LOS ANGELES RIVER ECOSYSTEM RESTORATION INTEGRATED FEASIBILITY REPORT: FINAL FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT/ENVIRONMENTAL IMPACT REPORT

COMMUNICATION

FROM

THE ASSISTANT SECRETARY OF THE ARMY, CIVIL WORKS, THE DEPARTMENT OF DEFENSE

TRANSMITTING

THE CORPS' LOS ANGELES RIVER ECOSYSTEM RESTORATION INTEGRATED FEASIBILITY REPORT: FINAL FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT/ENVIRONMENTAL IMPACT REPORT FOR SEPTEMBER 2015

PART 1 OF 2

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DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
CIVIL WORKS
108 ARMY PENTAGON
WASHINGTON DC 20310-0108

JAN -5 2017

Honorable Paul Ryan
Speaker of the House of Representatives
U.S. Capitol Building, Room H-232
Washington, DC 20510-0012

Dear Mr. Speaker:

Under the authority of section 4018(a) of the Water Resources Development Act of 2007, Public Law 110-114, 121 Stat. 1175-1176 and a resolution by the Senate Committee on Public Works approved June 25, 1969, requesting review of "the report of the Chief of Engineers on the Los Angeles and San Gabriel Rivers and Ballona Creek, California, published as House Document numbered 838, Seventy-sixth Congress, and other pertinent documents," the Secretary of the Army supports the authorization and construction of the Los Angeles River Ecosystem Restoration project in Los Angeles, California for the purpose of ecosystem restoration of the Los Angeles River. The proposal is described in the report of the Chief of Engineers, dated December 18, 2015. The Secretary of the Army plans to implement the project at the appropriate time, considering National priorities and the availability of funds. The Water Resources Development Act of 2016 (Public Law 114-322) authorized the recommended project in section 1401(7) and the recommended cost sharing is authorized by section 1402.

The project study was conducted to analyze and formulate aquatic ecosystem restoration improvements for an approximately 11-mile stretch of the Los Angeles River, from Griffith Park to Downtown Los Angeles, California. The non-Federal sponsor has voluntarily offered to forgo reimbursement for its costs that exceed the non-Federal statutory share of project costs. Upon request by the non-Federal sponsor, the U.S. Army Corps of Engineers (Corps) recommended and I granted an exception to policy on August 8, 2013, to allow the non-Federal sponsor to voluntarily forgo reimbursement for non-Federal lands, easements, relocations, rights-of-way, and disposal site (LERRDs) costs in excess of its statutory 35 percent share of the costs of ecosystem restoration. In May 2014, based on the request of the non-Federal sponsor for a Locally Preferred Plan (LPP), the Corps specifically requested an exception to policy to recommend the LPP and I granted this exception to policy. My determination was based upon the unique aspects of the project which permitted the Corps to also consider modified, increased cost sharing of the ecosystem restoration plan, with the continued policy of the non-Federal sponsor forgoing reimbursement or credit of LERRDs which may exceed 35 percent of the LPP.

The recommended plan is a deviation from the National Ecosystem Restoration (NER) Plan and is the LPP for ecosystem restoration with a corresponding recreation plan. The recreation features include trails and other features for passive recreation

that are compatible with the restored environment. The recommended plan as the LPP includes the same elements as the NER plan with additional restoration benefits at Verdugo Wash, the Los Angeles State Historic Park (Cornfields), and at the Los Angeles Trailer and Container Intermodal Facility site. These additional restoration benefits are substantial and include direct restoration of an additional 131 acres, for a total of 719 acres of restoration, and provision of a direct connection to the significant habitat areas of the Verdugo Mountains. The recommended plan includes the following elements:

a. Restoration of the riparian habitat corridor throughout the 11 miles; restoration of the Arroyo Seco confluence and the Verdugo Wash confluence; restoration of riparian habitat, the historic wash and its braided channels in the Los Angeles Trailer and Container Intermodal Facility site; restoration of freshwater marsh in the Los Angeles State Historic Park; restoration of riparian habitat and reconnection to the historic floodplain in Taylor Yard; and restoration of 13 minor tributaries through stream daylighting.

b. Removal of 0.75 miles of channel concrete and associated riverbed restoration.

c. Widening of the Los Angeles River and establishment of side channels.

d. Removal of invasive vegetation throughout the project area.

Over the last 150 years, the Los Angeles River has been degraded by development, flooding and channelization, including the Corps construction of the Los Angeles County Drainage Area (LACDA) flood risk management project that modified most of the Los Angeles River, with concrete banks and a mostly concrete bed to protect the city and surrounding areas from catastrophic flooding. The Flood Control Act of 1944 (Public Law 78-534) directed the Corps to construct the LACDA project which ultimately involved construction of five dams and over 240 miles of channels to protect communities from significant and recurring flood damages. Restoration of 11 miles of the Los Angeles River under this project is within the footprint of the existing flood risk management project. The ecosystem project would in part, reverse a portion of the degradation associated with the existing developmental pressures in an urban environment and the restoration activities would advance the goals of restoring the ecosystem and balancing revitalization with flood avoidance to ensure public safety for 11 miles of 51 miles of the Los Angeles River.

Based on October 2016 (Fiscal Year (FY) 2017) price levels, the estimated project first cost is $1,420,307,000. The estimated total project first cost for the aquatic ecosystem restoration features is $1,401,629,000 and the estimated total project first cost for the separable recreation features is $18,678,000. The total project first cost includes: $70,294,000 for pre-construction engineering and design (PED); $475,756,000 for construction of the ecosystem restoration features, $15,436,000 for construction of the recreation features, $31,511,000 for construction management, and $827,310,000 for LERRDs.

The City of Los Angeles is the non-Federal cost-sharing sponsor for all features. Operation, maintenance, repair, replacement, and rehabilitation expenses are estimated to be approximately $2,693,000 per year and are the responsibility of the non-Federal sponsor.

Based on FY 2017 price levels, a 2.875 percent discount rate, and a 50-year period of economic analysis, the total equivalent average annual costs of the ecosystem restoration features are estimated to be $57,577,000. The recommended plan is estimated to provide non-monetary restoration benefits of 6,782 average annual habitat units (AAHUs) across 719 acres. The NER Plan has an estimated total first cost for ecosystem restoration of $735,390,000 and provides restoration outputs of 5,989 AAHUs measured using the Combined Habitat Assessment Protocols approach. The recommended plan provides an increase of 793 AAHUs from the NER plan. The project area covers approximately 22 percent of the Los Angeles River where much of the riverine system has been heavily impacted by development and loss of aquatic ecosystem connectivity. Based on the anticipated restoration outputs throughout the project area, a considerable portion of the river ecosystem will experience notable improvements. The average annual costs of the recreation features are estimated to be $964,000. The average annual equivalent benefits are estimated to be $3,561,000. The average annual net benefits are $2,597,000. The benefit-to-cost ratio for the recreation features of the recommended plan is 3.69 to 1. The estimated total first cost of ecosystem restoration and recreation features combined for the LPP is $674,270,000 greater than the estimated cost of the NER Plan.

An environmental impact statement (EIS) and Record of Decision were prepared in accordance with the National Environmental Policy Act. The recommended plan has been identified as the environmentally preferred plan. Adverse environmental impacts have been avoided and minimized where practicable. No compensatory mitigation is required.

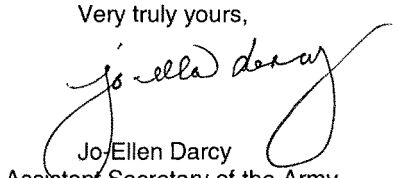
The Independent External Peer Review was completed by Battelle Memorial Institute. The review comments resulted in expanded narratives throughout the report to support the decision-making process and justify the recommended plan. All comments from the above referenced review have been addressed and incorporated into the final documents.

Having fully reviewed and taken into consideration the unique aspects of the project as described in the final feasibility report and EIS, the report of the Chief of Engineers, the concurrence by other Federal agencies in the plan, the city's willingness to limit the Federal government's exposure to LERRDs costs beyond 35 percent, and the non-Federal sponsor's offer to share equally in the costs of the LPP, I have concluded there is substantial Federal interest in the LPP. Equal cost sharing of the LPP, including the recreation features, between the Federal government and the non-Federal sponsor, as requested by the City of Los Angeles, would total $678,304,000 each. With the non-Federal sponsor voluntarily forgoing reimbursement of LERRDs costs above 35 percent

of the total project first costs, estimated at $280,158,300 and the non-Federal sponsor's responsibility to cover PED and construction management costs associated with relocations, estimated at $22,372,500, the Federal cost share is estimated at $375,773,200 and the non-Federal cost share (including LERRDs above 35 percent and relocation expenses), is estimated at $958,462,300 (which equates to 28% Federal and 72% non-Federal).

The Office of Management and Budget (OMB) advises that there is no objection to the submission of the report to Congress. A copy of OMB's letter, dated December 21, 2016, is enclosed. I am providing a copy of this transmittal and the OMB letter to the Subcommittee on Water Resources and Environment of the House Committee on Transportation and Infrastructure, and the Subcommittee on Energy and Water Development of the House Committee on Appropriations. I am also providing an identical letter to the President of the Senate.

Very truly yours,



Jo-Ellen Darcy
Assistant Secretary of the Army
(Civil Works)

Enclosures

Enclosures

1. Report of the Chief of Engineers, December 18, 2015
2. OMB Clearance Letter, December 21, 2016
3. Record of Decision, January, 3, 2017
4. Summary of State and Agency Review
5. Final Integrated Feasibility Report and Environmental Impact Statement, September 2015

DEPARTMENT OF THE ARMY
CHIEF OF ENGINEERS
2600 ARMY PENTAGON
WASHINGTON, D.C. 20310-2600

DAEN

DEC 1 8 2015

SUBJECT: Los Angeles River Ecosystem Restoration, Los Angeles, California

THE SECRETARY OF THE ARMY

1. I submit for transmission to Congress my report on ecosystem restoration in and along the Los Angeles River in Los Angeles, California. It is accompanied by the report of the district and division engineers. This report is in partial response to a resolution by the Senate Committee on Public Works approved 25 June 1969, requesting review of "the report of the Chief of Engineers on the Los Angeles and San Gabriel Rivers and Ballona Creek, California, published as House Document numbered 838, Seventy-sixth Congress, and other pertinent reports, with a view to determining whether any modifications contained therein are advisable at the present time, in the interest of providing optimum development of all water and related land resources in the Los Angeles County Drainage Area." Further authority is provided by Section 4018(a) of the Water Resources Development Act (WRDA) of 2007, Public Law 110-114, 121 Stat. 1175-1176, which provides authorization for a study "for environmental ecosystem restoration, flood risk management, recreation, and other aspects of Los Angeles River revitalization that is consistent with the goals of the Los Angeles River Revitalization Master Plan published by the city of Los Angeles...." The city of Los Angeles is the non-federal cost sharing sponsor for the project. Pre-construction engineering and design activities will be continued under the authority provided by the resolutions cited above.

2. The Los Angeles River is the 51-mile-long backbone of an 870-square-mile watershed. It once anchored a system of riparian and freshwater marsh habitat that carried seasonal rains and subterranean flows across the coastal plain to the Pacific Ocean. Over time, a cycle of urban development, flooding, and channelization has diminished aquatic and riparian habitat, reduced plant and wildlife diversity, and disconnected the river from its historic floodplain and nearby significant ecological zones. An 11-mile stretch of the river from Griffith Park to Downtown Los Angeles was identified as having the greatest potential for restoration.

3. The western cottonwood-willow forest association, a riparian ecosystem habitat type once prominent in the Los Angeles River, has been identified as one of the rarest forest types in North America, and one of most endangered ecosystems in the United States. The Los Angeles River study area is within a globally scarce Mediterranean ecosystem which is characterized by hot, dry summers and mild, wet winters and supports evergreen or drought deciduous shrublands and associated habitats. Over 90 percent of the riparian habitat and over 95 percent of the region's wetlands including freshwater marsh have been lost. Due to this large-scale habitat conversion, natural riparian communities persist only as isolated remnants of what was once a vast, interconnected system of rivers, streams, marshes, and vegetated washes. Although they occupy a very small area, these riparian ecosystems in the southwest are very important systems as they

support the majority of biodiversity in the region through their ecological and hydrologic connectivity. Approximately 80 percent of all wildlife uses the riparian ecosystem at some life stage, with more than 50 percent of bird species nesting primarily in riparian habitats. Restoration in the study area has the potential to create and improve habitat for select native fish species including the federally threatened Santa Ana sucker. In addition, the Los Angeles River was selected to be one of seven nationwide first-phase pilots for the Environmental Protection Agency's (EPA) Urban Waters Federal Partnership.

4. The reporting officers recommend a plan authorizing ecosystem restoration and recreation for an approximately 11-mile stretch of the Los Angeles River, from Griffith Park to Downtown Los Angeles, Los Angeles County, California. The recommended plan for ecosystem restoration includes restoration of habitat within 719 acres within and adjoining the river through the following measures and features:

- Riparian habitat corridor restoration throughout the 11 miles;
- Restoration of the Arroyo Seco confluence;
- Restoration of the Verdugo Wash confluence;
- Restoration of riparian habitat, the historic wash and its braided channels in the Los Angeles Trailer and Container intermodal facility site;
- Removal of channel concrete and riverbed restoration for 0.75 miles;
- Restoration of freshwater marsh in the Los Angeles State Historic Park;
- Restoration of riparian habitat and reconnection to the historic floodplain in Taylor Yard;
- River widening;
- Restoration of 13 minor tributaries through stream daylighting;
- Establishment of side channels; and
- Removal of invasive vegetation throughout the project area.

The restoration measures will substantially increase valley foothill riparian strand and freshwater marsh habitat, reestablish connectivity between the river and its historic floodplain, and restore habitat connections to significant habitat areas of the Santa Monica, Verdugo and San Gabriel Mountains. Monitoring and adaptive management of the environmental resources is required to ensure success of the project. The monitoring and adaptive management period will begin upon completion of construction of each feature and continue until ecological success criteria are met, but for no more than ten years. The recommended plan is a deviation from the National Ecosystem Restoration (NER) Plan and is the Locally Preferred Plan (LPP) for ecosystem restoration with a corresponding recreation plan. The recreation features include trails and other features for passive recreation that are compatible with the restored environment.

5. The LPP is greater in cost and scope than the NER Plan. Based upon October 2015 price levels, the NER Plan has an estimated total first cost for ecosystem restoration of $694,114,000 and provides restoration outputs of 5,989 average annual habitat units (AAHUs) measured using the Combined Habitat Assessment Protocols (CHAP) approach. The LPP has an estimated total first cost for ecosystem restoration of $1,338,554,000 and provides restoration outputs of 6,782

AAHUs. In addition to ecosystem restoration, the recommended LPP includes approximately $18,054,000 for recreation, for an estimated total first cost of $1,356,608,000. The non-federal sponsor would be responsible for the operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) of the respective ecosystem restoration and recreation features after construction, a cost currently estimated $2,530,000 on an average annual basis.

6. The non-federal sponsor has voluntarily offered to forgo reimbursement for its costs that exceed the non-federal statutory share of project costs. Upon request by the non-federal sponsor, the U.S. Army Corps of Engineers (Corps) recommended and the Assistant Secretary of the Army for Civil Works (ASA(CW)) granted an exception to policy in 2013 to allow the non-federal sponsor to voluntarily forgo reimbursement for non-federal real estate costs in excess of its statutory 35 percent share of the costs of ecosystem restoration. In 2014, based on the request of the non-federal sponsor for an LPP, the Corps specifically requested an exception to policy to recommend the LPP and the ASA(CW) granted this exception to policy. Furthermore, the ASA(CW), citing the unique aspects of the project, permitted the Corps to also consider modified, increased cost sharing of the ecosystem restoration plan, with the continued policy of the non-federal sponsor forgoing reimbursement or credit of lands, easements, rights of way, relocations, and disposal sites (LERRD) which may exceed 35 percent of the LPP.

7. I am recommending federal cost sharing of the LPP, with a 50 percent cost share, modified by the credit limit of 35 percent of ecosystem restoration costs for the value of LERRD provided by the non-federal sponsor, and by the non-federal sponsor's forgoing of reimbursement for LERRD value that may exceed 35 percent of ecosystem restoration costs.

8 The estimated total first cost for the recommended LPP, including recreation is $1,356,608,000. The recreation features have an estimated first cost of $18,054,000, with the federal and non-federal shares estimated at $9,027,000 and $9,027,000 respectively. The first cost for the ecosystem portion of the LPP is currently estimated to be $1,338,554,000, which includes $567,529,000 for design and construction of ecosystem restoration features, and $771,025,000 for LERRD. Equal cost sharing of the ecosystem restoration portion of the LPP between the federal government and the non-federal sponsor would total $669,277,000 each. The non-federal credit for LERRD is limited to 35% of the LPP ecosystem restoration cost, or $468,494,000. The sponsor is required to provide funding for the balance of the non-federal share above this amount, currently estimated to be $200,783,000. The result of this requirement is an estimated non-federal share of project costs of $971,808,000 and a federal share of project costs of $366,746,000 for the ecosystem portion of the LPP. The federal share of the total LPP cost of $1,356,608,000 is estimated at $375,773,000, or 28 percent of the total, and the overall non-federal share is estimated at $980,835,000, or 72 percent of the total.

9. Based on a 3.125 percent discount rate and a 50-year period of analysis, the total average annual costs of the project is estimated to be $58,647,000, with $57,703,000 for the ecosystem restoration purpose and $944,000 for the recreation purpose. Ecosystem restoration benefits for the selected plan include generating an estimated 6,782 AAHUs and restoring 719 acres.

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SUBJECT: Los Angeles River Ecosystem Restoration, Los Angeles, California

Average annual recreation benefits are estimated to be $3,510,000, with net average annual benefits of $2,566,000 and a benefit/cost ratio of 3.72.

10. The recommended plan was formulated and developed in coordination and consultation with various federal, state and local agencies to restore the ecosystem in and along the 11-mile stretch of the river within project constraints. Study formulation looked at a wide range of structural and non-structural alternatives. The study was conducted using a watershed perspective to examine ecosystem changes and connections within the watershed. CHAP and our cost effectiveness and incremental cost analysis techniques were used to formulate and evaluate restoration solutions. Goals and objectives included in the Environmental Operating Principles and the Campaign Plan of the Corps have been integrated into the Los Angeles River ecosystem restoration study process. The recommended plan would have substantial beneficial impacts for biological, water, aesthetic, and recreation resources and for environmental justice. The recommended plan would result in unavoidable significant adverse impacts to existing land use designations by converting land currently used for industrial purposes to riparian habitat.

11. The project would modify features of an existing federal project, the Los Angeles County Drainage Area (LACDA) project, authorized by the Flood Control Acts of 1936, 1938, and 1941, as amended. The modifications to this project will not impair the purposes for which it was authorized or the benefits it currently provides. The recommended plan is not currently estimated to result in an incremental increase in Corps OMRR&R costs for the existing LACDA project maintenance activities. Sea level rise is not expected to directly affect this project.

12. In accordance with Corps Engineer Circular (EC) 1165-2-214 (12 December 2012) on review of decision documents, all technical, engineering and scientific work underwent an open, dynamic and rigorous review process to ensure technical quality. This included District Quality Control (DQC), Division Quality Assurance (DQA) reviews, Agency Technical Review (ATR), an Independent External Peer Review (IEPR) (Type I), Cost Engineering Review and Certification, policy and legal compliance review, and model review and approval. All concerns of the ATR have been addressed and incorporated in the final report. The IEPR was completed by Battelle Memorial Institute. Battelle selected and managed an IEPR panel of experts with technical expertise in arid region riverine system ecology, socioeconomics, hydrologic and hydraulic (H&H) modeling, and geotechnical engineering. A total of 18 comments were documented. In summary, the panel felt that the engineering, economics and environmental analysis were adequate. However, following public review of the draft feasibility report, the panel recommended additional connectivity analysis be conducted and documented in the final report. The IEPR review comments and the recommended connectivity analysis did not result in significant changes to the plan formulation, engineering assumptions, and environmental analyses that supported the decision-making process and plan selection. All comments from the above referenced reviews have been addressed and incorporated in the final documents. Overall, the reviews resulted in improvement to the technical quality of the report. Since the project would modify features of the LACDA, which has associated levees, a safety assurance review (Type II IEPR) will be conducted during the design and construction phase of the project.

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13. Washington-level review indicates that the project recommended by the reporting officers is technically sound, environmentally and socially acceptable, and economically justified. The plan complies with all essential elements of the U.S. Water Resources Council's 1983 Economic and Environmental Principles and Guidelines for Water and Land Related Resources Implementation Studies and complies with other administrative and legislative policies and guidelines. The views of interested parties, including federal, state, and local agencies have been considered. State and agency comments received during review of the final report and environmental impact report primarily expressed support for the project and appreciation for addressing previous comments.

14. I concur with the findings, conclusions, and recommendations of the reporting officers. Accordingly, I recommend that the plan for ecosystem restoration and recreation for the Los Angeles River, California, be authorized at an estimated project first cost of $1,356,608,000 with such modifications as in the discretion of the Chief of Engineers may be advisable. This recommendation is consistent with applicable requirements of federal laws and policies, except with regard to the cost sharing of the ecosystem restoration features. The cost sharing that I have recommended departs from that required by Section 103 of WRDA 1986, as amended (33 U.S.C. 2213). Therefore, implementation of my recommendation will require the enactment of express statutory language authorizing cost sharing that deviates from Section 103. In making this recommendation, I have carefully considered the unique aspects of the project. Federal implementation of the recommended project also would be subject to the non-federal sponsor agreeing to comply with all applicable federal laws and policies, including, but not limited to, the following:

a. Provide a minimum of 50 percent of total LPP costs as further specified below:

1. Provide 35 percent of design costs in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;

2. Provide all LERRD determined by the government to be necessary for construction, operation, and maintenance of the project, and provide relocation assistance, all in compliance with applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended (42 U.S.C. 4601-4655), and the regulations contained in 49 C.F.R. Part 24;

3. Provide, during construction, a contribution of funds necessary to make its total contribution of ecosystem restoration costs equal to 50 percent, where credit for LERRD is limited to 35 percent of the total ecosystem restoration cost;

4. Provide, during construction, a contribution of funds necessary to make its contribution of recreation costs equal to 50 percent;

5. Provide, during construction, 100 percent of excess recreation costs in the event that the federal share of total recreation costs exceeds 10 percent of the federal share of total ecosystem restoration costs;

b. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the outputs produced by the ecosystem restoration features, hinder operation and maintenance of the project, or interfere with the project's proper function;

c. Shall not use the ecosystem restoration features or lands, easements, and rights-of-way required for such features as a wetlands bank or mitigation credit for any other project;

d. Keep the recreation features, and access roads, parking areas, and other associated public use facilities, open and available to all on equal terms;

e. For so long as the project remains authorized, operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, including any mitigation features, at no cost to the government, in a manner compatible with the project's authorized purposes and in accordance with applicable federal and state laws and regulations and any specific directions prescribed by the government;

f. Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, rehabilitation, and replacement of the project and any betterments, except for damages due to the fault or negligence of the United States or its contractors;

g. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended (42 U.S.C. 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the government determines to be required for construction, operation, and maintenance of the project. However, for lands that the government determines to be subject to the navigation servitude, only the government shall perform such investigations unless the government provides the non-federal sponsor with prior specific written direction, in which case the non-federal sponsor shall perform such investigations in accordance with such written direction;

h. Assume, as between the government and the non-federal sponsor, complete financial responsibility for all necessary remediation and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way that the government determines to be required for construction, operation, and maintenance of the project; and

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i. Agree, as between the government and the non-federal sponsor, that the non-federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, rehabilitate, and replace the project in a manner that will not cause liability to arise under CERCLA.

15. The recommendation contained herein reflects the information available at this time and current departmental policies governing formulation of individual projects. It does not reflect program and budgeting priorities inherent in the formulation of a national civil works construction program or the perspective of higher review levels within the executive branch. Consequently, the recommendation may be modified before it is transmitted to the Congress as a proposal for authorization and implementation funding. However, prior to transmittal to Congress, the non-federal sponsor, the state, interested federal agencies, and other parties will be advised of any significant modifications and will be afforded an opportunity to comment further.

THOMAS P. BOSTICK
Lieutenant General, USA
Chief of Engineers

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

December 21, 2016

The Honorable Jo-Ellen Darcy
Assistant Secretary of the Army (Civil Works)
108 Army Pentagon
Washington, DC 20310-0108

Dear Ms. Darcy:

As required by Executive Order 12322, the Office of Management and Budget has completed its review of your recommendation for the Los Angeles River Ecosystem Restoration project, Los Angeles, California. The Congress authorized this project for construction in Public Law 114-322.

The Office of Management and Budget appreciates the commitment of the City of Los Angeles to sustainability and environmental stewardship and its engagement with the Administration on these efforts. Further, the City has demonstrated strong support of this project as shown by its willingness to fully fund the lands, easements, rights-of-way, relocations, and dredged material disposal areas costs. The proposed plan is designed to benefit a rare ecosystem by repairing some of its degradation caused in part by past Corps activities, but the proposal is not designed to restore the full functionality of the ecological, hydrologic, and geomorphic functions and processes that affect watershed condition.

The proposed project may provide additional benefits that the report does not fully identify or quantify. We encourage the Corps to continue its work to develop a methodology to evaluate ecosystem services, including in urban settings, so that such benefits can be measured and taken into consideration in evaluating proposed projects and the overall performance of the Corps aquatic ecosystem restoration program.

The Office of Management and Budget does not object to your sending this report to the Congress. When you do so, please advise the Congress that this project, like all other Corps projects, would need to compete with other proposed investments in future budgets.

Sincerely,

John Pasquantino
Deputy Associate Director
Energy, Science, and Water

RECORD OF DECISION

LOS ANGELES RIVER ECOSYSTEM RESTORATION
LOS ANGELES, CALIFORNIA

The Final Integrated Feasibility Report and Environmental Impact Statement (IFR/EIS) dated September 2015, for the Los Angeles River Ecosystem Restoration project addresses opportunities for restoration of the Los Angeles River, Los Angeles, California. The final recommendation is contained in the report of the Chief of Engineers, dated December 18, 2015. Based on these reports, the reviews of other Federal, State, and local agencies, input from the public, and the review of my staff, I find that the plan recommended by the Chief of Engineers is technically feasible, environmentally justified, cost-effective, in accordance with environmental statutes, and in the public interest.

The final IFR/EIS, incorporated herein by reference, evaluated various alternatives that would restore riparian and floodplain habitat within the study area. The recommended plan is the locally preferred plan (LPP) which restores 719 acres, generates 6782 average annual habitat units (AAHUs), and includes:

- Restoration of the riparian habitat corridor throughout 11 miles of the optimal reach of the Los Angeles River; restoration of the Arroyo Seco confluence and the Verdugo Wash confluence; restoration of riparian habitat, the historic wash and its braided channels in the Los Angeles Trailer and Container Intermodal Facility site; restoration of freshwater marsh in the Los Angeles State Historic Park; restoration of riparian habitat and reconnection to the historic floodplain in Taylor Yard; and restoration of 13 minor tributaries through stream daylighting;
- Removal of 0.75 miles of channel concrete and associated riverbed restoration;
- Widening of the Los Angeles River and establishment of side channels;
- Removal of invasive vegetation throughout the project area;
- Implementation of separable recreation features including over nine miles of unpaved and paved trails, two bridges spanning the river, five bridges within other restored areas, parking lots, restrooms, 28 trail access points throughout the study area, 11 wildlife viewing points, and seven pedestrian underpasses along the river and adjacent project lands to support trail connectivity; and
- Implementation of a monitoring and adaptive management plan that provides for monitoring and adaptive management until ecological success criteria are met, for no more than ten years.

In addition to a "no action" plan, four alternatives were evaluated in the draft IFR/EIS, and the final IFR/EIS evaluated these alternatives as well as an additional variation. Each action alternative included a different configuration and amount of restoration within the 11-mile study area, ranging from a total of 528 to 719 acres that would benefit from restoration measures. Alternative 13v was identified as the National Ecosystem Restoration (NER) plan. Alternative 20, the LPP, was selected as the recommended plan as this alternative would realize significant increased benefits over the NER plan, including additional restoration benefits at the Verdugo Wash confluence and at and adjacent to the Los Angeles Trailer and Container Intermodal Facility site. The additional restoration benefits are substantial and include direct restoration of an additional 121 acres, for a total of 719 acres of restoration, generation of an additional 793

AAHUs from the NER plan, and provision of a direct connection to the significant habitat areas of the Verdugo Mountains. The recommended plan is the environmentally preferred alternative.

All practicable means to avoid and/or minimize environmental impacts are included in the recommended plan. Best management practices (BMPs) as detailed in the final IFR/EIS will be implemented to minimize impacts. No compensatory mitigation is required.

Pursuant to section 7 of the Endangered Species Act of 1973, as amended, the U.S. Army Corps of Engineers determined that the recommended plan will have no effect on federally listed species or their designated critical habitat.

Pursuant to section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended, the U.S. Army Corps of Engineers (Corps) determined that the recommended plan has the potential to cause effects to properties that are either included or eligible for inclusion on the National Register of Historic Places. In order to avoid and minimize impacts to these resources to the extent practicable and consistent with the requirements of section 106 of the NHPA, the Corps entered into a programmatic agreement with the California State Historic Preservation Office dated July 2, 2015. The programmatic agreement will be implemented in its entirety.

Pursuant to the Clean Water Act of 1972, as amended, any discharge of dredged or fill material associated with the recommended plan has been found to be compliant with section 404(b)(1) Guidelines (40 CFR 230). The final Clean Water Act section 404(b)(1) evaluation, Appendix A of the final IFR/EIS, is attached to this Record of Decision and incorporated by reference. A water quality certification pursuant to section 401 of the Clean Water Act will be obtained from the State of California's Regional Water Quality Control Board (RWQCB). The RWQCB stated their support of the project in a letter dated November 18, 2015. All conditions of the water quality certification will be implemented in order to minimize adverse impacts to water quality.

Public review of the draft IFR/EIS was completed on November 26, 2013. All comments from the public are addressed in the final IFR/EIS. A 30-day waiting period and state and agency review of the final IFR/EIS was completed on November 2, 2015. Comments from state and federal agencies did not result in any changes to the final IFR/EIS.

Technical, environmental, economic and cost-effective criteria used in the formulation of alternative plans were those specified in the Water Resource Council's 1983 Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies. All applicable laws, executive orders, regulations, and guidelines were considered in evaluating alternatives. Based on review of these evaluations, I find that the recommended plan reasonably maximizes ecosystem restoration benefits compared to costs and any adverse effects. This Record of Decision completes the National Environmental Policy Act process.

Jan. 3, 2017
Date

Jo-Ellen Darcy
Assistant Secretary of the Army
(Civil Works)

Attachment:

1. Los Angeles River Ecosystem Restoration Project, Appendix A Final Clean Water Section 404(b)(1) Evaluation, December 2015

US Army Corps
Of Engineers®
Los Angeles District

Los Angeles River Ecosystem Restoration Project

Appendix A
Final Clean Water Section 404(b)(1) Evaluation

December 2015

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Final Clean Water Act Section 404(b)(1) Evaluation

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1.0 Clean Water Act Section 404(b)(1) Regulatory Background

Section 404 of the Clean Water Act (CWA) governs the discharge of dredged or fill material into waters of the U.S. Although the Corps does not process and issue permits for its own activities, the Corps authorizes its own discharges of dredged or fill material by applying all applicable substantive legal requirements, including application of the Section 404(b)(1) Guidelines, 33 C.F.R. 336.1(a).

Under the Section 404(b)(1) Guidelines, an analysis of practicable alternatives is the primary tool used to determine whether a proposed discharge is prohibited. The Section 404(b)(1) Guidelines prohibit discharges of dredged or fill material into waters of the U.S. if a practicable alternative to the proposed discharge exists that would have less adverse impacts on the aquatic ecosystem, including wetlands, as long as the alternative does not have other significant adverse environmental impacts (40 C.F.R. 230.10(a)). An alternative is considered practicable if it is available and capable of being implemented after considering cost, existing technology, and logistics in light of overall project purpose (40 C.F.R. 230.10(a)(2)). The Section 404(b)(1) Guidelines follow a sequential approach to project planning that considers mitigation measures only after the project proponent shows no practicable alternatives are available to achieve the overall project purpose with less environmental impacts. Once it is determined that no practicable alternatives are available, the guidelines then require that appropriate and practicable steps be taken to minimize potential adverse effects on the aquatic ecosystem (40 C.F.R. 230.10(d)). Such steps may include actions controlling discharge location, material to be discharged, the fate of material after discharge or method of dispersion, and actions related to technology, plant and animal populations, or human use (40 C.F.R. 230.70-230.77).

Beyond the requirement for demonstrating that no practicable alternatives to the proposed discharge exist, the Section 404(b)(1) Guidelines also require the Corps to compile findings related to the environmental impacts of discharge of dredged or fill material. The Corps must make findings concerning the anticipated changes caused by the discharge to the physical and chemical substrate and to the biological and human use characteristics of the discharge site.

These guidelines also indicate that the level of effort associated with the preparation of the alternatives analysis be commensurate with the significance of the impact and/or discharge activity (40 C.F.R. 230.6(b)).

2.0 Basic and Overall Project Purpose

2.1 Basic Project Purpose

The basic project purpose comprises the fundamental, essential, or irreducible purpose of the proposed project, and is used by the Corps to determine whether a project is water dependent. The Section 404(b)(1) Guidelines state that if an activity associated with the discharge proposed for a special aquatic site does not require access or proximity to, or siting within, the special aquatic site in question to fulfill its basic purpose, the activity is not water-dependent.

The basic project purpose is aquatic ecosystem restoration. The activity is water dependent. See Section 5.5 of the Integrated Feasibility Report (IFR) for in-water construction required for all action alternatives.

2.2 Overall Project Purpose

The overall project purpose serves as the basis for the Corps' section 404(b)(1) alternatives analysis and is determined by further defining the basic project purpose in a manner that more specifically describes the goals and accounts for logistical considerations for the project, and which allows a reasonable range of alternatives to be analyzed. It is critical that the overall project purpose be defined to provide for a meaningful evaluation of alternatives. It should not be so narrowly defined as to give undue deference to the preferred alternative, thereby unreasonably limiting the consideration of alternatives. Conversely, it should not be so broadly defined as to render the evaluation unreasonable and meaningless.

As indicated in Section 1.1.1 of the IFR, the overall project purpose is to restore approximately 11 miles of the Los Angeles River (River) from Griffith Park to downtown Los Angeles by reestablishing riparian strand, freshwater marsh, and aquatic habitat communities and reconnecting the River to major tributaries, its historic floodplain, and the regional habitat zones of the Santa Monica, San Gabriel, and Verdugo mountain ranges while maintaining existing levels of flood risk management.

There is a secondary objective of the project to provide passive recreational opportunities consistent with the restored ecosystem, which is considered incidental to the overall project purpose and therefore not part of the overall project purpose under the CWA. There are no impacts to waters of the U.S. associated with recreation features corresponding to the restoration alternatives.

2.3 Study Area Description

There are eight geomorphically different reaches within the study area as shown in Figure 1 (see Section 2.2 of the IFR for additional information). They were defined based on the physical characteristics of channel morphology, bank characteristics, soil exposure, existing habitat, and surrounding land uses. Specific geomorphic criteria include: (1) channel bed type (either soft bed with groundwater/surface water exchange, or concrete), (2) side slope type (vertical or trapezoidal), and (3) adjacent land uses or open space. The reaches are described as follows:

- **Reach 1**: Reach 1 is the upstream segment of the study area and is approximately 1.5 river miles in length. In this reach the River's channel has a rectangular concrete-lined configuration with subdrains and no low flow channel.
- **Reach 2**: Reach 2 is approximately 0.75 mile in length. The bed transitions from concrete-lined to a cobblestone bed, and then transitions back to concrete. The channel has a trapezoidal configuration with grouted derrick stone banks. The banks are toed-down (secured by extending the bank wall below the River bed) with sheet pile and quarry run stone.
- **Reach 3**: This reach is approximately 1 mile in length. From upstream to downstream, the bed transitions from cobbles to concrete and back to cobbles. The channel in this area has a rectangular concrete configuration.
- **Reach 4**: This reach is approximately 1.75 miles long. The bed transitions from a concrete-lined rectangular channel to a trapezoidal channel with a cobble bed and grouted derrick stone banks. Banks are toed-down with sheet pile and quarry run stone. Sediment deposited in the channel has formed sand bars/islands, which are stabilized by the root systems of the many trees and other vegetation.
- **Reach 5**: This reach is approximately 1.55 miles long. The bed transitions from concrete under each of the large bridges to a trapezoidal channel with a cobblestone bed and grouted derrick stone banks between the bridges. Banks are toed-down with sheet pile and quarry run stone. Sediment deposited in the channel has formed sand bars/islands, which have stabilized as the root systems of the many trees and other vegetation have trapped sediment.
- **Reach 6**: This reach is approximately 2.34 miles long. From upstream to downstream, the bed transitions from cobblestone to concrete-lined. Here, the channel is in a trapezoidal configuration with a cobble bed and grouted derrick stone banks. The banks are toed-down with sheet pile and quarry run stone. Sediment deposited in the channel has formed sand bars/islands, which have become stabilized as the root systems of the many trees and other vegetation have trapped sediment.
- **Reach 7**: This reach is approximately 1-mile-long. The channel in this area transitions out of the rectangular concrete channel at the Arroyo Seco confluence, and becomes a trapezoidal concrete channel that is approximately 30 feet deep.
- **Reach 8**: This approximately 1-mile-long reach is a trapezoidal concrete channel approximately 30 feet deep.

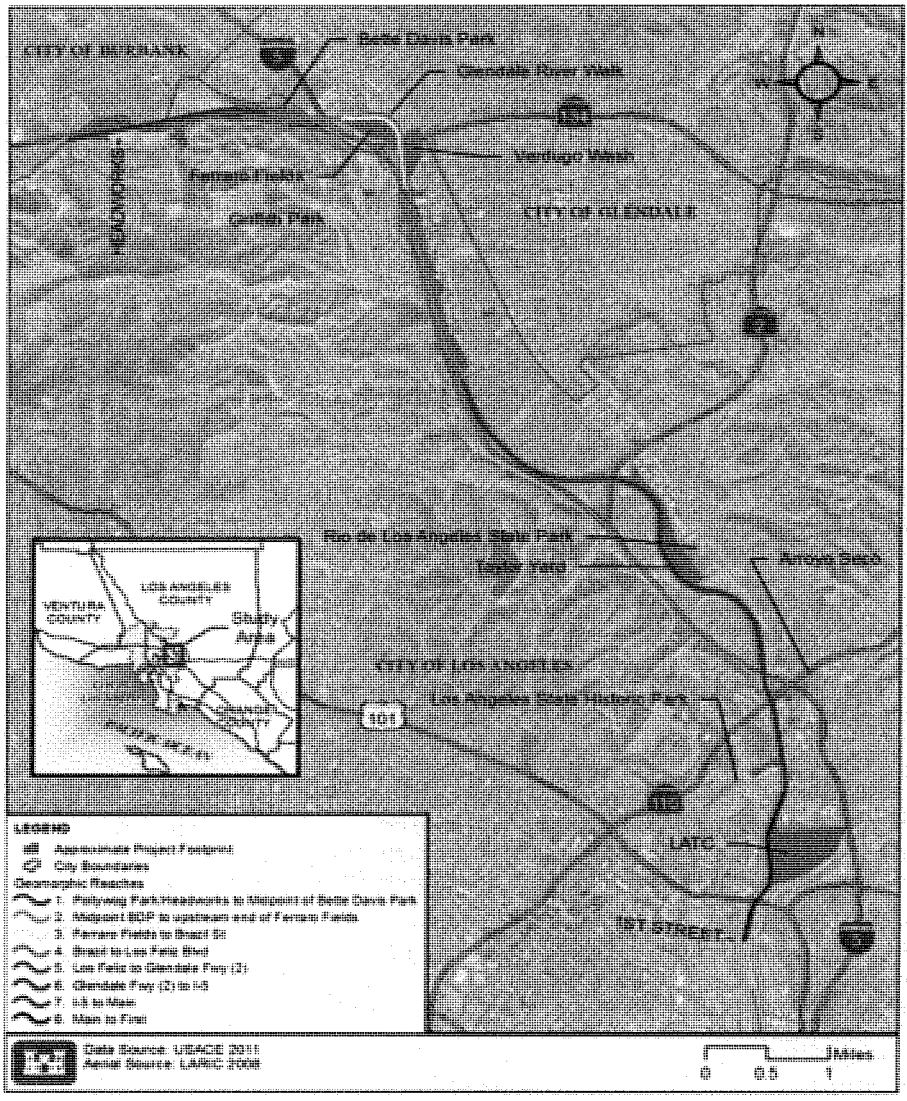

Figure 1: Study Area Reaches

2.4 Jurisdictional Determination of Waters of the U.S.

The study area encompasses 11 miles of the River and approximately 1,500 feet of the lower reaches of Verdugo Wash, Arroyo Seco Channel, and Burbank Western Channel.

Los Angeles River

In the 2010 Special Case Evaluation Regarding Status of the River, the U.S. Environmental Protection Agency documented the historical and current navigability of the River and deemed the River to be a Traditional Navigable Water (TNW), a water of the U.S. pursuant to 33 C.F.R. 328.3(a)(1).

In the absence of adjacent wetlands, jurisdictional limits in non-tidal waters of the U.S. extend to the ordinary high water mark (OHWM). When adjacent wetlands are present, jurisdiction extends beyond the OHWM to the limit of the adjacent wetlands. No adjacent wetlands were identified in the River study area. Wetlands within the non-concrete bottom portions of the River are located on sand banks and are variable, prone to changes in size and location depending on the severity of storm flows.

OHWM within the River was established by examining debris lines deposited on the trapezoidal embankments during and after storm flows. Based on a conservative interpretation of physical evidence, the OHWM is halfway up the embankment.

Arroyo Seco,Verdugo Wash, Burbank Western Channel

Per the 2008 joint U.S. Environmental Protection Agency-Department of the Army guidance implementing the Supreme Court's decision in the consolidated cases Rapanos v. United States and Carabell v. United States which address the jurisdiction over waters of the U.S. under the CWA, the agencies will assert jurisdiction over relatively permanent non-navigable tributaries of TNWs. A non-navigable tributary of a TNW is a non-navigable water body whose waters flow into a TNW either directly or indirectly by means of other tributaries. Non-navigable tributaries of TNWs are relatively permanent where the tributaries typically flow year-round or have continuous flow at least seasonally (e.g., typically three months). Relatively permanent waters do not include ephemeral tributaries which flow only in response to precipitation and intermittent streams which do not typically flow year-round or have continuous flow at least seasonally.

The Arroyo Seco Channel is a direct tributary to the River. Due to a high ground water table in unlined reaches as well as nuisance flows and runoff from golf courses, daily base flow ranges from 0.25-1 cubic feet per second (cfs). As such, flows are perennial. Arroyo Seco Channel is therefore a relatively permanent non-navigable tributary of a TNW, and a jurisdictional water of the U.S. pursuant to 33 C.F.R. 328.3(a)(5). No adjacent wetlands were identified. OHWM was established by examining the extent of concrete stains on the vertical wall. Based on the physical evidence, the OHWM is halfway up the vertical walls.

Verdugo Wash is a relatively permanent non-navigable tributary of a TNW. The wash is a direct tributary to the River, draining an urbanized area within the City of Glendale as well as the Verdugo Hills. Due to nuisance flows and runoff from golf courses, daily base flow ranges from 1-3 cfs. As such, flows are perennial. Verdugo Wash is therefore a relatively permanent non-navigable tributary of a TNW, and a jurisdictional water of the U.S. pursuant to 33 C.F.R.

328.3(a)(5). No adjacent wetlands were identified. Examination of available photographs does not indicate presence of concrete stains or other physical evidence of OHWM. Thus, based on the available evidence at Arroyo Seco, the OHWM is assumed to be halfway up the vertical walls.

The Burbank Western Channel is a relatively permanent non-navigable tributary of a TNW. The channel is a direct tributary to the River, draining an urbanized area within the City of Burbank as well as the Verdugo Hills. Daily base flow averages at approximately 10 cfs. As such, flows are perennial. Burbank Western Channel is therefore a relatively permanent non-navigable tributary of a TNW, and a jurisdictional water of the U.S. pursuant to 33 C.F.R. 328.3(a)(5). No adjacent wetlands were identified. Examination of available photographs does not indicate presence of concrete stains or other physical evidence of OHWM. Based on the available evidence at Arroyo Seco, the OHWM is assumed to be halfway up the vertical walls.

3.0 Alternatives Considered

3.1 Management Measures and Associated Discharges of Fill

Alternatives were formulated from a combination of management measures. See Chapter 4 of the IFR for additional information. This section describes the management measures and qualitatively characterizes the anticipated discharges of fill material associated with each management measure.

Daylight Streams

This management measure entails excavation of currently enclosed drainages in the historic floodplain of the River. Once excavated, the drainages would be naturalized in areas within the vicinity of their respective confluences with the River. Many of the enclosed drainages convey storm flows from the uplands into the River through existing storm water outfalls. Materials to be excavated/removed from the drainages include, but are not limited to, corrugated metal pipes and reinforced concrete boxes. Once excavated, the drainages would be graded, contoured, and planted with native riparian vegetation. In some cases, storm drains that are not being daylighted (naturalized) may need to be reconfigured or new outfalls constructed, due to other restoration work occurring in the vicinity. These activities may also result in discharges of fill material. Discharges of fill material into existing waters of the U.S. for all storm drain modification activities would entail placement of concrete for new outfalls, and would entail like-for-like replacement of existing outfalls. Temporary discharges of fill material would include potential placement of dewatering structures within the invert in the area of the outfalls.

Widen River and Tributaries

This management measure entails excavation of uplands behind the existing embankment, construction of a new embankment in the uplands, and removal of the existing embankment of the River, Verdugo Wash, or Arroyo Seco. The activity would require discharge of native substrate associated with grading in the vicinity of the existing embankment as well as temporary discharges of fill material for dewatering structures, such as k-rails, to divert water around the work area during construction; establishment of access ramps; and establishment of staging areas.

Creation of Side Channels

This management measure entails the excavation of new drainages in the uplands parallel to the River. Once excavated, the drainages would be graded, contoured, and planted with native riparian vegetation. The principal sources of hydrology could be storm water or existing flows from the River. Discharges of fill material into existing waters of the U.S. would be limited to discharges of fill material associated with the construction or reconstruction of concrete outfalls or construction of intake structures in the River. In many cases, the discharges would entail like-for-like replacements.

Vegetated Channel Walls

This management measure supplements the existing riparian vegetation in the River by attaching turf reinforcement mat, a pre-seeded turf matrix, to the existing sloped embankments of the River. The portion of the turf laid upon the sloped embankments would be anchored with

fasteners. The portion of the turf within the invert would be anchored with engineered rock keys. The work would also require the temporary discharges of fill material for dewatering structures, such as k-rails, to divert water around the work area during construction; establishment of access ramps; and establishment of staging areas.

Modify Channel Banks

This management measure would remove a portion of the upper sloped embankments of the River to create a two-tiered sloped embankment profile. It would include excavation to create basins or terraces that tie into the channel and adjacent topography. These modifications would have slopes at a 3 to 1 transition ratio or more gradual and be interspersed with freshwater marsh (retention basins) and riparian vegetation. In other cases, the trapezoidal embankments of the River would be replaced with a vertical wall to widen the channel. The work would also require the temporary discharge of dewatering structures, such as k-rails, to divert water around the work area during construction.

3.2 Alternatives and Impacts to Waters of the U.S.

The IFR evaluated an array of alternatives in Chapter 4. A number of alternatives were deemed impracticable due to costs while one would not have met the overall project purpose. Due to the need to maintain existing flood risk levels, several alternatives incorporated tunnels to divert flood flows around the study area. These alternatives were determined to be impracticable due to the approximately $1.5 billion cost of tunneling (see Section 4.10 of the IFR). Another alternative that would have widened the channel width by 3 to 5 times to accommodate a natural riparian river system was determined to be impracticable due to the approximately $7.6 billion real estate acquisition cost (see Section 4.10.1 of the IFR). One alternative limiting the ecosystem restoration to the Los Angeles County Drainage Area (LACDA) right-of-way (i.e., channel and bicycle paths) would not meet the overall project purpose (see Section 4.10.1 of the IFR). Chapter 4 of the IFR provides complete descriptions of these alternatives as well as discussions of alternatives considered but not carried forward for further analysis.

Subsequent to the application of measures to screen alternatives, four action alternatives (Alternatives 10, 13, 16, and 20) as well as the No Federal Action Alternative were further evaluated in the IFR, constituting a reasonable range of alternatives. Furthermore, after additional economic analysis, a more cost effective variation was identified for one alternative; this variation alternative, known as Alternative 13v, is identical to Alternative 13 except in Reach 7, where it includes restoration measures in Reach 7 identical to those proposed under Alternative 20. Specifically, the Reach 7 plan in Alternative 20 includes the three daylighted streams in the Reach 7 plan from Alternative 10, the Arroyo Seco softening and backwater wetland creation from Alternative 13, and adds restoration of wetland habitat at the Los Angeles State Historic Park (LASHP) along with terracing of the right bank of the channel adjacent to the LASHP.

No Federal Action

Under the No Federal Action alternative, none of the proposed management measures would be implemented. The Corps would continue to maintain the channel for flood risk management purposes, but would not seek to restore habitat values. There would be no impacts to wetlands or

other waters of the U.S. from restoration activities as none would occur. Channel maintenance activities would continue to include vegetation and sediment removal as funding allows.

Alternative 10

Alternative 10 is called the ART (for ARBOR Riparian Transitions) as it provides some restoration in all reaches and provides transitions or connections between existing riparian corridors and concrete lined river reaches. In Reach 1, it establishes riparian corridors along the overbanks of both sides of the River channel, improving potential wildlife connections from the river to the Headworks study site and the Santa Monica Mountains. It also restores riparian habitat at the Pollywog Park Area of Griffith Park and along the left overbank of the Burbank Western Channel. In Reach 2, the plan continues the establishment of the riparian corridor along the overbank on both sides of the River, with habitat connections to the Santa Monica Mountains. In Reach 3, it continues the riparian corridor on the right side of the River along Zoo Drive and daylights and restores riparian and freshwater marsh habitat at three streams currently encased in culverts, two on the east side of the River and one on the west side. In Reach 4, it establishes a riparian corridor on the left overbank, creates a side channel at the edge of Griffith Park Golf Course with inlet and outlet to the River under I-5 on the right bank, lowers a portion of the Los Feliz Golf Course on the left bank of the River to allow seasonal flooding through existing culverts, and daylights eight streams. In Reach 5, this alternative continues the riparian corridor on the left overbank and includes a daylighted stream at the downstream end. In Reach 6, it widens the channel approximately 80 feet along Taylor Yard, restores riparian habitat in the widened area and overbank, and creates a small terraced area in the Bowtie parcel. Restoration is continued in Reach 7 with three daylighted streams. In Reach 8, at the LATC site, it restores a historic wash and riparian habitat. This restoration would allow flows from the ephemeral wash to enter the River through existing culverts under the railroad lines. In addition to the specific features outlined above, this alternative removes invasive vegetation throughout the restoration features and within the River and tributary channel bottom throughout the project footprint. Table 3-1 below details measures that either fill waters of the U.S. or create new waters of the U.S. In total, Alternative 10 would discharge fill material into approximately 4.63 acres of waters of the U.S. Permanent fill material would be discharged into 4.52 acres. Dewatering structures would temporarily discharge fill material into 0.11 acre. Alternative 10 would establish approximately 56 acres of new waters of the U.S.

Maintenance of ecosystem restoration features would be conducted under this alternative by the City of Los Angeles, the non-Federal sponsor. Maintenance in general would include removal of invasive species throughout the project footprint, including the River and tributary channel bottom; repair and replacement of irrigation pipes and sprinklers; maintenance of constructed trails, terraces, and viewing areas; trimming of native vegetation; removal of trash and accumulated sediment; graffiti abatement; vector management; and like-for-like structural repair. Project areas subject to invasive removal include the channel bottom of the River, Verdugo Wash-River confluence, Burbank-Western Channel-confluence and short distance upstream, and the Arroyo Seco-River confluence as well as constructed restoration features. The Corps would continue to be responsible for maintaining all other aspects of the portion of the LACDA project that overlaps with the restoration project footprint.

Maintenance activities within waters of the U.S. may require use of excavators, backhoes, or grapple trucks for removal of trash, debris, and sediment. Maintaining design grades, elevations,

contours, and conveyance may require limited earthmoving activities on a periodic basis. In such cases, there may be discharges of fill material associated with the use of earthmoving equipment such as bulldozers within newly established waters of the U.S. Impacts would be temporary in nature. In other cases, like-for-like structural repair below the OHWM could result in permanent discharges of fill material into waters of the U.S. However, temporary or permanent discharges of fill material would not decrease the amount of newly established waters of U.S. Invasive species in the River and tributary channel bottom within the study area would typically be removed by hand tools. Thus, the activity would not result in discharges of fill material in most instances. In cases where limited earthmoving may be required, there would be discharges of earthen fill. However, impacts would be temporary and there would be no loss of waters of the U.S.

Table 3-1 Alternative 10 – Summary of Fill Material in Existing Waters of the U.S. and Establishment of New Waters of the U.S.

Reach	Management Measures	Acres of New Waters of the U.S.	Fill Material in Existing Waters of the U.S.			
			Discharge Material and Activity	Impacts (Perm./ Temp.)	Quantity	Acres Filled
3. Ferraro Fields area of Griffith Park	Daylight Streams	5	None: activity is occurring in overbank area outside of existing waters of the U.S.	NA	NA	NA
4. Griffith Park	Daylight Streams	9	None: activity is occurring in overbank area outside of existing waters of the U.S.	NA	NA	NA
	Side Channel	1	None: Removal of materials at inlet and outlet connections	NA	(200 CY)	0
			Backfill as needed to create stable inlet and outlet	Perm.	100 CY	.02
			Install k-rails or sandbags	Temp.	220 linear feet (LF)	0.01
5. Riverside Drive	Daylight Streams	1	None: activity is occurring in overbank area outside of existing waters of the U.S.	NA	NA	NA
6. Taylor Yard	Modify Channel Banks/Widen Channel	12	None: Excavate embankment to channel bed to within the waters of the U.S.	Perm.	(145,381 CY)	0
			Backfill with clean topsoil	Perm.	8,066 CY	4.5
			Install k-rails or sandbags	Temp.	4,224 LF	0.10

Reach	Management Measures	Acres of New Waters of the U.S.	Fill Material in Existing Waters of the U.S.			
			Discharge Material and Activity	Impacts (Perm./ Temp.)	Quantity	Acres Filled
7. Arroyo Seco	Daylight Streams	3	None: activity is occurring in overbank area outside of existing waters of the U.S.	NA	NA	NA
8. LATC	Restore historic wash	25	None: activity is occurring in overbank area outside of existing waters of the U.S.	Perm.	NA	NA

Alternative 13

Alternative 13 is named ACE (for ARBOR Corridor Extension). Alternative 13 has the same restoration features as Alternative 10 in Reaches 1, 2, 4, 5, and 8 and provides additional restoration in Reaches 3, 6, and 7. In Reach 3, in addition to the measures identified in Alternative 10, this alternative would create a side channel entering upstream from the River behind Ferraro Fields and re-entering the River at the downstream end of the reach. In Reach 6, this alternative widens the river channel by over 300 feet into Taylor Yard with restoration of the floodplain and freshwater marsh in the widened channel. It also creates a backwater wetland at the Bowtie parcel, and it restructures the left bank upstream of the backwater wetland and downstream of Taylor Yard, as well as the entirety of the right bank, in this reach with implanted vegetation. In Reach 7, this alternative restores a portion of the Arroyo Seco tributary and makes nodal connections on the left side of the River to the Arroyo Seco watershed. This is accomplished through softening of the bed and banks with development of a riparian corridor in the tributary confluence and for one half mile upstream. The Arroyo Seco restoration supports connections through the River from the Santa Monica Mountains to the San Gabriel Mountains. Instead of the daylighted streams included in this reach in Alternative 10, this alternative lines the banks of the River downstream from the Arroyo Seco with overhanging vines and implanted vegetation. In addition to the specific features outlined above, this alternative removes invasive vegetation throughout the restoration features and within the River and tributary channel bottom throughout the project footprint. Table 3-2 below summarizes the measures that either fill waters of the U.S. or create new waters of the U.S. In total, Alternative 13 would discharge fill material into approximately 27.51 acres waters of the U.S. Permanent fill material would be discharged into 26.84 acres. Dewatering structures would temporarily discharge fill material into 0.67 acre. Alternative 13 would establish approximately 86 acres of new waters of the U.S.

Maintenance of ecosystem restoration features would be conducted under this alternative by the City of Los Angeles. Maintenance in general would include removal of invasive species throughout the project footprint, including the River and tributary channel bottom; repair and replacement of irrigation pipes and sprinklers; maintenance of constructed trails, terraces, and viewing areas; trimming of native vegetation; removal of trash and accumulated sediment; graffiti abatement; vector management; and like-for-like structural repair. Project areas subject to invasive removal include the channel bottom of the River, Verdugo Wash-River confluence, Burbank-Western Channel-confluence and short distance upstream, and the Arroyo Seco-River

confluence as well as constructed restoration features. The Corps would continue to be responsible for maintaining all other aspects of the portion of the LACDA project that overlaps with the restoration project footprint..

Maintenance activities within waters of the U.S. may require use of excavators, backhoes, or grapple trucks for removal of trash, debris, and sediment. Maintaining design grades, elevations, contours, and conveyance may require limited earthmoving activities on a periodic basis. In such cases, there may be discharges of fill material associated with the use of earthmoving equipment, such as bulldozers, within newly established waters of the U.S. Impacts would be temporary in nature. In other cases, like-for-like structural repair below the OHWM could result in permanent discharges of fill material into waters of the U.S. However, temporary or permanent discharges of fill material would not decrease the amount of newly established waters of U.S. Invasive species in the River and tributary channel bottom within the project area are typically removed by hand tools. Thus, the activity would not result in discharges of fill material in most instances. In cases where limited earthmoving may be required, there would be discharges of earthen fill. However, impacts would be temporary and there would be no loss of waters of the U.S.

Table 3-2 Alternative 13 – Summary of Fill Material in Existing Waters of the U.S. and Establishment of New Waters of the U.S.

Reach	Management Measures	Acres of New Waters of the U.S.	Fill Material in Existing Waters of the U.S.			
			Discharge Material and Activity	Impacts (Perm./ Temp.)	Quantity	Acres Filled
3. Ferraro Fields area of Griffith Park	Daylight Streams	5	None: activity is occurring in overbank area outside of existing waters of the U.S.	NA	NA	NA
	Side Channel	6	Removal of materials at inlet and outlet connections, above existing waters of the U.S.	Perm.	(200 CY)	0
			Backfill to create stable inlet and outlet	Perm.	100 CY	.02
			Install k-rails or sandbags	Temp.	220 LF	.01
4. Griffith Park	Daylight Streams	9	None: activity is occurring in overbank area, outside of existing waters of the U.S.	NA	NA	NA
	Side Channel	1	Removal of materials at inlet and outlet connections, above existing waters of the U.S.	Perm.	(200 CY)	0
			Backfill as needed to create stable inlet and outlet, above existing waters of the U.S.	Perm.	100 CY	.02
			Install k-rails or sandbags	Temp.	220 LF	0.01

Reach	Management Measures	Acres of New Waters of the U.S.	Fill Material in Existing Waters of the U.S.			
			Discharge Material and Activity	Impacts (Perm./ Temp.)	Quantity	Acres Filled
5. Riverside Drive	Daylight Streams	1	None: activity is occurring in overbank area, outside of existing waters of the U.S.	NA	NA	NA
6. Taylor Yard	Vegetated Channel Walls (Right Bank)	NA	Install vegetation anchor materials	Perm.	67,819 Square Yards (SY)	14
			Rock at vegetation anchor tie-in	Perm.	2,833 CY	
			Install k-rails or sandbags	Temp.	7,392 LF	0.2
	Vegetated Channel Walls (Left Bank)	NA	Install vegetation anchor materials	Perm.	16,855 SY	3.3
			Rock at vegetation anchor tie-in	Perm.	778 CY	
			Install k-rails or sandbags	Temp.	11,960 LF	0.25
	Modify Channel Banks/Widen Channel	12	None: Excavate embankment to channel bed to within the waters of the U.S.	Perm.	(145,381 CY)	0
			Backfill with clean topsoil	Perm.	8,066 CY	4.5
			Install k-rails or sandbags	Temp.	4,224 LF	0.10
	Create New Wetlands Behind Bank	13	None: activity is occurring in overbank area, outside of existing waters of the U.S.	NA	NA	NA
7. Arroyo Seco/Los Angeles River State Park	Modify Channel Banks	14	None: Excavate embankment to channel bed to within the waters of the U.S.	Perm.	(79,723 CY)	0
			Backfill with clean topsoil	Perm.	3,000 CY	5
			Install k-rails or sandbags	Temp.	4,200 LF	0.10
8. LATC	Restore Historic Wash	25	None: activity is occurring in overbank area outside of existing waters of the U.S.	NA	NA	NA

Alternative 16

Alternative 16 is called AND (for ARBOR Narrows to Downtown). This alternative includes the same features as Alternative 13 in Reaches 1-4 and 6-8 and includes greater restoration in Reaches 5 and 8. In Reach 5, this alternative widens the River channel by modifying the right

bank from a trapezoidal bank to a vertical wall and modifies the left bank from trapezoidal to a terraced vegetated bank. At the downstream end of this reach, the River channel will also be widened by modifying the left bank. The daylighted stream in Alternatives 10 and 13 is also included in this reach. In Reach 8, the alternative includes additional restoration by terracing upstream of LATC on the right bank of the River, terracing downstream on the left bank, and removing the left bank and the concrete bed adjacent to LATC. The channel bed will be naturalized to support freshwater marsh in the River. This alternative widens the River into the LATC site by 500 feet on a low terrace and another 1000 feet on a second terrace. The restoration features at the LATC site would also include the restoration of the historic wash, along with wetland habitat. In addition to the specific features outlined above, this alternative removes invasive vegetation throughout the project footprint, including the River and tributary channel bottom. Table 3-3 below summarizes the measures that either fill waters of the U.S. or create new waters of the U.S. In total, Alternative 16 would permanently discharge fill material into approximately 50.25 acres waters of the U.S. Permanent fill would be discharged into 49.21 acres. Dewatering structures would temporarily discharge fill material into 1.04 acres. Alternative 16 would establish approximately 145.6 acres of new waters of the U.S.

Maintenance of ecosystem restoration features would be conducted under this alternative by the City of Los Angeles. Maintenance in general would include removal of invasive species throughout the project footprint; repair and replacement of irrigation pipes and sprinklers; maintenance of constructed trails, terraces, and viewing areas; trimming of native vegetation; removal of trash and accumulated sediment; graffiti abatement; vector management; and like-for-like structural repair. Project areas subject to invasive removal include the channel bottom of the River, Verdugo Wash-River confluence, Burbank-Western Channel-confluence and short distance upstream, and the Arroyo Seco-River confluence as well as constructed restoration features. The Corps would continue to be responsible for maintaining all other aspects of the portion of the LACDA project that overlaps with the restoration project footprint.

Maintenance activities within waters of the U.S. may require use of excavators, backhoes, or grapple trucks for removal of trash, debris, and sediment. Maintaining design grades, elevations, contours, and conveyance may require limited earthmoving activities on a periodic basis. In such cases, there may be discharges of fill material associated with the use of earthmoving equipment, such as bulldozers, within newly established waters of the U.S. Impacts would be temporary in nature. In other cases, like-for-like structural repair below the OHWM could result in permanent discharges of fill material into waters of the U.S. However, temporary or permanent discharges of fill material would not decrease the amount of newly established waters of U.S. Invasive species in the river and tributary channel bottom within the project area are typically removed by hand tools. Thus, the activity would not result in discharges of fill material in most instances. In cases where limited earthmoving may be required, there would be discharges of earthen fill. However, impacts would be temporary and there would be no loss of waters of the U.S.

Table 3-3 Alternative 16 – Summary of Fill Material in Existing Waters of the U.S. and Establishment of New Waters of the U.S.

Reach	Management Measures	Acres of New Waters of the U.S.	Fill Material in Existing Waters of the U.S.			
			Discharge Material and Activity	Impacts (Perm./ Temp.)	Quantity	Acres Filled
3. Ferraro Fields area of Griffith Park	Daylight Streams	5	None: activity is occurring in overbank area, outside of existing waters of the U.S.	NA	NA	NA
	Side Channel	6	Removal of materials at inlet and outlet connections	Perm.	(200 CY)	0
			Backfill to create stable inlet and outlet	Perm.	100 CY	.02
			Install k-rails or sandbags	Temp.	220 LF	.01
4. Griffith Park	Daylight Streams	9	None: activity is occurring in overbank area, outside of existing waters of the U,S,	NA	NA	NA
	Side Channel	1	Removal of materials at inlet and outlet connections	Perm.	(200 CY)	0
			Backfill as needed to create stable inlet and outlet	Perm.	100 CY	.02
			Install k-rails or sandbags	Temp.	220 LF	0.01
5. Riverside Drive	Daylight Streams	1	None: activity is occurring in overbank area, outside of existing waters of the U.S.	NA	NA	NA
	Terrace/Vegeta ted Channel Walls	NA	Install vegetation anchor materials	Perm.	14,520 SY	3
			Rock at vegetation anchor tie-in	Perm.	778 CY	0.02
			Install k-rails or sandbags	Temp.	11,960 LF	0.25
	Modify Trapezoidal Channel to Vertical Banks	20.6	Demolition and materials removal	Perm.	(140,763 CY)	0
			Backfill for stabilization	Perm.	113,991 CY	6.2
			Install k-rails or sandbags	Temp.	8,448 LF	0.02
6. Taylor Yard	Vegetated Channel Walls (Right Bank)	NA	Install vegetation anchor materials	Perm.	67,819 CY	14
			Rock at vegetation anchor tie-in	Perm.	2,833 CY	0.2

Reach	Management Measures	Acres of New Waters of the U.S.	Fill Material in Existing Waters of the U.S.			
			Discharge Material and Activity	Impacts (Perm./ Temp.)	Quantity	Acres Filled
			Install k-rails or sandbags	Temp.	7,392 LF	0.2
	Vegetated Channel Walls (Left Bank)	NA	Install vegetation anchor materials	Perm.	16,855 SY	3.3
			Rock at vegetation anchor tie-in	Perm.	778 CY	.05
			Install k-rails or sandbags	Temp.	11,960 LF	0.25
	Modify Channel Bed and Banks	12	Excavate embankment to channel bed within waters of the U.S.	Perm.	(145,381 CY)	0
			Backfill with clean topsoil	Perm.	8,066 CY	4.5
			Install k-rails or sandbags	Temp.	4,224 LF	0.10
	Create New Wetlands Behind Bank	13	None: activity is occurring in overbank area, outside of existing waters of the U.S.	NA	NA	NA
7. Arroyo Seco/Los Angeles River State Park	Modify Channel Banks	14	Excavate embankment to channel bed to within the waters of the U.S.	Perm.	(79,723 CY)	0
			Backfill with clean topsoil	Perm.	3,000 CY	5
			Install k-rails or sandbags	Temp.	4,200 LF	0.10
8. LATC	Create Side Channel	13	Demolition and materials removal	NA	(46,826 CY)	0
			Backfill for stabilization	Perm.	42,476 CY	0.2
			Install k-rails or sandbags	Temp.	220 LF	0.01
	Modify Channel Bed and Banks	26	Excavate embankment and channel bed to within the waters of the U.S.	Perm.	(397,871 CY)	0
			Backfill with clean topsoil	Perm.	18,996 CY	11.3
			Install k-rails or sandbags	Temp.	3,168 LF	0.08
	Restore Historic Wash	25	Demolition and materials removal within waters of the U.S.	Perm.	(48,340 CY)	0
			Backfill for stabilization	Perm.	2,193 CY	1.4
			Install k-rails or sandbags	Temp.	3,168 LF	0.01

Alternative 20

Alternative 20 is called RIVER (for Riparian Integration via Varied Ecological Reintroduction) as it includes the same features as Alternative 16 in Reaches 1, 4, 5, 6, and 8 and includes greater restoration in Reaches 2, 3 and 7. In Reach 2, this alternative widens the the River channel by modifying the right bank from a trapezoidal bank to a vertical wall. In Reach 3, the alternative restores the confluence with Verdugo Wash by softening the bed of the stream and significantly widening the mouth of the wash, thus providing riparian habitat and an additional connection to the San Gabriel Mountains through the Verdugo Hills. In Reach 7, this alternative includes the same Arroyo Seco restoration as Alternative 13, and in addition, reintroduces the daylighted streams included in Alternative 10 in lieu of the channel bank vegetation features that were in Alternatives 13 and 16. Also in Reach 7, this alternative restores freshwater marsh at the Los Angeles State Historic Park and creates a terraced bank connection to the River. In addition to the specific features outlined above, this alternative removes invasive vegetation throughout the project footprint, including within the River and tributary channel bottom. Table 3-4 below summarizes the measures that either fill waters of the U.S. or create new waters of the U.S. In total, Alternative 20 would permanently discharge fill material into approximately 67.29 acres waters of the U.S. Permanent fill would be discharged into 65.61 acres. Dewatering structures would temporarily discharge fill material into 1.68 acres. Alternative 20 would establish approximately 168.6 acres of new waters of the U.S.

Maintenance of ecosystem restoration features would be conducted under this alternative by the City of Los Angeles. Maintenance in general would include removal of invasive species throughout the project footprint; repair and replacement of irrigation pipes and sprinklers; maintenance of constructed trails, terraces, and viewing areas; trimming of native vegetation; removal of trash and accumulated sediment; graffiti abatement; vector management; and like-for-like structural repair. Project areas subject to invasive removal include the channel bottom of the River, Verdugo Wash-River confluence, Burbank-Western Channel-confluence and short distance upstream, and the Arroyo Seco-River confluence as well as constructed restoration features. The Corps would continue to be responsible for maintaining all other aspects of the portion of the LACDA project that overlaps with the restoration project footprint.Maintenance activities within waters of the U.S. may require use of excavators, backhoes, or grapple trucks for removal of trash, debris, and sediment. Maintaining design grades, elevations, contours, and conveyance may require limited earthmoving activities on a periodic basis. In such cases, there may be discharges of fill material associated with the use of earthmoving equipment, such as bulldozers, within newly established waters of the U.S. Impacts would be temporary in nature. In other cases, like-for-like structural repair below the OHWM could result in permanent discharges of fill material into waters of the U.S. However, temporary or permanent discharges of fill material would not decrease the amount of newly established waters of U.S. Invasive species in the River and tributary channel bottom within the study area would typically be removed by hand tools. Thus, the activity would not result in discharges of fill material in most instances. In cases where limited earthmoving may be required, there would be discharges of earthen fill. However, impacts would be temporary and there would be no loss of waters of the U.S.

Table 3-4 Alternative 20 – Summary of Fill Material in Existing Waters of the U.S. and Establishment of New Waters of the U.S.

Reach	Management Measures	Acres of New Waters of the U.S.	Fill Material in Existing Waters of the U.S.			
			Discharge Material and Activity	Impacts (Perm./ Temp.)	Quantity	Acres Filled
2. Bette Davis Park area of Griffith Park	Vegetated Channel Walls	NA	Install vegetation anchor materials	Perm.	8,206 SY	1.7
			Rock at vegetation anchor tie-in	Perm.	424 CY	0.02
			Install k-rails or sandbags	Temp.	11,960 LF	0.25
	Modify Trapezoidal Channel to Vertical Banks	5.5	Demolition and removal of materials	Perm.	(7,020 CY)	0
			Backfill for stabilization	Perm.	41,625 CY	1.75
			Install k-rails or sandbags	Temp.	8,448 LF	0.2
3. Ferraro Fields/Verdugo Wash area of Griffith Park	Daylight Streams	2	None: activity is occurring in overbank area, outside of existing waters of the U.S.	NA	NA	NA
	Side Channel	6	Removal of materials at inlet and outlet connections, above OHWM	Perm.	(200 CY)	0
			Backfill to create stable inlet and outlet	Perm.	100 CY	0.02
			Install k-rails or sandbags	Temp.	220 LF	0.01
	Widen Tributaries	8	Demolition and removal of materials	Perm.	(509,058 CY)	0
			Backfill for stabilization and add vegetation anchoring materials	Perm.	24,115 CY	6.5
			Install k-rails or sandbags	Temp.	2,000 LF	0.02
4. Griffith Park	Daylight Streams	9	None: activity is occurring in overbank area, outside of existing waters of the U.S.	NA	NA	NA
	Side Channel	1	Removal of materials at inlet and outlet connections, above OHWM	Perm.	(200 CY)	0
			Backfill as needed to create stable inlet and outlet	Perm.	100 CY	0.02
			Install k-rails or sandbags	Temp.	220 LF	0.01
5. Riverside Drive	Daylight Streams	1	None: activity is occurring in overbank area, outside of existing waters of the U.S.	NA	NA	NA
	Vegetated Channel Walls (Both Banks)	NA	Install vegetation anchor materials	Perm.	14,520 CY	9
			Rock at vegetation anchor tie-in	Perm.	2,333 CY	0.05
			Install k-rails or sandbags	Temp.	11,960 LF	0.25
	Modify Trapezoidal	20.6	Demolition and materials removal	Perm.	(140,763 CY)	0

Reach	Management Measures	Acres of New Waters of the U.S.	Fill Material in Existing Waters of the U.S.			
			Discharge Material and Activity	Impacts (Perm./ Temp.)	Quantity	Acres Filled
	Channel to Vertical Banks		Backfill for stabilization	Perm.	113,991 CY	6.2
			Install k-rails or sandbags	Temp.	8,448 LF	0.02
6. Taylor Yard	Vegetated Channel Walls (Right bank)	NA	Install vegetation anchor materials	Perm.	67,819 SY	14
			Rock at vegetation anchor tie-in	Perm.	2,833 CY	0.2
			Install k-rails or sandbags	Temp.	7,392 LF	0.2
	Vegetated Channel Walls (Left bank)	NA	Install vegetation anchor materials	Perm.	16,855 SY	3.3
			Rock at vegetation anchor tie-in	Perm.	778 CY	0.05
			Install k-rails or sandbags	Temp.	11,960 LF	0.25
	Modify Channel Banks	12	Excavate embankment to channel bed to within the waters of the U.S.	Perm.	(145,381 CY)	0
			Backfill with clean topsoil	Perm.	8,066 CY	4.5
			Install k-rails or sandbags	Temp.	4,224 LF	0.1
	Create New Wetlands Behind Bank	13	None: activity is occurring in overbank area, outside of existing waters of the U.S.	NA	NA	NA
7. Arroyo Seco and Los Angeles State Historic Park	Daylight Streams	3	None: activity is occurring in overbank area, outside of existing waters of the U.S.	NA.	NA	NA
	Create Wetland	9	Install vegetation stabilization features, concrete, riprap, and topsoil	Perm.	NA	NA
	Modify channel Banks	14	Excavate embankment to channel bed to within the waters of the U.S.	Perm.	(79,723 CY)	0
			Backfill with clean topsoil	Perm.	3,000 CY	5
			Install k-rails or sandbags	Temp.	4,200 LF	0.1
	Terrace banks	0.5	Demolition and removal of materials to within waters of the U.S.	Perm	(3,771 CY)	0
			Backfill for stabilization and add vegetation anchoring materials	Perm	3,052 SF	0.5
		0	Install k rails or sandbags	Temp	595 LF	0.5
8. LATC	Create Side Channel	13	Demolition and materials removal	Perm.	(46,826 CY)	0
			Backfill for stabilization	Perm.	42,476 CY	0.1
			Install k-rails or sandbags	Temp.	220 LF	0.01
		26	Excavate embankment and channel bed within waters of the U.S.	Perm.	(397,871 CY)	0

Reach	Management Measures	Acres of New Waters of the U.S.	Fill Material in Existing Waters of the U.S.			
			Discharge Material and Activity	Impacts (Perm./ Temp.)	Quantity	Acres Filled
	Modify Channel Bed and Banks		Backfill with clean topsoil	Perm.	18,996 CY	11.3
			Install k-rails or sandbags	Temp.	3,168 LF	0.08
	Restore Historic Wash	25	Excavate embankment to channel bed within waters of the U.S.	Perm.	(48,340 CY)	0
			Backfill with clean topsoil	Perm.	2,193 CY	1.4
			Install k-rails or sandbags	Temp.	3,168 LF	0.01

Alternative 13v

Alternative 13v would include all measures and impacts of Alternative 13. Moreover, Alternative 13v would add restoration measures in Reach 7 identical to those proposed under Alternative 20. Within Reach 7, streams would be daylighted; freshwater marsh would be created; embankments would be terraced; and channel banks would be modified. Like the other alternatives, this alternative includes invasive vegetation removal throughout project footprint, including the River and tributary channel bottom. This Alternative has been identified as the National Ecosystem Restoration plan. Table 3-5 below summarizes the measures that either fill waters of the U.S. or create new waters of the U.S. In total, Alternative 13v would permanently discharge fill material into approximately 27.51 acres waters of the U.S. Permanent fill would be discharged into 26.84 acres. Dewatering structures would temporarily discharge fill material into 0.67 acre. Alternative 13v would establish approximately 98.5 acres of new waters of the U.S.

Maintenance of ecosystem restoration features would be conducted under this alternative by the City of Los Angeles. Maintenance in general would include removal of invasive species throughout the the project footprint; repair and replacement of irrigation pipes and sprinklers; maintenance of constructed trails, terraces, and viewing areas; trimming of native vegetation; removal of trash and accumulated sediment; graffiti abatement; vector management; and like-for-like structural repair. Project areas subject to invasive removal include the channel bottom of the River, Verdugo Wash-River confluence, Burbank-Western Channel-confluence and short distance upstream, and the Arroyo Seco-River confluence as well as constructed restoration features. The Corps would continue to be responsible for maintaining all other aspects of the portion of the LACDA project that overlaps with the restoration project footprint.

Maintenance activities within waters of the U.S. may require use of excavators, backhoes, or grapple trucks for removal of trash, debris, and sediment. Maintaining design grades, elevations, contours, and conveyance may require limited earthmoving activities on a periodic basis. In such cases, there may be discharges of fill material associated with the use of earthmoving equipment, such as bulldozers, within newly established waters of the U.S. Impacts would be temporary in nature. In other cases, like-for-like structural repair below the OHWM could result in permanent discharges of fill material into waters of the U.S. However, temporary or

permanent discharges of fill material would not decrease the amount of newly established waters of U.S. Invasive species in the River and tributary channel bottom within the project area would typically be removed by hand tools. Thus, the activity would not result in discharges of fill material in most instances. In cases where limited earthmoving may be required, there would be discharges of earthen fill. However, impacts would be temporary and there would be no loss of waters of the U.S.

Table 3-5 Alternative 13v – Summary of Fill Material in Existing Waters of the U.S. and Establishment of New Waters of the U.S.

Reach	Management Measures	Acres of New Waters of the U.S.	Fill Material in Existing Waters of the U.S.			
			Discharge Material and Activity	Impacts (Perm./ Temp.)	Quantity	Acres Filled
3. Ferraro Fields area of Griffith Park	Daylight Streams	5	None: activity is occurring in overbank area outside of existing waters of the U.S.	NA	NA	NA
	Side Channel	6	None: Removal of materials at inlet and outlet connections, above existing waters of the U.S.	Perm.	(200 CY)	0
			Backfill to create stable inlet and outlet	Perm.	100 CY	0.02
			Install k-rails or sandbags	Temp.	220 LF	0.01
4. Griffith Park	Daylight Streams	9	None: activity is occurring in overbank area, outside of existing waters of the U.S.	NA	NA	NA
	Side Channel	1	None: Removal of materials at inlet and outlet connections, above existing waters of the U.S.	Perm.	(200 CY)	0
			Backfill as needed to create stable inlet and outlet, above existing waters of the U.S.	Perm.	100 CY	0.02
			Install k-rails or sandbags	Temp.	220 LF	0.01
5. Riverside Drive	Daylight Streams	1	None: activity is occurring in overbank area, outside of existing waters of the U.S.	NA	NA	NA
6. Taylor Yard	Vegetated Channel Walls (Right Bank)	NA	Install vegetation anchor materials	Perm.	67,819 (SY)	14
			Rock at vegetation anchor tie-in	Perm.	2,833 CY	
			Install k-rails or sandbags	Temp.	7,392 LF	0.2
	Vegetated Channel Walls (Left Bank)	NA	Install vegetation anchor materials	Perm.	16,855 SY	3.3
			Rock at vegetation anchor tie-in	Perm.	778 CY	
			Install k-rails or sandbags	Temp.	11,960 LF	0.25

Reach	Management Measures	Acres of New Waters of the U.S.	Fill Material in Existing Waters of the U.S.			
			Discharge Material and Activity	Impacts (Perm./ Temp.)	Quantity	Acres Filled
	Modify Channel Banks/Widen Channel	12	None: Excavate embankment to channel bed to within the waters of the U.S.	Perm.	(145,381 CY)	0
			Backfill with clean topsoil	Perm.	8,066 CY	4.5
			Install k-rails or sandbags	Temp.	4,224 LF	0.1
	Create New Wetlands Behind Bank	13	None: activity is occurring in overbank area, outside of existing waters of the U.S.	NA	NA	NA
7. Arroyo Seco and Cornfields	Daylight Streams	3	None: activity is occurring in overbank area, outside of existing waters of the U.S.	NA	NA	NA
	Create Wetland	9	Install vegetation stabilization features, concrete, riprap, and topsoil	NA	NA	NA
	Terrace banks	0.5	None: Demolition and removal of materials to within waters of the U.S.	Perm	(3,771 CY)	0
	Modify Channel Banks	14	None: Excavate embankment to channel bed to within the waters of the U.S.	Perm.	(79,723 CY)	0
			Backfill with clean topsoil	Perm.	3,000 CY	5
			Install k-rails or sandbags	Temp.	4,200 LF	0.1
8. LATC	Restore Historic Wash	25	None: activity is occurring in overbank area outside of existing waters of the U.S.	NA	NA	NA

3.3 Impacts to Waters of the U.S.

All action alternatives would entail both temporary and permanent discharges of fill material into waters of the U.S. None of the alternatives would entail permanent loss of waters of the U.S.

There are incremental increases in permanent and temporary discharges of fill material from Alternative 10 through Alternative 20. Likewise, there are incremental increases in the scope of restoration activities from Alternative 10 through Alternative 20.

The types of fill material include restoration fill and stabilization fill.

- **Restoration fill** includes fill that would enhance aquatic functions and services.
    - **Seeded Turf Mat:** The management measure to vegetate channel walls (See Section 3.1.4) with seeded turf would entail discharge of a seeded mat on top of the existing concrete embankments. The discharge of the seeded mat would not change the channel configuration, or reduce groundwater recharge area. Alternatives 13, 13v, 16, and 20 would include the discharge of this fill material. The turf reinforcement mat is a pre-seeded mat that would be put in place to facilitate the process of formation of riparian and wetland plant communities.
    - **Clean Backfill:** Another management measure entails removal of concrete from waters of the U.S. and discharge of backfill into the excavated areas to support riparian vegetation. The discharge of clean backfill would not change the channel configuration, but would increase the area of riparian vegetation and surface area for groundwater recharge. In both cases, the discharge of permanent fill material would not lead to the permanent loss of existing waters of the U.S. All action alternatives include the discharge of clean backfill. Clean fill material would be placed to allow formation of wetland and riparian habitat where concrete is excavated from the channel.
- **Stabilization fill** is fill material required to stabilize the substrate of newly created waters of the U.S. Alternatives 13, 13v, 16 and 20 would entail measures that would set back the existing levees which in turn would widen channel invert. Fill material such as rocks or concrete would be discharged as appropriate within the widened channel invert to stabilize the substrate. The discharge of this material would not result in the permanent loss of existing waters of the U.S. All action alternatives include the discharge of concrete or rock backfill. This type of fill material would be installed in areas where trapezoidal channel walls were set back to increase the invert width, thereby exposing erodible soils; where the channel banks were notched to allow for creation of inlets and outlets for new side channels; and where existing concrete banks were terraced to allow for plantings.

Table 3-6 Classes of Permanent Fill Material for Restoration Activities

Alternative	Permanent Fill Within Existing Waters of the U.S. (Acres)	Classes of Permanent Fill		
		Seeded Turf (Acres)	Soil Backfill Within Excavated Concrete (Acres)	Fill to Stabilize Expanded Waters of the U.S.
10	4.52	0	4.5	0.02
13	26.84	17.3	9.5	0.04
13v	26.84	17.3	9.5	0.04
16	49.21	20.57	20.8	7.84
20	65.61	28.32	22.20	15.09

3.4 Permanent Losses of Existing Waters of the U.S.

The discharge of permanent fill material would not result in the permanent loss of waters of the U.S. Typical examples of changes that constitute permanent loss of waters of the U.S. include permanent decrease in surface area available for water recharge or permanent loss of riparian habitat.

- **Ground Water Recharge**: All action alternatives would discharge permanent fill material into existing waters of the U.S. However, the fill material would not result in an increase of impermeable surfaces. Seeded reinforced mats would be placed on top of existing embankments. Excavated concrete would be replaced with either soil backfill or rocks. Furthermore, all action alternatives would create new, soft bottom waters of the U.S., resulting in an increase of permeable surface areas to enhance groundwater recharge functions.
- **Riparian Habitat:** There would be no permanent loss of aquatic habitat associated with discharges of fill under any of the action alternatives. The discharges of fill material would entail placement of reinforced vegetated mats or rocks and clean soil for the establishment of vegetation in open water area and soft river bottom area, and at side channels and tributaries.

Table 3-7 Fill and Loss of Existing Waters of the U.S. and New Waters of the U.S. Established

Alternative	Fill Within Existing Waters of the U.S. (Acres)		Permanent Loss of Existing Waters of the U.S. (Acres)	New Waters of the U.S. Established (Acres)
	Permanent	Temporary		
10	4.52	0.11	0	56
13	26.84	0.67	0	86
13v	26.84	0.67	0	98.5
16	49.21	1.04	0	145.6
20	65.61	1.68	0	168.6

4.0 Alternatives Analysis

4.1 Restrictions on Discharge

The 404(b)(1) Guidelines prohibit the discharge of dredged or fill material into waters of the U.S. if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem[1], so long as the alternative does not have other significant adverse environmental consequences. 40 C.F.R. 230.10(a). To be "practicable," an alternative must be "available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes." 40 C.F.R. 230.10(a)(2).

4.2 Overall Project Purpose

With the exception of the No Federal Action Alternative all alternatives meet the overall project purpose. The No Federal Action Alternative has been dropped from consideration in the 404(b)(1) evaluation since it does not meet the overall project purpose.

4.3 Practicability (Technology)

All action alternatives can be constructed with existing technology. All action alternatives would utilize conventional construction techniques and conventional construction equipment.

4.4 Practicability (Logistics)

As detailed in Appendix J of the IFR, all action alternatives would require acquisition of approximately 145 acres of privately-owned lands and relocation of private businesses and industrial operations which include two railway yards: 93 acres at LATC (existing yard) and 43 acres at Taylor Yard (former yard, no existing business/operations). Acquisition of up to 8 acres of private land with business operations would occur at the confluence of Verdugo Wash under Alternative 20. Implementation of any action alternative would require the acquisition of land, changes in zoning, and relocation of the rail facilities and operations. The City of Los Angeles is responsible for acquisition of lands, easements and rights-of-way and performing relocations (Appendix J, Section 11). Furthermore, City of Los Angeles is fully capable of fulfilling its responsibility (Appendix J, Section 13). Based on the above, all action alternatives are practicable with respect to logistics.

4.5 Practicability (Cost)

Per Engineer Regulation (ER) 1105-2-100 the economic analysis associated with the IFR is required to identify the alternative that reasonably maximizes benefits, the NER. Under ER 1105-2-100, the NER plan is the recommended plan unless a waiver is granted to consider an alternative plan as the Locally Preferred Plan. Though not bound to do so, the U.S. Congress

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[1]In this instance, the terms *aquatic environment* and *aquatic ecosystem* mean waters of the U.S., including wetlands that serve as habitat for interrelated and interacting communities and populations of plants and animals. 40 C.F.R. 230.3.

may select the recommended plan for authorization and appropriation. Alternatively, the U.S. Congress may select another plan from the final array of alternatives for authorization and appropriation. All alternatives are considered practicable in terms of cost.

The cost comparison discussion is a summary of a detailed cost analysis prepared for the action alternatives in Chapters 4 and 6 of the IFR. As summarized in Tables 6-2 and 6-3 of the IFR, all action alternatives from Alternative 10 through Alternative 20 would incrementally increase the scope of ecosystem restoration activities. Likewise, there is an incremental increase in total construction costs from Alternative 10 through Alternative 20. See Table 6-6 of the IFR and Table 7, below. Alternative 10 would entail the smallest scope of restoration activities and would cost the least. In contrast, Alternative 20 would entail the largest scope of restoration activities and would cost the most. However, as summarized in Table 4-10 of the IFR, the incremental-increase pattern is not evident in more refined measurements. With respect to incremental construction cost Alternative 13v would result in the smallest incremental construction cost. In contrast, Alternative 16 would result in the largest incremental construction cost. With respect to habitat output, Alternative 13v would result in the largest incremental output while Alternative 20 would result in the smallest incremental output. In sum, Alternative 13v maximizes incremental habitat output and minimizes total construction costs. Therefore, Alternative 13v is identified as the plan that maximizes NER benefits (See Section 6.6 of the IFR).

However, the City of Los Angeles has requested the Corps recommend Alternative 20 as a Locally Preferred Plan. The Assistant Secretary of the Army (Civil Works) has permitted the Corps to consider Alternative 20 as a Locally Preferred Plan for recommendation to Congress.

Table 4-1 Comparison of Costs[2] and Habitat Output (October 2014 Price Levels)

	Alternative 10	Alternative 13	Alternative 13v*	Alternative 16	Alternative 20
First Cost	$591,371,000	$707,800,000	$703,062,000	$1,050,057,000	$1,309,332,000
Average Annual Costs (AAC)	$26,722,000	$32,089,000	$31,851,377	$49,271,000	$60,656,000
Annual Average Habitat Output (AAHU)	5,321	5,902	5,989	6,509	6,782
Cost/Habitat Output (AAC/AAHU)	$5,022	$5,437	$5,318	$7,570	$8,944

* The IFR identifies Alternative 13v as the plan that maximizes NER benefits.

[2] Costs in Table 4-1 are based upon estimates in December 2014. MCACES estimates have only been prepared for Alternatives 13v and 20 and therefore these will differ from more refined estimates found elsewhere in the IFR.

Table 4-2 Comparison of 404(b)(1) Evaluation Criteria

Alternatives	Practicability Test			Significant Environmental Impacts to Non-Aquatic Resources?	Permanent Fill Within WoUS (acres)	Permanent Loss of WoUS (acres)	Meets Overall Project Purpose?
	Cost (Amount)	Logistics	Technology				
Alternative 10	Yes ($591M)	Yes	Yes	Yes	4.52	0	Yes
Alternative 13	Yes ($708M)	Yes	Yes	Yes	26.84	0	Yes
Alternative 13v	Yes ($703M)	Yes	Yes	Yes	26.84	0	Yes
Alternative 16	Yes ($1,050M)	Yes	Yes	Yes	49.21	0	Yes
Alternative 20	Yes ($1,309M)	Yes	Yes	Yes	65.61	0	Yes
No Federal Action Alternative	N/A	N/A	N/A	No	0	0	No

5.0 Environmental Effects

5.1 Effects on Aquatic Resources

The potential impacts of the construction associated with all action alternatives have been analyzed in the IFR.

The purpose of the Section 404(b)(1) Guidelines is to restore and maintain the chemical, physical, and biological integrity of the waters of the U.S. through the control of discharges of dredged or fill material. Except as provided under CWA Section 404(b)(2), no discharge of dredged or fill material will be authorized if there is a practicable alternative to the proposed discharge that would have less adverse impact on the aquatic ecosystem, as long as the alternative does not have other significant adverse environmental consequences. In accordance with the Section 404(b)(1) Guidelines, the potential short-term or long-term effects of a proposed discharge of dredged or fill material on the physical, chemical, and biological components of the aquatic environment must be determined.

All action alternatives would entail the discharge of fill material into waters of the U.S. The following discussion evaluates impacts of all action alternatives on environmental resources identified in Subpart C through Subpart F of the Section 404(b)(1) Guidelines.

5.2 Effects on Non-Aquatic Resources

All action alternatives would result in significant impacts to:

- **Land Use:** Restoration of the LATC site and other properties in Reach 8 would result in a conflict with the existing industrial land use designation, constituting a significant impact to land use. See Section 5.3 of the IFR. Alternative 20 would also convert lands designated industrial to restored habitat in Reach 3, constituting a significant impact to land use.

5.3 Potential Direct and Secondary Impacts on Physical and Chemical Characteristics of the Aquatic Ecosystem (Subpart C)

Substrate

Construction: All alternatives would entail excavation or disturbance of substrate during the construction process. In some cases, excavated materials would be replaced with materials such as natural substrate and vegetation that would support the proposed habitat restoration measures. In other cases, fill material such as concrete would be discharged to create grade stabilizers or similar features at key transition points to ensure that flood damage reduction is not impaired. Native substrates that are supportive of riparian or wetland vegetation will be left in place to the degree possible.

Alternative 10 would have minimal disturbance on existing substrates at or below the OHWM, and would require minimal permanent fill. Excavation of the channel wall and some soil removal would occur to allow upstream and downstream River connections to a proposed side channel at Griffith Park. Approximately 100 cy of concrete and topsoil would be removed at each of the connections for a total of 200 cy of excavated substrate. Each connection would be backfilled with approximately 50 cy of clean topsoil and riprap and/or concrete for a total of approximately 100 cy of permanent fill. These and all other construction areas would be temporarily isolated from the River during construction by installation of k-rails or sandbags, resulting in up to 4,440 linear feet of temporary fill. It is estimated that these materials would be used in the River channel for no more than one month at any given location, after which this temporary fill would be removed.

Under Alternative 10, up to 12 acres of new waters of the U.S. would be created at Taylor Yard by excavating and permanently removing approximately 145,381 cy of mostly earthen substrate to lower the channel banks, reconnecting the River with a portion of the historic floodplain. Revegetating this area would require backfilling with up to 8,066 cy of clean topsoil, meaning that on balance the prism of waters of the U.S. would increase by up to 137,315 cy at this location. Backfilling would not entail discharge into waters of the U.S. since the temporary isolation of the construction area would prohibit establishment of the OHWM. Both the excavation and backfill would occur in order to allow wetland and riparian conditions to develop.

Alternative 13 would include the measures described under Alternative 10, and would include additional measures that would increase the amount of permanent substrate removal, permanent backfill, and temporary fill. Additional excavation of 79,723 cy of concrete and soil would occur by lowering the channel banks at Arroyo Seco, and additional backfilling with 3,000 cy of clean topsoil would then occur at this location. Toe of the bank on both sides would be moved outward to create a vertical wall and widen the Riverbed in Reach 5. Twelve storm drains would

be daylighted. An additional side channel would be created, which would double both the permanent and temporary fill and excavation amounts relative to Alternative 10, but which would also double the amount of waters of the U.S. in the newly created side channels. In newly created waters of the U.S., engineered substrates such as concrete, asphalt, or corrugated metal pipe as well as compacted earthen substrates would be replaced with earthen vegetated substrate similar to those found in natural riparian systems. Within existing waters of the U.S., concrete would be discharged for the construction or modification of existing outfalls. Therefore, in many instances the change in substrate would be like-for-like.

Vegetating the channel walls would require permanent fill in the form of pre-seeded turf reinforcements matting, which is a thin geotextile mesh that is installed to allow for retention of soil and vegetation in relatively steep areas. This mesh would cover approximately 84,650 square yards (sy) of waters of the U.S. and would be anchored by approximately 3,600 cy of rock. Both the pre-seeded turf reinforcements matting and rock would constitute permanent fill, but would allow wetland vegetation to occur in areas that are now covered by concrete.

Alternative 16 would include the same measures as Alternative 13, and additional measures that would increase the amount of both permanent substrate removal, permanent backfill, and temporary fill. The toe of the bank would be moved outward to create a vertical wall and widen the Riverbed in Reach 5. Twelve storm drains would be daylighted. Addition of a side channel relative to Alternative 13 would increase the amount of permanently removed concrete and topsoil by excavating an additional inlet and outlet, and would increase the amount backfill with stabilizing rock and/or concrete in these locations. Temporary fill would also increase in the form of sandbags or k-rails to allow for dewatering at construction areas. An additional 14,520 sy of pre-seeded turf reinforcements matting would be installed in Reach 5, and would be anchored by 778 cy of rock, constituting permanent fill to allow for retention of soil and vegetation. K-rails or sandbags would be installed at 11 locations to allow for dewatering, and would constitute temporary fill. Backfilling with clean topsoil to allow for wetland and riparian vegetation establishment would occur at 3 locations, all of which would be newly created waters of the U.S. that were isolated from the River by dewatering devices.

Terracing banks would allow for increased wetland and riparian vegetation in Reach 5 and at LATC. This measure would entail both excavation of existing materials, primarily concrete, and backfill with both concrete and clean topsoil. Temporary fill in the form of sandbags or k-rails would also occur at these locations. Additional waters of the U.S. would be created by modifying the trapezoidal channel. The toe of the bank would be moved outward to create a vertical wall and widen the Riverbed in Reach 5. Backfill would occur at this location to stabilize the bank, but would occur in newly created waters of the U.S. which would be isolated from the River by dewatering structures, such as k-rails or sandbags. Dewatering structures at this location would add approximately 8,450 lf of temporary fill.

In these existing and newly created waters of the U.S., engineered substrates such as concrete, asphalt, or corrugated metal pipe as well as compacted earthen substrates would be replaced with earthen vegetated substrate similar to those found in natural riparian systems. Within existing waters of the U.S., concrete would be discharged for the construction or modification of existing outfalls. Therefore, in many instances the change in substrate would be like-for-like.

Alternative 20 would entail all measures specified above, and increase the amount of waters of the U.S. over Alternative 16, including by widening the trapezoidal channel in Reach 2 and excavating upland areas to create wetland and riparian habitat at the Verdugo Wash confluence in Reach 3. Thirteen storm drains would be daylighted. Within Reach 7, streams would be daylighted and wetlands be created and channel banks modified at the Arroyo Seco confluence and the LASHP. Permanent and temporary fill would be most extensive under this alternative, as would creation of new waters of the U.S.

In these existing and newly created waters of the U.S., engineered substrates such as concrete, asphalt, or corrugated metal pipe as well as compacted earthen substrates would be replaced with earthen vegetated substrate similar to those found in natural riparian systems. Within existing waters of the U.S., concrete would be discharged for the construction or modification of existing outfalls. Therefore, in many instances the change in substrate would be like-for-like.

Alternative 13v would include all measures and impacts of Alternative 13. Moreover, Alternative 13v would add restoration measures in Reach 7 identical to those proposed under Alternative 20. Within Reach 7, streams would be daylighted; wetlands would be created; embankments would be terraced; and channel banks would be modified.

In these existing and newly created waters of the U.S., engineered substrates such as concrete, asphalt, or corrugated metal pipe as well as compacted earthen substrates would be replaced with earthen vegetated substrate similar to those found in natural riparian systems. Within existing waters of the U.S., concrete would be discharged for the construction or modification of existing outfalls. Therefore, in many instances the change in substrate would be like-for-like.

Under all action alternatives, invasive species would be removed throughout the project area, including the River channel and tributary bottom. Invasive species in channel within the project area would typically be removed by hand tools. Thus, the activity would not result in discharges of fill in most instances and the existing substrate would be left intact. In cases where limited earthmoving may be required, there would be discharges of earthen fill. However, the fill would be identical to the existing native substrate.

Secondary effects of the fill would be de minimis for all alternatives. Concrete, rocks, and soils discharged in waters of the U.S. would not be substantially different from the existing concrete, rocks, and soils at the site.

Operation: Maintenance activities within waters of the U.S. for all action alternatives may require use of excavators, backhoes, or grapple trucks for removal of trash, debris, and sediment. Invasive species removal throughout the project footprint, including the River channel and tributary channel bottom, would typically be performed with hand tools. Thus, the activity would not result in discharges of fill in most instances. In cases where limited earthmoving may be required, there would be discharges of earthen fill. However, the fill would be identical to the existing native substrate. Maintaining design grades, elevations, contours, and conveyance may require limited earthmoving activities on a periodic basis. In such cases there may be discharges of fill material associated with the use of earthmoving equipment, such as bulldozers, within newly established waters of the U.S. Impacts will be temporary in nature. In other cases, like-for-like structural repair below the OHWM could result in permanent discharges of fill material

into waters of the U.S. However, temporary or permanent discharges of fill would not decrease the amount of existing or newly established waters of U.S.

Secondary effects of the fill would be de minimis for all maintenance activities. Concrete, rocks, and soils discharged in waters of the U.S. would not be substantially different from the existing concrete, rocks, and soils at the site.

Suspended particulates and turbidity

Construction: Alternative 10 would require construction activities within waters of the U.S. Work areas within the channel invert would be isolated from flows with k-rails or sandbags during construction. In total, Alternative 10 would result in the temporary discharge of approximately 4,444 lf of the k-rails. Movement of vehicles across earthen substrate during the placement and removal of dewatering structures would temporarily elevate turbidity in the water column. When fully isolated from surrounding flows, work within River would result in minimal or no increases in turbidity.

Alternative 13 would require construction activities within waters of the U.S. Work areas within the channel invert would be isolated from flows with k-rails or sandbags during construction. In total, Alternative 13 would result in the temporary discharge of approximately 24,544 lf of the k-rails. Movement of vehicles across earthen substrate during the placement and removal of dewatering structures would temporarily elevate turbidity in the water column. When fully isolated from surrounding flows, work within River would result in minimal or no increases in turbidity.

Alternative 16 would require construction activities within waters of the U.S. Work areas within the channel invert would be isolated from flows with k-rails or sandbags during construction. In total, Alternative 16 would result in the temporary discharge of approximately 61,276 lf of the k-rails. Movement of vehicles across earthen substrate during the placement and removal of dewatering structures would temporarily elevate turbidity in the water column. When fully isolated from surrounding flows, work within River would result in minimal or no increases in turbidity.

Alternative 20 would require construction activities within waters of the U.S. Work areas within the channel invert would be isolated from flows with k-rails or sandbags during construction. In total, Alternative 20 would result in the temporary discharge of approximately 118,639 lf of the k-rails. Movement of vehicles across earthen substrate during the placement and removal of dewatering structures would temporarily elevate turbidity in the water column. When fully isolated from surrounding flows, work within River would result in minimal or no increases in turbidity.

Alternative 13v would include all measures and impacts of Alternative 13 in Reaches 1-6 and 8. Moreover, Alternative 13v would include restoration measures in Reach 7 identical to those proposed under Alternative 20. Within Reach 7, streams would be daylighted; wetlands would be created; embankments would be terraced; and channel banks would be modified. When fully isolated from surrounding flows, work within River would result in minimal or no increases in turbidity.

Secondary effects of the fill would mostly be identical for all alternatives. Concrete and rocks discharged into waters of U.S. would not increase turbidity. The increase in soft bottom waters of the U.S. would likely increase the potential for turbidity beyond existing baseline levels. The potential increase would be commensurate with increased project footprints. However, most of the soft bottom areas would be vegetated. The vegetation would attenuate turbidity levels. Secondary impacts over the long-term would be minimal.

The amount of in-channel work would increase from Alternative 10 through Alternative 20. However, active construction areas would be dewatered and isolated from active flows to minimize water quality impacts. Furthermore, adherence to the storm water pollution prevention plan (SWPPP) and permitting requirements, and implementation of best management practices (BMPs) described in Section 5.6 of the IFR, would further reduce water quality impacts. Furthermore, because most of the surfaces in the River channel are hardened, channel modifications are not expected to result in water quality impacts due to excessive erosion, scour, and head cuts. Thus, long term impacts to water quality across all alternatives are expected to be approximately the same.

Under all action alternatives, invasive species would be removed throughout the project area, including the River channel and tributary bottom, during construction. Invasive species in the channel would typically be removed by hand tools. Thus, the activity would not result in discharges of fill in most instances and there would be no temporary increases in turbidity. In cases where limited earthmoving may be required, there would be discharges of earthen fill. However, any increase in turbidity would be temporary.

Secondary effects of the fill would mostly be identical for all alternatives. Concrete and rocks discharged into waters of U.S. would not increase turbidity. The increase in soft bottom waters of the U.S. would likely increase the potential for turbidity beyond existing baseline levels. The potential increase would be commensurate with increased project footprints. However, most of the soft bottom areas would be vegetated. The vegetation would attenuate turbidity levels. Furthermore, much of the permanent fill would also be chemically inert, and would consist of materials such as concrete, rock from a certified source, or pre-seeded turf reinforcement matting, none of which would leach contaminants into the water column. Topsoil would be acquired from a certified contaminant-free source, and would be free of most weed seeds and free of hazardous toxic, and radioactive wastes (HTRW) or other contaminants. Thus, potential for long-term leaching of contaminants into the water column would be minimal.

Operation: Maintenance activities within waters of the U.S. may require use of excavators, backhoes, or grapple trucks for removal of trash, debris, and sediment. Invasive species removal throughout the project footprint, including the River channel and tributary channel bottom, would typically be performed with hand tools. Thus, the activity would not result in discharges of fill in most instances. In cases where limited earthmoving may be required, there would be discharges of earthen fill. However, the fill would be identical to the existing native substrate. Maintaining design grades, elevations, contours, and conveyance may require limited earthmoving activities on a periodic basis. In such cases, there may be discharge of fill material associated with the use of earthmoving equipment, such as bulldozers, within newly established waters of the U.S. Impacts will be temporary in nature. In other cases, like-for-like structural repair below the OHWM could result in permanent discharges of fill material. However,

temporary or permanent discharges of fill material would not decrease the amount of existing or newly established waters of U.S.

Maintenance may require use of excavators, backhoes, or grapple trucks for removal of trash, debris, and sediment. Maintenance activities requiring in-water work would likely require the use of water diversion structures, such as k-rails or sandbags. Movement of vehicles across earthen substrate during the placement and removal of dewatering structures would temporarily elevate turbidity in the water column. When fully isolated from surrounding flows, maintenance work within aquatic areas would result in minimal or no increases in turbidity.

Secondary effects of the fill associated with maintenance activities would be minimal. Discharge of concrete or rocks within waters of the U.S. would be associated with associated with like-for-like repairs. Thus, impacts would be small in scope. Furthermore, concrete and rocks discharged into waters of U.S. would not increase turbidity. Vegetation within restoration elements would attenuate turbidity from soils. Discharge of soils would also be limited in scope. Furthermore, much of the permanent fill would also be chemically inert, and would consist of materials such as concrete, rock from a certified source, or pre-seeded turf reinforcement matting, none of which would leach contaminants into the water column. Topsoil would be acquired from a certified contaminant-free source, and would be free of most weed seeds, and free of HTRW, or other contaminants. Thus, potential for long-term leaching of contaminants into the water column would be minimal.

Contaminants

Construction: All temporary fill would be chemically inert and would consist of either concrete k-rails or sandbags comprised of clean sand obtained from a source that is certified in providing contaminant-free materials. Much of the permanent fill would also be chemically inert, and would consist of materials such as concrete, rock from a certified source, or pre-seeded turf reinforcement matting, none of which would leach contaminants into the water column. Topsoil would be acquired from a certified contaminant-free source, and would be free of most weed seeds, HTRW, or other contaminants.

All alternatives would entail excavation at or below the OHWM, potentially allowing for release or suspension of contaminants at or below the ground surface into the water column. All HTRW impacted soil within the project footprint must be remediated to the requirements of the local environmental regulatory agencies and be compatible with the future land uses for and needs of the restoration project prior to the City of Los Angeles providing those lands to the restoration project. At this time, those areas with HTRW impacted soil to be addressed by the City of Los Angeles are anticipated to be the Taylor Yard G1 and G2 sites and the LATC. In addition, groundwater contamination is known to be present due to the San Fernando Valley Superfund Site (SFVSS), and other localized groundwater contamination may also be present. With respect to groundwater contamination that cannot be remediated prior to construction, the City of Los Angeles will design, implement, coordinate and fully fund all treatment and disposal of contaminated groundwater during construction, with regulator concurrence and any necessary permits. These temporary operations should also be consistent with current management of contaminated groundwater at SFVSS and Pollock Well Field. Furthermore, all work areas would be isolated from the River during construction, and storm water runoff at construction locations would be contained according to SWPPP conditions.

Use of construction vehicles increases the potential for accidental release of fuels, solvents, or other petroleum-based contaminants. Although releases of such substances in any part of the construction footprint could drain to the River and thereby affect aquatic resources, releases in the overbank area are most removed from the River and most likely to be contained and removed before reaching the River, compared to releases occurring below the top of the bank. Also, under any alternative, BMPs designed to minimize the potential for release of toxic substances will be implemented. These BMPs are listed in Section 5.11.4 of the IFR.

Under Alternative 10, most of the ground-disturbing work and work involving heavy machinery will occur in the overbank area, outside of the River channel. As with all alternatives, some use of machinery in the channel is anticipated to assist in removing invasive species and to install dewatering equipment. Additional ground-disturbing work and use of construction equipment in the River channel would occur in Reach 4 to create an inlet and outlet for a side channel, and in Reach 6 to lower the channel banks.

Alternative 13 would require ground-disturbing work and use of construction equipment at up to 6 locations within the River channel, not including invasive species removal areas. Measures under this alternative that could increase the potential for releases of contaminants from ground sources into waters of the U.S. include the same measures as under Alternative 10, as well as creation of additional side channels and additional lowering of channel banks.

Alternative 16 would require ground-disturbing work and use of construction equipment at up to 12 locations within the River channel, not including invasive species removal areas. Measures under this alternative that could increase the potential for releases of contaminants from ground sources into waters of the U.S. include the same measures as under Alternative 13, as well as creation of additional side channels, additional lowering of channel banks, terracing banks, and modifying the trapezoidal channel to vertical banks.

Alternative 20 would require ground-disturbing work and use of construction equipment at up to 15 locations within the River channel, not including invasive species removal areas. Measures under this alternative that could increase the potential for releases of contaminants from ground sources into waters of the U.S. include the same measures as under Alternative 16, and would excavate upland area at the mouth of Verdugo Wash in Reach 3 to create additional wetland and riparian habitat.

Alternative 13v would include all measures and impacts of Alternative 13 in Reaches 1-6 and 8. Moreover, Alternative 13v would include restoration measures in Reach 7 identical to those proposed under Alternative 20. Within Reach 7, streams would be daylighted; wetlands would be created; embankments would be terraced; and channel banks would be modified. Ground-disturbing work will be undertaken at Arroyo Seco-River confluence and LASHP.

The potential for accidental release of contaminants from construction equipment into the water column increases as the amount of in-channel work increases. However, impacts would be short term and would be minimized with the implementation of BMPs, such as use of water diversion structures or regulatory requirements such as SWPPPs. Per requirements of ER 1165-2-132 discussed above, long term release of HTRW into the water column under all alternatives would be unlikely.

Under all action alternatives, invasive species would be removed throughout the project area, including the River channel and tributary bottom, during construction. Invasive species in the channel would typically be removed by hand tools. Thus, the activity would not result in discharges of fill in most instances. In cases where limited earthmoving may be required, there would be discharges of earthen fill. However, the fill would be identical to the existing native substrate.

Secondary effects of the fill would mostly be identical for all alternatives. Much of the permanent fill would also be chemically inert, and would consist of materials such as concrete, rock from a certified source, or pre-seeded turf reinforcement matting, none of which would leach contaminants into the water column. Topsoil would be acquired from a certified contaminant-free source, and would be free of most weed seeds; HTRW, or other contaminants. Thus, potential for long-term leaching of contaminants into the water column would be minimal.

Operation: Maintenance activities within waters of the U.S. may require use of excavators, backhoes, or grapple trucks for removal of trash, debris, and sediment. Invasive species removal throughout the project footprint, including the River channel and tributary channel bottom, would typically be performed with hand tools. Thus, the activity would not result in discharges of fill in most instances. In cases where limited earthmoving may be required, there would be discharges of earthen fill. However, the fill would be identical to the existing native substrate. Maintaining design grades, elevations, contours, and conveyance may require limited earthmoving activities on a periodic basis. In such cases, there may be discharges of fill material associated with the use of earthmoving equipment, such as bulldozers, within newly established waters of the U.S. Though minimal, there is potential for accidental release of petroleum based products from construction equipment into the water column during maintenance activities. However, impacts would be short term and would be minimized with the implementation of BMPs such as use of water diversion structures or regulatory requirements, such as SWPPPs.

Secondary effects of the fill associated with maintenance activities would be minimal. Discharge of concrete, rocks, or soils within waters of the U.S. would be associated with associated with like-for-like repairs. Thus, impacts would be small in scope. Much of the permanent fill would also be chemically inert, and would consist of materials such as concrete, rock from a certified source, or pre-seeded turf reinforcement matting, none of which would leach contaminants into the water column. Topsoil would be acquired from a certified contaminant-free source, and would be free of most weed seeds and free of HTRW or other contaminants. Thus, potential for long-term leaching of contaminants into the water column would be minimal.

Water Flow

Construction: For all alternatives, restoration measures would be designed to not impair flood risk management functions in any portion of the study area or areas downstream. It is assumed that in-channel construction and modification of the project reaches would be conducted outside of the winter storm season (April 15 - October 15) to avoid wet weather storm flows, or that work areas would be adequately protected and not affect flood conveyance. In areas where in-channel construction would occur, diversions would be implemented to bypass dry weather flows downstream. Base flows may be temporarily affected in the immediate construction zone, but would not be affected upstream or downstream of the study area.

Under all alternatives, modifications to the channel will not increase the maximum water surface elevation. Under all alternatives, modifications to the channel are not expected to result in substantial changes to water velocity and circulation. While initial assessment identified that an increase in water surface elevation could occur at transition areas (areas where the channel has geometric changes (transitioning from trapezoidal to rectangular or from a widened section to a narrow section) or changes in construction material (transitioning between soft-bottom and concrete)) if no design refinements were made, the detailed design will ensure the maximum water surface elevations will not increase when compared to the existing conditions. Any change in water surface in the transition areas will be avoided through design refinements to the project modifications to channel geometry and/or avoidance of introduction of vegetation and enforcing O&M requirements limiting vegetation growth in those areas. Additional hydraulic analysis will be conducted and design modifications will be implemented during the design phase to provide more detail on the channel hydraulics with the recommended plan in place. Under all the alternatives, with implementation of such design refinements, there will be no increase in flood damages through the project area as compared to existing conditions.

Under all action alternatives, invasive species would be removed throughout the project area, including the River channel and tributary bottom, during construction. Invasive species in the channel would typically be removed by hand tools. Thus, the activity would not result in discharges of fill in most instances. In cases where limited earthmoving may be required, there would be discharges of earthen fill. Removal of invasive vegetation from in-channel areas would facilitate conveyance of flows and would not increase flood risks.

Operation: Maintenance activities within waters of the U.S. required to maintaining design flow velocity and water surface elevations would primarily entail vegetation maintenance especially in areas where ecosystem restoration features transition to flood risk management elements of LACDA. An operation and maintenance would be developed as part of the project. Full implementation of the maintenance regimen would ensure that maintenance activities do not impact flow velocity, circulation, and water surface elevation.

Maintaining design grades, elevations, contours, and conveyance may require limited earthmoving activities on a periodic basis. In such cases there may be discharge of fill associated with the use of earthmoving equipment such as bulldozers or temporary stockpiling within newly established waters of the U.S. Impacts will be temporary in nature. In other cases, like-for-like structural repair below the OHWM could result in permanent discharges of fill material into waters of the U.S. However, temporary or permanent discharges of fill would not change the design elevations or contours. Invasive species removal throughout the project footprint, including the River channel and tributary channel bottom, would typically be performed with hand tools. Thus, the activity would not result in discharges of fill in most instances. In cases where limited earthmoving may be required, there would be discharges of earthen fill. However, the fill would be identical to the existing native substrate. Removal of invasive vegetation from the project footprint would facilitate conveyance of flows and would not increase flood risks. Thus, changes in velocity and circulation are not expected.

Cumulative Impacts

Due to the reduced flood risks subsequent to the channelization of the River, development increased within the vicinity of the study area, with residential, commercial, and industrial uses

abutting the channel. As development increased, the channel was further modified for bridge crossings, utility crossings, and construction of storm drain outfalls. In addition, maintenance activities were conducted. These modifications and maintenance activities resulted in the discharge of concrete structural fill below the OHWM. Since the River was channelized, concrete-on-concrete discharges would not have resulted in significant impacts to substrate.

Previous construction likely resulted in temporary impacts to water quality during construction. However, increased development in the uplands has resulted in long-term water quality impairments from nuisance flows. The River is consistently listed on the CWA Section 303(d) List from 1998-2010 for water quality impairments. The 2010 Integrated Report CWA Section 303(d) List indicates that the water quality of the River traversing the study area is impaired due to presence of ammonia, copper, lead, algae, and trash.

All action alternatives would entail direct impacts on the physical and chemical characteristics of the aquatic ecosystem due to the discharge of temporary and permanent fill. Furthermore, the potential for impacts to water quality, circulation, and water surface elevations from construction and maintenance would increase from Alternative 10 to Alternative 20 as the amount of in-channel work and required maintenance incrementally increases. However, with implementation of design refinements increase in water surface elevations across all alternatives would be attenuated to a sufficiently acceptable level that would not compromise the flood risk management functions of the River. Furthermore, with implementation of BMPs to fully isolate work areas from surrounding flows, and implementation of SWPPPs, short-term impacts to water quality would be minimal and remain the same across all action alternatives.

Under all action alternatives, there would be incidental benefits to functions of the aquatic environment through increase adsorption and absorption of contaminants. Furthermore, there would be increased structural and functional heterogeneity as concrete structures are modified into vegetative connections, side channels, and in some cases restoration of restoration of full floodplain connectivity within particular reaches. See Section 5.4 of the IFR for further information.

Under all action alternatives, invasive species would be removed throughout the project area, including the River channel and tributary bottom, during construction. Invasive species in the channel would typically be removed by hand tools. Thus, the activity would not result in discharges of fill in most instances and there would be no temporary increases in turbidity. In cases where limited earthmoving may be required, there would be discharges of earthen fill. Impacts to turbidity would be minimal. There would be no impacts to substrate, contaminants or flow characteristics.

In addition to project construction, constructed ecosystem features would be maintained and invasives management conducted throughout the project footprint under all alternatives. Furthermore, the Corps would continue to conduct maintenance for flood risk management operation of the LACDA project in the channel areas outside the restoration features except for invasives removal throughout the in-channel areas. Maintenance would continue to include native vegetation management. Under both maintenance programs there may be discharge of fill associated with the use of earthmoving equipment such as bulldozers or temporary stockpiling within existing or newly established waters of the U.S. Impacts will be temporary in nature. In other cases, like-for-like structural repair below the OHWM could result in permanent discharges

of fill material into waters of the U.S. However, temporary or permanent discharges of fill would not change the design elevations or contours. Thus, changes in velocity and circulation are not expected.

Removal of invasive vegetation from the project footprint, including the River channel and tributary channel bottom, would typically be performed with hand tools. Thus, this activity is not expected to result in discharges of fill in most instances. In cases where limited earthmoving may be required, there would be discharges of earthen fill. Such fill would be identical to the existing native substrate. Impacts to turbidity would be minimal. There would be no impacts to substrate, contaminants or flow characteristics.

The channel is currently surrounded by a developed urban landscape consisting of commercial, public, and residential uses in adjacent areas. As a result, present and future projects in the uplands within the study area would likely entail redevelopment or conversion of existing land uses. Minor modifications to the River channel associated with construction, modifications, and maintenance of existing and future infrastructure such as bridges and utilities are anticipated. Changes to circulation, velocity, and water surface elevations would be mitigated as appropriate for actions requiring Rivers and Harbors Act Section 408, 33 U.S.C. 408, approvals and reviews. Impacts to water quality would be temporary and would be attenuated through CWA Section 401 and Section 404 requirements.

With a renewed public interest in the revitalized River, additional projects within the study area are likely. Future projects include the Atwater Pedestrian-Equestrian Bridge and the Los Angeles Waterwheel. Construction would temporarily affect water quality. However, land uses are expected to remain urban. Thus, the existing water quality impairments are unlikely to change substantially. Therefore, construction of the ecosystem restoration project would not result in cumulative significant impacts to the physical and chemical characteristics of the aquatic ecosystem. See Chapter 5 if the IFR for additional discussion on cumulative impacts.

5.4 Potential Direct and Indirect Impacts on Biological Characteristics of the Aquatic Ecosystem (Subpart D)

Threatened and Endangered Wildlife

Construction: The only listed species with a potential to occur in the study area is the least Bell's vireo, a federally listed bird species associated with the riparian areas. The study area does not include any designated critical habitat for vireo. Due to the linear and confined nature of existing habitat and the lack of breeding pairs in the most recent survey conducted in 2009, presence of the vireo is unlikely. Pre-construction surveys would be performed with all the action alternatives. If nesting vireos are found, construction in those areas would be halted until the Corps completes consultation with the U.S. Fish and Wildlife Service (USFWS) under the Endangered Species Act. Construction in areas not occupied with vireo would continue as scheduled. At this time, however, the Corps has determined that no effects to listed species will occur under any of the action alternatives. Please refer to Section 5.5.3 of the IFR for additional discussion. No other special status species are expected to occur due to the degraded conditions within the study area and lack of suitable habitat.

During construction, noise and presence of visual forms associated with an active construction site may discourage establishment of nests or foraging within the vicinity of the construction footprint. Under all action alternatives, invasive species would be removed from the project footprint, including the River and tributary channel bottoms, during construction.

However, construction would not occur simultaneously within the entire project area. The construction footprint would migrate from one location to another over a number of years through the project area. As a result, avian and wildlife species within the active construction zone should be able to relocate to and utilize unaffected areas. Upon completion of construction, presence of native vegetation within the restoration project footprint would indirectly benefit wildlife by restoring regional connectivity to the Santa Monica Mountains, San Gabriel Mountains, and the Verdugo Mountains.

Operation: Maintenance activities within waters of the U.S. required for maintaining habitat restoration or recreational features would primarily entail vegetation maintenance especially in areas where ecosystem restoration features transition to flood risk management elements of LACDA. Maintaining design grades, elevations, contours, and conveyance may require limited earthmoving activities on a periodic basis. In such cases there may be discharges of fill material associated with the use of earthmoving equipment such as bulldozers or temporary stockpiling within existing or newly established waters of the U.S. Impacts will be temporary in nature. In other cases, like-for-like structural repair below the OHWM could result in permanent discharges of fill material into waters of the U.S. However, temporary or permanent discharges of fill material would not change the design elevations or contours.

The only listed species with a potential to occur in the study area is the least Bell's vireo, a federally listed bird species associated with the riparian areas.

The Corps has determined that there will be no effect to least Bell's vireo from operations of the proposed project. Removal of non-native vegetation and trimming of in-channel vegetation to maintain flood conveyance would occur outside the breeding season. Overall, operations will support the establishment and expansion of native riparian vegetation in the restored areas, which has the potential to support future populations of vireo, and may support foraging and stop over habitat for southwestern willow flycatcher and coastal California gnatcatcher. Presence/absence surveys for these species will be performed during operation of the proposed project as part of the Monitoring and Adaptive Management Plan. The Corps and non-Federal sponsor will continue to coordinate with the U.S. Fish and Wildlife Service and the California Department of Wildlife during operations of the proposed project.

Vegetation management activities, including removal of invasive vegetation from the project footprint, including the River channel and tributary bottom, would be scheduled outside of migratory bird nesting season to the extent practicable. However, vegetation management or other types of maintenance may be required during the nesting season in order to maintain design flow velocities; water surface elevations; and conveyance capacity. In such cases, pre-construction surveys for the vireo would be performed prior to maintenance activities. If nesting vireos are found, maintenance activities would be coordinated with a qualified biologist to avoid take, or consultation with the USFWS would first be required.

No other special status species are expected to occur due to the degraded conditions within the study area and lack of suitable habitat. Impacts to threatened and endangered species are not expected to occur.

During maintenance activities, noise and presence of visual forms associated with an active construction site may discourage establishment of nests or foraging within the vicinity of the work area. However, the duration of maintenance activities would be approximately 30 days. Furthermore, the work area would be small and would migrate from one location to another as needed. Other vegetated areas within the ecosystem restoration project and the flood risk minimization project will continue to be available for nesting and foraging. As a result, there would be no indirect impacts to the vireo or other avian species within the project area. Maintenance of the ecosystem restoration elements would indirectly benefit wildlife by maintaining established regional connectivity to the Santa Monica Mountains, San Gabriel Mountains, and the Verdugo Mountains.

Other Wildlife

Construction: Wildlife species that utilize the open aquatic areas, wetlands, and riparian areas along the River channel may be temporarily impacted by construction in those areas, and will experience long-term beneficial impacts from restoration in those areas. In general, species present in the study area are those that are opportunistic and/or habituated to human presence. These species are able to move to alternative locations if they are disturbed by construction activities and, therefore, are not anticipated to be impacted adversely. Alternative 10 would result in the least overall temporary impacts to wildlife, while each subsequent alternative would result in incremental increases in temporary impacts and benefits to wildlife. BMPs would be implemented under all action alternatives to avoid or minimize impacts to wildlife during construction, including but not limited to:

- Vegetation clearing activities would be avoided to the maximum extent practicable in any areas identified as breeding or nesting habitat for any bird species during the breeding season, which generally runs from March 1-August 31.
- If vegetation removal must occur during the breeding season, a qualified biologist would perform nesting bird surveys following established protocol prior to construction. If nests are detected during these surveys, a 300-foot no construction buffer would be delineated around the nest (500 feet for raptors).
- Construction in breeding areas would be monitored by a qualified biologist.
- Construction would be phased to minimize impacts to wildlife species, so that the entire study area would not be under construction all at once to minimize human intrusion.

Under all action alternatives, invasive species would be removed throughout the project area, including the River channel and tributary bottom, during construction. Invasive species in the channel have typically been removed by hand tools. Thus, the activity would not result in discharges of fill in most instances. In cases where limited earthmoving may be required, there would be discharges of earthen fill. All BMPs listed above would be implemented during invasive vegetation removal operations.

There would be no permanent loss of native habitat or impacts to wildlife under any action alternatives. Thus, no significant adverse impacts will result. All action alternatives will result

in beneficial impacts to the aquatic ecosystem through the expansion of open water area, soft river bottom area, riparian zones, wetlands, and connection to side channels and tributaries. Beneficial impacts would be commensurate with the footprint of restoration. Thus, long-term beneficial impacts will increase with Alternatives 13, 13v, and 16, with the greatest amount of beneficial impact occurring under Alternative 20.

Operation: Maintenance activities within waters of the U.S. required for maintaining habitat restoration or recreational features would primarily entail vegetation maintenance especially in areas where ecosystem restoration features transition to flood risk management elements of LACDA. Invasive species removal throughout the project footprint, including the River channel and tributary channel bottom, would typically be performed with hand tools. Thus, the activity would not result in discharges of fill in most instances. In cases where limited earthmoving may be required, there would be discharges of earthen fill. However, the fill would be identical to the existing native substrate.

Maintaining design grades, elevations, contours, and conveyance may require limited earthmoving activities on a periodic basis. In such cases there may be discharges of fill associated with the use of earthmoving equipment such as bulldozers or temporary stockpiling within existing or newly established waters of the U.S. Impacts will be temporary in nature. In other cases, like-for-like structural repair below the OHWM could result in discharges of permanent fill. However, temporary or permanent discharges of fill material would not change the design elevations or contours.

Wildlife species that utilize the open aquatic areas, wetlands, and riparian areas along the River channel may be temporarily impacted by noise and temporary changes in the acreage of invasive vegetation as well as height and density of all vegetation. In general, species present in the study area are those that are opportunistic and/or habituated to human presence. These species are able to move to alternative locations if they are disturbed by construction activities and, therefore, are not anticipated to be impacted adversely. Maintenance of Alternative 10 would result in the least overall temporary impacts to wildlife, while maintenance of each subsequent alternative would result in incremental increases in temporary impacts to wildlife. BMPs would be implemented under all action alternatives to avoid or minimize impacts to wildlife during construction. There would be no permanent loss of habitat or impacts to wildlife under any action alternatives. Thus, no significant adverse impacts will result.

Aquatic Organisms

Construction: As indicated in Section 3.5.3 of the IFR, the study area supports nonnative fish species such as mosquito fish, catfish, and green sunfish, and carp throughout the study reach. Native fish species are not present. In-channel activities during construction will require dewatering. However, dewatering would only occur with phased construction designed to impact isolated areas for short periods of time. As with impacts to wildlife, temporary adverse impacts will be least in Alternative 10, increasing with each alternative, but overall would be temporary and not significant. There would be no permanent adverse impacts to aquatic organisms under any build alternative. Instead, with each increasing footprint in each alternative, a greater area of aquatic habitat will be created or enhanced, resulting in improved conditions for aquatic organisms. This indirectly benefits the rest of the fish and wildlife assemblage in the area through creating more abundant food sources.

Operation: Maintenance activities within waters of the U.S. required for maintaining habitat restoration or recreational features would primarily entail vegetation maintenance especially in areas where ecosystem restoration features transition to flood risk management elements of LACDA. Furthermore, the City of Los Angeles would also be responsible for removal of invasive species throughout the project footprint, including the River channel and tributary bottom. Invasive species within the project footprint would typically be removed by hand tools. Thus, in most instances there would be no impacts to aquatic organisms.

Maintaining design grades, elevations, contours, and conveyance may require in-water work on a periodic basis. In-water work would likely require the use of water diversion structures, such as k-rails or sandbags. Movement of vehicles across earthen substrate during the placement and removal of dewatering structures would temporarily elevate turbidity in the water column. When fully isolated from surrounding flows, maintenance work within aquatic areas would result in minimal or no increases in turbidity. As indicated in Section 3.5.3 of the IFR, the study area supports nonnative fish species such as mosquito fish, catfish, and green sunfish, and carp throughout the study reach. Native fish species are not present. As a result, impacts would result in de minimis impacts to fish population.

Vegetation

Construction: Within each alternative, a number of measures are designed to create additional riparian and wetland habitats, which are closely associated with water and may be indirectly affected by changes to water during construction or operation. During construction, in-water work may temporarily affect riparian vegetation. Impacts would be temporary. Due to the existing seed bank and perennial flow, affected vegetation is expected to recover soon after completion of construction. Under all action alternatives, invasive species would be removed throughout the project area, including the River channel and tributary bottom, during construction. Invasive species in the channel would typically be removed by hand tools. Thus, the activity would not result in discharges of fill in most instances. In cases where limited earthmoving may be required, there would be discharges of earthen fill. Invasive species removal would result in a more natural and functional plant community. There would be no permanent loss or impact to existing native vegetation under any action alternative. After construction is complete, under each alternative, new acres of riparian and wetland habitat would be present within the study area. Day lighting uplands culverts will create riparian corridors which will provide additional filtration of storm water entering the system. Riparian and wetland vegetation, along with vegetated embankments, will combine to increase shading of the River, which may reduce microclimate temperatures. Alternative 10 provides the least total area of new vegetation, with increasing areas in each subsequent Alternative, meaning that beneficial impacts increase with each alternative. Alternative 20 provides the greatest area of beneficial impacts.

Operation: Maintenance activities within waters of the U.S. for maintaining habitat restoration or recreational features would primarily entail vegetation maintenance especially in areas where ecosystem restoration features transition to flood risk management elements of LACDA. Invasive species removal throughout the project footprint, including the River channel and tributary channel bottom, would typically be performed with hand tools. Thus, the activity would not result in discharges of fill in most instances. In cases where limited earthmoving may be required, there would be discharges of earthen fill. However, the fill would be identical to the existing native substrate.

Vegetation maintenance would result in temporary changes in the acreage of invasive vegetation as well as the height and density of all vegetation. Maintaining design grades, elevations, contours, and conveyance may require in-water work on a periodic basis. Impacts to during construction would be temporary. Due to the existing seed bank and perennial flow, affected vegetation is expected to recover soon after completion of construction. Impacts would be temporary and less than significant.

Cumulative Impacts

The study area for biological resources includes the River watershed. The River was once a 51-mile-long backbone of a vast system of riparian foothill, riverine, and freshwater marsh habitat that carried seasonal rains and subterranean flows to the coastal plain and the Pacific Ocean. Over time, the River has been degraded by a cycle of increasing urban development, flooding, and channelization, culminating in the mid-20th Century with the LACDA system. The LACDA project encased the River in concrete banks and a mostly concrete bed, and straightened the river's course, thereby significantly diminishing its plant and wildlife diversity and quality, and disconnecting it from its floodplain and significant ecological zones. The entire River corridor is degraded due to historic activities.

During construction activities, noise and presence of visual forms associated with an active construction site may discourage establishment of nests or foraging within the vicinity of the work area. However, construction would not occur simultaneously within the entire project area. The construction footprint would migrate from one location to another over a number of years through the project area. As a result, avian and wildlife species within the active construction zone should be able to relocate to and utilize unaffected areas. Upon completion of construction, presence of vegetation within ecosystem restoration elements would indirectly benefit wildlife by restoring regional connectivity to the Santa Monica Mountains, San Gabriel Mountains, and the Verdugo Mountains. No other special status species are expected to occur due to the degraded conditions within the study area and lack of suitable habitat in the immediate future. Impacts to threatened and endangered species are not expected to occur.

In addition to project construction, constructed ecosystem features would be maintained under all alternatives. Furthermore, the City of Los Angeles would also be responsible for removal of invasive species from the project footprint, including the River channel and tributary bottom areas. The Corps would continue to be responsible for maintaining all other aspects of the portions of the LACDA project that overlap with the restoration project footprint.

Under both maintenance programs vegetation within LACDA project and the ecosystem restoration project would be managed in accordance with the respective operating manuals. Maintaining design grades, elevations, contours, and conveyance may require limited earthmoving activities on a periodic basis. During maintenance activities noise and presence of visual forms associated with an active construction site may discourage establishment of nests or foraging within the vicinity of the work area. However, the duration of maintenance activities for both projects would be approximately 30 days. Furthermore, the work area would be small and would migrate from one location to another as needed. Other vegetated areas within the ecosystem restoration project and the flood risk management project will continue to be available for nesting and foraging. As a result, avian and wildlife species within the active construction zone should be able to relocate to and utilize unaffected areas.

The restoration measures in Alternatives 10, 13, 13v, 16, and 20 would contribute to beneficial cumulative impacts to biological resources. These impacts would increase the amount of fish and wildlife habitat; provide greater ecological/biological benefits; aid in linking isolated habitats; help increase the amount of open space; help expand species diversity; and reduce the amount of impermeable surface area in the study area. These impacts would be beneficial from a regional perspective since they would benefit fish and wildlife species that may migrate outside of the study area. These benefits would also accrue to past, present, and reasonably foreseeable projects including the Albion Dairy Park, Griffith Park on the East Bank, Sennett Creek Park, and the Rio de Los Angeles State Parks that are located along or in the vicinity of the River. Cumulative impacts have been assessed in Chapter 5 of the IFR.

5.5 Potential Direct and Indirect Impacts on Special Aquatic Sites (Subpart E)

Sanctuaries and refuges

Construction: There are no sanctuaries or refuges designated under state or federal laws within the footprint of any of the action alternatives. Therefore, no alternative would directly or indirectly impact sanctuaries or refuges.

Operation: There are no sanctuaries or refuges designated under state or federal laws within the footprint of any of the action alternatives. Operations and maintenance would not directly or indirectly impact sanctuaries or refuges.

Wetlands

Construction: Wetlands are known to occur in the soft bottom areas in Reach 2 and in the Glendale Narrows (Reaches 4-6) and at the River-Verdugo Wash confluence. When there is low-energy, sediment-laden flow within these reaches, the sediments will occasionally form sandbars, and remain intact as flow diminishes. Wetland vegetation will establish temporarily on these sandbars until high flows wash them away. Wetland vegetation establishment will vary from year to year due to flows and ongoing LACDA maintenance activities. Because wetland vegetation in the channel does not expand jurisdictional waters and is highly variable, prior to each phase of construction, the project area would be surveyed for the current location of jurisdictional wetlands.

Aside from invasive species removal efforts, the only actions that would occur in the River channel under Alternative 10 would be creation of an inlet and outlet for a side channel in Reach 4 and lowering the channel banks to widen the River in Reach 6. Primary construction for these measures would occur relatively high on the River channel banks, away from any wetlands, which would be found at the bottom of the channel. Construction at the toe of the slope in Reach 6 could occur close to wetlands and may necessitate working in wetland areas, resulting in temporary adverse impacts to this resource. Construction would avoid or minimize impacts to wetlands to the maximum extent practicable.

Unavoidable impacts to wetlands during construction would be temporary. Due to the existing seed bank and perennial flow, affected wetland vegetation is expected to recover soon after completion of construction. Subsequent to construction, Alternative 10 would result in a net gain in wetlands in the study area. Because Alternative 10 has the least amount of construction in the River channel in Reaches 2, 4, 5, and 6, it also has the least potential for adverse impacts to wetlands of any action alternative. New riparian areas would be created in the overbank areas where streams would be daylighted and a side channel constructed, and additional wetlands may form where channel banks are lowered in Reach 6. With presence of sufficient hydrology either seasonally or on a relatively permanent basis, the riparian areas could develop hydric soils, one indicator of jurisdictional wetlands.

Potential for impacts to wetlands under Alternative 13 would be similar to Alternative 10, since the amount of in-channel construction remains similar. Construction would avoid or minimize impacts to wetlands to the maximum extent practicable. Unavoidable impacts to wetlands during construction would be temporary. Due to the existing seed bank and perennial flow, affected

wetland vegetation is expected to recover soon after completion of construction. New riparian areas would be created in Reaches 3 and 4 where streams would be daylighted and side channels constructed in the overbank areas; in Reaches 6 and 7 where channel banks would be lowered; and in Reach 8 where a historic wash would be restored. With presence of sufficient hydrology either seasonally or on a relatively permanent basis, the riparian areas could develop into wetlands.

Potential for impacts to wetlands under Alternative 16 would increase relative to Alternative 13 due to the increased amount of in channel construction associated with terracing the banks and modifying the trapezoidal channel in Reach 5. Construction would avoid or minimize impacts to wetlands to the maximum extent practicable. Unavoidable impacts to wetlands during construction would be temporary. Due to the existing seed bank and perennial flow, affected wetland vegetation is expected to recover soon after completion of construction. New riparian areas would be created in Reaches 3 and 4 where streams would be daylighted and side channels constructed in the overbank areas; in Reach 5 where streams would be daylighted and a concrete-lined, tropical channel would be converted into a soft bottom rectangular channel; in Reaches 6 and 7 where channel banks would be lowered and additional riparian areas would be treated behind the banks; and in Reach 8 where a historic wash would be restored and channel banks would be modified. With presence of sufficient hydrology either seasonally or on a relatively permanent basis, the riparian areas could develop into wetlands.

Potential for impacts to wetlands under Alternative 20 would be similar to Alternative 16. Construction would avoid or minimize impacts to wetlands to the maximum extent practicable. Unavoidable impacts to wetlands during construction would be temporary. Due to the existing seed bank and perennial flow, affected wetland vegetation is expected to recover soon after completion of construction. Furthermore, modifying the trapezoidal channel in Reach 2 to increase the amount of soft bottomed surface area under Alternative 20 could yield additional wetlands.

Under all action alternatives, invasive species would be removed from the project footprint, including the River and tributary channel bottom, during construction. Invasive species within the project footprint would typically be removed by hand tools. Thus, in most instances there would be no impacts to wetlands.

In general, long-term direct or indirect impacts to wetlands are not anticipated. Subsequent to the completion of construction and sufficient growth of plants and vegetation, the ecosystem restoration elements would provide increased wetland functions and services such as increasing foraging and nesting habitat for wildlife especially avian species. Though not designed as treatment wetlands, wetlands within newly created waters of the U.S. would provide some level of filtration commensurate with the duration of water residence times within these areas. There would be an increase in turbidity minimization functions.

Operation: Maintenance activities within waters of the U.S. required for maintaining habitat restoration or recreational features would primarily entail vegetation maintenance especially in areas where ecosystem restoration features transition to flood risk management elements of LACDA. Furthermore, the City of Los Angeles would also be responsible for removal of invasive species throughout the project footprint. Invasive species within the project footprint

would typically be removed by hand tools. Thus, in most instances there would be no impacts to wetlands.

Maintaining design grades, elevations, contours, and conveyance may require in-water work on a periodic basis. Impacts to during construction would be temporary. Due to the existing seed bank and perennial flow, affected vegetation is expected to recover soon after completion of construction. Impacts would be temporary and less than significant.

Long-term direct or indirect impacts to wetlands are not anticipated for maintenance activities within ecosystem restoration elements. Maintenance and adaptive management of habitat elements (such as non-native removal) would ensure that benefits continue to be realized for the life of the project.

Mudflats

Construction: Mudflats are generally found in intertidal, estuarine or near-shore habitats, in deltas, or at river mouths. None of these conditions occur in the study area. Sediment deposits may occur on occasion in some parts of the River, but they do not function as mudflats, which are generally rich biologically and support benthic organisms that are supportive of fish and avian species. The action alternatives would not directly or indirectly affect mudflats.

Operation: As no mudflats are present or will result from construction of restoration features, operations and maintenance activities would not directly or indirectly affect mudflats.

Vegetated shallows

Construction: Vegetated shallows are areas that are permanently inundated and under normal circumstances have rooted aquatic vegetation, such as sea grasses in marine and estuarine systems and a variety of vascular rooted plants in freshwater systems. Vegetated shallows are not present in the study area. The action alternatives would not directly or indirectly affect vegetated shallows.

Operation: As no vegetated shallows are present or will result from construction of restoration features, operations and maintenance activities would not directly or indirectly affect vegetated shallows.

Coral reefs

Construction: Coral reefs consist of skeletal deposits, usually of calcareous or silicaceous materials, and occur in marine environments, which does not exist in the study area. Therefore, there would be no direct or indirect effects to coral reefs.

Operation: As no coral reefs are present or will result from construction of restoration features, operations and maintenance activities would not directly or indirectly affect coral reefs.

Riffle and pool

Steep gradient sections of streams are sometimes characterized by riffle and pool complexes. Such stream sections are recognizable by their hydraulic characteristics. The rapid movement of water over a coarse substrate in riffles results in a rough flow, a turbulent surface, and high

dissolved oxygen levels in the water. Pools are deeper areas associated with riffles. Although this habitat type is generally associated with higher-gradient streams, some form of riffle and pool complex may occur where boulders and gravel have accumulated to the extent that they can back up flows to cause pools and allow for increased water velocity or formation of eddies on the downstream side.

Occasional riffle and pool complexes may be found in the soft bottom reaches of the study area and are subject to variation based on flows and maintenance activities (Reaches 2, 4, 5 and 6). Prior to initiation of construction, the study area would be surveyed for the current location of riffle and pool complexes. Per recommendations of the Fish and Wildlife Coordination Act Report, feasibility of constructing riffle and pool complexes in the soft bottom reaches would be further evaluated during the design phase. During construction, the potential for impacts would increase from Alternative 10 through Alternative 20, commensurate with the amount of in-channel work. Construction would avoid or minimize impacts to these features to the maximum extent practicable. Furthermore, the project would create conditions that would allow for the natural formation of riffle and pool complexes.

Under all action alternatives, invasive species would be removed from the project footprint, including the River and tributary channel bottom, during construction. Invasive species within the project footprint would typically be removed by hand tools. Thus, in most instances there would be no impacts to riffle and pool complexes.

Long-term impacts to aeration and downstream scour would be de minimis since the River downstream of the project area would remain channelized. Furthermore, as indicated in Section 3.5.3 of the IFR, the study area supports nonnative fish species such as mosquito fish, catfish, and green sunfish, and carp throughout the study reach. Native fish species are not present. As a result, impacts would result in de minimis impacts to fish population. Under all action alternatives, direct and indirect impacts to functions and services associated with riffle and pool complexes would be temporary.

Implementation of any action alternative may result in indirect long term benefits to aquatic species. Per recommendations of the Fish and Wildlife Coordination Act Report, feasibility of implementing design refinements and placement of measures to support native fish habitat in the study area would be examined during the design phase. The measures in the soft bottom reaches include but are not limited to water shaded by riparian vegetation, riffle and pool complexes, refugia, in-channel woody debris, and gravel and cobble substrates. In concrete reaches the measures may include installation of boulder clusters to provide some refugia for native fish between widened areas depending on results of design analysis.

Operation: Maintenance activities within waters of the U.S. required for maintaining habitat restoration or recreational features would primarily entail vegetation maintenance especially in areas where ecosystem restoration features transition to flood risk management elements of LACDA. Furthermore, the City of Los Angeles would also be responsible for removal of invasive species throughout the project footprint. Invasive species within the project footprint would typically be removed by hand tools.

Maintaining design grades, elevations, contours, and conveyance may require in-water work on a periodic basis. Maintenance activities would avoid or minimize impacts to riffle and pool

complexes to the maximum extent practicable. If disturbed during maintenance activities, riffle and pool complexes would be restored to match pre-construction configurations to the maximum extent practicable. Furthermore, the project would create conditions that would allow for formation of additional riffle and pool complexes.

Long-term impacts to aeration and downstream scour would be de minimis since the River downstream of the project area would remain channelized. Furthermore, as indicated in Section 3.5.3 of the IFR, the study area supports nonnative fish species such as mosquito fish, catfish, and green sunfish, and carp throughout the study reach. Native fish species are not present. As a result, impacts would result in de minimis impacts to fish population. For all maintenance activities, direct and indirect impacts to functions and services associated with riffle and pool complexes would be de minimis.

Cumulative impacts

The River was once a 51-mile-long backbone of a vast system of riparian foothill, riverine, and freshwater marsh habitat that carried seasonal rains and subterranean flows to the coastal plain and the Pacific Ocean. Coral reefs and mudflats have not been present historically within the study area. However, wetlands as well as riffle pool and complexes were likely present. Over time, the River has been degraded by a cycle of increasing urban development, flooding, and channelization, culminating in the mid-20th Century with the LACDA system. The LACDA project encased the river in concrete banks and a mostly concrete bed, and straightened the river's course, thereby significantly diminishing the range and size of special aquatic sites.

In addition to project construction, constructed ecosystem features and invasives removal throughout the project footprint would be maintained under all alternatives. The Corps would continue to be responsible for maintaining all other aspects of the portions of the LACDA project that overlap with the restoration project footprint. Removal of invasive vegetation would benefit recruitment of riparian vegetation and establishment of wetlands.

In-channel work under both maintenance programs may require work within wetland areas. Impacts to wetlands during construction would be temporary. Due to the existing seed bank and perennial flow, affected wetland vegetation is expected to recover soon after completion of construction. Naturally formed or engineered riffle and pool complexes within the ecosystem restoration project would be maintained.

5.6 Potential Direct and Indirect Effects on Human Use Characteristics (Subpart F)

Municipal and private water supplies

Construction: The River is not a source for municipal or private water supplies. It conveys storm flows and discharge from wastewater treatment plants, which are not suitable for potable use. Furthermore, the proposed action alternatives would not alter flows through the system. Therefore, there would be no direct or indirect effects on municipal or private water supplies under any alternative.

Operation: Maintenance activities within waters of the U.S. required for maintaining habitat restoration or recreational features would primarily entail vegetation maintenance especially in

areas where ecosystem restoration features transition to flood risk management elements of LACDA. Furthermore, the City of Los Angeles would also be responsible for removal of invasive species throughout the project footprint. Invasive species within the project footprint would typically be removed by hand tools.

Maintaining design grades, elevations, contours, and conveyance may require limited earthmoving activities on a periodic basis. In such cases there may be discharge of fill associated with the use of earthmoving equipment such as bulldozers or temporary stockpiling within newly established waters of the U.S. Impacts will be temporary in nature. In other cases like-for-like structural repair below the OHWM could result in discharge of permanent fill. However, temporary or permanent discharges of fill would not change the design elevations or contours. Because the River is not a source for municipal or private water supplies, in-channel work would not directly or indirectly affect municipal or private water supplies.

Recreational and commercial fisheries

Construction: Recreational fishing at the Elysian Valley area (Reaches 4-6) is authorized during the summer months from Memorial Day through Labor Day by the Mountains Recreation and Conservation Authority and City of Los Angeles in cooperation with the Corps and County of Los Angeles. Though access is generally discouraged or unauthorized during other times of the year, recreational fishing still occurs. Fish within the Glendale Narrows reach are nonnative, primarily mosquito fish, catfish, and green sunfish, and carp. There is no commercial fishery associated with the River.

Short-term adverse impacts may occur to the recreational fishery if pools where fish may occur are made inaccessible during construction. Due to construction phasing, the amount of area made inaccessible at any given time would be a minor amount of the available area, so adverse impacts would likewise be minor and short-term. This type of effect would be least under Alternative 10 since it has the smallest amount of in channel construction, and greatest under Alternative 20 since it has the greatest amount of in channel construction. Under all action alternatives, impacts would be temporary.

Implementation of any build alternative may result in indirect long term benefits to aquatic species and recreational fishing. Per recommendations of the Fish and Wildlife Coordination Act Report, feasibility of implementing design considerations and placement of measures to support native fish habitat in the study area would be examined during the design phase. The measures in the soft bottom reaches include but are not limited to water shaded by riparian vegetation, riffle and pool complexes, refugia, in channel woody debris, gravel and cobble substrates. In concrete reaches the measures may include installation of bolder clusters to provide some refugia for native fish between widened areas.

Water-related recreation

Construction: Kayaking and fishing are permitted in the Elysian Valley area (Reaches 4-6) from Memorial Day to Labor Day each year through the Mountains Recreation and Conservation Authority and City of Los Angeles in cooperation with the Corps and County of Los Angeles. Under all alternatives, access may be limited during construction if parts of these reaches need to be restricted for dewatering. Impacts would be temporary.

Alternative 10 proposes the least construction in Reaches 4-6, and would therefore have the least temporary effect on water-related recreation.

Alternative 13 proposes additional restoration measures. These measures may require construction access in the River channel. Thus, a larger portion part of the channel maybe restricted during construction than under Alternative 10.

Alternatives 16 and 20 propose the same measures in Reaches 4 and 6 as Alternative 13, and add the measure of modifying the banks to a vertical wall on one side and primarily terracing the bank on the other in Reach 5. This additional measure may require construction access in the River channel, meaning that a larger portion of the channel may be restricted during construction than under Alternative 13.

Alternative 13v would include all measures and impacts of Alternative 13 in Reaches 1-6 and 8. Moreover, Alternative 13v would include restoration measures in Reach 7 identical to those proposed under Alternative 20. Within Reach 7, streams would be daylighted; wetlands would be created; embankments would be terraced; and channel banks would be modified. This additional measure may require construction access in the River channel. However, since water related recreation is not supported in Reach 7, impacts to water-related recreation would be identical to Alternative 13.

There would be long-term, indirect benefits to water-related recreation upon completion of the ecosystem restoration project. As noted above, the study area already supports water-related recreation through the Mountains Recreation and Conservation Authority. With increasing public interest in a revitalized River, the ecosystem restoration project would likely catalyze implementation of future water-related recreational programs.

Operation: Maintenance activities within waters of the U.S. required for maintaining habitat restoration or recreational features primarily entail vegetation maintenance especially in areas where ecosystem restoration features transition to flood risk management elements of LACDA as well as invasive management throughout the project footprint, including the River and tributary channel bottom. Maintaining design grades, elevations, contours, and conveyance may require in-water work on a periodic basis. In-water work during from Memorial Day to Labor Day may temporarily disrupt kayaking, fishing, or other authorized recreation programs. However, since work would likely be localized, impacts would be de minimis and temporary.

Indirect benefits to water-related recreation from maintenance activities would be limited. In general, maintenance activities would ensure that the ecosystem research elements are maintained to design specifications and would not interfere with flood risk minimization functions of the LACDA project.

Aesthetics

Construction: As noted in the IFR, minor, short-term adverse impacts to aesthetic resources are likely to occur under all action alternatives during construction. The proposed restoration measures under all alternatives require large equipment to be present to conduct extensive earthwork and in-channel construction. The extent and duration of temporary impacts is commensurate with the scope of the construction footprint, increasing from Alternative 10 to Alternative 20.

The fewest temporary adverse impacts would occur under Alternative 10, since it entails the smallest construction footprint and would occur over the shortest timeframe (9 years). There would be no significant adverse impacts from this alternative.

Alternative 13 and 13v would have more adverse and beneficial impacts than Alternative 10 due to the larger footprint of construction, and would occur over a longer time period (10 years). There would be no significant adverse impacts from this alternative.

Alternative 16 and 20 would have more adverse and beneficial impacts than Alternative 13 and 13v due to the larger footprint of construction, and would occur over a longer time period (15 year). There would be no significant adverse impacts from this alternative.

Long-term beneficial impacts would occur under all action alternatives. The benefits are commensurate with the scope of the construction footprint, increasing from Alternative 10 to Alternative 20. Management measures common to all alternative would benefit aesthetics. Riparian plantings would occur under all action alternatives as would non-native plant removal, trash removal, installation of linear strips for biofiltration, greening of River channel walls, and creation of buffer zones and planted swales. These common elements require little to no machinery, can be implemented quickly, and would have less than significant impacts on aesthetic resources.

There would be long-term, indirect benefits to aesthetics upon completion of the ecosystem restoration project. Currently, views from waters of U.S. are composed of trapezoidal concrete or rectangular channels, urban development at the top of banks, perennial water, debris, graffiti, and intermittent vegetation. With the project, existing views of the River composed of linear lines, sharp angles and other geometric forms as well as industrial colors and textures associated with an engineered channel would be attenuated by non-linear forms, heterogeneous textures and a natural color palette associated with a vegetated River. Furthermore, future projects within waters of the U.S., such as the Atwater Pedestrian-Equestrian Bridge or the Los Angeles Waterwheel, would juxtapose unique architectural elements against the enhanced natural views. With increasing public interest in a revitalized River, the ecosystem restoration project may catalyze implementation of future projects that would further accentuate the aesthetic elements described above.

Operation: Maintenance activities within waters of the U.S. for maintaining habitat restoration or recreational features would primarily entail vegetation maintenance especially in areas where ecosystem restoration features transition to flood risk management elements of LACDA. Furthermore, the City of Los Angeles would also be responsible for removal of invasive species throughout the project footprint. Invasive species within the project footprint would typically be removed by hand tools. Removal of invasive vegetation would benefit recruitment of riparian vegetation and establishment of wetlands.

Vegetation maintenance would result in temporary changes in the height and density of vegetation, affecting aesthetics. Impacts to during construction would be temporary. Due to the existing seed bank and perennial flow, affected vegetation is expected to recover soon after completion of construction. Furthermore, since work would likely be localized, impacts would be de minimis and temporary.

Indirect impacts to aesthetics from maintenance activities would be limited.

Parks, national and historical monuments, national seashores, wilderness areas, and research sites

Two state parks and several city parks are located in the study area, and would be affected by construction. There are no national parks, national or historical monuments or seashores, wilderness areas, or research sites in the study area.

Temporary partial closure of Harding Park Golf Course, and temporary full closure of Los Feliz Golf Course, would occur under all alternatives. This is considered a less than significant adverse impacts because closures would be phased and golfers would have options to golf elsewhere during construction. Conversion of a small portion of the LASHP to wetland habitat is proposed under Alternative 20, but this is not expected to result in a significant impact as the new use is consistent with the parks' general plan.

Operation: Maintenance activities within waters of the U.S. within the River would not affect parks. However, maintenance of restored historic channels in the uplands could be located in parks and result in temporary closure of the immediate area surrounding the restoration feature. Impacts would be de minimis and temporary.

Cumulative impacts

The study area encompasses a built out urban environment with residential, commercial, industrial, and recreational land uses. As a result, present and future projects within the study area would likely entail redevelopment or conversion of existing land uses. Thus, the existing urban viewshed is unlikely to change substantially. The views from waters of U.S. are composed of trapezoidal concrete or rectangular channels, urban development at the top of banks, perennial water, debris, graffiti, and intermittent vegetation. The project would substantially alter the views from waters of the U.S. Existing views of the River composed of distinctive form, line, color, and texture associated with an engineered channel would be attenuated by non-linear forms, textures and color palette associated with a vegetated channel. Furthermore, future projects within waters of the U.S., such as the Atwater Pedestrian-Equestrian Bridge or the Los Angeles Waterwheel, would add unique architectural elements to views from waters of the U.S. Cumulative impacts to aesthetics would be beneficial and significant.

Existing recreational uses within the vicinity of the study area includes a number of parks. Immediately adjacent to the study area is Griffith Park, a large regional recreational area that supports many recreational activities. Recreational opportunities along the study reach include year-round jogging and biking trails. In addition, annual kayaking and fishing in the River during summer months is offered through the Mountains Recreation and Conservation Authority. The project would indirectly increase recreational opportunities within the study area. Demand for recreation is expected to increase proportionally to population growth in the study area. Furthermore, due to the increasing public interest in revitalizing the River, implementation of additional recreational programs or construction of recreational amenities within the vicinity of the study reach in the future is likely. Cumulative impacts to recreation would be beneficial and significant.

The River is not a source for municipal or private water supplies. It conveys storm flows and discharge from wastewater treatment plants, which are not suitable for potable use. In consideration of the on-going drought in the Los Angeles area and an increasing emphasis on water conservation to augment water supplies, future implementation of programs and infrastructure to utilize existing flows remains a possibility. Due to real estate requirements and technical challenges for establishment of large groundwater recharge basins within the vicinity of the study area, future projects would likely entail small-scale demonstration or pilot programs. Impacts to water supplies would be less than significant.

Please refer to Section 5 of the IFR for the scope of analysis and discussion of past, present, and reasonably foreseeable future projects.

5.7 Evaluation and Testing (Subpart G)

All action alternatives would entail discharges of fill materials within waters of the U.S. Temporary discharges of fill would entail dewatering structures such as k-rails and sand bags. Dewatering structures would be removed upon completion of each phase of construction. Permanent discharges of fill would entail discharges of rock, concrete, reinforced vegetated matting, and top soil.

Both temporary and permanent fills would be chemically inert and would not leach contaminants into the water column. Topsoil would be acquired from a certified contaminant-free source to ensure that fill material is most likely to be free from chemical, biological, or other pollutants. Thus, topsoil would be suitable for discharge into the aquatic environment. Per 40 C.F.R. 230.60(a), additional chemical, biological, and physical evaluation testing would not be required.

6.0 Measures to Minimize Adverse Impacts (Subpart H)

Under any alternative, the following measures will be taken prior to and during construction to monitor the degree of impacts related to wetland and riparian construction, and to ensure that materials used in construction or operations are appropriate for use in an aquatic restoration project.

- Sources of seeds used for revegetation and soils used for backfilling will be required to show that they are weed free to the degree possible.
- Soils and all materials used for backfilling or stabilization must be certified to be free of contaminants.
- All sites with known and suspected HTRW soil contamination will be investigated and remediated prior to project construction. All groundwater contamination that cannot be remediated prior to project construction will be subject to appropriate handling, treatment and disposal ensured by the non-Federal sponsor. All work shall be consistent with ER 1165-2-132.

Construction plans will identify optimum phasing and timing and specify the guidelines for minimum standards necessary to protect soils, biological resources, and water and prevent generation of fugitive dust. Specific guidelines may include;

- Limiting certain aspects of in-channel construction outside of the winter storm season (April 15 - October 15) to minimize soil erosion.
- Installing silt fences around construction areas to prevent silt and sediment from entering the River channel.
- Designing and implementing a dewatering plan to avoid operating equipment in flowing water by using temporary cofferdams or some other suitable diversion to divert channel flow around the channel and bank construction area.
- Complying with an established Spill Prevention and Response Plan, which would define requirements for storage, handling, and containment of hazardous materials.
- Developing and implementing a storm water pollution prevention plan.
- Vegetation clearing activities would be avoided to the maximum extent practicable in any areas identified as breeding or nesting habitat for any bird species during the breeding season, which generally runs from March 1-August 31.
- If vegetation removal must occur during the breeding season, a qualified biologist would perform nesting bird surveys following established protocol prior to construction. If nests are detected during these surveys, a 300-foot no construction buffer would be delineated around the nest (500 feet for raptors).
- Construction in breeding areas would be monitored by a qualified biologist.
- Construction would be phased to minimize impacts to wildlife species, so that the entire study area would not be under construction all at once to minimize human intrusion.
- Stabilizing and reseeding disturbed areas with native grasses, shrubs, and trees after construction is complete.
- Conducting operation and maintenance during times of the year when wildlife is not likely to be breeding or nesting.
- Avoiding sensitive habitat types to the degree possible when performing maintenance,
- Prior to initiation of construction of each project phase, the relevant portion of the project area would be surveyed for wetlands. Construction would avoid or minimize impacts to wetlands to the maximum extent practicable.
- Prior to initiation of construction of each project phase, the relevant portion of the project area would be surveyed for riffle and pool complexes. Construction would avoid or minimize impacts to these features to the maximum extent practicable.

7.0 Summary of Effects to the Aquatic Environment

In general, potential for temporary impacts during construction would increase from Alternative 10 through Alternative 20, commensurate with the increasing scope for a number of aquatic resources. However, with implementation of measures to minimize adverse impacts, there would be no permanent loss or reduction of aquatic functions and services for any build alternative.

8.0 Conclusion

Alternative 20 is the Locally Preferred Plan and Recommended Plan. The discharge complies with the 404(b)(1) guidelines pursuant to 40 C.F.R. § 230.12. Our determination of compliance is based on the following findings:

(1) There are no available, practicable alternatives having less adverse impact on the aquatic ecosystem and without other significant adverse environmental consequences that do not involve discharge into Waters of the United States. Alternative 20 is the least environmentally damaging practicable alternative (LEDPA).

Alternatives 10, 13, 13v, 16, and 20 meet the overall project purpose and are practicable with respect to cost, technology, and logistics (See Section 4.3, 4.4, and 4.5). All action alternatives would entail significant impacts to non-aquatic resources (See Section 4.7). *The long term benefits to aquatic services and functions would be commensurate with the scale of construction and associated impacts.* The acreage of permanent fill within existing waters of the U.S. would increase from Alternative 10 (4.52 acres) through Alternative 20 (65.61 acres). The acreage of temporary fill would also increase correspondingly. However, all temporary fill would be removed upon completion of construction. Likewise, the acreage of new waters of the U.S. created will increase from Alternative 10 (56 acres) through Alternative 20 (156.9 acres).

All action alternatives would entail discharges of permanent fill into waters of the U.S. The discharge of fill material is required for the restoration of aquatic functions and services within waters of the U.S, and stabilization of new waters of the U.S. The discharge of permanent fill material would not result in the permanent loss of existing waters of the U.S.

All action alternatives would require implementation of environmental commitments to further avoid and minimize effects to the aquatic environment. No significant adverse impacts to aquatic resources have been identified in the IFR. No take of protected or sensitive aquatic species would occur under any build alternative.

(2) The discharge will not violate state water quality standards.

Active construction areas would be dewatered and isolated from active flows to minimize water quality impacts. Adherence to the SWPPP, CWA Section 401 water quality certification requirements, implementation of BMPs described in Section 5.6 of the IFR, and the measures to minimize adverse impacts stated in Section 6 above would ensure compliance with state water quality standards throughout construction.

Maintenance activities may require use of excavators, backhoes, or grapple trucks for removal of trash, debris, and sediment. Maintenance activities requiring in-water work would likely require the use of water diversion structures, such as k-rails or sandbags. Adherence to the SWPPP, CWA Section 401 water quality certification requirements, implementation of BMPs described in Section 5.6 of the IFR, and the measures to minimize adverse impacts stated in Section 6 above would ensure compliance with state water quality standards throughout operation.

Both temporary and permanent fills used during construction and operation would be chemically inert and would not leach contaminants into the water column. Topsoil would be acquired from a certified contaminant-free source to ensure that fill material is most likely to be free from chemical, biological, or other pollutants. Thus, topsoil would be suitable for discharge into the aquatic environment. See Sections 5.3 and 5.7 above.

(3) The discharge will not violate toxic effluent standards.

The proposed Federal action entails ecosystem restoration. Facilities that receive, treat, and discharge effluent would not be constructed. Both temporary and permanent discharges of fill during construction and operation would not violate state water quality standards. All work areas would be isolated from active flows during construction and operation, and storm water runoff at construction and maintenance locations would be contained according to SWPPP conditions. With respect to groundwater contamination that cannot be remediated prior to construction, the City of Los Angeles will design, implement, coordinate and fully fund all treatment and disposal of contaminated groundwater during construction, with regulator concurrence and any necessary permits. See Sections 5.3 and 5.7 above.

(4) The discharge will not jeopardize endangered or threatened species or their critical habitat.

The Corps has determined that there will be no effect to least Bell's vireo from the proposed project. There is no critical habitat present in the project area. See Section 5.4 above and Section 5.5.3 of the IFR for more information.

(5) The discharge will not violate standards set by the Department of Commerce to protect marine sanctuaries.

No sanctuaries as designated by the Marine Protection, Research and Sanctuaries Act of 1972 will be affected by the proposed project. No sediments would be disposed of at designated ocean dredged material disposal sites. See Section 5.5 above.

(6) The proposed discharge material will meet testing exclusion criteria.

Both temporary and permanent fills during construction and operation would be chemically inert and would not leach contaminants into the water column. Topsoil would be acquired from a certified contaminant-free source to ensure that fill material is most likely to be free from chemical, biological, or other pollutants. Thus, topsoil would be suitable for discharge into the aquatic environment.

All HTRW impacted soil within the project footprint must be remediated to the requirements of the local environmental regulatory agencies and be compatible with the future land uses for and

needs of the restoration project prior to the City of Los Angeles providing those lands to the restoration project. With respect to groundwater contamination that cannot be remediated prior to construction, the City of Los Angeles will design, implement, coordinate and fully fund all treatment and disposal of contaminated groundwater during construction, with regulator concurrence and any necessary permits. These temporary operations should also be consistent with current management of contaminated groundwater at SFVSS and Pollock Well Field. Furthermore, all work areas would be isolated from active flows during construction and operation, and storm water runoff at construction and maintenance locations would be contained according to SWPPP conditions. See Sections 5.3 and 5.7 above.

Evaluation of the information above indicates that the proposed discharge material meets testing exclusion criteria for the following reason(s):

( ) based on the above information, the material is not a carrier of contaminants.

( ) the levels of contaminants are substantially similar at the extraction and disposal sites and the discharge is not likely to result in degradation of the disposal site and pollutants will not be transported to less contaminated areas.

(X) acceptable constraints are available and will be implemented to reduce contamination to acceptable levels within the disposal site and prevent contaminants from being transported beyond the boundaries of the disposal site.

(7) The discharge will not contribute to significant degradation of Waters of the United States through adverse impacts to human health or welfare, through pollution of municipal water supplies, fish, shellfish, wildlife and special aquatic sites.

The River is not a source for municipal or private water supplies. It conveys storm flows and discharge from wastewater treatment plants, which are not suitable for potable use. The River does not support commercial fisheries or shellfish operations. Recreational fishing does take place in the River. However, the discharges of fill during construction and operation would not degrade surface water quality. The proposed project would result in beneficial impacts to the aquatic ecosystem through the expansion of open water area, soft river bottom area, riparian zones, wetlands, and connection to side channels and tributaries. See Sections 5.3 and 5.6 above.

(8) The discharge will not contribute to significant degradation of Waters of the United States through adverse impacts to diversity, productivity, and stability of the aquatic ecosystem, such as the loss of fish or wildlife habitat, or loss of the capacity of wetland to assimilate nutrients, purify water or reduce wave energy.

The discharges would result in beneficial impacts to the aquatic ecosystem through the expansion of open water area, soft river bottom area, riparian zones, wetlands, and connection to side channels and tributaries after completion of construction. Due to the existing seed bank and perennial flow, affected vegetation is expected to recover soon after completion of construction.

Maintenance activities within waters of the U.S. would partly entail maintaining ecosystem restoration features throughout the project footprint. Invasive species within the project footprint would typically be removed by hand tools. Other maintenance activities may require use of

excavators, backhoes, or grapple trucks for removal of trash, debris, and sediment. Maintaining design grades, elevations, contours, and conveyance may require in-water work on a periodic basis. Due to the existing seed bank and perennial flow, affected vegetation is expected to recover soon after completion of maintenance activities. Thus, in most instances there would be no impacts to wetlands. Any impacts would be minor and temporary. Maintenance and adaptive management of habitat elements (such as non-native removal) would ensure that benefits continue to be realized for the life of the project. See Section 5.6 above.

(9) The discharge will not contribute to significant degradation of Waters of the United States through adverse impacts to recreational, aesthetic, and economic values.

The project area supports limited recreational fishing and in-water recreational activities. Furthermore, there are no commercial fisheries in the proposed project area. Thus, impacts to recreational and economic values during construction would be minor. The restored ecosystem would result in long term beneficial impacts to recreational and aesthetic values after completion of construction.

Maintenance activities within waters of the U.S. would partly entail maintaining ecosystem restoration features throughout the project footprint. Invasive species within the project footprint would typically be removed by hand tools. Other maintenance activities may require use of excavators, backhoes, or grapple trucks for removal of trash, debris, and sediment. Maintaining design grades, elevations, contours, and conveyance may require in-water work on a periodic basis. The activities may temporarily disrupt kayaking, fishing, or other authorized recreation programs. However, since work would likely be localized, impacts would be de minimis and temporary. Maintenance and adaptive management of habitat elements (such as non-native removal) would ensure that aesthetic and economic values associated with the restored ecosystem would continue to be realized for the life of the project. See Section 5.6 above

(10) The discharge includes all appropriate and practicable measures (40 C.F.R. §§ 230.70-77) to minimize the potential harm to the aquatic ecosystem.

See Section 6 above.

On the Basis of the Guidelines, the Proposed Disposal Site(s) for the Discharge of Dredged or Fill Material is:

____ (1) Specified as complying with the requirements of these guidelines; or,

__X__(2) Specified as complying with the requirements of these guidelines, with the inclusion of appropriate and practical conditions to minimize pollution or adverse effects on the aquatic ecosystem; or,

____ (3) Specified as failing to comply with the requirements of these guidelines. The required 404(r) statements are included in the Integrated Report.

December 18, 2015

Los Angeles River, Los Angeles County, CA
Ecosystem Restoration Feasibility Study
Final Report State and Agency and Public Review Summary

State and Agency review was conducted between September 25, 2015 and November 2, 2015. Comments on the final Integrated Feasibility Report and Chief of Engineers' Report from the State and Agency Review were received from the Environmental Protection Agency (EPA), Department of Interior (DOI), Federal Highway Administration (FHWA), Department of Housing and Urban Development (HUD), California Department of Fish and Wildlife (CDFW), and Regional Water Quality Control Board (RWQCB). EPA, HUD, and RWQCB provided letters expressing general support for the project. DOI, FHWA, and CDFW expressed that they had no comment and/or that their comments on the Draft IFR had been adequately addressed. Other agencies did not provide a comment letter.

Comments received from the public as part of the 30-day Final Integrated Feasibility Report NEPA review included one letter of general opposition to the project, three letters of general support, eight letters of technical or substantive content, and 18 letters of general support that also expressed support for sharing the costs of the Recommended Plan as 50 percent Federal, 50 percent non-Federal. A form comment letter expressing support for a 50 percent Federal, 50 percent non-Federal cost share was sent by approximately 1,000 people.

The District also received an email from the local Federal projects coordinator for the U.S. Fish and Wildlife Service Carlsbad Office indicating that the Carlsbad Office had no new substantive comments but clarifying his views regarding responses to the Coordination Act Report. The District considers this email to be a part of ongoing informal coordination regarding the Recommended Plan and will include a memorandum for record in the administrative record for this project, addressing the clarifications.

The eight comments of technical or substantive content include: letters from the Fernandeño Tataviam Band of Mission Indians, Los Angeles County Metropolitan Transportation Authority (MTA), California Department of Transportation (Caltrans), John Tommy Rosas with the Tongva Ancestral Territorial Tribal Nation, and four residents: Carolyn West, Patricia Wood, Joyce Dillard, and Jennifer Deines. There was also one comment of opposition from resident Craig Doerr.

The comments from the Fernandeño Tataviam Band of Mission Indians requested that Native American monitors be used during ground disturbing activity of any known archaeological, cultural, or tribal resources. The Programmatic Agreement for the project, included in Appendix O of the Final Integrated Feasibility Report (IFR), outlines the process for identification and evaluation of historic properties. HQUSACE will respond stating that the Fernandeño Tataviam Band of Mission Indians will receive the executed Programmatic Agreement with an invitation to sign as a concurring party. The Corps will seek input from the tribes throughout the process to ensure that historic and cultural properties are identified in order to avoid, minimize, and mitigate effects.

December 18, 2015

The MTA provided a list of comments related to their facilities, operations, and plans, and generally requested further coordination during detailed design. They requested that the Corps closely coordinate with MTA during detailed design and analysis to ensure impacts to their facilities, operation, and maintenance are avoided and minimized. They requested that costs related to railroad trestling, as well as acquisition and construction, be refined during detailed design. MTA also presented their agency goals and plans that may have synergies or conflicts with the proposed project and requested collaboration during design to achieve common goals or avoid conflicting plans. MTA expressed that some of its facilities are located close to the existing river banks and must be protected against potential wash-out. MTA requested continued collaboration during design to exhibit that tracks will be protected during storm events. A short list of minor technical corrections was also provided. The District will continue to coordinate with MTA during detailed design to ensure MTA's facilities, operations, and plans are adequately addressed.

Comments from Caltrans, the State agency responsible for highway management, indicated that some project construction would take place within the State's right of way and that an encroachment permit will be required. They further commented that transport of large construction equipment and materials on State highways requires a transportation permit and recommended large size truck trips be limited to off peak hours. Caltrans requested continued coordination on any project features that may impact State transportation facilities. The District and the City of Los Angeles will continue to coordinate with Caltrans during detailed design and construction for the project. The City will coordinate with Caltrans to obtain all necessary interests in land and to support project construction and operation. The IFR includes a commitment to develop a construction traffic management plan which would include travel time restrictions to avoid peak travel periods on selected roadways.

Mr. John Tommy Rosas of the Tongva Ancestral Territorial Tribal Nation requested that he be added to the Programmatic Agreement and all tribal consultations including Section 106 of the National Historic Preservation Act. The Corps has included Mr. Rosas in previous coordination regarding the National Historic Preservation Act. The Corps is responding to Mr. Rosas to indicate he will be treated as a consulting party under the Programmatic Agreement executed by the Corps and the State Historic Preservation Officer. As a consulting party, he will be included throughout the process for identification and evaluation of historic properties, assessment of effects, and management and treatment of historic properties outlined in that agreement.

Ms. Carolyn West commented with concerns about flooding near her home with implementation of the project. She also commented on the impacts to public river access by constructing vertical walls and a potential rodent problem with installation of hanging vines. Ms. West indicated that her similar comments on the draft went unanswered. Ms. West's comments on the draft were addressed in Appendix L.2 of the Final IFR (pp. 152-153). Ms. West's comments on the Final IFR will be responded to as in the response to her comments on the Draft IFR.

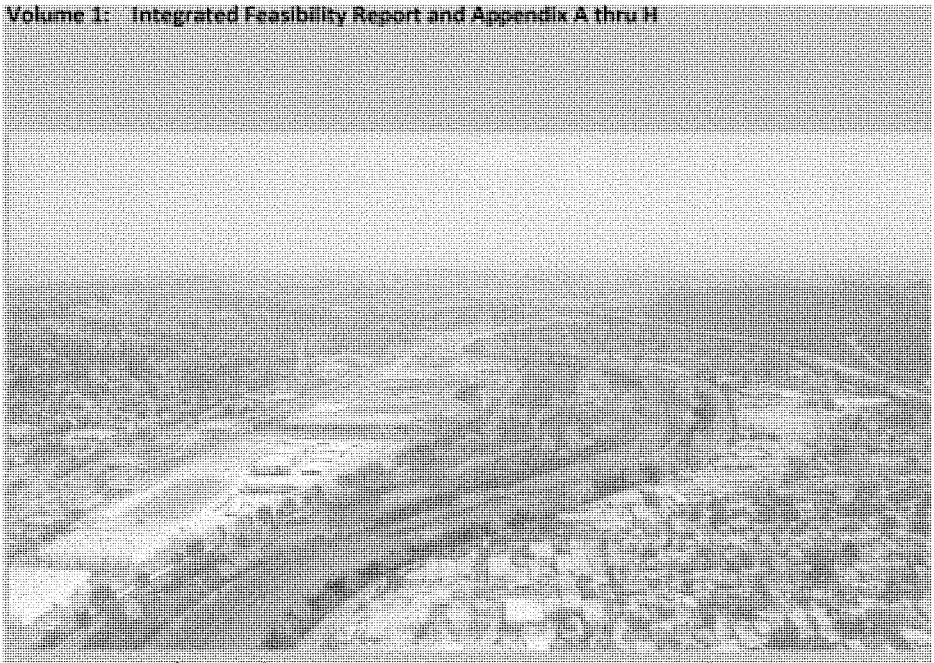
Ms. Patricia Wood expressed concern regarding the Corps' response to her comments on the Draft IFR in terms of how the project will cause no adverse impacts to flood conveyance. She commented that the proposed changes to the operation and maintenance of the channel with the proposed project would result in a decrease in flood capacity and increase in water surface levels.

She also commented that the proposed changes to operation were not clearly disclosed to the public and that impacts were not properly analyzed, resulting in non-compliance with NEPA and CEQA. As analyzed in the IFR, the restoration features have been planned to avoid negative effects on the flood risk management functions of the Los Angeles County Drainage Area (LACDA) project. The Corps will conduct additional detailed hydrologic and hydraulic analysis during the design phase to ensure that the constructed restoration features avoid increases in water surface elevation. The restoration project does not propose to maintain the vegetation and sediment present today in the channel as a permanent condition. The Corps will modify the existing operation and maintenance manual for the LACDA project to exclude the constructed restoration features and invasives vegetation removal, as these maintenance requirements will be a City responsibility. The Corps will also use the detailed design analysis to determine to what extent some native vegetation outside the restoration features can remain in the channel without negatively affecting flood risk management.

Ms. Joyce Dillard and Ms. Jennifer Deines commented on increased City and private development in the river corridor being presented under the guise of restoration, and its impacts to the community. The Corps will clarify that the Recommended Plan is for purposes of ecosystem restoration, with appropriate resource analysis in the IFR. Their concerns regarding private development in the river corridor have been shared with the City. The projects for redevelopment identified along the river channel would be outside the purview of the Corps except to the extent that they involve a proposed discharge of materials into waters of the United States or an alteration or modification of an existing flood risk management project. Ms. Dillard also stated that the consideration of Union Pacific's Los Angeles Trailer and Container Intermodal Facility site (LATC), a portion of which is proposed to be included in the Recommended Plan for ecosystem restoration, for use as an Olympic Village during the 2024 Olympic Games presents a risk of conflict with the restoration project. The City must provide all lands necessary for the restoration project, and the City has indicated its intent to do so. The two individuals also raised concerns about a current planning effort by Frank Gehry Partners requested by the Los Angeles River Revitalization Corporation, a non-profit entity established by the City. This planning effort is in the early stages and has not played a role in the formulation of the restoration study.

Mr. Craig Doerr expressed general opposition to the proposed project, particularly removal of concrete placed to provide flood risk management. Mr. Doerr also expressed support for groundwater replenishment and use of diverted water for agricultural purposes. The Corps will respond by reiterating that the restoration features included in the Recommended Plan have been planned to avoid negative effects on the flood risk management function of the Los Angeles County Drainage Area project. Groundwater recharge and diversion of water for agricultural use is outside the scope of the current study.

Volume 1: Integrated Feasibility Report and Appendix A thru H



Los Angeles River Ecosystem Restoration Integrated Feasibility Report

FINAL Feasibility Report and Environmental Impact Statement/Environmental Impact Report

Los Angeles County, California

September 2015

US Army Corps of Engineers®
Los Angeles District

Los Angeles River Ecosystem Restoration Feasibility Study
Final Integrated Feasibility Report (Feasibility Study/Environmental Impact Statement/Environmental Impact Report)
Los Angeles County, California

The Federal lead agency responsible for implementing the National Environmental Policy Act (NEPA) is the U.S. Army Corps of Engineers, Los Angeles District (USACE). The local lead agency responsible for implementing the California Environmental Quality Act (CEQA) is the City of Los Angeles.

The Integrated Feasibility Report (IFR) for the Los Angeles River Ecosystem Restoration Feasibility Study evaluates alternatives for restoring 11 miles of the Los Angeles River from approximately Griffith Park to downtown Los Angeles while maintaining existing levels of flood risk management.

Restoration measures considered include creation and reestablishment of historic riparian strand and freshwater marsh habitat to support increased populations of wildlife and enhance habitat connectivity within the study area, as well as to provide opportunities for connectivity to ecological zones such as the Santa Monica Mountains, Verdugo Hills, Elysian Hills, and San Gabriel Mountains. Restoration also includes the reintroduction of ecological and physical processes such as a more natural hydrologic and hydraulic regime that reconnects the river to historic floodplains and tributaries, reduces flow velocities, increases infiltration, improves natural sediment processes, and improves water quality. The study also evaluates opportunities for passive recreation that are compatible with the restored environment. The study evaluated the No Action Alternative and five action alternatives, Alternative 10, 13, 13v, 16, and 20. The Recommended Plan is Alternative 20, which includes compatible recreation features.

The official closing date for the receipt of comments is 30 days from the date on which the Environmental Protection Agency publishes the Notice of Availability of this Final IFR in the *Federal Register*.

Comments should be addressed to:
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LOS ANGELES RIVER ECOSYSTEM RESTORATION INTEGRATED FEASIBILITY REPORT

FINAL FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT/ ENVIRONMENTAL IMPACT REPORT

LOS ANGELES COUNTY, CALIFORNIA

SEPTEMBER 2015

Prepared by:
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

In Partnership With:

THE CITY OF LOS ANGELES

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ACRONYMS AND ABBREVIATIONS

AAHU	Average Annual Habitat Units
AAQS	Federal Ambient Air Quality Standard
ACE	Annual Chance Exceedance
ADA	Americans with Disabilities Act
AFB	Alternative Formulation Briefing
APE	Area of Potential Effects
AQMP	Air Quality Management Plan
ARBOR	Area with Restoration Benefits and Opportunities for Revitalization
BMP	Best Management Practice
BNSF	Burlington Northern-Santa Fe Railway
CADC	California Department of Conservation
Caltrans	California Department of Transportation
CASP	Cornfield Arroyo Specific Plan and Redevelopment Plan
CCR	California Code of Regulations
CDFG	California Department of Fish and Game
CDFW	California Department of Fish and Wildlife
CDPR	California Department of Parks and Recreation
CEQA	California Environmental Quality Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CESA	California Endangered Species Act
cfs	Cubic feet per second
CGS	California Geological Survey
CHAP	Combined Habitat Assessment Protocol
CHL	California Historical Landmarks
CNEL	Community Noise Equivalent Level
CNPS	California Native Plant Society
CO	Carbon monoxide
CO2	Carbon dioxide
COLD	Cold Freshwater Habitat
CRHR	California Register of Historical Resources
CRWQCB	California Regional Water Quality Control Board
CWA	Clean Water Act
dB	Decibels
dBA	Decibels A-weighted
DCA	Dichloroethane
DNL	Day-Night Level
DWR	California Department of Water Resources
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EO	Executive Order
EP	Engineer Pamphlet
EOO	Emergency Operations Organization
EQ	Environmental Quality
ER	Engineer Regulation
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FoLAR	Friends of the Los Angeles River
ft/s	Feet per second
GHG	Greenhouse Gases
GIS	Geographic Information System
GLACVCD	Greater Los Angeles County Vector Control District
HFC	Hydrofluorocarbons

HTRW	Hazardous, Toxic and Radioactive waste
HU	Habitat Unit
IFR	Integrated Feasibility Report
IRP	Integrated Resources Plan
IWR	Institute for Water Resources
LACC	Los Angeles County Code
LACDA	Los Angeles County Drainage Area
LACDPW	Los Angeles Department of Public Works
LACFCD	Los Angeles County Flood Control District
LADOT	Los Angeles Department of Transportation
LADWP	Los Angeles Department of Water and Power
LAEDC	Los Angeles County Economic Development Corporation
LAFD	Los Angeles Fire Department
LAHCM	Los Angeles Historic-Cultural Monuments
LAMC	Los Angeles Municipal Code
LAPD	Los Angeles Police Department
LA-RIO	Los Angeles River Improvement Overlay
LARRC	Los Angeles River Revitalization Corporation
LARRMP	Los Angeles River Revitalization Master Plan
LATC	Union Pacific Los Angeles Trailer and Container Intermodal Facility
LERRD	Lands, easements, rights-of-way, and disposal sites
MCL	Maximum Concentration Levels
MCACES	Micro-Computer Aided Cost Estimating System
Metro	Los Angeles County Metropolitan Transit Authority
Metrolink	Southern California Regional Rail Authority
mm/year	Millimeter per year
MTBE	Methyl tertiary butyl ether
MUN	Municipal
NED	National Economic Development
NER	National Ecosystem Restoration
NHPA	National Historic Preservation Act
NO	Nitric oxide
NO2	Nitrogen dioxide
NOx	Nitrogen oxides
NPDES	National Pollution Discharge Elimination System
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NWI	National Wetland Inventory
O3	Ozone
OHW	Ordinary high water
O&M	Operations and Maintenance
OSE	Other social effects
OSHA	Occupational Safety and Health Administration
P&G	Water Resources Principles and Guidelines
Pb	Lead
PCE	Perchloroethylene
PEMC	Palustrine emergent, seasonally flooded
PFOC	Palustrine forested, seasonally flooded
PLUM	Planning and Land Use Management Committee, Los Angeles City Council
PM	Particulate matter
Ppm	Parts per million
PSSC	Palustrine scrub-shrub, seasonally flooded
PSSF	Palustrine scrub-shrub, semi-permanently flooded
RCRA	Resource Conservation and Recovery Act
REC1	Water Contact Recreation
REC2	Non-contact Water Recreation

RED	Regional Economic Development
ROG	Reactive Organic Gas
RUM	River Update Meetings
RWQCB	Los Angeles Regional Water Quality Control Board
SCAB	South Coast Air Basin
SCAG	Southern California Association of Governments
SCAQMD	South Coast Air Quality Management District
SCCWRP	Southern California Coastal Watershed Research Program
SCS	Soil Conservation Service
SF6	Sulfur hexafluoride
SHPO	State Historic Preservation Office
SIP	State Implementation Plan
SO2	Sulfur dioxide
SR	State Route
SVOC	Semi-volatile organic compounds
SWPPP	Stormwater Pollution Prevention Plan
SWRCB	State Water Resources Control Board
TAC	Toxic Air Contaminants
TCE	Trichloroethylene
TMDL	Total Maximum Daily Load
TNW	Traditional Navigable Waters
TPCS	Total Project Cost Summary
TSS	Total Suspended Solids
ULARA	Upper Los Angeles River Area
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geologic Survey
VOC	Volatile Organic Compounds
WARM	Warm Freshwater Habitat
WET	Wetland Habitat
WILD	Wildlife Habitat
WRP	Water Recycling Program

EXECUTIVE SUMMARY

ES.1 INTRODUCTION

This document is an Integrated Feasibility Report, Environmental Impact Statement, and Environmental Impact Report—known as an Integrated Feasibility Report (IFR)—for the United States Army Corps of Engineers (USACE or Corps) Los Angeles River Ecosystem Restoration Feasibility Study (Study), for which the City of Los Angeles (City) is the non-Federal sponsor.

This IFR is prepared as a partial response to the resolution adopted by the Senate Committee on Public Works approved June 25, 1969, and Section 4018 of the Water Resources Development Act of 2007. This study was initiated in 2003, when funds were appropriated to conduct a reconnaissance study of ecosystem degradation in the "Cornfields" area (now Los Angeles State Historic Park) of the Los Angeles River in Los Angeles, California, to determine whether there was a Federal interest in ecosystem restoration for the study area. The *Los Angeles River Cornfields Area Environmental Restoration Study Reconnaissance Phase 905(b) Report* (USACE 2003) found that there was Federal interest to study the feasibility of solutions for ecosystem degradation on the Los Angeles River in the City of Los Angeles, California.

The feasibility phase of this study was initiated in 2006, when USACE and the City signed a Feasibility Cost Sharing Agreement (FCSA).

ES.2 BACKGROUND

The Los Angeles (River) is the 51-mile-long backbone of an 870-square-mile watershed. It once anchored a vast system of riparian foothill, riverine, and freshwater marsh habitat that carried seasonal rains and subterranean flows across the coastal plain to the Pacific Ocean. Over the last 150 years, the River has been degraded by a cycle of increasing urban development in the floodplain, flooding, and channelization, culminating in the mid-20th century with the construction of the Federal flood risk management project known as Los Angeles County Drainage Area (LACDA). These changes are illustrated in Figure ES-1.

Like many other rivers in the Southwestern United States, much of the River was an ephemeral stream, which would appear dry for much of the year, but become a powerful torrent during the rainy season, expanding over the floodplain. Prior to development, the river's course was consistent through the San Fernando Valley, but *"once the river rounded the bend of the Santa Monica Mountains at Griffith Park, however, its path became much more circuitous. Between the mouth of Verdugo Wash and the Arroyo Seco, the river spread over a broad depression two thousand feet wide, its course meandering considerably from year to year"* (Gumprecht 2001). Below the gap between the Elysian and San Rafael Hills, the channel widened and banks disappeared, with floodwaters able to stretch more than a mile wide (Gumprecht 2001). During storm events, the river's course could shift by as much as 90 degrees, changing its outlet from Santa Monica Bay to San Pedro Bay (see Figure ES-2 for a watershed map). Development removed vegetation and converted floodplains to agricultural uses, vineyards, and later, residential, industrial, and commercial areas. When the railroads arrived in the 1870s, they placed tracks close along its banks, further hemming in the river. Bridges and railroad trestles constrained and quickened flows and created barriers during major storm events (Figure ES-1). Groundwater and surface withdrawals reduced regular river flows significantly, but flood threats to the populace from the seasonal storm flows increased as development and infrastructure expanded within the river's natural floodplain, constraining the river's flow and removing supporting vegetation and areas for infiltration.

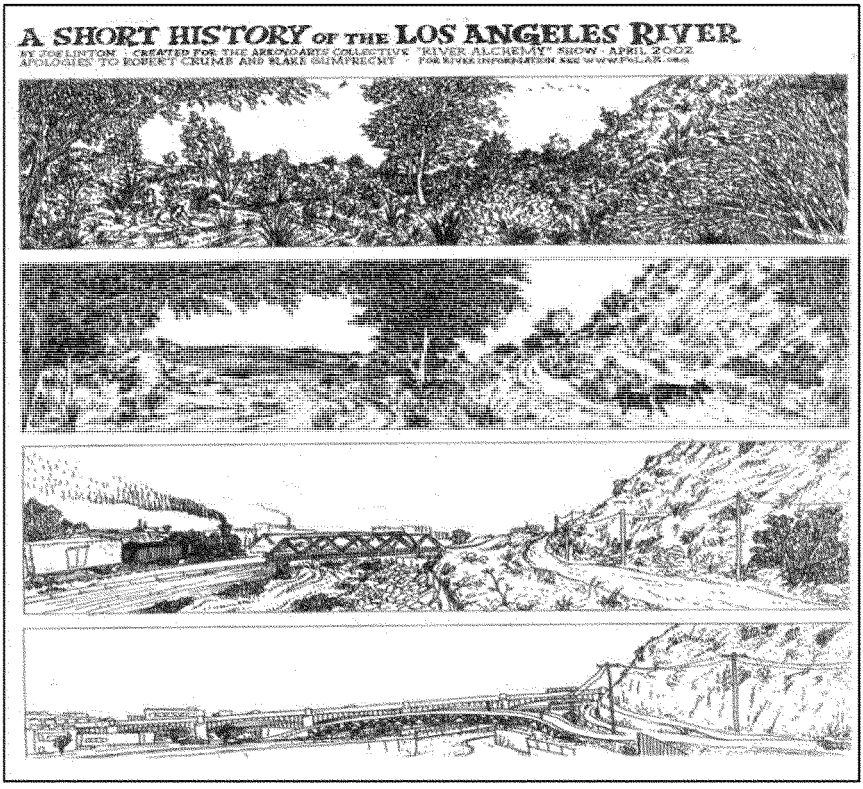


Figure ES- 1 Changes to the Los Angeles River (*source: Joe Linton with permission*)

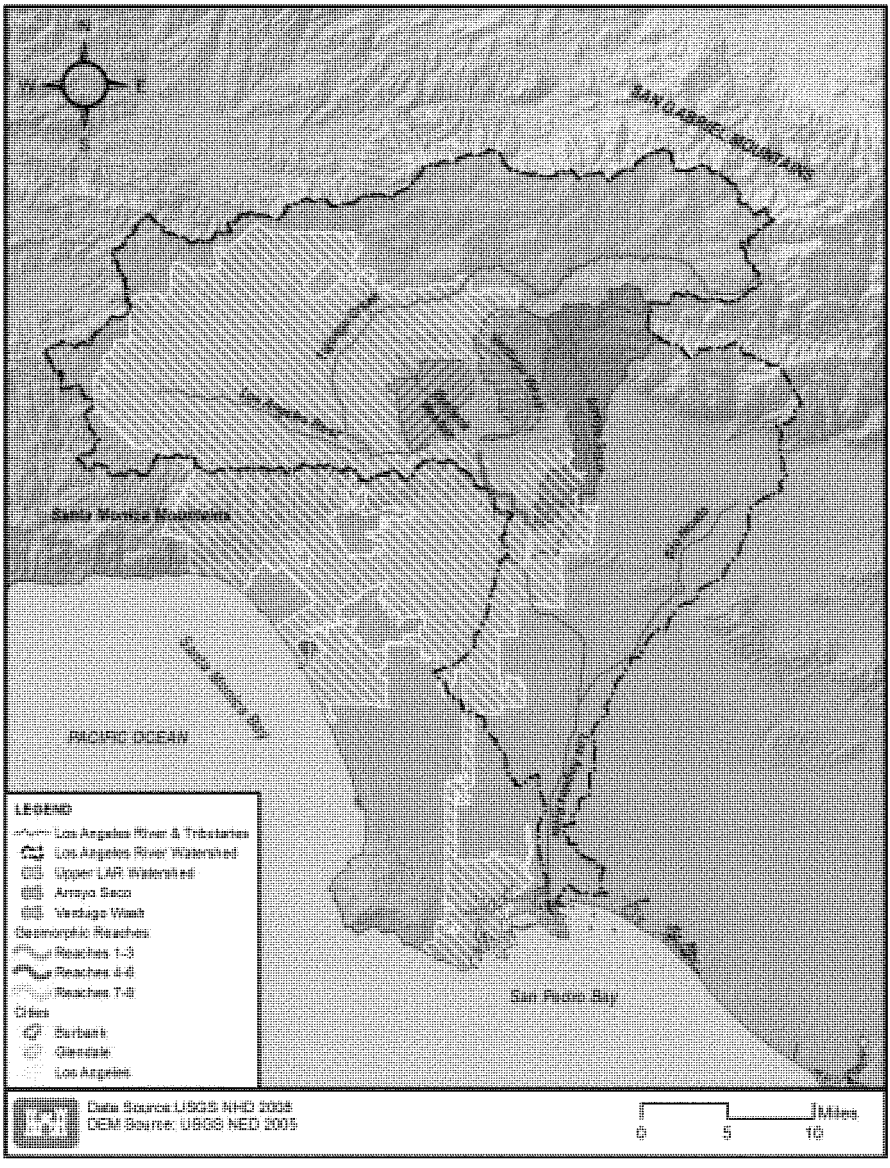


Figure ES- 2 Los Angeles River Watershed

In the late 19th and early 20th centuries, storm flows in the river caused catastrophic flooding that resulted in the loss of lives and millions of dollars in property damage to areas in the river's floodplain. As a result, City and County leaders initiated a formal flood risk management program (then known as "flood control") to channelize the natural river system with the goal of moving flood flows to the ocean as efficiently as possible. In the 1930s, Congress tasked the USACE with engineering the flood risk management system, as outlined in the County's Comprehensive Plan. The program resulted in the channelization of the river and its tributaries in concrete as part of the LACDA project.

Given the houses, businesses and infrastructure in the floodplain that encroached on the river channel, the increase in impervious surfaces accompanying development, and a complex system of storm drains that delivered runoff to the river, concrete channels were one of the few options left at the time for effective flood risk management. "*Federal flood control engineers had little choice but to confine the Los Angeles River to a relatively narrow channel, a fraction of the width of natural floodplain, because of the nature of existing development and the high price of real estate along its course.*" (Gumprecht 2001).

The further channelization and engineering of the already degraded river provided flood protection for the increasingly developed region and a consistent path for the River course. However, by encasing the river in concrete banks and a mostly concrete bed, widening and deepening its channel, and straightening the river's course, the channelization project further diminished the diversity and quality of the river system's plants and wildlife and disconnected it from its floodplain and significant ecological zones. The final section of the LACDA project in the Study Area was completed in 1959 as one component of the transformation of the region's watersheds through development and flood risk management projects. The LACDA project continues to provide critical protection against flooding of surrounding and downstream areas. The project is operated by the Corps and the County of Los Angeles.

ES.3 LOS ANGELES RIVER STUDY AREA

Today the Los Angeles River flows through the nation's second-largest urban region—from the San Fernando Valley into the Pacific Ocean at Long Beach. The first 32 miles of the river flow through the City of Los Angeles and along the cities of Burbank and Glendale (see Figure ES-2). Restoration of the river has been a long-standing priority of the City, and this is reflected in the Los Angeles River Revitalization Master Plan (Plan), adopted by the City Council in 2007. The Plan proposes ecosystem restoration with natural open spaces, wildlife habitat areas, recreational facilities and more than 240 projects connecting to five key "opportunity areas": Canoga Park, River Glen, Taylor Yard, Cornfields/Chinatown, and Downtown Industrial. Initially, the study area for this IFR included the 32 miles of the river within the City. However, the iterative study process resulted in a narrowing of the Study's geographic focus from the entire 32 miles to the 11 miles that includes the soft-bottomed Glendale Narrows stretch because that area shows the most promise for ecosystem restoration (Figure ES-3). Apart from the Sepulveda Basin, the San Fernando Valley area of the River (upstream of the study area) is characterized by large segments of channel that are entirely concrete with very few opportunities for adjacent land acquisition. In Studio City, the River is even more constrained—with a narrow boxed channel configuration less than 200 feet wide with development on either side. The lower reach of the river is highly constrained by development, including downtown Los Angeles and a heavy industrial corridor that also includes a major transmission corridor and a freeway system. The upper and lower reaches of the river have less potential to connect nationally and regionally significant ecological zones because of the state of existing development. These considerations make the potential for habitat connectivity and expansion very difficult in the near term.

The Glendale Narrows stretch of the river, in contrast, features a non-concrete bottom or natural bed (due to high groundwater levels), which has robust patches of vegetation—important habitat for birds and other wildlife—and free-flowing water that supports aquatic species. In addition, this area offers an opportunity to connect to existing large habitat areas of importance. Key tributary confluences connect to the river in this reach along and within Griffith Park, the eastern terminus of the Santa Monica Mountains. These connections include the Verdugo Wash, which connects to the Verdugo Mountains, and the Arroyo Seco, which connects to the San Gabriel Mountains and another USACE Feasibility Study area further upstream on the Arroyo Seco. The area also directly connects large open spaces either used as publicly-accessible parks with habitat areas or intended for this future use: USACE Headworks Feasibility Study area, California State Parks' Bowtie Parcel, the Taylor Yard, Río de Los Angeles State Park, and Los Angeles State Historic Park (formerly known as the Cornfields). Three of the five key opportunity

areas of the City's Plan are located within the Study area: River Glen, Taylor Yard, and Cornfields/Chinatown. Restoration within the study area would assist with the goal of transforming the river corridor into the "green spine" of the City. Existing habitat and perennial surface flow in the ARBOR (Area with Restoration Benefits and Opportunities for Revitalization) reach provide a base for restoration and maintain the most diverse assemblages of wildlife on the river today. The study thus focuses on the ARBOR reach, from Griffith Park to downtown Los Angeles.

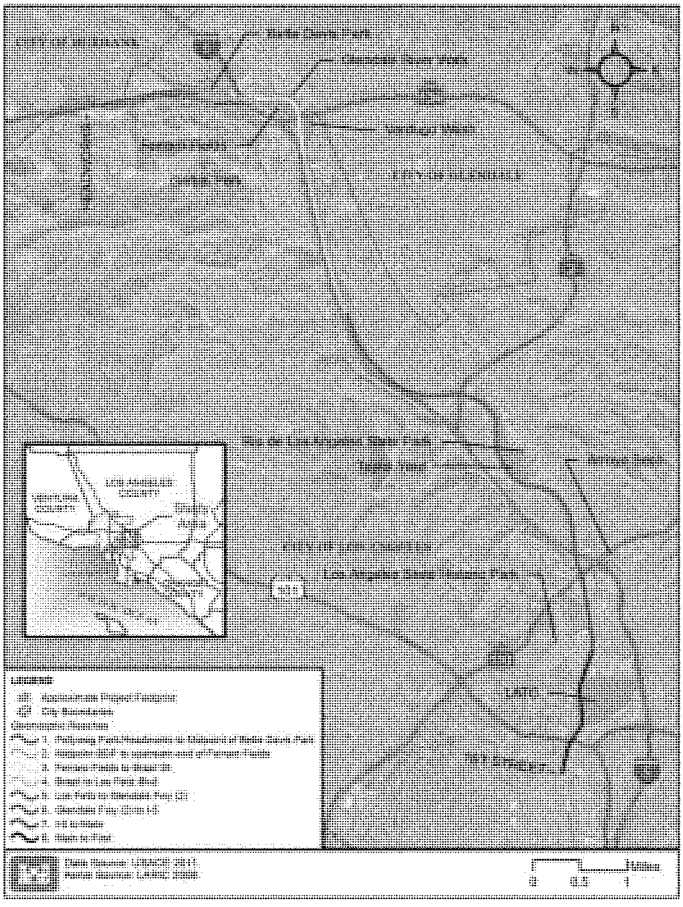


Figure ES- 3 Study Area, the ARBOR Reach

ES.4 RESOURCE SIGNIFICANCE

Consideration of significant resources is central to plan formulation, especially in the context of ecosystem restoration planning because non-monetary outputs are being considered. Per USACE Engineering Regulation (ER) 1105-2-100, significance of resources and effects will be derived from institutional, public, or technical recognition as discussed in further detail in Chapter 2 of the IFR. Table ES- 1 summarizes resource significance within the study area.

Table ES- 1 Summary of Resource Significance

	TECHNICAL RECOGNITION
Habitat Scarcity	Global – Study area is within the rare Mediterranean ecosystem that covers only 2% of the Earth's land surface but accounts for 20% of all known plant species (Kaufman 2003).
	Western Hemisphere – The western riparian ecosystem is one of the rarest habitat types in North America (Krueper 1995).
	United States – Western cottonwood-willow forest is one of the rarest and most endangered forest types in the U.S. (Noss & Peters 1995).
	Southwest – Due to arid Mediterranean climate, riparian areas are critical ecosystem as they occupy a very small area but support the majority of the region's biodiversity (Levick 2008).
Biodiversity	California has the highest total number of species of plants and animals, including native species not found anywhere else, than any other state in the U.S. (Stein et al. 2000).
	The California Floristic Province has been declared a global biodiversity hotspot and is one of the world's 25 most biologically rich and threatened terrestrial ecoregions. Hotspots must contain at least 1,500 species of endemic vascular plants, and lost at least 70 percent of its original habitat (Myers et al. 1999).
	The California Floristic Province is one of the world's 25 most biologically rich and threatened terrestrial ecoregions (Myers et al. 1999).
	California ranks number one in the United States for endemic (native) plants, amphibians, reptiles, mammals, and freshwater fish species that are unique to the state. Approximately 61% of the plants in the California occur nowhere else in the world. Approximately 50% of bird species and mammals in the United States are found in California (Bittman et al. 2003).
	Approximately 80 percent of all wildlife use the riparian ecosystem at some life stage, with over 50 percent of bird species nesting primarily in riparian habitats (Krueper 1993). The abundance and diversity of riparian vegetation, as compared to uplands areas, is key in providing food, shelter, water, breeding habitat, and movement corridors.
	In terms of species richness, the Los Angeles River area includes over 50 plant alliances and approximately 1,000 plant types (Bittman et al. 2003).
	The upper Los Angeles River watershed has a relatively high occurrence of rare plant species, due to underlying soil properties and other geomorphic and environmental conditions. The lower watershed includes rare special status invertebrates (Bittman et al. 2003).
	Approximately 140 federally protected bird species are supported on the LA River. Restoration would support the federally endangered least Bell's vireo, the yellow breasted chat, yellow warbler (State Species of Concern), hooded and Bullock's oriole, lazuli bunting, blue grosbeak, western tanager, woodpeckers, owls, ducks (Cinnamon teal, ring-necked duck, northern pintail), hawks (sharp shinned hawk, osprey), and shorebirds (great blue heron, spotted sandpiper, black necked stilt). Over 20 species of mammal are supported on the LA River. Restoration of movement corridors could support use by top predators such as bobcat and coyote. Nine species of bat are supported on the LA River. Restoration would expand bat habitat along bridges and support local bat populations that are known to regulate insect populations (vector control).

Status & Trends	The study area is in one of the top 25 global hotspots experiencing rapid biodiversity loss (Stein et al. 2000).
	Only 45,000 square miles of the California Floristic Province (or 25%) remains out of 183,000 square miles of the historic extent of vegetation (CEPF website).
	A total of 31% of plant and animal species at risk within the United States are found within California. This figure includes 32% of plant species, 41% of mammals, and 29% of reptiles at risk (Bittman et al. 2003). Less than 10% of wetlands' surface area remains in California, a 90% loss compared to wetland loss of 50% in the rest of the country (Dahl 1990).
	Over 90 percent of southern California's coastal region riparian habitat including Valley Foothill riparian habitats (Faber et al. 1989), and over 95 percent of California's wetlands and freshwater marsh, have been lost (Dahl 1990).
	Due to the unique hydrology in the semi-arid southwest, the Los Angeles Basin supported a small but native freshwater fish population (Swift and Siegel 1993). At least five of the seven fish species native to southern California have been extirpated from this watershed (Gumprecht 2001; FoLAR 2008). Extirpated fish species include federally listed southern California steelhead, unarmored threespine stickleback, and Pacific lamprey. California listed species arroyo chub and Santa Ana sucker still exist in small numbers in the upper watershed (Gumprecht 2001). Current conditions support non-native fish species that thrive in highly altered habitats with perennial flow, high nutrient levels, higher temperature, and lack of a flood disturbance regime (FoLAR 2008).
	Prior to habitat loss and conversion, the river was home to least Bell's vireo (federally endangered, state endangered), yellow billed cuckoo (federally threatened), and yellow warbler (state species of special concern), and provided foraging habitat for CA coastal gnatcatcher (federally threatened) and southwestern willow flycatcher (federally endangered, state endangered).
Connectivity	River channels in arid regions provide wildlife movement corridors essential to species survival due to the continuous chains of vegetation that wildlife can use for cover and food (Levick et al.2008).
	The remaining fragments of Los Angeles River aquatic and riparian habitat (or habitat "nodes") within the urban landscape context contribute significantly to the integrity of the larger ecosystem by supporting metapopulations (assemblages of local populations connected by migration) (Hanski and Gilpin 1991). By increasing patches and reducing the distances between them, colonization among populations improves (Hanski and Thomas 1994).
	The existing habitats in the Glendale Narrows and connection to major tributaries provide the backbone for restoration of regional habitat connectivity and wildlife movement between significant ecological areas including the Santa Monica Mountains, the Verdugo Hills, and nationally significant San Gabriel Mountains National Monument.
Hydrologic & Geomorphic Character	The highly seasonal hydrology and permeable sediments create a dynamic system where the river constantly shifts with the highly variable flood regime. Historically, "the river spread over a broad depression two thousand feet wide" between the Verdugo Wash confluence and the Arroyo Seco (Gumprecht 2001).
	The dynamic channel and floodplain structure supports a diverse assemblage of plants and wildlife. High flows transport sediment, displace benthic invertebrates, clear gravel beds of accumulated silt allowing attachment of insect eggs, and import woody debris, creating new habitat. Overbank flows connect channels to floodplains, increases overall productivity and diversity, while scouring rejuvenates habitat. Low flows determine available habitat available during critical periods. Temporary drying of stream channels could provide habitat for specialized species (EPA 1999).
	Development, flood risk, and water supply projects have constrained and eliminated most such systems in the southwest (see Section 2.1.3). Flood control works in the Los Angeles region alone include 100 miles of channelization of major rivers and streams plus 370 miles of tributary channels (Gumprecht 2001). On the main Los Angeles River, 94% of its 51 miles is lined by concrete banks and only one-quarter of its length, including 6 miles within the ARBOR, has a non-concrete bottom.

	The current hydrologic system has a highly altered regime that is simplified with intensified flows, functioning more as a drainage channel than a river ecosystem. Input of gravels and cobbles are prevented, water temperatures are higher, channel morphology is simplified, and the episodic succession-setting flood regime necessary to sustain the target riparian communities and native fish habitats has been altered.
INSTITUTIONAL RECOGNITION	
U.S. Fish & Wildlife Service	The U.S. Fish and Wildlife Service's recovery plan for the federally threatened Santa Ana sucker recognizes the importance of the Los Angeles River for recovery of the species. Per the plan, the Los Angeles River Watershed Recovery Unit includes the Los Angeles River down to the Arroyo Seco confluence, which encompasses the study area. Increasing the extent of native fish habitat will provide opportunities to improve the resiliency and redundancy, improving the status of the species (USFWS 2014).
Environmental Protection Agency	The Los Angeles River was selected to be one of seven nationwide first-phase pilots for the Environmental Protection Agency's (EPA) Urban Waters Federal Partnership. The Partnership includes the USACE, the Departments of Interior, Commerce, Agriculture, and Housing and Urban Development, the Environmental Protection Agency, four state agencies, seven local governmental entities, and 11 nongovernment organizations. The group's first goal is to "restore ecosystem function," and half of the group's 22 projects being tracked for progress are focused on this goal. This study was selected as the group's top priority.
Clean Water Act	The Los Angeles River is protected by the Clean Water Act. In 2010, EPA designated the entire river as a Traditionally Navigable Water (TNW), citing the River's historic and continuing importance and the potential beneficial impacts of river restoration on the region. The State of California cited the TNW designation and the character of the River in codifying the River's status as a navigable water of the state protected as part of the Public Trust under the State Constitution in SB 1201, signed by the Governor in 2012.
San Gabriel Mountains National Monument	Approximately 350,000 acres of the San Gabriel Mountains, headwaters of the Los Angeles River Watershed, were designated in late 2014 as the "San Gabriel Mountains National Monument." The San Gabriels contain some of the highest biodiversity in the country, with unique geological features and 300 endemic plants found nowhere else in the world.
Department of Interior	The President's America's Great Outdoors is an initiative to develop a 21st Century approach to conservation and outdoor recreation, identified the Los Angeles River watershed as a priority project in its "50 State Report."
Regional Conservation Agencies	The State of California Santa Monica Mountains Conservancy (SMMC) and its affiliate agency, the Mountains Recreation and Conservation Authority (MRCA) have restored or protected valuable open space along the banks of the Los Angeles River, increasing public ownership and access along the river, while increasing restoration opportunities that were not available even 15 years ago.
Los Angeles River Revitalization Master Plan (adopted 2007)	The City's Los Angeles River Revitalization Master Plan (adopted 2007) contains input of Federal, State, and regional agencies and stakeholders, and Congress specifically directed in WRDA 2007, section 4018, that the present study be consistent with the Master Plan goals. A key goal is to restore a functional riparian ecosystem to (1) create a continuous functional riparian corridor; (2) connect this corridor to other significant habitat and migration routes along the tributaries and into the mountains; (3) provide support for desirable fish species; and (4) bioengineer or naturalize the river's edge where feasible.

PUBLIC RECOGNITION	
Urban Waters Federal Partnership-Non-Governmental Organizations	Eleven nongovernmental organizations actively participate alongside the 11 Federal agencies of the Urban Waters Federal Partnership and many have a Los Angeles River ecosystem restoration focus. Key groups include: 1. Friends of the Los Angeles River (FoLAR), founded in 1986, has spearheaded efforts to restore the river. 2. The Council for Watershed Health, formerly the Los Angeles and San Gabriel Rivers Watershed Council, collaborates with government agencies, businesses and scientists to enhance the social, ecological, and economic health of the watersheds through education, research, and planning, 3. Urban Forestry groups TreePeople and North East Trees have worked to "green" the Los Angeles River and surrounding urban communities, and 4. Other key Los Angeles River and watershed groups include the Los Angeles River Revitalization Corporation, the Arroyo Seco Foundation, The River Project, Los Angeles Conservation Corps, the Trust for Public Land, the Urban Rivers Institute, and Urban Semillas.
Local, State, and Federal	In summer 2013 and 2014, a portion of the river channel within the study area was opened for seasonal activities, reflecting increased public interest for ecological education and passive recreational opportunities. Activities include hiking, bird-watching, environmental education, and non-motorized boating. This local, State, and Federal collaboration supports California Senate Bill 1201, which facilitates restoration and recreation where compatible with flood risk management.
Scholarly & Media Attention	The Los Angeles River, its degradation and potential restoration, have been the subject of increasing scholarly attention, national media coverage, inclusion in environmental history texts, art exhibitions, 20 films, and news and magazine stories, inspiring local and national artists, filmmakers, authors and poets.
National Recreation Trail System	In 2012, the portion of the Los Angeles River Trail that extends throughout the study area was designated by the Secretary of the Interior as part of the National Recreation Trail System increasing awareness and stewardship of the River's natural resources.

ES.5 PURPOSE AND NEED

Purpose: The primary purpose of the alternatives and proposed project considered in this Study is to restore approximately 11 miles of the Los Angeles River from Griffith Park to Downtown Los Angeles by reestablishing riparian strand, freshwater marsh, and aquatic habitat communities and reconnecting the River to major tributaries, its historic floodplain, and the regional habitat zones of the Santa Monica, San Gabriel, and Verdugo mountain ranges while maintaining existing levels of flood risk management. A secondary objective is to provide recreational opportunities consistent with the restored ecosystem.

Need: The Los Angeles River was once the backbone of a vast system of riparian foothill, riverine and freshwater marsh habitat that carried seasonal rains and subterranean flows through the coastal plain to the Pacific Ocean. Over time, the river has been degraded by a cycle of urban development, flooding, and channelization. Plant and wildlife diversity and habitat quality has been severely diminished, and the river has been severed from its floodplain and nearby significant ecological zones.

ES.6 PLANNING OBJECTIVES

The significant resources identified were used to develop problems and opportunities, and from there, objectives. The objectives of the study are to:

1. Restore Valley Foothill Riparian Strand and Freshwater Marsh Habitat: Restore Valley Foothill Riparian wildlife habitat types, aquatic freshwater marsh communities, and native fish habitat within the ARBOR

reach throughout the period of analysis[1], including restoration of supporting ecological processes and biological diversity, and a more natural hydrologic and hydraulic regime that reconnects the river to historic floodplains and tributaries, reduces velocities, increases infiltration, and improves natural sediment processes.

2. Increase Habitat Connectivity: Increase habitat connectivity between the river and the historic floodplain, and increase nodal connectivity for wildlife between restored habitat patches and nearby significant ecological zones such as the Santa Monica Mountains, Verdugo Hills, Elysian Hills, and San Gabriel Mountains within the ARBOR reach throughout the period of analysis.
3. Increase Passive Recreation: Include recreation that is compatible with the restored environment in the ARBOR reach throughout the period of analysis.

ES.7 KEY CONSTRAINTS, CONSIDERATIONS AND POLICY ISSUES INFLUENCING ALTERNATIVES FORMULATIONS, COMPARISON, AND SELECTION

Just as the national and regional perspective on the Los Angeles River has changed over time, the Corps mission has grown to include ecosystem restoration. Projects proposed by the Corps for ecosystem restoration should be responsive to the purpose, intent, and scope of the restoration mission.

- Purpose: "... to restore significant structure, function and dynamic processes that have been degraded" (Engineer Pamphlet or EP 1165-2-501).
- Intent: "... to partially or fully reestablish the attributes of a naturalistic, functioning, and self-regulating system" (EP 1165-2-502),
- Scope: "Nationally and regionally significant wetlands, riparian and other floodplain and aquatic systems" (ER 1105-2-100).

In developing and comparing alternatives, the Corps and City gave substantial consideration to the way in which structure, function and dynamic processes work together to achieve restoration objectives. Corps guidance states that, "Restoration projects should be conceived in a systems context … in order to improve the potential for long-term survival as self-regulating, functioning systems. This system view will be applied both in examination of the problems and the development of alternative means for their solution. Consideration should be given to the interconnectedness and dynamics of natural systems…" (ER 1105-2-100). The final array of alternatives takes into account the physical dynamics of the aquatic ecosystem.

Further, the proposed restoration has a direct association with historic and ongoing Corps activities. Nationwide, the Corps is engaged in transforming single-purpose, 20th century infrastructure that did not evaluate environmental effects before construction into multi-purpose, 21st century infrastructure that incorporates consideration for the natural environment and public access and use. The Corps has a central role to play in ecosystem restoration projects that are related to its existing projects. The Corps continues to operate the LACDA project within the river in the study area today, and that project remains necessary for the continued management of flood risk in surrounding areas. In addition, the Corps is uniquely suited as the Federal proponent in this endeavor because it is a lead water resources agency with appropriate engineering and ecological expertise. In order to appropriately respond to the scale of the identified problems in and along the River and warrant Federal investment, ecosystem restoration features that directly connect overbank areas with the channel to restore degraded functions and processes are critical.

Key issues encountered in developing the alternatives were the high costs of real estate, the presence of sites contaminated with hazardous substances, levee policies that restrict planting on levees, and flood risk. Each of these issues is typical of urban areas—acquisition of lands in urban areas is more expensive because of development

[1] The period of analysis is the period of time over which any alternative plan would have significant beneficial or adverse effects. The period of analysis is 50-years. (ER 1105-2-100)

pressures; a long-standing history of mixed uses for commerce, industry, intensive intermodal transportation yields contamination concerns; intensive development in historical floodplains includes associated building of roadways and other paved surfaces; and flood risk management infrastructure that is still critical to protecting adjacent communities is aging. The following summarize resolution and constraints related to key issues.

- Real estate costs for all plans identified for detailed study exceeded the Corps policy limitation that real estate costs not exceed 25 percent of total ecosystem restoration cost. To allow the study to consider recommendation of any of the plans identified, the City of Los Angeles offered to waive reimbursement for real estate costs exceeding its statutory share. The Assistant Secretary of the Army (Civil Works) granted the City's request and granted a policy exception to allow the consideration of these plans.
- Hazardous, Toxic and Radioactive Waste (HTRW) is present or suspected to be present in parcels key to alternatives formulation. Because Corps policy is to avoid HTRW contaminated lands when practicable, the study confirmed that where contaminated lands were included in alternatives, they were necessary to meet objectives. The sponsor will ensure lands with soil contamination are remediated prior to any construction by the Corps.
- Levee policies limit the planting that can occur on levees within the study area.
- The study area overlaps with the existing LACDA flood risk management project. Alternatives may not decrease the flood risk management function or level of protection provided by that project. This limited the modifications that could be made to the river channel.

ES.8 PLAN FORMULATION, EVALUATION, AND COMPARISON

Management measures, the components of alternatives, were developed based on the expert opinions of Federal, State, and local agencies, the Corps, and the sponsor. The measures were combined along the potential project area based on the problems, opportunities, objectives, and the practicability of implementation of each measure at each site given the constraints and land uses along the river. Teams of experts in the disciplines of economics, biology, engineering, hydraulics, landscape architecture, geotechnical/soils engineering, planning, and recreation were able to apply their expertise—along with the information gathered from the public and other stakeholders during the Revitalization Master Plan outreach efforts—to a focused charrette process. The participants considered refinement of the study objectives and a wide variety of measures that could be combined into alternatives meeting the planning objectives. The alternatives were formulated for the entire study area during the planning charrette with additional alternatives formulated during public outreach and individual team efforts including the USACE design team, City design team, and a multi-agency habitat team (with members from the USACE, the sponsor, Regional Water Quality Control Board (RWQCB), United States Fish and Wildlife Service (USFWS), California State Parks, California Department of Fish and Wildlife (CDFW), and academic experts). Other conceptual alternatives such as widening of the entire channel were initially considered and dismissed based on feasibility.

This produced a preliminary array of 19 alternatives. Typical designs, costs, and habitat benefits were developed for the elements of these alternatives. For this study, benefits (or outputs) were quantified using a habitat model called the Combined Habitat Assessment Protocols (CHAP) approach. CHAP looks at species and their function within the habitat. After mapping, doing a field inventory of the study area, and assessing a species list, the habitat team forecast the change in habitat for each measure at each site along the river. Habitat value was measured in habitat units (HU) based on an assessment of multiple species, habitat features, and functions by habitat type. Since the CHAP model utilized species, habitat, and functions in calculating HUs, there is more than 1 HU per acre.

Due to the high velocity flows that are carried in the channel during storm events, several of the preliminary alternatives relied, in whole or in part, on the diversion of flood flows through an underground tunnel or storage mechanism. The alternatives requiring the most extensive and expensive engineering interventions, such as the creation of underground detention/retention basins or very large bypass culverts or tunnels, were determined to be infeasible because of their cost and because they only exacerbated or moved the problems with the current channelized system and deferred important decisions about what needs to occur regarding peak flow reduction in the river's watershed.

The original 19 alternatives were each divided into eight reaches based on geomorphic character, which includes their physical shape, and channel configuration. Each reach plan from each of the 19 preliminary alternatives was input into the cost effectiveness/incremental cost analysis (CE/ICA) software (IWR Plan). The preliminary alternatives were also entered as a whole. The analysis then recombined the geomorphic reaches into plans for

comparison and evaluation with the preliminary plans, providing plans that were more cost effective and not dependent on a tunnel or other diversion measure. The recombination of plans by reach produced an array of 171 cost effective plans and 21 best buy plans. "Cost effective" means that, for a given level of non-monetary output, no other plan costs less, and no other plan yields more output for less money. The most efficient plans are called "Best Buys."

ES.9 DRAFT IFR ARRAY OF ALTERNATIVES

The array of alternatives presented in the Draft IFR was selected from the best buy plans based on the CE/ICA and the study objectives. Four plans were identified that best combined the reach plans to present a reasonable range of alternatives. The alternatives included in the final array involve a mix of working with and building upon the existing habitat in the river and providing new solutions that extend existing habitat with new upstream-to-downstream (such as at the key tributary confluences) and in-channel-to-outer-bank (such as with adjacent large areas) connections. The alternatives were named to assist the team, reviewers, and the public. The final array of alternatives from the Draft IFR is briefly described below:

- **Alternative 10** is called the **ART** (for ARBOR Riparian Transitions). It provides restoration in all reaches, restores a historic wash at the Los Angeles Trailer and Container Intermodal Facility (LATC) site, widens the river at Taylor Yard, restores a side channel and a seasonal flow area in the Griffith Park area, restores several daylighted streams, and provides transitions or connections between existing riparian corridors and concrete lined river reaches.

- **Alternative 13** is named **ACE** (for ARBOR Corridor Extension). It includes most of the features in Alternative 10, and it restores an additional side channel, increases widening of the river at Taylor Yard, and restores the Arroyo Seco confluence.

- **Alternative 16** is called **AND** (for ARBOR Narrows to Downtown). It includes most of the features in Alternative 13, and in addition, in Reach 5, it widens the river channel bottom and terraces the bank, and in Reach 8, it reconnects the river to the historic floodplain in LATC by removing the channel wall, restores the historic wash and freshwater marsh within the LATC site, removes concrete and restores wetlands within the channel bed, and terraces channel banks.

- **Alternative 20** is called **RIVER** (for Riparian Integration via Varied Ecological Reintroduction). It includes all the features of Alternative 16 except that in Reach 7 in addition to restoring the lower Arroyo Seco, it daylights three streams, restores freshwater marsh at the Los Angeles State Historic Park, and creates a terraced bank connection to the River. In addition, it widens the channel in Reach 2 and restores the confluence with Verdugo Wash in Reach 3.

ES.10 COMPARISON IN THE DRAFT IFR TO IDENTIFY THE NER AND TSP

As part of the planning process, the Corps and City identify an "NER" Plan, the National Ecosystem Restoration Plan. The NER Plan is not always the plan recommended for authorization by Congress, as the City can decide to take on the additional costs of implementing what is called a Locally Preferred Plan (LPP). Either an NER plan or an LPP can be the recommended plan.

As described in Corps planning guidance, the NER Plan is the alternative and scale having the maximum monetary and non-monetary beneficial effects over monetary and nonmonetary costs. This plan occurs where the incremental beneficial effects just equal the incremental costs, or alternatively stated, where the extra environmental value is just worth the extra costs. The guidance also notes that in all but the most unusual cases, the NER Plan should be derived from the final set of "Best Buy" solutions. To put it simply, the Corps and City have to answer the question about whether the plan's benefits are worth the costs, but this is a difficult process because monetary calculations do not capture all ecosystem benefits.

To further inform the decision on the NER and Tentatively Selected Plan (TSP), the alternatives array was compared using the study objectives, Principles and Guidelines comparison criteria, and the four comparison accounts of national economic development, environmental quality, regional economic development, and other social effects. The plans' environmental impacts were evaluated, as required by the Corps planning process and NEPA. These considerations all provide information to the public in comparing alternatives and assist the Corps and City in identifying what is called the NER Plan, and choosing a plan to recommend for authorization.

Based on the comparison, the Draft IFR identified Alternative 13 as the NER plan. Alternative 13 was also identified as the Tentatively Selected Plan in the Draft IFR. Although Alternatives 16 and 20 provided the greatest habitat restoration output of the plans in the final array, they did so at a very high incremental cost when compared to Alternative 13. For example, the cost associated with the 121 additional acres in Alternative 20 is relatively high because the acres are restored through modifications to the river channel by removing concrete or reconfiguring channel walls, and widening the channel to restore hydrologic connectivity and additional wetland habitat.

ES.11 ACTIONS SUBSEQUENT TO THE DRAFT IFR

Public Comments and Independent External Peer Review

During the public comment period for the Draft IFR, which closed on 18 November 2013, the Corps received and evaluated nearly 500 comment letters, forms and emails. The majority of the public and public agencies indicated their support of Alternative 20, which was taken into consideration by the Corps in determining the recommended plan. Comments were received from Federal agencies, State and local agencies, Non-Governmental Organizations (NGOs), interest groups, elected officials, and private citizens. Many public comments received, as well as a comment from the project's Independent External Peer Review (IEPR) Panel, suggested that an additional analysis of connectivity benefits would assist with alternative comparison and selection. The Corps used a framework suggested by the project's IEPR panel to better quantify the beneficial outputs of connectivity. Four different metrics were developed to further quantify different connectivity outputs. By evaluating hydrologic, local, and regional connectivity and combining the resulting output with the initial habitat model output, the Corps was able to more comprehensively compare the alternatives in the final array.

Although quantifying connectivity showed more restoration output for each of the alternatives, larger alternatives also had substantially higher costs. Given the magnitude of the incremental costs relative to the incremental increase in benefits, quantifying these connectivity benefits did not provide sufficient basis to justify the selection of a much larger scale plan as the NER Plan.

Identification of Variation on Alternative 13

Following the public review period for the Draft IFR, the Corps performed a more detailed cost analysis using Mii software, real estate cost updates, and further modified contingencies based upon a full cost risk summary analysis. This analysis identified a more efficient variation on Alternative 13 that is identical to Alternative 13 except for Reach 7, where it includes the reach plan included in Alternative 20. This alternative is within the spectrum of alternatives considered in the Draft IFR.

Alternative 13v (for variation) includes all the features in Alternative 13 except that in Reach 7, in addition to restoring the lower Arroyo Seco, it restores freshwater marsh at the Los Angeles State Historic Park, creates a terraced bank connection to the River and daylights three streams rather than including a restructured bank with overhanging vines.

Comparison of Final Array of Alternatives

Table ES- 2 below is a summary comparison of the restoration benefits across the final array of alternatives including Alternative 13v. Habitat benefits were calculated using a habitat evaluation method, CHAP (Combined Habitat Assessment Protocol), as described in Section 4.9.

Table ES- 2 Comparison of Ecosystem Benefits of Alternatives

Reach	Alt 10	Alt 13	Alt 13v	Alt 16	Alt 20
	1. Pollywog Park to Bette Davis Park				
Output (HU)	866	*same as 10*	*same as 10*	*same as 10*	*same as 10*
Acres	82				
	2. Bette Davis Park to Ferraro Fields (Alt 20 Adds Reach 2 Channel Widening)				
Output (HU)	392	*same as 10*	*same as 10*	*same as 10*	Δ = 55
Acres	39				Δ = 20
	3. Ferraro Fields to Upstream Glendale Narrows (Alt 13 Adds Ferraro Fields; Alt 20 Adds Verdugo Wash)				
Output (HU)	40	Δ = 160	*same as13*	*same as 13*	Δ = 130
Acres	33	Δ = 17			Δ = 30
	4. Upstream Glendale Narrows to Los Feliz				
Output (HU)	492	*same as 10*	*same as 10*	*same as 10*	*same as 10*
Acres	59				
	5. Los Feliz to Bowtie Parcel (Alt 16 adds Reach 5 widening/terracing)				
Output (HU)	87	*same as 10*	*same as 10*	Δ = 265	*same as 16*
Acres	41			Δ = 27	
	6. Bowtie Parcel to Downstream Glendale Narrows/Arroyo Seco (Alt 13 adds marsh/widening)				
Output (HU)	1,256	Δ = 191	*same as 13*	*same as 13*	*same as 13*
Acres	138	Δ = 21			
	7. Downstream Glendale Narrows/Arroyo Seco to Main Street (Alt 13 Adds Arroyo Seco, Alt 20 Adds Cornfields)				
Output (HU)	29	Δ = 230	Δ = 87	*same as 13*	*same as 13v*
Acres	27	Δ = 22	Δ = 32		
	8. Main Street to First Street (Alt 16 Adds Channel Bottom Concrete Removal, Terracing, Off Channel Wetlands, and H&H connection at LATC)				
Output (HU)	2,159	*same as 10*	*same as* 10	Δ = 342	*same as 16*
Acres	109			Δ = 44	
Alternative Totals	**Alt 10**	**Alt 13**	**Alt 13v**	**Alt 16**	**Alt 20**
Total AAHU	5,321	5,902	5989	6,509	6,782
Total Acres	528	588	598	659	719
Δ= change from next smallest alternative					

All five alternatives provide substantial ecosystem benefits as shown in the table. The larger alternatives provide more benefits, but they do so at a higher relative increase in costs.

Table ES- 3 provides a comparison of alternatives based on habitat connections. Percent increase in nodal "connectedness" was performed based on the sizes of habitat nodes in the study area and the minimum distance of vegetated corridors between nodes (Rudd et al. 2002). "Connectedness" was calculated based on the size of habitat nodes with natural hydrologic connections to the river and the length of natural habitat corridors between them. Restoration of large nodes that are close, together connected by natural habitat, corridors increase the level of "connectedness". For each alternative in the final array, additional nodes and/or corridors are restored, increasing the level of "connectedness" in the project area.

Table ES- 3 Final Array Comparison by Objectives-Habitat Connections

Habitat Connections	10 ART	13 ACE	Alt 13v	16 AND	20 RIVER
Incremental / nodal increase between alternatives	Minor improvement	309% over Alt 10	33% over Alt 13	39% over Alt 13v	120% over Alt 16
Added Regional Connections	Santa Monica Mtns	Santa Monica & San Gabriel Mtns	Elysian Hills, Santa Monica & San Gabriel Mtns	Santa Monica & San Gabriel Mtns	Verdugo & Elysian Hills, Santa Monica & San Gabriel Mtns
Connectivity benefits were evaluated in terms of nodal and regional connectivity as described in Sections 2.2.4 and 6.1. Nodal connectivity is provided when patches of habitat are connected by wildlife corridors. Connectivity improves with larger nodes that are closer together. Regional connectivity is a more general term referring to longer distance connections to significant habitat areas, such as the Santa Monica and San Gabriel Mountains.					

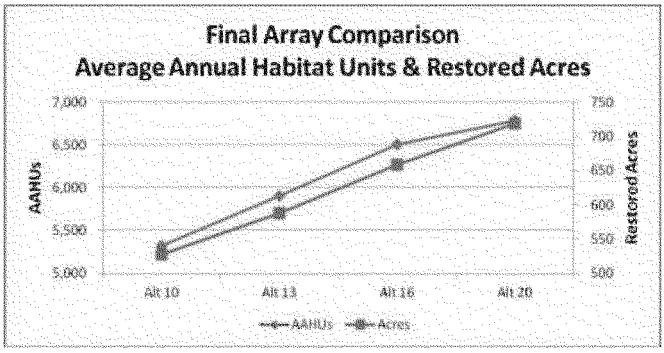


Figure ES- 4 Draft IFR Final Array Comparison-AAHU's and Restored Acres

Figure ES-4 provides a visual comparison of Average Annual Habitat Units (AAHUs) and restored acres by alternative. Alternative 13v is essentially the same as Alternative 13 with the change in Reach 7 resulting in an increase of 87 HUs and 10 acres.

Environmental Impacts

The alternatives were also evaluated and compared for their environmental impacts. The analysis identified beneficial impacts to biological resources, water resources, and other resource categories. All impacts were less than significant except for land nse impacts under NEPA and CEQA and air quality under CEQA. All of the action alternatives include siguificant unavoidable adverse impacts under NEPA and significant and unavoidable impacts under CEQA to land use for construction and operations. All of the action alternatives other than 13v would have significant and unavoidable impacts to air quality under CEQA from construction emissions. These impacts are summarized in Table ES-4.

Table ES- 4 Final Array Comparison of Significant Unavoidable Adverse Environmental Impacts (NEPA) and Significant and Unavoidable Impacts (CEQA)

Resource	Alternative 10 (ART)	Alternative 13 (ACE)	Alternative 13v	Alternative 16 (AND)	Alternative 20 (RIVER)
AIR QUALITY	The construction phase of the proposed project is expected to exceed the CEQA localized significance thresholds for NOx. This results in a significant unavoidable impact under CEQA. Impacts under NEPA would be less than significant.	Same as Alt 10.	Impacts under all air quality significance criteria would be less than significant.	Same as Alt 10.	Same as Alt 10.
LAND USE	Restoration in Reach 8 would conflict with the Industrial and Light Industrial land use designation. This results in a significant adverse impact under NEPA and a significant and unavoidable impact under CEQA for both construction and operations.	Same as Alt 10.	Same as Alt 10.	Same as Alt 10.	Same as Alt 10, additional conflict with Industrial designation in Reach 3, resulting in a significant adverse impact (NEPA), and significant and unavoidable impact (CEQA) for both construction and operations.

Refinement of NER Plan

Based on the comparative analysis, the NER Plan was refined from what was identified in the Draft IFR. Because the variation on Alternative 13, Alternative 13v, provides more benefits than Alternative 13 at lower cost, it has been identified as the NER Plan.

Alternative 13v is the same as Alternative 13 except for the change in Reach 7. The inclusion of the different Reach 7 plan results in an increase of 87 HUs and decrease in cost of approximately $40,000,000 compared to Alternative 13. Alternative 13v generally performs equivalently to Alternative 13 in the categories analyzed except with more cost effectiveness and greater benefits in Reach 7. In addition, Alternative 13v meets all of the Principles and Guidelines criteria as an effective, efficient, complete, and acceptable plan. An updated cost comparison of Alternative 13 and 13v is provided in Table ES-5 below.

Table ES- 5 Comparison of Alternative 13 and 13v (Price level October 2014)

	Alt 13	Alt 13v
Construction Cost	$147,851,000	$113,958,000
PED/EDC (14%)	$24,182,000	$15,954,120
S&A (9.5%)*	$16,856,000	$10,826,010
Lands & Damages (P.L. 91-646 Included)	$350,474,000	$348,648,000
Utility/Facility Relocations	$168,437,000	$177,886,000
Total LERRDs	$518,911,000	$526,534,000
TOTAL FIRST COST	**$707,800,000**	**$667,272,130**
AAHU	5,902	5,989
Annualized Investment Cost*	$31,147,128	$27,810,000
Annual O&M	$941,566	$951,887
Total Annual Cost	$32,088,695	$28,761,887
Total Annual Cost per AAHU	$5,438	4,802
Acres	588	598

** Interest during construction is included via simple addition of individual reach-based IDC calculations.*
PED- Preconstruction, engineering and design
EDC- Engineering during construction
LERRDs-lands, easements, rights-of-way, relocations or disposal areas

The recreation plan option corresponding to ecosystem restoration Alternative 13 includes the following specific features:

- 5.89 miles of new unpaved non-motorized multi-use trail *(to include decomposed granite surface and trail signage)*
- 0.3 miles of new paved multi-use trail *(short extension of current southern end of LA River Bike Path)*
- 1 small bridge/crossing within Taylor Yard
- 1 medium bridge within LATC
- 2 paved parking lots, one at Taylor Yard and one at LATC *(each about 15,000 square feet)*
- 4 restrooms, one at Bette Davis Park, two at Taylor Yard, and one at LATC
- 1 pedestrian underpass at the south end of Taylor Yard
- 24 trail access points throughout the study area *(access points would include grading and planting, signage, stairs, benches, gating, and trash receptacles to provide quality trail access)*
- 6 wildlife viewing points throughout the study area *(viewpoints would include an elevated wood deck with railing, benches, interpretive signage, and trash receptacles to allow users to enjoy high quality viewsheds within the restored ARBOR reach)*
- 4 pedestrian underpasses along the river to support trail connectivity

Request for Locally Preferred Plan

By letter dated April 10, 2014, the City of Los Angeles requested that Alternative 20 be the plan recommended to Congress. The basis for the City's request for Alternative 20 included: the Administration's America's Great Outdoors and Urban Waters Federal Partnership initiatives; strong public, agency, and stakeholder support; Los Angeles Congressional delegation support; the Corps' acceptability criteria; the scarcity of Mediterranean-type habitat; the need to connect to opportunity areas highlighted in the City's LA River Revitalization Master Plan; and redressing environmental injustice.

By memorandum of May 27, 2014, the Assistant Secretary of the Army (Civil Works) approved recommendation of Alternative 20 as a Locally Preferred Plan. Therefore, this Final IFR identifies Alternative 20 as the Locally Preferred Plan and the Recommended Plan.

ES.12 RECOMMENDED PLAN

The LPP and Recommended Plan

The recommended plan for restoration of the Los Angeles River in the ARBOR reach is Alternative 20 (RIVER), which is the locally preferred plan (LPP). The LPP includes additional restoration benefits above those identified for the NER plan. These additional benefits include restoration of the Verdugo Wash confluence in Reach 3, widening of the river's natural bed in Reaches 2 and 5, and restoring channel bottom and a direct connection of the river into the LATC site in Reach 8. These additional restoration benefits include direct restoration of an additional 121 acres, nearly twice the acreage of local and increased hydrologic connectivity (298 acres total), and provision of a direct connection to the significant habitat areas of the Verdugo Mountains. It also includes all elements of the NER plan with the exception of the number of daylighted streams. This plan has 13 daylighted streams. Daylighting in this instance is defined as opening underground pipes and storm drains near their confluence with the River to restore them to a natural stream channel.

Nearly unanimous support for Alternative 20 was expressed by the public through review of the Draft IFR and public meetings. The LPP is consistent with the goals of the Los Angeles River Revitalization Master Plan published in 2007 by the City of Los Angeles. Implementation of the LPP appears to best address the public's expressed desire for increased habitat and hydrologic connectivity, regional economic development and recreation, and restored community cohesion.

Environmental Commitments

Numerous environmental commitments and Best Management Practices have been developed and will be implemented to minimize or avoid any adverse effects that would occur primarily during construction. These measures are listed following the impact evaluation for each resource category addressed in Chapter 5.

Monitoring Commitments

An effective monitoring program is required to determine if the project outcomes are consistent with original project objectives. A Monitoring and Adaptive Management Plan (MAMP) was developed to identify performance measures along with desired outcomes and monitoring design in relation to specific objectives. Monitoring parameters for vegetation and native fish habitat are included. Results of the monitoring will be assessed in comparison to project objectives and decision-making triggers to evaluate whether the project is functioning as planned and whether adaptive management actions are needed to achieve project objectives. Cost-shared monitoring will not extend beyond ten years after construction of each component. The results of the monitoring will be provided to an Adaptive Management Team (AMT) who will evaluate and compare data to project objectives and decision making triggers. The information generated by the monitoring plan will be used by the Corps and City in consultation with the other AMT members to guide decisions on adaptive management that may be needed to ensure that the ecosystem restoration project meets the success criteria. Final decisions on implementation of adaptive management actions are made by the Corps. See Appendix H, MAMP, for the full discussion.

Recreation Plan

The LPP includes a recreation plan formulated to be consistent with the restoration plan. The recreation plan features are integrated into the ecosystem restoration plan; however, these features are formulated as separable components of the plan. The recreation plan associated with Alternative 20 includes the following specific features:

- 7.98 miles of new unpaved non-motorized multi-use trail *(to include decomposed granite surface and trail signage)*
- 1.26 miles of new paved multi-use trail *(extension of current southern end of LA River Bike Path)*
- 2 bridges spanning the LA River
- 1 smaller bridge/crossing within Taylor Yard
- 4 small/medium bridges within LATC
- 2 paved parking lots, one at Taylor Yard and one at LATC *(each about 15,000 square feet)*
- 4 restrooms, one at Bette Davis Park, two at Taylor Yard, and one at LATC

- 1 pedestrian underpass at the south end of Taylor Yard
- 28 trail access points throughout the study area *(access points would include grading and planting, signage, stairs, benches, gating, and trash receptacles to provide quality trail access)*
- 11 wildlife viewing points throughout the study area *(viewpoints would include an elevated wood deck with railing, benches, interpretive signage, and trash receptacles to allow users to enjoy high quality viewsheds within the restored ARBOR reach)*
- 6 pedestrian underpasses along the river to support trail connectivity

ES. 13 COSTS OF THE NER AND LPP

A project cost summary for total first cost[2] for the NER and the LPP are provided in Table ES- 6 and Table ES- 7. Note that these tables include costs for the recreation plans that were formulated for corresponding NER and LPP ecosystem restoration plans. Also note that preconstruction engineering and design (PED) and construction management (S&A) costs shown in the tables below include such costs for the construction of ecosystem restoration and recreation features, as well as for relocations, although all costs of relocations are assigned to LERRD.

Table ES- 6 Cost Summary of the NER Plan, Alternative 13v

Los Angeles River Ecosytem Restoration (Effective Price Level 1 Oct 2015)	
Construction Item	**Cost ($1,000)**
Lands and Damages (P.L. 91-646 Included)	$348,615
Utility/Facility Relocations	$181,305
Fish and Wildlife Facilities	$125,023
Recreation Facilities	$8,556
Preconstruction Engineering and Design (PED)	$27,556
Construction Management (S&A)	$13,412
Total First Cost	**$704,467**

Table ES- 7 Cost Summary Table of the LPP, Alternative 20

Los Angeles River Ecosytem Restoration (Effective Price Level 1 Oct 2015)	
Construction Item	**Cost ($1,000)**
Lands and Damages (P.L. 91-646 Included)	$526,285
Utility/Facility Relocations	$228,562
Fish and Wildlife Facilities	$462,483
Recreation Facilities	$14,921
Preconstruction Engineering and Design (PED)	$85,135
Construction Management (S&A)	$39,222
Total First Cost	**$1,356,608**

[2] First Cost is the project implementation cost not including ongoing costs such as Operation and Maintenance.

Average Annual Costs and Benefits

A summary of total and average annual benefits and costs is provided in

Table ES- 8 for ecosystem restoration and in Table ES- 9 for the recreation plans formulated for the NER and LPP restoration plans.

Table ES- 8 Equivalent Annual Benefits and Costs
(October 2015 Price Level, 50-Year Period of Analysis, 3.375 Percent Discount Rate)

ECOSYSTEM RESTORATION	NER	LPP
Construction	$85,685,000	$329,118,000
Contingency	$28,952,000	$121,115,000
Total Construction Cost	**$114,637,000**	**$450,233,000**
PED/EDC	$19,760,742	$62,304,915
Contingency	$6,554,638	$20,666,540
Total PED/EDC	$26,315,380	$82,971,455
Construction Management	$9,649,373	$28,711,353
Contingency	$3,206,487	$9,540,782
Total Construction Management	**$12,855,860**	**$38,252,135**
Adaptive Management & Monitoring	$7,763,000	$8,955,000
Contingency	$2,623,000	$3,295,000
Total Adaptive Management & Monitoring	**$10,386,000**	**$12,250,000**
Lands & Damages (P.L. 91-646 Included)	$303,144,000	$457,104,000
Contingency	$45,471,000	$69,181,000
Utility/Facility Relocations	$134,387,000	$168,718,000
Contingency	$46,918,000	$59,844,000
Total LERRDs	**$529,920,000**	**$754,847,000**
Ecosystem Restoration First Cost	$694,114,240	$1,338,553,590
Interest During Construction	$26,235,000	$57,911,000
Total Investment Cost	**$720,349,240**	**$1,396,464,590**
Annualized Investment Cost	$30,022,181	$58,200,816
Annualized O&M	$1,366,047	$2,306,385
Total Annual Cost	**$31,388,228**	**$60,507,201**
AAHU	**5,989**	**6,782**

Note: Total LERRD Costs for Ecosystem Restoration shown in the table above do not include the PED/EDC and construction management costs related to Relocations and are instead shown in PED/EDC and construction management lines (due to the breakdown of costs by Code of Accounts in the Cost Engineering WBS Structure). However, PED/EDC and Construction Management costs related to Relocations are part of LERRD rather than Construction. Because provision and performance of LERRD required for the project is a non-Federal responsibility, Relocation related costs (for PED/EDC and Construction Management) are included as separate line items in Cost Apportionment Tables. Also, a portion of the Lands and Damages line item represents Federal Administration costs for administration and review activities relating to the non-Federal Sponsor's provision of LERRD. These costs are not part of sponsor LERRD and are a cost shared component of the project. These costs are also shown as separate items in Cost Apportionment Tables.

Table ES- 9 Recreation Component
(October 2015 Price Level, 50 Year Period of Analysis, 3.375 Percent Discount Rate)

RECREATION	NER	LPP
Construction	$6,396,000	$10,907,000
Contingency	$2,160,000	$4,014,000
Total Construction Cost	**$8,556,000**	**$14,921,000**
PED/EDC	$931,600	$1,624,600
Contingency	$309,000	$538,900
Total PED/EDC	**$1,240,600**	**$2,163,500**
Construction Management	$417,600	$728,300
Contingency	$138,500	$241,600
Total Construction Management	**$556,100**	**$969,900**
Recreation First Cost	**$10,353,000**	**$18,054,000**
Interest During Construction	$33,200	$53,700
Total Investment Cost	**$10,386,200**	**$18,107,700**
Annualized Investment Cost	$432,900	$754,700
Annualized O&M	$172,800	$223,400
Total Annual Cost	**$605,700**	**$978,100**
Average Annual Benefits	**$2,479,100**	**$3,509,800**
Net Benefits	**$1,873,400**	**$2,531,700**
Benefit Cost Ratio (BCR)	**4.09**	**3.59**

ES.14 COST APPORTIONMENT AND NON-FEDERAL SPONSOR RESPONSIBILITIES

The non-Federal sponsor is responsible for providing 100 percent of lands, easements, rights of way, relocations, and disposal sites (LERRD) but has voluntarily offered to forgo reimbursement for the value of LERRD that exceed its statutory share (35%) of total ecosystem restoration costs. The ASA(CW) has approved this voluntary request. Cost sharing policy for LPPs requires the non-Federal sponsor to pay 100 percent of ecosystem restoration costs above the NER plan. A cost share which incorporates this information has been developed. In addition a non-standard cost sharing option is also presented in response to a request by the non-Federal sponsor. As explained in Section 7.5.1, specific statutory language would be required for the implementation of the non-standard cost sharing option. The two options are presented in Chapter 7. Selection of a cost sharing option for recommendation to Congress will be made subsequent to the circulation of this Final IFR and documented in the Chief of Engineers' Report.

ES.15 CONCLUSION AND RECOMMENDED PLAN

By letter dated April 10, 2014, the City of Los Angeles requested that Alternative 20 be the plan recommended to Congress. The basis for the City's request for Alternative 20 included: the Administration's America's Great Outdoors and Urban Waters Federal Partnership initiatives; strong public, agency, and stakeholder support; Los Angeles Congressional delegation support; the Corps' acceptability criteria; the scarcity of Mediterranean-type habitat; the need to connect to opportunity areas highlighted in the City's LA River Revitalization Master Plan; and redressing environmental injustice. The ASA(CW) granted the Corps permission to recommend Alternative 20 as the LPP. Chapter 7 of this Final IFR provides comparison of the NER and LPP, as well as the cost share options for the LPP referenced above.

1 INTRODUCTION

This document is an Integrated Feasibility Report, Environmental Impact Statement, and Environmental Impact Report for the Los Angeles River Ecosystem Restoration Study, which is referred to as the IFR. This IFR presents the potential alternatives for environmental restoration of the Los Angeles River, analyzes the environmental impacts of implementing those alternatives, reviews the process for selecting the best alternative, and concludes with recommendations for project implementation.

Integrated Feasibility Report

Los Angeles River Ecosystem Restoration Integrated Feasibility Study, Environmental Impact Statement, and Environmental Impact Report

NEPA Lead Agency

U.S. Army Corps of Engineers, Los Angeles District

CEQA Lead

City of Los Angeles, Department of Public Works, Bureau of Engineering

The U.S. Army Corps of Engineers, Los Angeles District (USACE or Corps) is the National Environmental Policy Act (NEPA) lead agency, and the City of Los Angeles, Department of Public Works (LADPW) Bureau of Engineering, referred to as the City of Los Angeles, City or non-Federal sponsor, is the California Environmental Quality Act (CEQA) lead agency for this IFR. These two co-lead agencies, as well as the Los Angeles County Department of Public Works (LACDPW), have historically been responsible for overseeing various functional aspects of the Los Angeles River (River). They have been engaged, both separately and cooperatively, in ongoing efforts to manage flood risks, maintain and improve water quality and supply, restore natural ecosystem functions of the River, and enhance the quality of life along the River.

1.1 STUDY AUTHORIZATION

The study is authorized as a partial response to Senate Committee on Public Works Resolution, approved June 25, 1969, reading in part:

> *Resolved by the Committee on Public Works of the United States Senate, that the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act, approved June 13, 1902, be, and is hereby requested to review the report of the Chief of Engineers on the Los Angeles and San Gabriel Rivers and Ballona Creek, California, published as House Document Numbered 838, Seventy-sixth Congress, and other pertinent reports, with a view to determining whether any modifications contained therein are advisable at the present time, in the interest of providing optimum development of all water and related land resources in the Los Angeles County Drainage Area.*

In addition, Section 4018 of the Water Resources Development Act of 2007 provided authorization for a "feasibility study for environmental ecosystem restoration, flood risk management, recreation, and other aspects of Los Angeles River revitalization that is consistent with the goals of the Los Angeles River Revitalization Master Plan published by the city of Los Angeles...." The implementation guidance for this section identified that the scope and substance of the study under the Senate resolution is identical to the study mandated by section 4018 and directed that the ongoing study incorporate the section 4018 study. The feasibility study incorporates, where applicable, conceptual elements and addresses restoration goals from the City's Los Angeles River Revitalization Master Plan.

This feasibility study provides interim partial response to the study authority, and the study efforts will determine the feasibility of ecosystem restoration of the Los Angeles River and surrounding environment. There is no sponsor available to investigate flood risk management at this time.

1.1.1 Purpose

The primary purpose of the proposed project and alternatives considered in this Study is to restore approximately 11 miles of the Los Angeles River from Griffith Park to downtown Los Angeles by reestablishing riparian strand, freshwater marsh, and aquatic habitat communities and reconnecting the River to major tributaries, its historic floodplain, and the regional habitat zones of the Santa Monica, San Gabriel, and Verdugo mountain ranges while maintaining existing levels of flood risk management. A secondary objective is to provide recreational opportunities consistent with the restored ecosystem. This reach is identified as the "Area with Restoration Benefits and Opportunities for Revitalization" reach, or ARBOR (Figure 1-2). This reach is referred to as the study area or ARBOR reach for the purposes of this IFR.

Study Area

The initial study area included the 32 miles of the Los Angeles River from its origination in Canoga Park to Washington Boulevard downstream of downtown Los Angeles.

ARBOR Reach

This is the 11-mile reach identified in the City's Master Plan as having the best opportunities for restoration within the larger 32 mile stretch of the River.

1.1.2 Need

The Los Angeles River was once a 51-mile-long backbone of a vast system of riparian foothill, riverine, and freshwater marsh habitat that carried seasonal rains and subterranean flows to the coastal plain and the Pacific Ocean. Over time, the River has been degraded by a cycle of increasing urban development, flooding, and channelization. This process culminated in the mid-20th century with the Federal flood risk management project, the Los Angeles County Drainage Area (LACDA) project. The LACDA project encased the river in concrete banks and a mostly concrete bed, and straightened the river's course, thereby diminishing its plant and wildlife diversity and quality, and disconnecting it from its floodplain and significant ecological zones. Apart from the Sepulveda Basin, the San Fernando Valley area of the River (upstream of the study area) is characterized by large segments of concrete channel with very few opportunities for adjacent land acquisition. The lower reach of the river is constrained by development, including downtown Los Angeles and a heavy industrial corridor that also includes a major transmission corridor and a freeway system. The upper and lower reaches of the river have less potential to connect nationally and regionally significant ecological zones because of the state of existing development. These considerations make the potential for habitat connectivity and expansion very difficult in the near term.

Despite its degraded condition, the ARBOR reach has the greatest potential for restoration along the River because it includes the Glendale Narrows, one of the few reaches in the River with a non-concrete bed and natural flows fed by underground sources. This portion of the River also has connections to the Verdugo Wash and Arroyo Seco tributaries that can eventually link to significant habitat areas, as well as to Griffith Park, the eastern terminus of the Santa Monica Mountains. Habitat within the Glendale Narrows area continues to be nourished by treated effluent discharges, which supplement the remaining natural flows in the River. Although wildlife use is primarily by species adapted to urban environments, habitat continues to degrade due to both the establishment of invasive species, such as giant reed (*Arundo donax*), and inflows from storm drain runoff. The existing habitat and perennial surface flow in the ARBOR reach provide a base for restoration and support the most diverse assemblages of wildlife on the River today. This reach is adjacent to state and local parks and natural areas. Some of the railroad facilities have been abandoned or removed from the channel corridor, providing opportunity for widening the channel while maintaining existing flood risk management levels. The ARBOR reach, therefore, provides the backbone for restoring significant habitat and reconnecting the River to other vital habitat areas. Expansion of riparian and marsh habitat along this portion of the River and at the confluences of key tributaries is a first step in putting portions of the once vast riverine ecosystem back together.

1.2 WATERSHED LOCATION AND LOCATION OF STUDY AREA

1.2.1 Watershed Description and Location

The confluence of Arroyo Calabasas and Bell Creek forms the start of the Los Angeles River. From that confluence, the River flows through the western San Fernando Valley to the Sepulveda Basin (a USACE flood risk management facility), receiving flows from various tributaries along the way (e.g., Browns Canyon Wash, Aliso Creek/Canyon Wash, Caballero Creek and within the Basin, Bull, Hayvenhurst, Woodley, and Encino Creeks). In Studio City, the River connects with the Tujunga Wash. The Tujunga Wash receives flows from the USACE's Hansen Dam facility and the Pacoima Wash. The Burbank-Western Channel connects to the Los Angeles River just north of Griffith Park in the City of Burbank, and smaller creeks draining the western San Gabriel Mountains join the River as it flows through the eastern San Fernando Valley. The River bends southward at its confluence with the Verdugo Wash, which flows from the east and serves as the border between the cities of Glendale and Los Angeles at the confluence. From this point, the River flows south through the Glendale Narrows and onto the broad coastal plain. Along the way, the River is joined by a number of tributaries, including the Arroyo Seco and the Rio Hondo Diversion Channel, which carries runoff from Whittier Narrows Dam. From the Rio Hondo Diversion Channel confluence, the River continues south another 12 miles and discharges into the Pacific Ocean at the San Pedro/Long Beach Harbor.

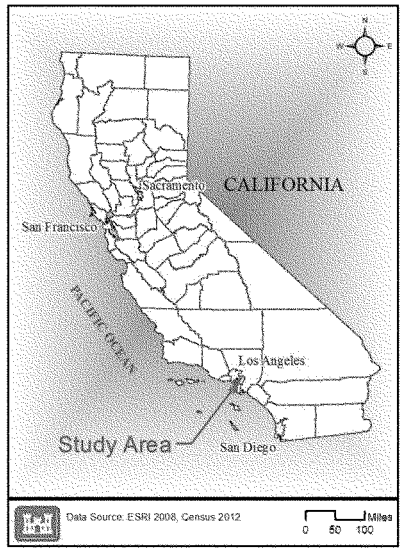


Figure 1-1 Study Area within the State of California

The watershed has highly varied terrain consisting of precipitous mountains, low-lying foothills, valleys, and coastal plains. The upper portion of the watershed (about 360 square miles) is predominantly forest or open space including more than 100 square miles of the Angeles National Forest. The remainder of the watershed (about 464 square miles) lies in the coastal plain, which includes the entire City of Los

Angeles. It is a highly developed area with commercial, industrial, and residential land uses. North of Downtown Los Angeles to the confluence with the Rio Hondo, the River flows through industrial and commercial areas and is bordered by rail yards, freeways, and major commercial/industrial and government facilities. From the Rio Hondo Diversion Channel to the Pacific Ocean, the River flows through industrial, residential, and commercial areas, including major refineries and petroleum products' storage facilities, freeways, rail lines, and rail yards serving the Ports of Los Angeles and Long Beach. The River and most of its tributaries in the urbanized portions of the Los Angeles watershed have been highly modified from their original natural courses to protect property and human life from the effects of flooding.

From its headwaters to the Pacific Ocean, the River drops approximately 790 feet in elevation over roughly 51 miles (about 15 feet per mile, yielding an average slope of approximately 0.3 percent). During the rainy season from October to March, heavy flows and occasional floods occur. In times of peak flow, the river carries more than 180,000 cubic feet of water per second (cfs) at velocities exceeding 25 feet per second in some areas. That volume of discharge is approximately 14 times the flow of New York's Hudson River moving at a velocity of more than 17 miles per hour. Prior to channelization, seasonal flows slowed to a trickle throughout most of the dry season, and the winter storm flood threat increased as development expanded on the River's natural floodplain. Storms produced massive flows in the River causing flooding that resulted in the loss of lives and millions of dollars in property damage in the late 19th and early 20th centuries.

Modifying the River to contain these periodic floods has rendered it a flood damage reduction channel that does not resemble a natural river system. Improvements for flood risk management have included bank hardening and lining the bed of the channel with concrete for most of its 51 miles. An approximately 6-mile stretch of the River in the study area has a non-concrete bed and grouted riprap side slopes, and is the only portion of the study area left with a soft bed; this soft bottom area was originally engineered with a cobblestone bed, but that has migrated or washed away over the years. During the dry season, base flows in the channel are often less than 100 cfs and are entirely composed of discharge from municipal and industrial wastewater treatment plants and urban/irrigation runoff. Open space, parks, and greenways are scarce. Instead, impervious surfaces, industrial development, and residential and commercial areas dominate the study area.

With the exception of publically owned steep mountain headwaters, the Los Angeles River watershed is completely built out. The LACDA damage reduction project includes two large dams upstream from the project plus numerous debris basins. In addition, Los Angeles County owns and maintains several water supply dams and hundreds of debris basins and check dams along the foothills of the upper watershed. There are a dozen or so grade stabilizers/cut-off walls and derrick stones within the ARBOR reach. Although the ARBOR reach of the river is stable, existing cross sections along the ARBOR reach reflect an uneven invert due to capture and entrapment of sediment by vegetation as well as horizontally varying velocities that create localized scour.

1.2.2 Location of Study Area

The baseline study area that was initially considered during the planning process included the 32 miles of the River that are within the City of Los Angeles, within a half mile of each bank. This reach begins at the origin of the River, which is the confluence of Bell Creek and Arroyo Calabasas in the northwest San Fernando Valley at Owensmouth Boulevard, and ends near the City of Vernon in the downtown Los Angeles area. Figure 1-1 shows the City of Los Angeles where the study area is located, and Figure ES-2 shows the watershed. The upper watershed, which begins in the Santa Susana, Santa Monica, and San Gabriel Mountains, is dominated by coastal sage, chaparral, pine forest, and open space. The watershed is highly urbanized and densely populated, encompassing a broad alluvial plain dominated by residential,

commercial, and industrial land uses. The 51-mile River enters the Pacific Ocean at the San Pedro/Long Beach Harbor.

Through initial investigation of constraints in the baseline study area and the identification of where ecosystem restoration might best be accomplished, the planning process defined the focused study area as the ARBOR reach, which extends from the Headworks site downstream to First Street (see Figure 1-2).

The major reason the ARBOR reach became the focused study area was the potential for increased habitat connectivity. In key San Fernando Valley sites, there was limited ability for habitat connections because of urbanization in the surrounding areas and the 100 percent concrete character of the LA River and tributary channels between the habitat "node" areas. Although restoration is possible along completely concrete channels, the lack of available space adjacent to the river in combination with concrete channel bottoms lowered the priority of this area compared to the Glendale Narrows stretch. By contrast, in the Glendale Narrows there is considerable indigenous in-channel habitat that may be connected to adjacent areas and, since the survivability of the existing habitat in the Narrows is under threat from invasive species and further fragmentation if connections are not strengthened, that area was prioritized for near-term restoration. Moreover, there are already meaningful habitat connections for avian species and small mammals between the LA River in the Glendale Narrows and nearby large habitat areas, including Griffith Park, Angeles National Forest, and the Santa Monica, San Gabriel, and Verdugo mountain ranges. Finally, the Glendale Narrows area was most robustly supported by community stakeholders when asked for their input regarding the area with the greatest ecosystem restoration potential. Recent actions in the area demonstrate this support. California State Parks has recently acquired large parcels along the River (at Taylor Yard and the Cornfields), small parks and greenways have been implemented throughout the area by various organizations and individuals, and informal fishing, boating, and wildlife viewing activity have increased in the area. The narrowing of the study area early in the process based on the factors stated above represents a narrowing of the scope and purpose to identify attainable and implementable alternatives within the existing constraints.

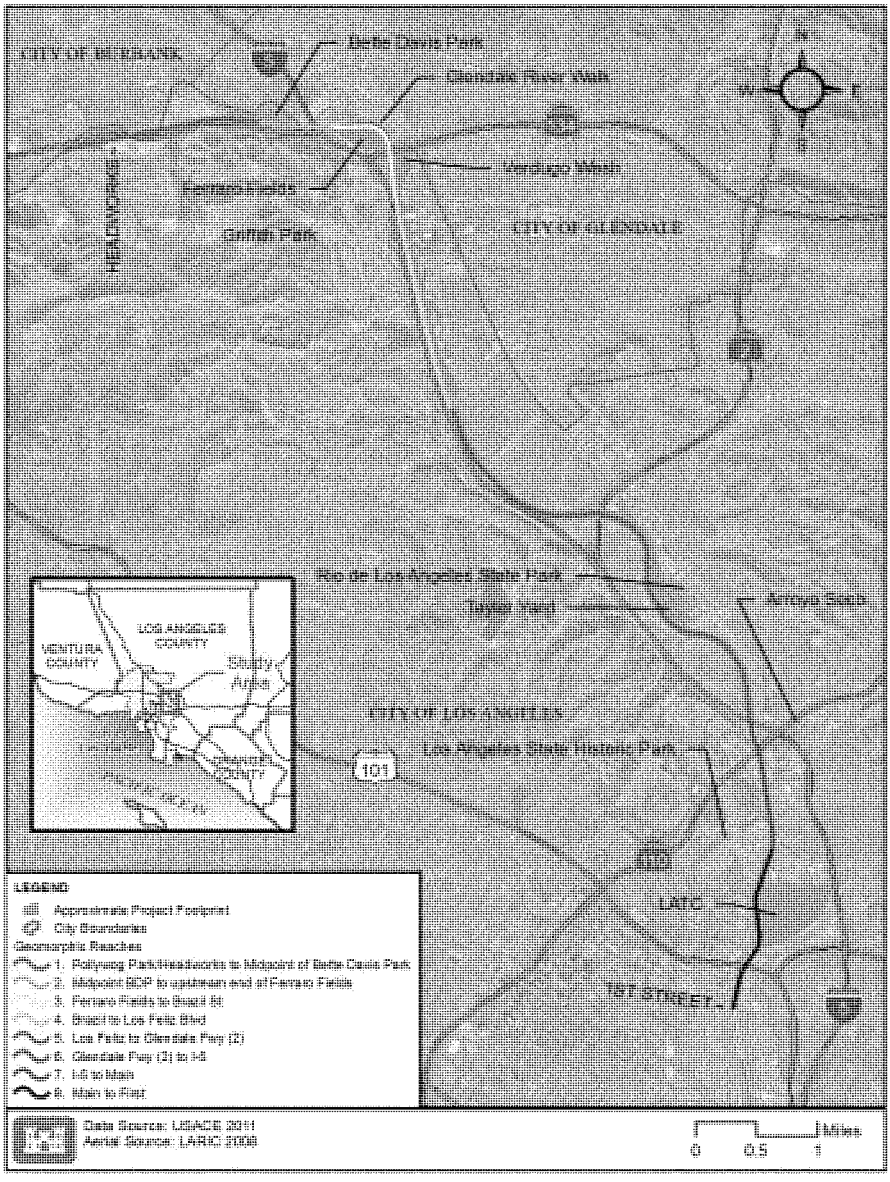


Figure 1-2 Study Area, the ARBOR Reach

1.2.3 Historic Conditions

The Los Angeles Basin is a broad alluvial plain stretching from Santa Monica to Newport Beach, where historically the waters of the Los Angeles, San Gabriel, and Santa Ana Rivers joined during intense flood events. The natural rivers' braided channels spread across wide areas and their courses migrated considerably over time. These channels carried various sediments (boulders, rocks, gravel, sand, and silt) that were eroded from the adjacent mountains and deposited in the valleys and plains along the path to the ocean (Gumprecht 2001).

The natural river is typical of watercourses in the arid/semi-arid southwest, which are unlike river systems in any other part of the country. Landscapes in the arid southwest are characterized by low, but highly variable rainfall. The resulting dry conditions create a stark contrast between riverine and riparian areas and the adjacent upland vegetation. In this way, the riparian ecosystem in the southwest is a critically important system because it occupies a very small area but supports the majority of the ecological and hydrologic connectivity in the local landscape and the biodiversity in the region (Levick et al. 2008). The highly seasonal hydrology and permeable sediments that are characteristic of the southwest region create a dynamic system, wherein river courses are constantly shifting in response to the highly variable seasonal storm regime, creating expansive floodplains that are often miles wide. Where river beds are dry much of the year, seasonal storms can result in high velocity, turbulent flash floods that carry heavy sediment loads (including coarse sediments) through the system. In some southwestern rivers and streams, there may not be perennial or intermittent surface flow, but rather water may be present below ground and accessible to a rich assemblage of plant and animal life. These more ephemeral streams also perform the same critical hydrologic functions as perennial streams: they move water, sediment, nutrients, and debris through the river system and provide both hydrologic and habitat connectivity within the watershed (Levick et al. 2008).

Due to the deposition of this alluvium, much of the runoff during winter rains infiltrated into the ground, creating large underground basins. As a result, the river channel only carried significant surface flow during major storms. This periodic surface flow resulted in shallow, poorly defined river channels where sudden storms transformed the typically dry streambed into a powerful, flowing river. Seasonal storm flows overtopped the ill-defined river banks, flooding large areas and creating lakes on the coastal plain. The forceful floodwaters, which carried large amounts of rock, sediment, and debris, carved new river channels, reshaped the topography of the surrounding landscape, and created new sloughs, marshes, and ponds. For much of the year, the river on the surface was a gentle stream that flowed through a wide, sandy bed. Winter storms, however, generated powerful and unpredictable flows that resulted in the river's course shifting significantly across the coastal plain from year to year (Gumprecht 2001).

The original Pueblo de Los Angeles location was chosen because of its adjacency to the river, near where downtown Los Angeles is today. The river north of downtown had in some cases constant flows, fed by springs in the study area and other underground sources. South of downtown, the river's course would disappear at times into floodplain forest but would reappear during seasonal rains and major storm events, jumping its old channel and changing direction. The river's historic course to the ocean often migrated by as much as ninety degrees. Some years the river flowed west emptying into Santa Monica Bay near Playa del Rey, some years the river flowed south emptying into San Pedro Bay, and other years it was so dry it never met the ocean and instead emptied into small lakes along its course. On its southerly course, the river channel was very indistinct, sometimes meandering east toward Long Beach or joining with the San Gabriel River. Where flows were pushed to the surface or seasonal floodwaters inundated the surrounding lands, large marshlands were created. At San Pedro Bay, the river mouth and its location were in constant flux, with the mouth migrating 1,400 feet over 20 years in the late 1800s (Hughes 1937). Seasonal winter overflow at the river mouth created extensive saltwater marshes and tidal lagoons along the coast between Palos Verdes and Long Beach. Likewise, 2,100 acres of mud flats and lagoons were created at the river

outlet to Santa Monica Bay. Most of the year, the river would not have carried enough water to reach the ocean and, therefore, each new flood flow created a new outlet (Gumprecht 2001).

Loss of habitat is illustrated in Figure 1-3, which compares study area mapping created in 1896-97 to cover types in 2010 (Compston and Dockweiler 1897). Additional discussion of historic habitat is provided in Section 2.2.3. As is apparent, vast expanses of valley foothill riparian habitat once existed in the floodplain. As late as 1888, after some marshlands had been drained and groundwater pumped for human consumption, surveys of the coastal plain documented nearly 6,000 acres of freshwater marsh, 3,000 acres of wetlands, and 15,000 acres of coastal salt marshes and estuaries (Hall 1888). Intense urbanization and subsequent infestation by non-native invasive plant species has led to the loss of these native habitats.

The river historically meandered across the coastal plain, periodically flooding the area during the rainy winter season and changing course. The photograph in Figure 1-4 was taken from a balloon in June 1887 and shows the river flowing across its floodplain and the beginnings of urban encroachment in downtown Los Angeles (downtown in foreground of photo, with farthest north river crossing on Mission Street on left side of photo).

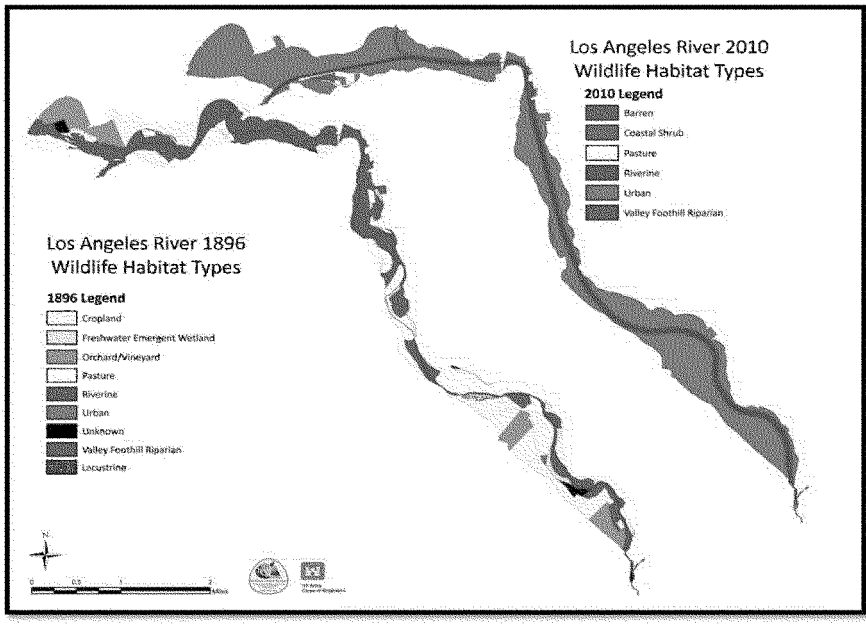


Figure 1-3 Comparison of Los Angeles River Habitat Covers 1896-2010.

(1897 Map obtained from Huntington Library, developed by C.S. Compton and J.H. Dockweiler, City Engineers)

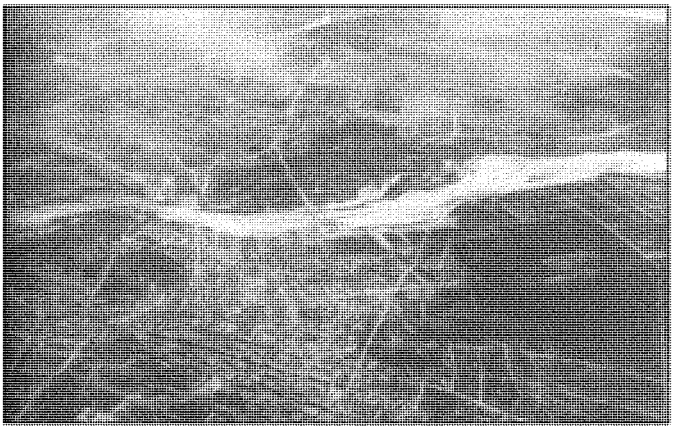


Figure 1-4 A Photo from 1887 (Seaver Center for Western Research, Natural History Museum of Los Angeles)

When the railroads arrived in the 1870s, tracks were constructed along the river's banks, hemming it in and quickening flows. Bridges and trestles further constrained flows and created barriers during major storm events. After William Mulholland secured the Owens River water to supply the city, the city's dependence on the river's surface flow as a water source diminished, and it became a dumping ground for trash, dead horses, and sewage. In the late 19th and early 20th centuries, very large storm flows in the river caused catastrophic flooding that resulted in the loss of lives and millions of dollars in property damage. As a result, the City of Los Angeles and Los Angeles County leaders initiated a flood risk management program that eventually channelized the natural river system with the goal of moving flood flows to the ocean as efficiently as possible.

The USACE joined the effort in the 1930s during the Great Depression, directed by Congress to assist with flood risk management efforts under Emergency Relief Acts. Soon after, Congress authorized the USACE, with the County as partner, to undertake a modified version of the County's comprehensive plan, thereby solidifying the implementation of a structural solution to flood risk management. Urbanization and infrastructure constrained options for flood risk management. Development in the floodplain included agricultural, residential, commercial, and industrial uses, as well as paved surfaces and railroads alongside the channels. Multiple bridges depended on a narrowed riverbed, and the County developed a complex system of storm drains delivering runoff to the river. The channel built in the 20th century—constrained and largely concrete—was thus one of the few options left at the time without revisiting the entire system of development. Even though the river was already substantially altered, channelization and concreting under the Federal project degraded the remaining habitat values by straightening the river's course, diminishing its plant and wildlife diversity and quality, fully disconnecting it from its floodplain and significant ecological zones, and dramatically changing its appearance and function. Figure 1-5 depicts the evolution of changing conditions along the River caused by agricultural development and increasing urbanization.

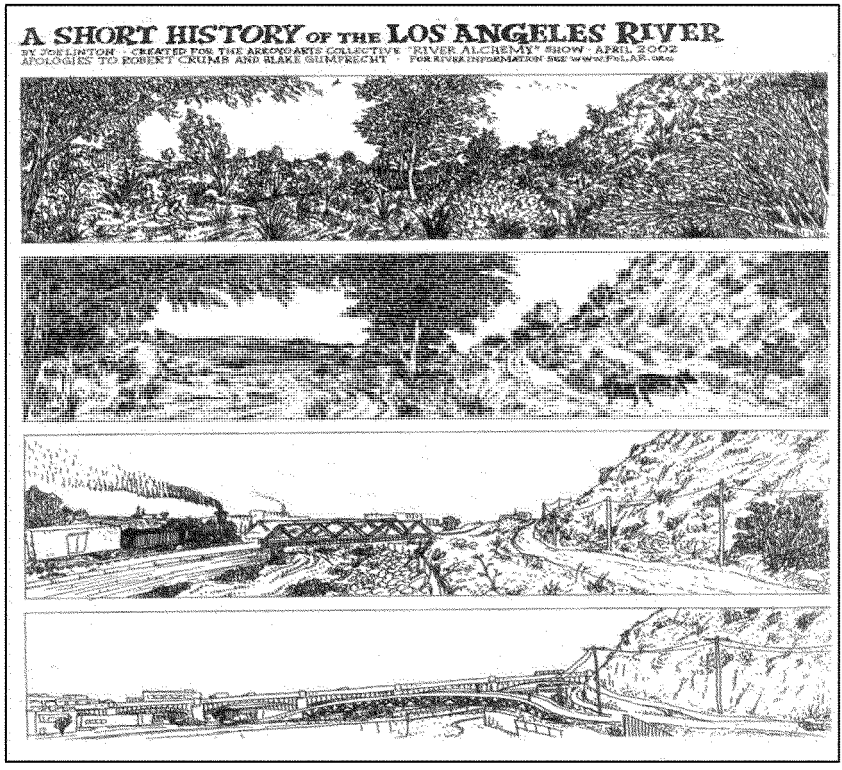


Figure 1-5 Artist's illustration of changes to the Los Angeles River through urbanization

(Source: Joe Linton with permission)

1.3 STUDY/PROJECT PARTICIPANTS AND COORDINATION

The development of proposed restoration measures has been conducted with the assistance of a wide variety of organizations, communities, agencies, and other stakeholders and achieved through a systematic 3-step process as follows: (1) evaluating the River's existing conditions and the associated problems and opportunities, (2) identifying objectives to help solve the problems, and (3) inviting public and agency coordination and input to help identify the types of measures that would achieve restoration of the study area in a way compatible with the Corps restoration policy, local interests, and regulatory needs. Throughout this process, public involvement has been essential. Over the course of the past eight years, the public has been invited to engage in the decision-making process at each step. An overview of public and stakeholder involvement throughout this process is described in detail in Chapter 8.

1.4 RELATED STUDIES AND REPORTS

The following section provides a list of the studies that have been conducted within the study area in the past, and which are relevant to this IFR. It includes several reports prepared primarily by the City of Los Angeles, USACE, and LACDPW, and also includes reports prepared by other agencies, individuals, and local community groups. Each of the reports listed below was reviewed as a part of this study. Several study efforts connected to the River are being conducted concurrently and, as a result, are not ready for review or incorporation into this study.

1.4.1 U.S. Army Corps of Engineers Reports

- Los Angeles County Drainage Area Review, December 1991.
- Final Report, Review of Water Resources within the Los Angeles County Drainage Area, 1985.
- Hansen Dam Preliminary Formulation Report, 1984.
- Hansen Dam Sediment Modeling Study, 1983.
- Interim Feasibility Report for Ballona Creek and Tributaries, 1982.
- Report on Floods of February and March 1978 in Southern California, 1978.
- Interim Report on Hydrology and Hydraulic Review of Design Features of Existing Dams for Los Angeles County Drainage Area Dams, 1978.
- Operations and Maintenance Manual, Los Angeles County Drainage Area, 1975.
- Flood Control in the Los Angeles County Drainage Area, 1939.

1.4.2 Individual, Local, and Agency Reports

- Tujunga Wash Ecosystem Restoration Feasibility Study, 2012.
- Los Angeles Stormwater, Water Quality Compliance Plan, 2009.
- City of Los Angeles, Los Angeles River Revitalization Master Plan, 2007.
- City of Los Angeles, Widening and Seismic Retrofitting of the Riverside Drive Bridge at Zoo Drive, June 2007.
- Arroyo Seco Watershed Management and Restoration Plan, 2005.
- California Department of State Parks, Los Angeles District Office, Cornfield Interim Public Use Plan, June 2003.
- Cal Poly Pomona's College of Environmental Design Graduate Program, Case Studies Relative to Taylor Yard, January 2002.
- California Coastal Conservancy, Taylor Final Multiple Objective Feasibility Study Final Report, June 2002.
- UCLA Berkeley's Environmental Planning Studio, Connecting Communities at Taylor Yard, February 2002.
- The River Project for the California Coastal Conservancy, Taylor Yard Preliminary Groundwater and Surface Water Study, March 2002.
- Common Ground from the Mountains to the Sea, San Gabriel and Los Angeles Rivers Watershed and Open Space Plan, 2001.
- California Department of Fish and Wildlife, The California Natural Diversity Database, Last updated spring 2001.
- Los Angeles County Department of Public Works, 1999-2000 Hydrologic Report, June 2001.
- Los Angeles County Department of Public Works, Watershed Hydrology Study, March 2001.
- Mountains and Rivers Conservation Authority, Arroyo Seco/Los Angeles River Confluence Park Plan, 2001.
- UCLA Extension's Landscape Architecture Program, Bridging Brownfields to Greenfields – The Los Angeles River State Park at Taylor Yard, March 2001
- California Coastal Conservancy, Wetlands of the Los Angeles River Watershed: Profiles and Restoration Opportunities, May 2000.

- California Regional Water Quality Control Board, Los Angeles Region, Total Maximum Daily Load of Trash for the Los Angeles River Watershed Draft Report, November 2000.
- Deverell, William and Greg Hise, Eden by Design: The 1930 Olmsted-Bartholomew Plan for the Los Angeles Region, 2000.
- Los Angeles and San Gabriel Rivers Watershed Feasibility Study, 2000.
- Los Angeles and San Gabriel Rivers Watershed Council, Current Water Quality Improvement, Land Acquisition and Restoration Projects in Los Angeles County, August 1999.
- U.S. Environmental Protection Agency, Review of California's 1998 303(d) List, 1998.
- Tetra Tech, Inc. (Simons, Li & Associates), Los Angeles River Alternative Flood Control Study, Volume I: Baseline Conditions Report, Los Angeles: Los Angeles County Department of Public Works, 1997.
- Tetra Tech, Inc. (Simons, Li & Associates), Los Angeles River Alternative Flood Control Study. Volume II: Evaluation of Alternatives, Los Angeles: Los Angeles County Department of Public Works, 1997.
- Tetra Tech, Inc. (Simons, Li & Associates), Los Angeles River Alternative Flood Control Study. Volume III: Final Report Appendices, Los Angeles: Los Angeles County Department of Public Works, 1997.
- Los Angeles County Department of Public Works, Los Angeles River Master Plan and Update, June/July 1996.
- Los Angeles River Advisory Committee, Los Angeles River Master Plan, Los Angeles, 1996.
- Friends of the Los Angeles River, Proposed Flood Control Strategy for the Los Angeles and San Gabriel River Systems, January 1995.
- Los Angeles County Department of Public Works, Final Master Environmental Impact Report: Los Angeles County Drainage Area Project, Prepared by Woodward-Clyde Consultants. 1995.
- Los Angeles County Department of Public Works, Multi-Use Study on the Los Angeles River at Taylor Yard, 1994.
- Garrett, Kimball. California Department of Fish and Wildlife, The Biota of the Los Angeles River: An Overview of the Historical and Present Plant and Animal Life of the Los Angeles River Drainage, March 1993.
- Los Angeles County Departments of Public Works, Parks and Recreation, Regional Planning, National Parks Service, Rivers, Trails and Conservation Assistance Program.

1.4.3 Concurrent Studies

- Headworks Ecosystem Restoration Feasibility Study. This ongoing USACE feasibility study, initiated in 2004, is adjacent to the River and the westernmost extent of the ARBOR reach, and is sponsored by the City of Los Angeles Department of Water and Power. The study is transitioning to a USACE Continuing Authority Program project, and is evaluating restoration of wetlands and riparian habitats as well as ancillary recreation opportunities. The ARBOR directly connects to this study's area. The Headworks study continues to have strong support from the local sponsor (City of Los Angeles DWP), and stakeholders. Though originally started under the General Investigations program, the District has established, with concurrence from the sponsor, that due to the limited size, anticipated cost, and the lack of complexity of the project, it would be more appropriate to pursue implementation under CAP Section 1135 (Project Modifications for Improvement to the Environment) focused on 23 acres of the Headworks study site. With conversion to CAP (planned for August 2015), the next milestone would be the Alternatives Formulation Briefing in FY16.

- Arroyo Seco Watershed Ecosystem Feasibility Study. This continuing USACE feasibility study is investigating ecosystem restoration opportunities between its headwaters in the San Gabriel Mountains and downstream near the confluence with the Los Angeles River. This study was

initiated in 2005 and concluded a Planning Rescoping Charrette in November 2013; it is proceeding towards an Alternatives Milestone in spring of 2015. The sponsor for this Study is the County of Los Angeles Department of Public Works.

- Sun Valley Ecosystem Restoration Feasibility Study. The Sun Valley Ecosystem Restoration Study was initiated in 2006 and covers a 2,800-acre urban watershed located approximately 14 miles northwest of downtown Los Angeles; the watershed is a tributary to the Los Angeles River and the sponsor is the County of Los Angeles. The USACE completed a reconnaissance report that recognized Federal interest in ecosystem restoration, flood risk management, stormwater recharge, and recreation; the study is on hold pending funding.

- East San Pedro Bay Ecosystem Restoration Feasibility Study. This effort, in partnership with the City of Long Beach, will seek opportunities to increase aquatic ecosystem function at the mouth of the Los Angeles River and within East San Pedro Bay up to the Long Beach Breakwater. The USACE completed a reconnaissance report in 2010 and in 2015 rescoped the study effort to be compliant with new USACE planning requirements, so now the study can move forward as funding permits.

- The boundaries of these studies do not overlap with the Los Angeles River study area.

1.4.4 Details of Selected Background Reports

This IFR has drawn on existing information and planning efforts in the Los Angeles River watershed. Notable reports including the Los Angeles River Master Plan, Los Angeles River Revitalization Master Plan (LARRMP), LARRMP Final Programmatic Environmental Impact Report/Environmental Impact Statement (EIR/EIS), Integrated Regional Water Management Plan for the Los Angeles River watershed, City General Plans, Arroyo Seco Watershed Management and Restoration Plan EIR, Los Angeles State Historic Park (Cornfields) reports, City of Los Angeles Integrated Resources Plan (IRP) and EIR, and a plan and EIR for the Rio de Los Angeles State Park.

Los Angeles River Master Plan, 1996

Los Angeles County's Department of Parks and Recreation and Department of Regional Planning coordinated the development of the original master plan for the Los Angeles River right-of-way. The plan identified ways to revitalize the publicly owned rights-of-way along the River and Tujunga Wash by developing a uniform landscaping protocol featuring appropriate native vegetation and enhancement of aesthetic, recreational, flood risk management, and environmental values, thereby creating a community resource, enriching the quality of life for residents, and recognizing the River's primary purpose of flood risk management.

The Los Angeles River Revitalization Master Plan, 2007

Over the past two decades, the City of Los Angeles, non-governmental organizations, stakeholder groups, and individual communities have been actively pursuing the objectives of restoring the River by reconnecting it to its neighborhoods and improving its environmental/ecological health. The integration and conceptualization of these initiatives resulted in preparation of the LARRMP (City of Los Angeles 2007). With extensive public, private, nonprofit, and resident involvement, the plan was developed as a conceptual framework to guide the City of Los Angeles in the long-term revitalization of the River. The LARRMP provides a blueprint for restoring the River's former ecological significance as a natural system, as a place that brings neighborhoods together and provides green space in the heart of the city, and as an amenity and investment that restores value to the city. Conceptual designs in the LARRMP call for improved natural habitat, water quality, recreation, open space, and public access to the river, as well

as incidental recreational space/trails, and opportunities to reinvest in the urban infrastructure system to encourage economic growth.

LARRMP Programmatic EIR/EIS, 2007

The USACE participated in the development of the LARRMP and acted as the lead Federal agency for the accompanying Final Programmatic Environmental Impact Report/Environmental Impact Statement (EIR/EIS). The USACE determined that no Federal action resulted from the information and analyses developed for, and presented in, the LARRMP and accompanying Programmatic EIR/EIS since it was a local master plan with no associated Federal recommendations. Therefore, no finalization (e.g., Record of Decision) was prepared by the USACE for the Programmatic EIR/EIS.

City of Los Angeles Integrated Resources Plan, 2006

The City of Los Angeles applied a contemporary approach to develop its IRP by incorporating wastewater, stormwater and runoff, and recycled water management into a single strategy. This reflects the understanding that all water services are interdependent and recognizes the complex, intertwined relationships of the City's varied water resource departments and functions. The Los Angeles Department of Public Works and Department of Water and Power partnered in developing the IRP, a departure from prior single-purpose plans.

Los Angeles County Integrated Regional Water Management Plan for the Los Angeles River Watershed

The purpose of the Integrated Regional Water Management Plan (IRWMP) is to define a clear vision and direction for the sustainable management of water and land resources in the greater Los Angeles County region over the next 20 years—a process that is required by the State of California to demonstrate coordination on the local level. The plan, adopted in December 2006, presents basic information regarding possible solutions, the costs and benefits of those solutions, quantified goals and objectives, and a list of projects that can be implemented to achieve the goals. Management agencies and groups that participate include those in the watersheds of North Santa Monica Bay, Upper Los Angeles River, Upper San Gabriel River and Rio Hondo, Lower San Gabriel and Lower Los Angeles Rivers, and the South Bay.

Arroyo Seco Watershed Management and Restoration Plan and EIR

In 2000, two non-governmental organizations, the Arroyo Seco Foundation and North East Trees, initiated the Arroyo Seco Watershed Restoration Program. This program assessed resource challenges including flood and stream management, habitat restoration, water resources, and recreational opportunities in the Arroyo Seco watershed. The program also identified goals and projects for conservation, better management, and restoration. Out of these efforts, North East Trees, in partnership with the Arroyo Seco Foundation, released the Arroyo Seco Watershed Restoration Feasibility Study in 2002. This study provided a blueprint for an environmentally sensitive and sustainable plan to manage and restore the Arroyo Seco watershed. The Arroyo Seco is one of the LA River's most significant tributaries and its confluence with the River is included in each of the study's final alternatives.

City General Plans, 2012

General Plans have been prepared for the purpose of guiding and regulating development and protection of land uses within each city that borders the study area, including the Cities of Los Angeles (2012), Burbank (2012), and Glendale (2012). These General Plans, prepared and maintained by the cities' planning departments, have a comprehensive, long-range declaration of purposes, policies, and programs for developing lands and protecting common uses into the future. They provide a comprehensive strategy for accommodating long-term growth should it occur as predicted. General Plans are regularly amended and updated.

Los Angeles State Historic Park Reports (Cornfields), 2003-2012

A Cornfields Reconnaissance Study, Section 905(b) Analysis (USACE 2003) was conducted to determine if there was a Federal interest in participating in a cost-shared feasibility phase study to provide environmental and riparian restoration, improved water quality, and flood risk management for a 5-mile reach of the river channel named the Cornfields area located approximately between the Glendale Freeway (CA-2) to the north and First Street to the south. This study was expanded to encompass the entire River, and was a precursor to the current study.

California State Parks prepared the Los Angeles State Historic Park General Plan and Final EIR, resulting in an interim park opening in September 2006 (California State Parks 2005). The Cornfield State Park Advisory Committee saw the Cornfield as a place to engage both nature and culture, to create a regional gathering space around the theme of a larger, more diverse Los Angeles history, which reconnected the City to the River.

In June 2013 the Cornfields-Arroyo Seco Specific Plan (CASP) and associated EIR was adopted by the Los Angeles City Council. The CASP was prepared through a comprehensive, community-based planning and environmental review process. The objective was to produce three documents, including: (1) the Specific Plan, which will guide future land uses, community development strategies, and infrastructure improvements; (2) goals, guidelines, and regulations for the plan area; and (3) a programmatic EIR, which will support the preparation and adoption of the Specific Plan and its associated land use instruments.

Rio de Los Angeles State Park (Taylor Yard), 2005

California State Parks prepared a General Plan and EIR for a park at the Taylor Yard site, about 2.5 miles north of downtown and within the IFR study area. The General Plan serves as a guide for future development, parkland acquisition, and construction of trails, parks, and other public facilities.

1.5 REPORT ORGANIZATION

This document has been divided into 14 primary chapters, each dealing with a specific subject area relating to the project components, alternatives, and planning process. Chapters noted below by an asterisk (*) are compliant with and required by the Council on Environmental Quality's Regulations for Implementing the National Environmental Policy Act. The proposed project is sponsored by the City of Los Angeles, which has determined that construction of the proposed project could have a significant effect on the environment. Therefore, this report also follows guidance provided in CEQA (Public Resources Code [PRC] 21000 et seq.) and other relevant regulations. Potential environmental impacts that may accompany implementation of all alternatives, including the No Project Alternative, have been identified and evaluated against baseline physical conditions (CEQA Guidelines 15125[a]).

- Chapter 1*, Introduction, provides background information concerning the purpose of and need for the project, project authorization, and project status, as well as the scope of the study. This chapter also notes relevance and integration of other related studies and reports.
- Chapter 2*, Problems and Opportunities, identifies resource significance, then identifies current and expected problems and opportunities in the study area based on the evaluation of existing and expected future without project conditions.
- Chapter 3*, Affected Environment, provides a detailed presentation of the existing environmental conditions within the study area. This chapter also includes a complete discussion of environmental resources that would be affected by implementation of project alternatives.
- Chapter 4*, Formulation of Alternative Plans, describes the USACE planning process with respect to the selection of candidate alternative plans for detailed analysis. In this chapter,

planning goals are set, objectives are established, and constraints are identified. This chapter identifies a range of potential management measures that address specific problems identified in Chapter 2 and various combinations to create a series of alternative plans that adequately address the goals and objectives established. Likewise, a discussion is also provided for why some alternatives were eliminated from further consideration.

- Chapter 5*, Evaluation of Alternative Plans and Potential Environmental Consequences, qualitatively and quantitatively describes potential impacts on and benefits to the environment as a result of implementation of the alternative plans relative to existing conditions.
- Chapter 6*, Comparison of Alternative Plans, the rationale and methodology behind the identification of final alternatives for detailed evaluation. This chapter includes a comparison and analysis of the final array of alternative plans and preliminary selection of one alternative plan that best meets the study objectives.
- Chapter 7, Details of NER and Recommended Plan, summarizes the environmental, economic, and social benefits and costs of both plans.
- Chapter 8*, Public Involvement, describes the numerous coordination and public involvement activities conducted throughout the course of the study. These activities include information workshops, status reports, informal briefings, presentations, and correspondence with various resource agencies.
- Chapter 9, Remaining Reviews, Approvals, Implementation, and Schedule, identifies the estimated project timeline for future actions, defines commitments and responsibilities, and verifies the fulfillment of procedural notice and review requirements.
- Chapter 10*, Environmental Compliance, identifies key environmental regulations that are relevant to this project.
- Chapter 11, Recommendations, presents the study conclusions and recommendations by the District Engineer.
- Chapter 12*, List of Preparers, identifies the list of individuals and organizations that contributed to the preparation of this report.
- Chapter 13*, Document Recipients, lists the individuals and organizations that will receive a copy of the draft IFR.
- Chapter 14, References, lists references including studies, reports, analyses, and other reference materials used in the preparation of this report.
- Chapter 15*, Index, includes an alphabetical listing of important terms, phrases, and acronyms to aid the reader in understanding the document.

2 PROBLEMS AND OPPORTUNITIES

2.1 RESOURCE SIGNIFICANCE OVERVIEW

Consideration of significant resources is central to plan formulation, especially in the context of ecosystem restoration planning because non-monetary outputs are being considered. Per ER 1105-2-100, significance of resources and effects will be derived from institutional, public, or technical recognition. Institutional recognition of a resource or effect means its importance is recognized and acknowledged in the laws, plans, and policies of government and private groups. Technical recognition of a resource or an effect is based upon scientific or other technical criteria that establish its significance. Public recognition means some segment of the general public considers the resource or effect to be important (USACE 2000). The importance of these resources, information specific to the Los Angeles River watershed, and restoration of these resources, is further described in more detail in the sections that follow this summary.

2.1.1 Technical Recognition

Several criteria for evaluating technical merit are reviewed in this section including: habitat scarcity/rarity, biodiversity, status and trends, special status species, connectivity, hydrologic and geomorphic character.

A. **Scarcity** – The Los Angeles River study area includes several scarce/rare ecosystem types that support significant life functions for myriad species (see Section 2.2.1 for additional detail).

   i. The western cottonwood-willow forest association, a riparian ecosystem habitat type once prominent in the Los Angeles River, has been identified as one of the rarest forest types in North America (Krueper 1995), and one of most endangered ecosystems in the United States (Noss and Peters 1995).

   ii. The Los Angeles River study area is within a globally scarce Mediterranean ecosystem. Mediterranean ecosystems only cover 2 percent of the Earth's land surface but account for 20 percent of all known plant species. This climate is found along the west coasts of continents in mid-latitudes from 30 degrees to 50 degrees N and 30 degrees to 40 degrees S, encompassing five places in the world including California/Baja California, the old world Mediterranean region (Europe, North Africa), and the subtropical regions of Chile, South Africa, and Australia. Mediterranean climates are characterized by hot, dry summers and mild, wet winters and support evergreen or drought deciduous shrublands and associated habitats (Kauffman 2003).

   Semi-arid southwestern landscapes are characterized by low, but highly variable winter rainfall. The resulting dry conditions create a stark contrast between riverine and riparian areas and the adjacent upland vegetation. As a result, riparian ecosystems in the southwest are very important systems because although they occupy a very small area, they support the majority of ecological and hydrologic connectivity in a landscape and biodiversity in the region (Levick 2008).

B. **Biodiversity** – In terms of richness, California has the highest total number of species of plants and animals, including endemic species not found anywhere else, than any other state in the U.S. (Stein et al. 2000) (see Section 2.2.2 for additional detail).

   i. The California Floristic Province, also referred to as a biodiversity hotspot (Stein et al. 2000), is considered one of the world's 25 most biologically rich and threatened terrestrial

ecoregions (Myers et al. 1999). To qualify as biodiversity hotspot, an ecoregion must have at least 1,500 vascular plants as endemics and must have 30 percent or less of its original natural vegetation. While these 25 biodiversity hotspots cover less than 1.5 percent of the earth's land surface, they account for roughly 60 percent or more of the remaining diversity of life on earth (Myers et al. 1999).

ii. California ranks number one in the United States for endemism of plants, amphibians, reptiles, mammals, and freshwater fish species that are unique to the state (Bittman et al. 2003). Approximately 61 percent of the plants in the California Floristic Province are endemic, occurring nowhere else in the world. Approximately 50 percent of bird species and mammals in the United States are found in California.

iii. The scarce riparian habitat in the arid southwest is crucial for species survival due to the high temperatures and dryness outside of the riparian ecosystem (Levick 2008). Approximately 80 percent of all wildlife use the riparian ecosystem at some life stage, with more than 50 percent of bird species nesting primarily in riparian habitats (Krueper 1993). The abundance and diversity of riparian vegetation, as compared to uplands areas, provide food, shelter, water, breeding habitat, and movement corridors.

iv. In terms of species richness, the Los Angeles River is within a region that includes over 50 plant alliances or groupings of plants that share similar structural conditions and approximately 1,000 plant types (depending on location within the watershed) (Bittman et al. 2003).

v. In terms of rarity, the upper Los Angeles River watershed has a relatively high occurrence of rare plant species, due to underlying soil properties and other geomorphic and environmental conditions (Bittman et al. 2003). The lower watershed includes rare special status invertebrates (Bittman et al. 2003).

vi. Approximately 140 bird species, which are federally protected under the Migratory Bird Treaty Act, are supported on the LA River. Restoration of large nodes of riparian habitat could support species such as the federally endangered least Bell's vireo, the yellow breasted chat, yellow warbler (State Species of Concern), hooded and Bullock's oriole, lazuli bunting, blue grosbeak, western tanager, several species of woodpeckers, owls, many species of ducks (Cinnamon teal, ring-necked duck, northern pintail), hawks (sharp shinned hawk, osprey), and shorebirds (great blue heron, spotted sandpiper, black necked stilt).

vii. Over 20 species of mammal are supported on the LA River. Restoration of movement corridors could support use by top predators such as bobcat and coyote whose ranges are currently limited by physical barriers and lack of regional pathways connecting populations. These are important species because they regulate the population of mesopredators (such as skunks and weasels).

viii. Nine species of bat are supported on the LA River (1 State Species of Special Concern). Restoration would expand bat habitat along bridges and support local bat populations that are known to regulate insect populations (vector control).

C. **Status and Trends** – The California Floristic Province has been declared a global biodiversity hotspot. Hotspots must contain at least 1,500 species of endemic vascular plants, and have lost at least 70 percent of their original habitat. The California Floristic Province is one of the world's 25 most

biologically rich and threatened terrestrial ecoregions (Myers et al. 1999). (See Section 2.2.3 for additional detail).

i. Only 45,000 square miles of the California Floristic Province (or 25 percent) remains out of 183,000 square miles of the historic extent of vegetation that supports the highest levels of biodiversity in the United States (CERF website).

ii. A total of 31 percent of plant and animal species at risk within the United States are found within California. This figure includes 32 percent of plant species, 41 percent of mammals, and 29 percent of reptiles at risk (Bittman et al. 2003).

iii. Historically within the study area, "the river spread over a broad depression two thousand feet wide" between the Verdugo Wash confluence and the Arroyo Seco (Gumprecht 2001). Like modifications to many rivers in the western United States, extensive channelization and damming of the LA River over the last century has altered the natural hydrologic process preventing input of larger substrates (i.e. gravel and cobble), increasing water temperatures, simplifying channel morphology, and altering the episodic succession-setting flood regime necessary to sustain the target riparian communities and native fish habitats.

iv. Less than 10 percent of wetlands surface area remains in California, a loss of more than 90 percent, compared to wetland loss of 50 percent in the rest of the country (Dahl 1990). Over 90 percent of the riparian habitat including Valley Foothill riparian habitats (Faber et al. 1989) and over 95 percent of the region's wetlands including freshwater marsh have been lost (Dahl 1990). Due to this large-scale habitat conversion, natural riparian communities persist only as isolated remnants of what was once a vast, interconnected system of rivers, streams, marshes, and vegetated washes (Krueper 1995).

v. Due to the unique hydrology in the semi-arid southwest, the Los Angeles Basin historically supported a small but highly endemic native freshwater fish fauna (Swift and Seigel 1993), none of which remained extant in the main river channel for more than several years following the channelization of the River that occurred in 1938 (Hall and Linton 2008). At least five of the seven documented native fish species, endemic to southern California, have been extirpated from this watershed (as well as surrounding watersheds) (Gumprecht 2001). Extirpated fish species include southern California steelhead and unarmored threespine stickleback, which are both listed as endangered under the Endangered Species Act. Pacific lamprey is a Federal species of concern. Arroyo chub (California species of special concern) and Santa Ana sucker (California threatened species) still exist in tributaries to the Los Angeles River but in very small numbers (Gumprecht 2001).

vi. Current channelized conditions in the mainstem no longer support endemic native fish species but do support non-native fish species. Alterations from the natural river ecosystem include perennial flow, high nutrient levels, higher temperature, and lack of a flood disturbance regime. This has led to the "homogenization of freshwater biota" and is seen as an increasing threat to biodiversity in California, and in other Mediterranean climate areas throughout the world (Ball et al. 2013). Although no native fish species currently exist in the ARBOR reach, the more natural channel bottom area supports non-native fish like tilapia and mosquitofish; a fish survey of the area in 2008 identified eight different species of fish (FoLAR 2008).

vii. Essential habitat components reduced or eliminated with channelization and change in geomorphic character include fish refugia (to allow fish to withstand high flows) and soft-

bottom spawning areas to bury eggs. Restoration of riffle/pool complexes and natural geomorphic character could support native species, including Santa Ana sucker and arroyo chub, further discussed in Institutional Recognition.

viii. Prior to habitat loss and conversion, the river was home to least Bell's vireo (federally endangered, state endangered) and yellow warbler (state species of special concern), and provided foraging habitat for CA coastal gnatcatcher (federally threatened) and southwestern willow flycatcher (federally endangered, state endangered) and yellow-billed cuckoo (federally threatened). Limited numbers of least Bell's vireo nest on the upper Los Angeles River but its historic range includes the ARBOR reach.

D. **Connectivity** – River channels in arid regions provide wildlife movement corridors that are essential to species survival due to the continuous chains of vegetation that wildlife can use for cover and food otherwise not supported in drier upland habitats (Levick et al. 2008) (see Section 2.2.4 for additional detail).

i. The remaining fragments of Los Angeles River aquatic and riparian habitat (or habitat "nodes") within the urban landscape context contribute significantly to the integrity of the larger ecosystem by supporting metapopulations (assemblages of local populations connected by migration) (Hanski & Gilpin 1991). By increasing patches and reducing the distances between them, colonization among populations improves (Hanski & Thomas 1994).

ii. The existing habitats in the Glendale Narrows and connection to major tributaries provide the backbone for restoration of regional habitat connectivity and wildlife movement between significant ecological areas including the Santa Monica Mountains, the Verdugo Hills, and nationally significant San Gabriel Mountains National Monument (see Institutional Recognition). Habitat restoration within the study area would contribute to greater regional connectivity, amplifying the effects of other ecosystem restoration studies and projects in progress.

E. **Hydrologic and Geomorphic Character** The loss of the naturally dynamic hydrologic and geomorphic character on Southern California rivers has had significant consequences for habitat and species richness and diversity (see Section 2.2.5 for additional detail).

i. The highly seasonal hydrology and permeable sediments of the natural systems of the Southern California region create dynamism, where the river courses are constantly shifting with the highly variable flood regime and the floodplains are expansive. This in turn supports a diverse channel and floodplain structure, and a diverse assemblage of plant and wildlife communities.

ii. The natural hydrologic pattern supports habitat diversity, ecosystem productivity, and biodiversity. High flows transport sediment, displace benthic invertebrates, clear gravel beds of accumulated silt allowing attachment of insect eggs, and import woody debris, creating new habitat. Overbank flows connect channels to floodplains, increasing overall productivity and diversity, while scouring rejuvenates habitat for plant species. Low flows may determine the amount of habitat available during critical periods. In some systems, temporary drying of stream channels provides habitat for specialized species (EPA 1999).

iii. Development and flood risk and water supply projects have constrained and eliminated most such systems in the southwestern United States. Flood control works in the Los Angeles region alone include over 100 miles of channelization of major rivers and streams plus 370

miles of tributary channels. The broad meandering of the river across the floodplain, two thousand feet or more in some areas, was reduced to a narrow channel. On the main Los Angeles River, 94 percent of its 51 miles is lined by concrete banks and only one-quarter of its length, including 6 miles within the ARBOR, has a non-concrete bottom (Gumprecht 2001).

2.1.2 Institutional Recognition

Public agencies and private interests, from the Federal to local levels, have worked collaboratively for years to restore the Los Angeles River. Many of these non-governmental organizations, local, State and Federal institutions are dual-purpose agencies with both natural resources management missions and recreational objectives. Managed passive reereation is necessary to protect sensitive and scarce habitat. This approach allows for the >10 million residents living in the vicinity of the watershed to recreate, steward and enjoy natural resources without severely impacting habitat value.

A. National Institutional Recognition

i. The U.S. Fish and Wildlife Service's recovery plan for the endangered Santa Ana sucker recognizes the importance of the Los Angeles River for recovery of the species (U.S. Fish and Wildlife Service 2014). Restoration in the study area has the potential to create and improve habitat for select native fish species including the federally threatened Santa Ana sucker (SAS). SAS are one of only a few native fish currently extant in southern California, and their historic range is limited to the rivers and larger streams in southern California. Per the plan, the Los Angeles River Watershed Recovery Unit (LARW-RU) includes the Los Angeles River down to the Arroyo Seco confluence, within the study area. Increasing the extent of native fish habitat will provide opportunities to improve the resiliency and redundancy of the Santa Ana sucker, thereby improving the status of the species (USFWS 2014).

ii. The Los Angeles River was selected to be one of seven nationwide first-phase pilots for the Environmental Protection Agency's (EPA) Urban Waters Federal Partnership. The Partnership includes the USACE, the Departments of Interior, Commerce, Agriculture, and Housing and Urban Development, the Environmental Protection Agency, four state agencies, seven local governmental entities, and 11 nongovernment organizations (see Public Recognition). The group's first goal is to "restore ecosystem function." Half of the 22 studies and projects currently being tracked for progress are focused on ecosystem restoration. This USACE restoration feasibility study was selected as the group's top priority; also on the group's list are five active USACE ecosystem restoration feasibility studies and one USACE project.

iii. At the national level, the Los Angeles River has been protected by the Clean Water Act since the Act's inception. However, in 2010, EPA designated the river as a Traditionally Navigable Water (TNW) in its entirety, citing the river's historic and continuing importance and the potential beneficial impacts of river restoration on the region.

iv. Approximately 350,000 acres of the San Gabriel Mountains, as the headwaters of the Los Angeles River Watershed, were designated in late 2014 as the "San Gabriel Mountains National Monument." The San Gabriels contain some of the highest biodiversity in the country, with unique geological features and 300 endemic plants found nowhere else in the world.

v. The President's America's Great Outdoors is an initiative to develop a 21st Century approach to conservation and outdoor recreation. The initiative identified the Los Angeles River watershed as a priority project in its "50 State Report." Leaders including the Secretary of Interior, the USEPA Administrator, the Assistant Secretary of the Army (Civil Works), the Chair of the White House Council on Environmental Quality, Congressional representatives, and state agency heads joined the Mayor of Los Angeles on the river's banks in the study area in 2012 to highlight the need to restore the River.

vi. The ARBOR reach contains some of the only wetlands remaining on the Los Angeles River and tributaries. Wetlands are recognized as special aquatic sites under the Clean Water Act and subject to protection under Executive Order 11990.

vii. The Department of the Interior conducted a study examining possible areas for inclusion in the national park system (i.e., the Rim of the Valley Corridor Special Resource Study). The Rim of the Valley study area extends North, East and West of the study area, and the river serves as a vital connection between the Santa Monica and San Gabriel Mountains within its boundaries. These two mountain ranges have previously been found by the National Park Service to contain nationally-significant resources, including unique geologic and cultural resources, as well as high quality biodiversity.

B. Statewide and Regional Institutional Recognition

i. The State of California cited the TNW designation and the character of the River in codifying the River's status as a navigable water of the state protected as part of the Public Trust under the State Constitution in SB 1201, signed by the Governor in 2012.

ii. The State of California has been involved in environmental enhancement and revitalization activities on the Los Angeles River since the 1990s through the Santa Monica Mountains Conservancy (SMMC) and its affiliate agency, the Mountains Recreation and Conservation Authority (MRCA). SMMC's mission is to implement strategic actions that "preserve, protect, restore, and enhance treasured pieces of Southern California to form an interlinking system of urban, rural and river parks, open space, trails, and wildlife habitats." SMMC and MRCA have reclaimed or protected valuable open space along the banks of the Los Angeles River by replacing derelict industrial or housing sites with a string of passive parks filled with native riparian plants and floodable permeable walkways. These efforts by the SMMC and MRCA to increase public ownership along the river have increased the restoration opportunities that were not available even 15 years ago.

C. Local Institutional Recognition

i. Congress specifically directed in WRDA 2007, section 4018, that this study develop a plan that is consistent with the goals of the City's Los Angeles River Revitalization Master Plan. The City's LARRMP contains input of Federal, State, and regional agencies and stakeholders. The Los Angeles City Council adopted the Los Angeles River Revitalization Master Plan in 2007. That plan identified opportunities for environmental restoration, including habitat improvements, in concert with recreation, water quality, flood risk management, and community revitalization benefits. One of the major goals is to restore a functional riparian ecosystem with recommendations to (1) create a continuous functional riparian corridor that provides habitat for birds, mammals, amphibians, reptiles, invertebrates, and fish within the channel bottom; (2) connect this corridor to other significant habitat and migration routes along the tributaries and into the mountains; (3) provide support for

desirable fish species (see Technical Recognition); and (4) bioengineer or naturalize the river's edge where feasible.

2.1.3 Public Recognition

A. Eleven nongovernmental organizations actively participate alongside the 11 Federal agencies of the Urban Waters Federal Partnership. Most of these groups hold the Los Angeles River as central mission focus or a priority. Key groups include:

i. Friends of the Los Angeles River (FoLAR) was founded in 1986 and has generated steadily increasing public attention to the River over the decades. This year marks FoLAR's 26th annual Great Los Angeles River clean up, expanded to cover three weekends in April and regularly drawing thousands of volunteers. FoLAR's mission is to protect and restore the natural and historic heritage of the Los Angeles River and its riparian habitat. FoLAR has spearheaded efforts to restore the river since its founding, and contributed funding to this study in 2013 to facilitate its completion.

ii. The Council for Watershed Health was recently renamed after over 10 years as the Los Angeles and San Gabriel Rivers Watershed Council. It began as a watershed restoration group but has since expanded to collaborate with government agencies, businesses and scientists to enhance the social, ecological, and economic health of the region's watersheds through education, research, and planning.

iii. Urban Forestry groups TreePeople and North East Trees have worked to "green" the Los Angeles River and surrounding urban communities. Their programs include urban green infrastructure, restoration, education, and watershed planning and policy programs. TreePeople enjoys significant media coverage and has successful urban sustainability programs. North East Trees employs local at-risk youth and has built a series of whimsical pocket parks along the Los Angeles River Bikeway with native plants, permeable paving and hardscape featuring local artists.

iv. The Los Angeles River Revitalization Corporation is focused on developing a 51 mile greenway along the River, and implementing the City of Los Angeles' Los Angeles River Revitalization Master Plan. One of its strengths is developing creative public-private partnerships along the river to facilitate sustainable land use projects with community benefits.

v. The Arroyo Seco Foundation is a group dedicated to restoring the Arroyo Seco sub-watershed, a major tributary to the Los Angeles River, and a historically and culturally significant corridor. The Arroyo Seco region sparked the 20th century Arts and Crafts movement and is home to the Arroyo Seco Parkway, the oldest parkway in the west.

vi. Other groups with Los Angeles River restoration, education, policy and revitalization programs include The River Project, Los Angeles Conservation Corps, the Trust for Public Land, the Urban Rivers Institute, and Urban Semillas.

B. In summer 2013 and 2014, a portion of the river channel within the study area was opened for seasonal activities. This unprecedented public access allowance, for the first time since the Los Angeles County Drainage Area (LACDA) Project was constructed, was a significant policy shift for governance and operation of the River. It reflected increased public interest and commitment to ecological education and passive recreational opportunities. River access has promoted

activities such as hiking, bird-watching, environmental education, and non-motorized boating. This is part of an effort spearheaded by the City of Los Angeles and the Mountains Recreation and Conservation Authority in coordination with the USACE and County, and which relates to California Senate Bill 1201 as part of the direction to facilitate restoration and recreation where compatible with flood risk management.

C. The Los Angeles River, its degradation and potential restoration, have been the subject of increasing scholarly attention and national and international news, including environmental history texts, art exhibitions, films, and news and magazine stories. The Los Angeles River is a source of inspiration and imagination for local and national artists, filmmakers, authors, and poets. The Los Angeles River is widely recognized as the wide concrete "freeway" featured in over 20 films. This popular cultural icon has helped shape a "concrete jungle" image of Los Angeles, completely negating the presence of a living river. Poet Lewis McAdams, founder of FoLAR and the Los Angeles Rivers' poet laureate, penned *The River: Books One, Two, and Three,* chronicling over 30 years of living with and advocating for the Los Angeles River.

D. In 2012, the portion of the Los Angeles River Trail that extends throughout the study area was designated by the Secretary of the Interior as part of the National Recreation Trail System. The designated trail is an approximately 10-mile section of greenway and bikepath along the river, increasing awareness and stewardship of the River's natural resources through interpretive signage that tells the story of the founding of Los Angles and its relationship to water resources. The trail also coincides with the National Park Service's Juan Bautista de Anza National Historic Trail.

2.2 SOUTHWEST RIPARIAN ECOSYSTEM SIGNIFICANCE

2.2.1 Scarce/Rare Southwestern Riparian Ecosystems

Riparian ecosystems in the Los Angeles River watershed, as well as the arid/semi-arid southwest region overall, are critical for wildlife, yet are exceedingly scarce. Vegetation communities along ephemeral and intermittent streams provide wildlife habitat and structural elements not otherwise available in adjacent dry upland communities, such as food, shelter, breeding habitat, and movement corridors. The importance of western riparian areas cannot be overemphasized (Carothers 1977), because of the high temperatures and dryness outside of the riparian ecosystem (Levick 2008). The abundance and diversity of riparian vegetation, as compared to uplands areas, is therefore a critical wildlife habitat feature of rivers and streams in the southwest. In the southwest region, approximately 80 percent of all wildlife use the riparian ecosystem at some life stage, with more than 50 percent of bird species nesting primarily in riparian habitats (Krueper 1993). The high wildlife species density and diversity associated with riparian habitats is attributed to the presence of highly varied vegetative structure, high vegetative density and diversity, availability of water and insect prey, and adjacency to several floral and faunal Eco regions (Krueper 1995).

Western riparian ecosystems are one of the rarest habitat types in the Western Hemisphere (Krueper 1995). Of the 106 forested types identified in North America, the western cottonwood-willow forest association has been identified as the rarest (Krueper 1995). Noss and Peters (1995) concluded that Southwestern riparian forests and California riparian forests and wetlands are two of the 21 most endangered ecosystems in the United States. Historically, riparian habitats occupied 1 percent of the land mass in western North America. Within the past century, an estimated 95 percent of this habitat has been altered, degraded, or destroyed due to such land use activities as river channelization, unmanaged livestock utilization, clearing for agriculture, water impoundments, and urbanization (Krueper 1995). Due

to habitat conversion, natural riparian communities persist only as isolated remnants of what was once a vast, interconnected system of rivers, streams, marshes, and vegetated washes (Krueper 1995).

The LA River Ecosystem Restoration Study focuses on restoration of the historically occurring marsh and riparian habitats, specifically the cottonwood-willow habitat which is the rarest habitat type in the Western Hemisphere (Krueper 1995). Restoration of this community would provide the habitat elements required to support a high density and diversity of wildlife species.

2.2.2 Biological Diversity

Over 175 species are known to occur on the LA River. Restoration of dense, structurally diverse riparian habitat and wetland communities would provide expanded habitat for species populations and restoration of habitat for sensitive and charismatic species. Restoration of riffle/pool complexes and natural geomorphic character could support native species including the Santa Ana Sucker (Federally threatened) and the Arroyo chub (State Species of Concern). Amphibian numbers are on the decline globally and restoration of a riparian ecosystem would provide for expansion, refuge, and habitat for amphibian populations on the river.

Approximately 140 bird species are supported on the LA River, which are Federally protected under the Migratory Bird Treaty Act. Restoration of large nodes of riparian habitat could support the Federally endangered least Bell's vireo. Restoration of large nodes of riparian habitat could also support yellow breasted chat and yellow warbler (State Species of Concern). Many other charismatic bird species would be supported by restoring the river including the hooded and Bullock's oriole, lazuli bunting, blue grosbeak, western tanager, several species of woodpeckers, owls, many species of ducks (Cinnamon teal, ring-necked duck, northern pintail), hawks (sharp shinned hawk, osprey), and shorebirds (great blue heron, spotted sandpiper, black necked stilt).

Over 20 species of mammal are supported on the LA River. Implementation of restoration could support top predators such as bobcat and coyote, whose ranges are currently limited by physical barriers and lack of regional pathways connecting populations. These are important species because they regulate the population of mesopredators (such as skunks and weasels). Left unchecked, mesopredators can impact populations of bird species (i.e. eating eggs) and other smaller wildlife. Nine species of bat are supported on the LA River (1 State Species of Special Concern).

2.2.3 Status and Trends

The natural river once covered the Los Angeles River Basin with marshes, thickets, and dense woodlands. The lowlands were covered by a dense floodplain forest of cottonwoods and willows (Garrett 1993). Where water ponded and soils were perennially saturated, marshland formed that supported cattails and bulrushes. At the coast, the salt marshes and lagoons were dominated by pickleweed and cordgrass. Nearby drier areas supported oaks and walnuts, cacti and yuccas, sage, and native prairie (Garrett 1993; Gumprecht 2001).

The species and structural diversity of native cottonwood and willow floodplain forests, oak woodlands and prairies, and fresh and salt water marshlands were lost due to urbanization and the spread of non-native invasive species, where invasive species out-compete natives (Garrett 1993). The wildlife species that depended on these habitats, including threatened and endangered species and their critical habitats, were also lost with the conversion of native habitat to urban uses and with non-native infestation.

Of the eleven historic vegetation types, four were particularly devastated by channelization of the river and introduction of non-native invasive plant species, two of which include (1) seasonal and permanent

freshwater and brackish wetlands and (2) lowland riparian forests and thickets, which would be restored by this study (Garrett 1993). The other two vegetation types are coastal estuaries and alluvial scrub. While minimal marginal habitat is still supported in certain portions of the river system, the historic habitat has been almost entirely eliminated (Garrett 1993). Figure 1-3 in Chapter 1 clearly illustrates this dramatic habitat type conversion from valley foothill riparian and freshwater emergent wetlands cover in 1896 to a largely urban land use cover today.

Changes to populations of mammal species are most evident in the lack of native carnivores, such as foxes, weasels, bear, and mountain lion, with remnant populations in the Santa Monica and San Gabriel Mountains (Barkley 1993). The channelized river now supports little remaining habitat suitable for native mammal species. The seven native fish species are no longer supported on the river, except on a few tributaries in the most upstream reaches (Friends of the Los Angeles River 2008; Swift and Siegel 1993). Only 58 percent of the pre-development reptile and amphibian fauna remain on the river today (Bezy et al. 1993). There has been local extirpation of several Federal and state sensitive bird species, including California condor, clapper rail, snowy plover, yellow-billed cuckoo, burrowing owl, as well as other common species. Data suggest that declines in many of these species are associated with river channelization in the early 20th Century (Garrett 1993). Myriad bird species still inhabit the river in the remaining isolated habitats; however, much of the wildlife diversity of the natural river system has been lost (Garrett 1993).

The continuing degradation is of concern, since over 90 percent of the region's riparian habitat and over 95 percent of the region's wetlands have been lost. The river is located within the California Floristic Province, which Conservation International identified as one of their top 25 global hotspots experiencing rapid biodiversity loss – the only hotspot in North America. Currently, wildlife in the Los Angeles River is restricted primarily to large mammals that are adapted to urban areas, as well as other small mammals and reptiles. Birds continue to use the river as much as is possible under current conditions. A diversity of shorebirds is consistently abundant on the river using the open water habitat where sediment and algal deposits encourage vegetation to establish in concrete reaches during winter rains. The least Bell's vireo, a Federal and state endangered species, has been known to inhabit these reaches.

2.2.4 Habitat Connectivity

Importance of Nodal Habitat Connectivity

River channels in the southwestern region provide important wildlife movement corridors because they support continuous chains of vegetation that wildlife can use for cover and food (which may not be supported in drier upland habitats). These river corridors naturally guide wildlife movement, both daily and generationally, which is essential to species survival (Levick 2008).

The remaining fragments of aquatic and riparian habitat in the urban landscape (or habitat "nodes") contribute significantly to the integrity of the larger ecosystem by supporting metapopulations (assemblages of local populations connected by migration) (Hanski & Gilpin 1991). By increasing patch sizes and reducing the distances between them, colonization among populations improves (Hanski & Thomas 1994). Metapopulations depend on seed dispersal and wildlife movements to persist, and such dispersal is in turn dependent on the connectivity of the landscape (Schippers et al. 1996). Improving nodal connectivity addresses aquatic habitat fragmentation.

Nodes may be larger or smaller. Large habitat nodes support colonization of wildlife in the smaller nodes, while smaller nodes act as peripheral refuge habitat (Rudd et al. 2002). Large nodes tend to have high biodiversity and provide important breeding and seeding habitat for interior species, as well as edge species and transients. Smaller nodes are partly or entirely dependent on individuals immigrating from the larger nodes as they have a higher rate of extinction and therefore need to be repopulated constantly

(Hansson 1991; van Apeldoorn et al. 1992).Smaller nodes (those under 250 acres) may not be able to support large numbers of species on their own but are able to provide important peripheral habitat to species in the larger nodes (Hansson 1991).

Generally, nodes have a greater overall interaction when they are larger and closer together (Linehan et al. 1995). Well-connected systems prevent inbreeding depression and disease, and have a lower extinction rate as populations can more easily colonize if they are highly connected (Noss 1983; Schippers et al. 1996). Without connections between habitat areas, isolation and loss of genetic diversity is imminent (Hobbs & Saunders 1990).

In order to restore the biological integrity of a landscape, corridors must be restored to allow for dispersal between habitat areas. More corridors equal more routes to suitable habitat, creating more opportunities for dispersal. A complex network of nodes and corridors is therefore critical to restoration in an urban environment, as suitable habitat often remains unused if isolated (Hanski & Thomas 1994).

Ideally, movement corridors would consist of a relatively wide strand of natural channel bed, with patches or a contiguous length of vegetative cover for shelter, shading and forage opportunities. However, the opportunistic species that occur in urban settings can use almost any walkable surface of almost any width, as long as sufficient cover is present to avoid predators, and as long as a desired forage opportunity or other destination is within sight. The presence of vegetation and absence of barriers provides a visual cue that encourages movement.

As most wildlife movement occurs from dusk to dawn (when noise and human presence is somewhat diminished), even a narrow corridor would be sufficient to provide safe passage. Wildlife movement between patches of habitat is important to reconnect genetically isolated populations of species and prevent inbreeding depression, to provide necessary interactions between predators and prey to control population size and provide a healthy ecosystem balance, and to connect individual wildlife to required resources that may not be present within one isolated area.

Importance of Regional and Watershed Habitat Connectivity

In addition to loss of wildlife species, habitat corridors for wildlife movement have been fragmented (Garrett 1993). After build out of the Los Angeles Basin and the channelization of the river, connectivity between these nationally significant ecological areas is exceedingly limited in the region (Garrett 1993). Limited habitat connectivity contributes to declines in wildlife populations including restricted access to food, shelter, and mates; inhibited gene flow and dispersal of offspring resulting in inbreeding depression; inability to migrate and avoid seasonally unfavorable conditions; increased incidence of disease; and conflicts over territories and resources (Beier et al. 2006).

Regional connectivity is a more general term referring to longer distance connections that could potentially be made. Connectivity to the Santa Monica Mountains, San Gabriel Mountains, and Verdugo Mountains are the specific regional connections made within some alternatives. Immediate opportunities for regional connectivity apply mainly to birds. Additionally, direct connections can be made to the Santa Monica Mountains via Griffith Park for other species including reptiles and mammals. Future opportunities for connections that link other projects on the Arroyo Seco and Verdugo Wash tributaries to the project area would support improved regional connectivity to the San Gabriel and Verdugo Mountains for reptiles and mammals.

Wildlife use river systems as guiding paths and corridors for movement at multiple temporal and geographic scales. Plants use river systems as corridors for dispersal of their genetic material. The biggest challenge to restoring habitat connectivity in the Los Angeles region for plants and wildlife at all scales is

the 51 miles of channelization. Although small in the context of the river's full length and its historic floodplain, the study area is the critical, central backbone in the restoration of regional habitat connectivity. Restoration of the study area would provide nodal habitat connections from the San Gabriel and Verdugo Mountains to the Santa Monica Mountains, and would provide opportunities for future direct habitat connections to these mountain ranges as well via tributaries. Since the study area is adjacent to Griffith Park (and includes areas within the original Griffith Park land grant), the eastern terminus of the Santa Monica Mountains, it provides opportunity for habitat and wildlife connectivity to the nationally significant Santa Monica Mountains National Recreation Area and the Pacific Ocean.

The study area includes the Glendale Narrows, which currently supports some of the only remaining riparian and freshwater marsh habitat on the river. The existing habitat and perennial surface flow in the Narrows provide a base for restoration and maintenance of one of the most diverse assemblages of wildlife on the river today. The USACE currently has other ecosystem restoration studies and projects on the Los Angeles River and its tributaries, including the Arroyo Seco Ecosystem Restoration Feasibility Study, the Headworks (adjacent to Griffith Park) Continuing Authority Program Restoration Study, the completed Tujunga Wash Ecosystem Restoration Project, and the Sun Valley Ecosystem Restoration Feasibility Study. Without restoration of the river, these projects would only provide isolated patches of habitat and would not be able to contribute to a greater regional habitat connectivity effort. The study area, therefore, provides the "bones" (structure) for restoring the river and serves as a hub for such regional connectivity. Expansion of riparian and marsh habitat along this portion of the River and at the confluences of the Arroyo Seco and Verdugo Wash tributaries is a first step in putting pieces of the once vast natural river ecosystem back together.

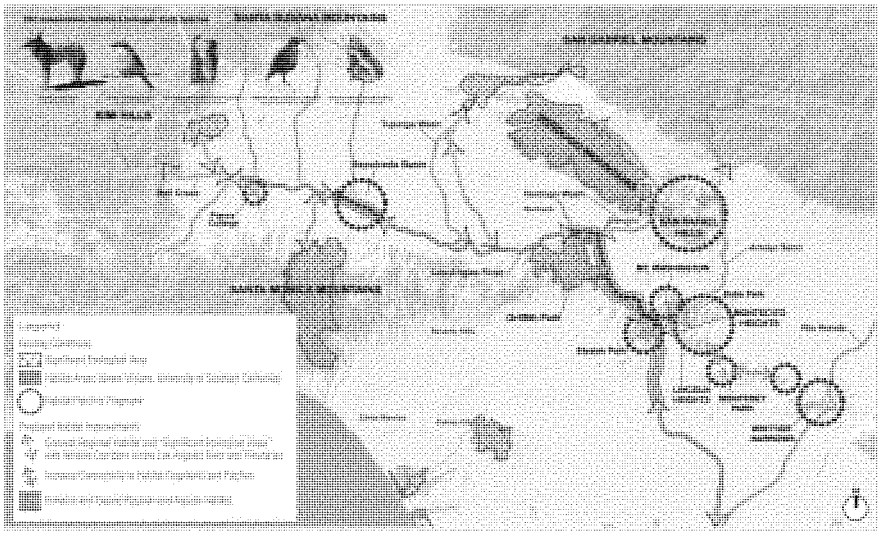


Figure 2-1 Regional Potential for Habitat Connectivity (Los Angeles River Revitalization Master Plan)

2.2.5 Importance of Restoring a More Natural Hydrologic Regime and Geomorphic Character

Ecological and evolutionary processes include natural disturbance regimes maintained by hydrologic processes, which facilitate nutrient recycling and biotic interactions (EPA 1999). Ecosystems are characterized by natural hydrologic patterns that move water through the system, to support organisms (plant and wildlife) and reshape the landscape. These patterns also move abiotic and biotic materials through the system, such as energy and nutrients. Biodiversity, production, and sustainability of ecosystems are dependent on the dynamic nature and variation in the physical environment. Aquatic ecosystems are completely dependent on hydrology; the hydrologic patterns are integral to this dynamic physical environment. Furthermore, hydrology provides connectivity between ecosystems that is critical to regional ecological functioning (EPA 1999).

The natural hydrologic pattern is important for maintaining the form of the channel and floodplain, habitat diversity, ecosystem productivity, and biodiversity. Hydrologic connections may be made naturally, by widening the river channel, removing artificial barriers, and allowing the river to naturally meander and reshape the adjacent floodplain area. These natural connections support contiguous aquatic and riparian habitat and direct habitat connections for wildlife, which facilitate wildlife movement via restored corridors. Natural hydrologic connections also support aquatic processes such as exchange of sediment, nutrients, and energy between the river and floodplain. Connections may also be made through culverts or other constructed features to assist the hydrologic regime and to support habitat, using river water to feed overbank sites via pipes, culverts, or pumps. Artificial connections are valuable to establish habitat, but are less capable of supporting other ecological processes and exchanges. Hydrologic and hydraulic connectivity address the need to restore underlying processes that support a functioning ecosystem, to reestablish habitat patches and corridors, and to reduce the habitat fragmentation created by urbanization. Removal of the concrete channel bed and banks recreate natural hydrologic connections by reconnecting the river to its floodplain.

Maintaining ecological and evolutionary processes includes natural disturbance regimes, hydrologic processes, nutrient recycling, and biotic interactions (EPA 1999). This can only be achieved with reconnection of the river to its floodplain. This will protect the integrity of the ecosystem and increase sustainability. Biogeochemical interactions between the river and terrestrial sources are not as vital to riparian systems as overbank flow from floodplain connections (Hein 2003).

Reconnection of the river to the floodplain is important from a hydraulic perspective as well. Removal of concrete and widening the river into the floodplain could increase the flood carrying capacity of the river. This added conveyance may be offset by additional vegetation; however, widening and removal of concrete restores other ecosystem processes such as natural disturbance, the hydrologic regime, nutrient cycling, biotic interactions, population dynamics, and evolution, which determine the species composition, habitat structure, and ecological health of an ecosystem (EPA 1999). Channel widening allows the river to connect to the overbank, which restores a dynamic floodplain and supports diverse riparian and in stream habitat for plants and wildlife. The larger sites are more beneficial to flood risk management. Without channel widening in the proposed locations 'removal of concrete' would be unacceptable from a flood risk standpoint and opportunities to restore a comprehensive, sustainable ecosystem would be limited.

Floodplain connectivity is also important for restoration of fish habitat. Floodplain habitats provide critical spawning and rearing habitats for many large-river fishes. The standard that floodplains are essential habitats is often a key reason for restoring altered rivers to natural flow regimes (Burgess 2012). In addition, confluence restoration provides an improved hydraulic connection to the LA River. Widening or laying back the side slopes adds capacity. Removal of concrete sides slopes and/or inverts allow

establishment of vegetation which reduces velocities, increases infiltration, and improves the natural sediment processes.

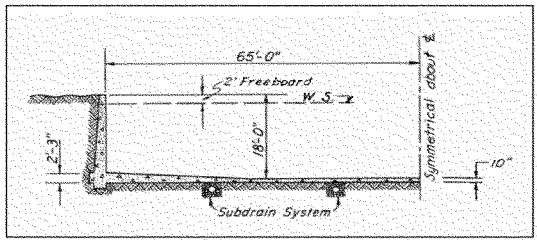
Habitat connectivity to the historic floodplain can be achieved through direct or indirect means. Direct connections are those in which the channel is widened and a more natural configuration is realized or in some cases where flows are diverted from the main channel and allowed to run through the overbank area. Flora and fauna establish themselves more in line with a typical natural river system. Indirect connections are those in which lands adjacent to the river are restored for riparian habitat and wildlife can more easily migrate between the river and these adjacent parcels. Daylighting streams creates additional habitat connectivity especially if a direct connection can be made.

2.3 DESCRIPTION OF STUDY REACHES

There are eight geomorphically different reaches within the study area, which were defined based on the physical characteristics of channel morphology, bank characteristics, soil exposure, existing habitat, and surrounding land uses. Specific geomorphic criteria include: (1) channel bed type (either soft bed with groundwater/surface water exchange, or concrete), (2) side slope type (vertical or trapezoidal), and (3) adjacent land uses or open space. The eight reaches are described in the following sections with photographs and example channel cross sections taken from LACDA as-built summary sheets circa 1962-1986.

2.3.1 Reach 1: Pollywog Park/Headworks to Midpoint of Bette Davis Park

Reach 1 is the upstream segment of the study area and is approximately 1.5 river miles in length. It connects the study area to the Pollywog Park area of Griffith Park, the USACE Headworks Ecosystem Restoration Study Site, and the city of Burbank at Disney Studios. In this reach the River's channel has a rectangular concrete-lined configuration with subdrains and no low flow channel (Figure 2-2) (the low-flow channel is located in the bottom center in other, all-concrete reaches. Its design enhances flow conveyance). There is a small temporary dam within the river bed near the upstream end of this reach that was once used to help divert water to the Headworks spreading grounds operated by the Los Angeles Department of Water and Power (LADWP). The channel is approximately 18 feet deep and the bank-to-bank width is approximately 115 feet.



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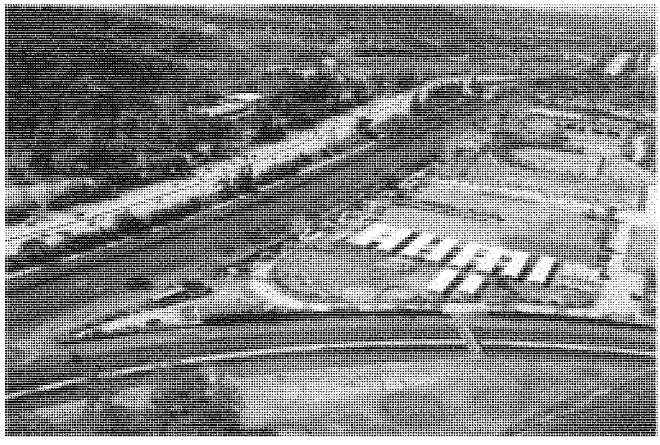
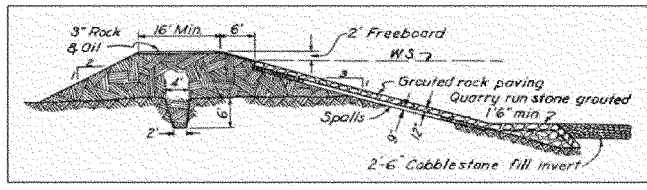


Figure 2-2 Typical Cross Section and Aerial Photo of Reach 1

2.3.2 Reach 2: Midpoint of Bette Davis Park to Upstream End of Ferraro Fields

This reach is approximately 0.75 mile in length. It extends from the midpoint of the Bette Davis Park area on the left bank (facing downstream), where the bed transitions from concrete-lined to a cobblestone bed, and then transitions back to concrete at approximately the upstream edge of Ferraro Fields 9 (public soccer field facility) on the right bank (Figure 2-3). The channel has a trapezoidal configuration with grouted Derrick stone banks. The banks are toed-down (secured by extending the bank wall below the river bed) with sheet pile and quarry run stone. The bed is approximately 18 feet deep from the top of bank and approximately 175 feet wide. Sediment deposited in the channel has formed sand bars/islands, which have stabilized as the root systems of the many trees and other vegetation in the channel have trapped sediment over time. This reach, however, is not as densely vegetated as areas farther downstream in Reaches 4 to 6.



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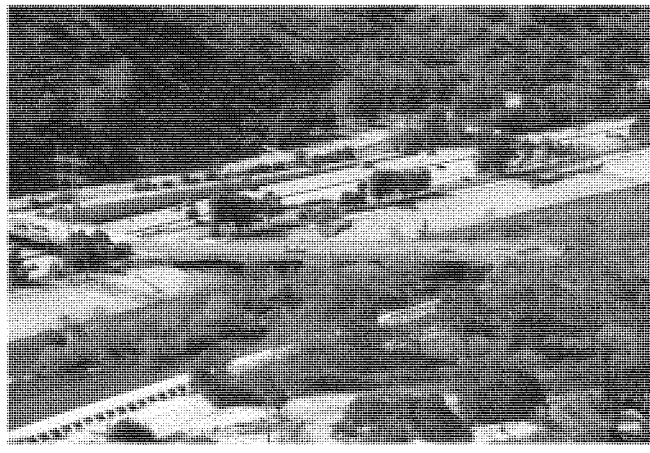


Figure 2-3 Typical Cross Section and Aerial Photo of Reach 2

2.3.3 Reach 3: Ferraro Fields to Brazil Street

This reach is approximately 1 mile in length. It begins at the upstream edge of the Ferraro Fields on the right bank where the bed transitions from cobbles to concrete. It makes an approximately 90-degree curve to the south around Griffith Park and transitions back to cobbles at approximately Brazil Street on the left bank. The channel in this area has a rectangular concrete configuration. The bed is approximately 18 to 23 feet deep from the top of bank and approximately 180 feet wide, widening to 380 feet downstream of the Verdugo Wash confluence. State Route (SR)-134 (Ventura Freeway) crosses the River at Verdugo Wash.

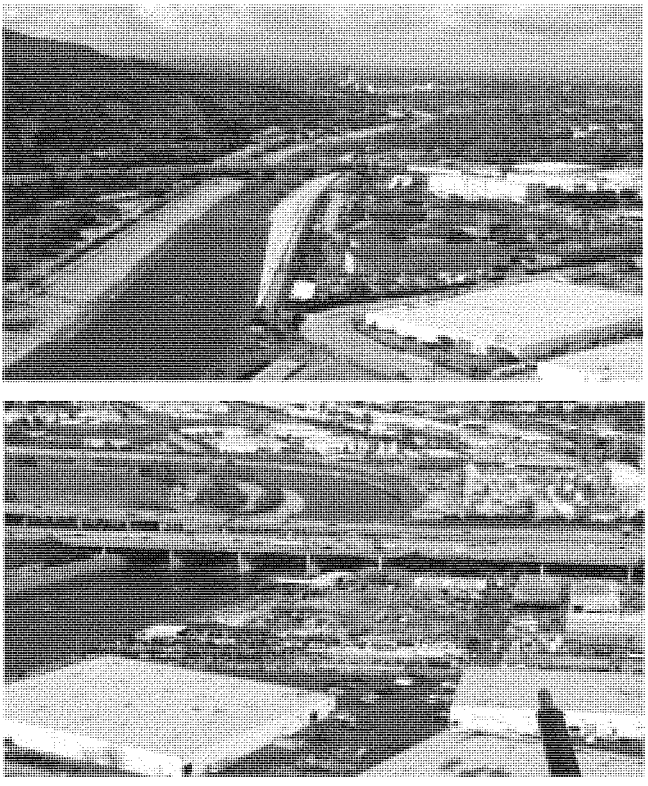
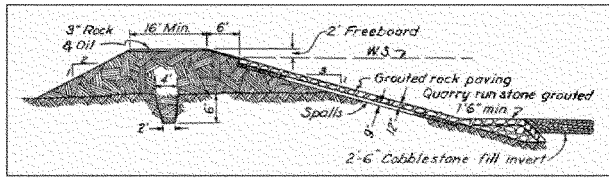


Figure 2-4 Aerial Photos of Reach 3

2.3.4 Reach 4: Brazil Street to Los Feliz Boulevard

This reach is approximately 1.75 miles long and extends from Brazil Street on the left bank downstream to the Los Feliz Boulevard Bridge. The bed transitions from a concrete-lined rectangular channel to a trapezoidal channel with a cobble bed and grouted derrick stone banks (Figure 2-5). Banks are toed-down with sheet pile and quarry run stone. The bed was constructed approximately 18 feet deep from the top of the slope, and the channel ranges from approximately 130 to 160 feet wide from top of bank to top of bank. Sediment deposited in the channel has formed sand bars/islands, which are stabilized by the root systems of the many trees and other vegetation. This reach ends at the Los Feliz Boulevard Bridge, where localized concrete lining of the bed and banks plus pier noses that extend upstream have been constructed to protect the bridge and lower the water surface underneath the bridge.



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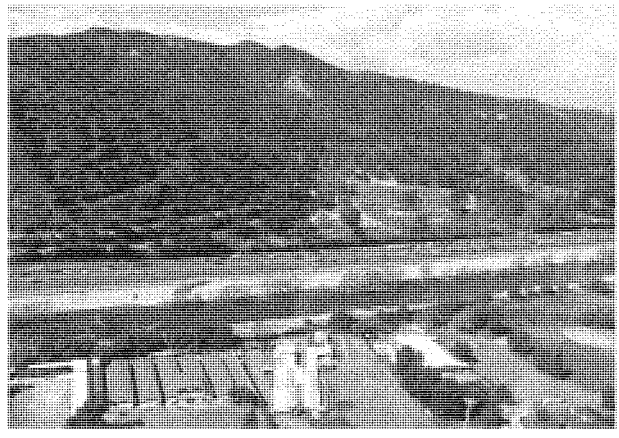
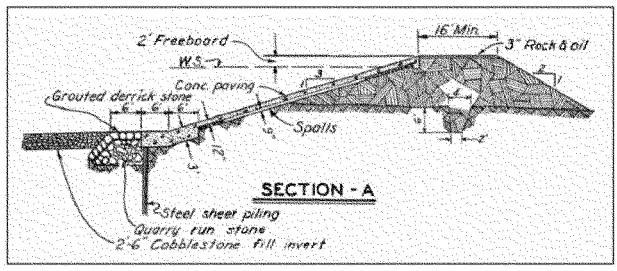


Figure 2-5 Typical Cross Section and Aerial Photo of Reach 4

2.3.5 Reach 5: Los Feliz Boulevard to Glendale Freeway

This reach is approximately 1.55 miles long and veers east between Hyperion Avenue and SR-2 (Glendale Freeway). The reach extends from the Los Feliz Boulevard Bridge, under the Sunnynook pedestrian bridge and the Hyperion Avenue Bridge, downstream to the Fletcher Drive Bridge and ends at the SR-2 Bridge. The bed transitions from concrete under each of the large bridges (e.g., Los Feliz Boulevard, Hyperion Avenue) to a trapezoidal channel with a cobblestone bed and grouted derrick stone banks between the bridges (Figure 2-6 and Figure 2-7). Banks are toed-down with sheet pile and quarry run stone. The bed is approximately 18 feet deep and the top of the channel is approximately 130 to 160 feet wide. Sediment deposited in the channel has formed sand bars/islands, which have stabilized as the root systems of the many trees and other vegetation have trapped sediment. This reach ends as the River begins to curve back east as it approaches Taylor Yard.



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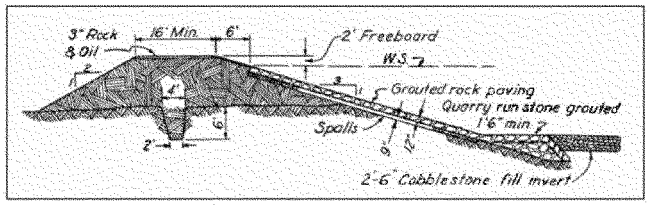

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Figure 2-6 Typical Cross Sections of Reach 5

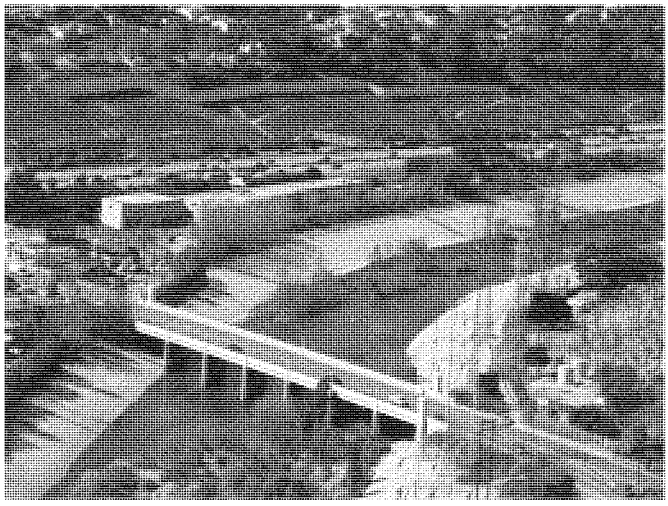
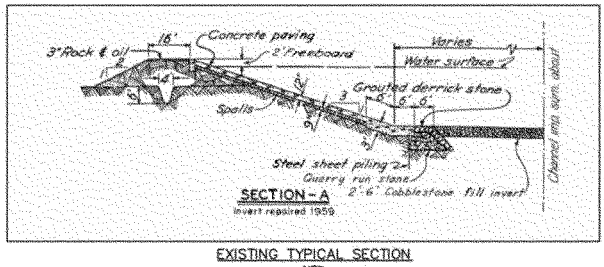


Figure 2-7 Aerial Photo of Reach 5

2.3.6 Reach 6: Glendale Freeway to I-5 Freeway

This reach is approximately 2.34 miles long and meanders through three river bends. It extends from the SR-2 Bridge to the downstream crossing of Interstate 5 (I-5), where the bed transitions from cobblestone to concrete-lined. Here, the channel is in a trapezoidal configuration with a cobble bed and grouted derrick stone banks (see Figure 2-8 and Figure 2-9). The banks are toed-down with sheet pile and quarry run stone. The bed is approximately 30 feet deep from the top of the slope and the top of the channel ranges from approximately 190 to 215 feet wide. Sediment deposited in the channel has formed sand bars/islands, which have become stabilized as the root systems of the many trees and other vegetation have trapped sediment. The channel narrows to 170 feet and transitions to a rectangular configuration just upstream of the complicated I-5 and SR-110 interchange.



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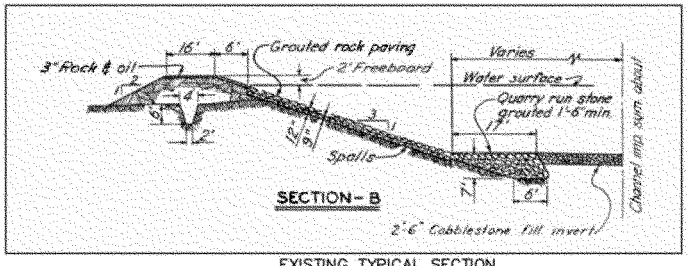

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Figure 2-8 Typical Cross Sections of Reach 6

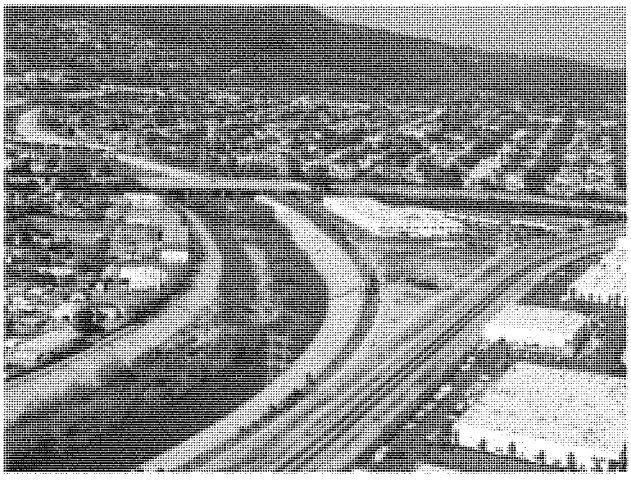
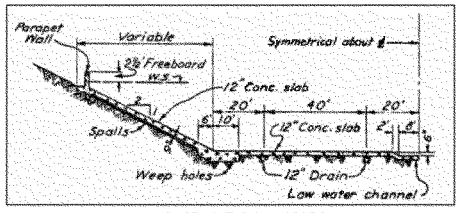


Figure 2-9 Aerial Photo of Reach 6

2.3.7 Reach 7: I-5 Freeway to Main Street

This approximately 1-mile-long reach begins at the I-5 Bridge and extends to the Main Street Bridge. The channel in this area transitions out of the rectangular concrete channel at the Arroyo Seco confluence, and becomes a trapezoidal concrete channel that is approximately 30 feet deep, with a top of bank width that ranges from approximately 150 to 190 feet (Figure 2-10). Three bridges cross the River in this reach, including a railroad bridge, the North Broadway Bridge, and the Spring Street Bridge. The channel has adjacent rail lines on both banks.



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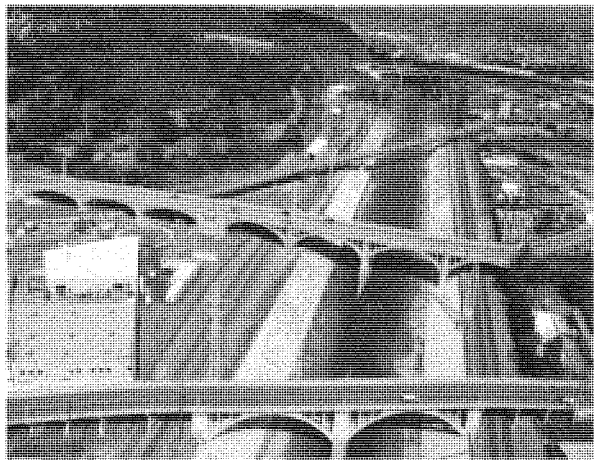


Figure 2-10 Typical Cross Section and Aerial Photo of Reach 7

2.3.8 Reach 8: Main Street to First Street

This approximately 1-mile-long reach begins at the Main Street Bridge and extends downstream to the First Street Bridge. The trapezoidal concrete channel is approximately 30 feet deep with a top of channel width that ranges from approximately 170 to 200 feet (Figure 2-11). Rail lines run adjacent to the channel on both banks, and two railroad bridges cross the river. US-101 crosses the river between César Chàvez and First Street.

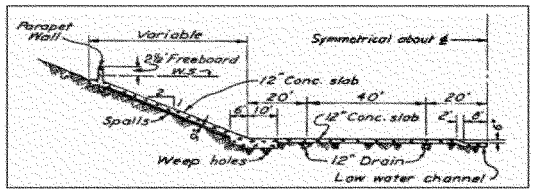


Figure 2-11 Typical Cross Section and Aerial Photo of Reach 8.

2.3.9 Reach Groupings

In many cases, because adjoining reaches are so similar in land use conditions, they have been addressed as a group, particularly in Chapters 4 and 5 where environmental conditions and impacts are presented. These reach groupings include:

- Reaches 1 through 3, adjacent to Griffith Park. Reach 2 is soft bottomed but Reach 1 and 3 predominantly have concrete bed and banks that transition between rectangular and trapezoidal configurations.
- Reaches 4 through 6, which predominantly have grouted rock side slopes with a soft cobblestone bed; these reaches also have more vegetation than the other reaches.
- Reaches 7 and 8, which predominantly have a concrete trapezoidal configuration through downtown industrial, residential, and commercial areas.

2.4 SUMMARY OF PROBLEMS AND OPPORTUNITIES

The problems and opportunities in the Los Angeles River watershed and along the 32 miles of river from the San Fernando Valley downstream through the City of Los Angeles were identified and assessed during the reconnaissance study. The USACE conducted plan formulation meetings with the sponsor, key agencies, and stakeholders during this feasibility phase.

2.4.1 Problems

The Los Angeles River study area is unique due to the extremely large human population and massive infrastructure development in and adjacent to the river channel and floodplain. The study team and the agencies involved with these planning efforts identified the following problems during planning charettes held in December of 2009.

Urbanization and flood risk management projects have created the following problems:

1. The elimination of the ability of aquatic species to move freely upstream-to-downstream and to find adequate locations for refuge and proliferation—in particular, there is a considerable absence of aquatic habitat for fish and other wildlife species;
2. The degradation of ecological processes, such as the exchange and flow of nutrients and sediment within the system, that are necessary to support ecosystem function in valley foothills riparian and freshwater marsh habitats;
3. The replacement of diverse substrate, such as naturally-occurring mixes of fine silts and boulders, necessary to support valley foothills riparian, freshwater marsh, and fish habitats with concrete;
4. Breaks in connections between the river and its historic floodplain, such as a meandering, fluctuating relationship with its tributaries, which associated loss of ecosystem functioning;
5. A highly-altered hydrologic regime that is simplified (reduced flow options) and magnified (higher flows concentrated in smaller spaces);
6. A highly-altered habitat cycle since extremely high velocity flows within the study area prevent robust establishment of riparian habitat and the adequate protection of species attracted to it;
7. Disruption of natural sedimentation processes and exaggeration of atypical/altered regimes, discouraging the ability of existing areas to support diverse habitat communities;
8. The inability of surface flows to infiltrate and recharge groundwater aquifers, which is necessary to restore native flow regimes and support native habitat communities;
9. The degradation of aquatic habitat due to flows conveyed through the many storm drains of

the channelized flood management system;

10. The proliferation of non-native/exotic species and trash/debris, which have degraded aquatic habitat and prevented establishment of native species; and
11. An unpleasant human experience that provides very little understanding of the river's natural history and value and reinforces an inability to access and participate in recreation at the river to learn more about its restoration potential.

The conceptual ecosystem model shown in Figure 2-12 and described in Table 2-1 presents the primary drivers and stressors to the riverine, riparian, and floodplain environments. The primary drivers of habitat quality, quantity, and distribution within the study area are: 1) climate and precipitation patterns; 2) hydrology and runoff; 3) sediment and wood transport; 4) connections (or the lack thereof) between the River and its floodplain; and 5) adjacent upland conditions. The primary stressors on the habitats include: 1) altered hydrology due to channelization and development (impervious surfaces) that increase the rapidity of runoff and increase overall volumes and velocities; 2) altered sediment and wood transport due to disrupted connections between natural sediment and wood sources and the river system (including the elimination of those sources); 3) adjacent upland conditions; and 4) disruption of natural river to floodplain connections and river/floodplain to groundwater connections.

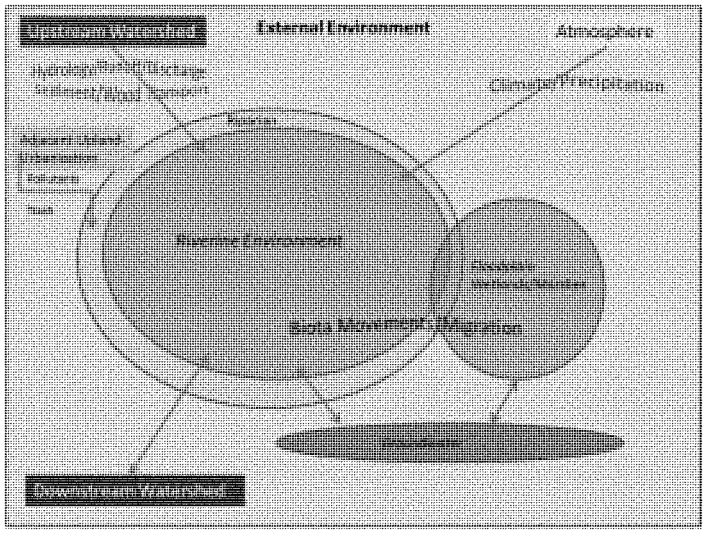


Figure 2-12 Conceptual Model Depicting the Study Area

1 **Table 2-1 Conceptual Model Components**

Model Parameter	Ecological Component	Description
Upstream Watershed		
	Hydrology	Annual and decadal variations in flow volume and timing based on precipitation and runoff
	Runoff	Volume and rate at which precipitation runs off watershed surfaces as surface water
	Sediment/wood Transport	The source volume and delivery of sediment and wood into the river system and its rate of transport
Riverine and Floodplain Environment		
	Water quality	Water temperature, dissolved oxygen, nutrients, and other chemical constituents including pollutants
	Habitat types	Quantity and distribution of habitat types (i.e., pools, riffles)
	Substrate/sediment	Type of substrate and sediments (i.e., gravel/cobble, concrete, silt)
	Adjacent riparian	Quantity, quality, and distribution of riparian habitats normally adjacent to river channels (i.e., cottonwood/willow forested and thickets)
	Floodplain	Quantity, quality, and distribution of floodplain habitats normally adjacent to river channels (also including topography, connections; plant communities)
	Groundwater	Elevation of and connections between groundwater table and river and floodplain habitats
	Sediment chemistry	Presence/absence of various chemical constituents and pollutants
Biota		
	Movements/ migration	Movements of biota laterally between river, riparian, and floodplain and upstream/downstream to other habitat types; disrupted by habitat and corridor fragmentation
	Primary production	The synthesis and storage of organic molecules during the growth and reproduction of photosynthetic organisms
	Invertebrates	Various invertebrate species typical for riverine and floodplain habitats (i.e., mayflies, caddisflies, annelid worms)
	Amphibians/reptiles	Amphibians and reptiles native to Southern California riverine and floodplain systems (i.e., Western toad, arroyo toad, salamanders)
	Fish	Fish species native to Southern California riverine systems
	Waterbirds	Birds most commonly found in and on water (i.e., waterfowl, alcids, pelicans, cormorants, grebes, and gull-like birds)
	Other birds	Birds commonly found foraging or resting in riparian or upland areas (i.e., songbirds, raptors, including threatened and endangered species)
	Mammals	Native mammals for Southern California region
Adjacent Upland		
	Pets and non-native wildlife	Pets and introduced species such as rats, bullfrog
	Non-native plant species	Plants including ornamental species and non-native invasive species
	Impervious surfaces	Development has led to primarily impervious surfaces in the uplands adjacent to the river preventing groundwater interactions and promoting rapid runoff of precipitation that can entrain pollutants
	Trash and debris	Trash and debris washed into or dumped into riverine and floodplain habitats
Atmosphere		
	Precipitation	Rain, snow, or other precipitation typical for the study area climate
	Chemical Constituents	Quantities of various chemicals present in air
	Temperature	Seasonal or typical air temperatures in the study area
	Climate	Prevailing precipitation and temperature regimes; potential changes to climate over time
Downstream Watershed		
	Estuary/ocean	Water, sediment, wood, pollutants, and biota move from riverine/floodplain environment towards downstream estuary reaches and the ocean, and biota may move upstream
	Sea level rise	Elevation of estuary/tidal reaches likely to move upstream over time and change habitat types and species distribution

2.4.2 Public Concerns

While flooding remains a concern in the ARBOR reach, much has already been accomplished to manage flood risk, including upstream dams and channelization of the River and its tributaries through the many USACE flood risk management projects in the watershed. The channel within the ARBOR reach provides a design conveyance that is less than the 1 percent Annual Chance Exceedance (ACE) (100-year) event. Following completion of the LACDA project, additional height was built into flood walls in the 1990s to protect the interests of downstream cities. However, no additional flood risk management features were constructed in the ARBOR reach in the years since LACDA, and extensive growth of vegetation, especially invasive species, and concentration of sediment have occurred within the soft-bottomed reaches of the River, including within the study area. This has the effect of reducing the flood flow capacity that can be conveyed by the LACDA project, thereby diminishing the benefits of higher walls. Therefore, the level of flood risk management in the ARBOR reach and the vegetation within the channel are important considerations—for both problems and opportunities—in formulating the study alternatives.

2.4.3 Opportunities

The study team and the agencies involved with these planning efforts agreed that the problems present the following opportunities for restoration of nationally and regionally significant ecosystem function within the study area. The relationship between each problem and opportunity is noted in parentheses. For example P1 refers to problem one in the previous list. Opportunities are as follows:

- Restore lost aquatic habitat including valley foothill riparian, freshwater marsh, and native fish habitat (P1).
- Improve diversity and abundance of native valley foothill riparian and freshwater marsh plants to support the diversity and abundance of wildlife species (P1).
- Improve and restore ecological processes in the project area to support ecosystem function in valley foothill riparian communities, freshwater marsh, and native fish habitats (P2).
- Restore substrate in valley foothill riparian, freshwater marsh, and native fish habitats (P3).
- Improve habitat connectivity to floodplains and functioning ecological zones (P4).
- Restore a more natural hydrologic regime (P5).
- Decrease peak discharges and/or increase floodplain area in the mainstem and at tributary confluences to reduce discharges and velocities that prevent establishment of native habitats (P6).
- Improve natural sedimentation processes (P7).
- Improve infiltration and recharge (P8).
- Improve water quality from urban runoff in the river, its tributaries, and other drainages entering the river to prevent degradation of aquatic habitat (P9). This project is not proposing measures to address water quality; any improvements will be ancillary to the project.
- Remove and manage invasives/exotics and trash to reestablish native vegetation (P10).
- Increase recreation allowing compatible human interaction with restored ecosystems (P11).

Objectives for the study described in Chapter 4 were developed based on the problems and opportunities as described in Chapter 4, which follows the Chapter 3 discussion of the Affected Environment.

3 AFFECTED ENVIRONMENT

The following sections describe the existing conditions within the study area for a suite of environmental resources. This provides a baseline to compare the potential impacts that may result from implementation of the proposed alternative (Figure 3-1). General descriptions are provided first, followed by reach-specific descriptions, typically grouped by geomorphic characteristics (Reaches 1-3, 4-6, and 7-8). Some resources cannot be described by reach, such as air quality. Also, operation and maintenance of the River is assumed to continue unchanged into the future. Chapter 5 described alternative impacts on the environment.

3.1 GEOLOGY, SEISMOLOGY, SOILS AND MINERALS

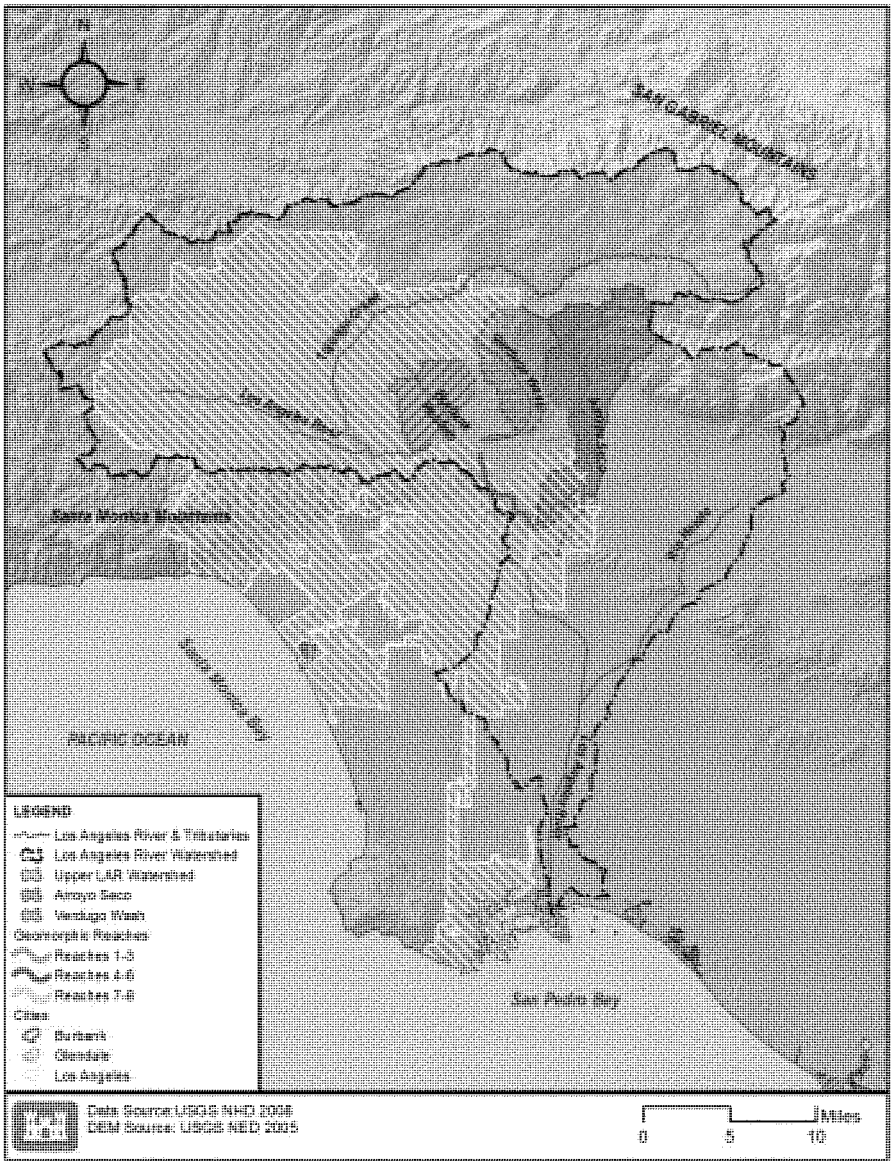
This section describes the geology, seismology, soils and minerals that are affected by the proposed project from an environmental impact viewpoint. In addition to the information provided herein, Appendix D (Geotechnical) provides descriptions, from an engineering perspective, of the geotechnical conditions of the study area. Appendix D also describes geotechnical constraints associated with each alternative as well as provides recommendations for future stages of study and design.

3.1.1 Topography, Geology, and Soils

The study area lies between two major geomorphic regions in the Los Angeles Basin: the east to west oriented Transverse Ranges and the north to south trending Peninsular Ranges (Figure 3-1). Elevations in the Los Angeles River watershed range from approximately 10,000 feet in the San Gabriel Mountains to sea level at the mouth of the river. Elevations within the study area range from a maximum of 490 feet at the upstream end of the study area to a minimum of 240 feet at the downstream end.

This upstream portion of the study area runs along the northeastern fringe of the Santa Monica Mountains in the Hollywood Hills through the San Fernando Valley. Elevations in Reaches 1-3 range from 490 feet upstream to 420 feet downstream. The San Fernando Valley is bounded by the Santa Susana Mountains to the northwest, the Simi Hills to the west, the Santa Monica Mountains to the south, the Verdugo Mountains to the east, and the San Gabriel Mountains to the northeast. These mountains and hills are part of the Transverse Ranges. Elevations in Reaches 4-6 range from 420 feet upstream to 300 feet downstream. Elevations in Reaches 7-8 range from 300 feet upstream to 240 feet downstream. Reaches 7-8 are bounded by the Elysian Hills to the west and the Repetto Hills to the east.

The parent material in the San Fernando Valley is derived from Miocene sedimentary rock consisting of siliceous and diatomaceous shale, siltstone, sandstone, and conglomerate. Santa Monica shale and old and highly metamorphosed sediment are found along the southern side of the valley (SCS 1980). The sediment within the westerly portion of the San Fernando Valley is comprised of relatively fine-grained silty and clayey debris eroded from the Santa Monica and Santa Susana Mountains which are principally comprised of Miocene sedimentary rock consisting of siliceous and diatomaceous shale, siltstone sandstone and conglomerate. The easterly portion of the valley is comprised of alluvial materials that were derived from granitic and metamorphic terrain to the north and east and contain significantly more sand gravel and boulders. The soils of the study area have been highly modified as a result of grading and cut and fill practices. Artificial fill was generally brought in and deposited along the major streams and river channels to fill in low lying areas and to channelize the river. Fill was also used in areas to raise the grade for the construction of roads, bridges, and railroads. In general, fill soils are brownish and consist of silty sands with gravel. However, fill material in the area ranges from clayey silt and silty clay to angular gravel with sand (City of Los Angeles 2005).



1 **Figure 3-1 Los Angeles River Watershed**

Prior to development and construction of the existing flood risk management features the dominant soil within the river channel was Tujunga fine sandy loam (LACDPW 2006). This soil consists of deep and somewhat excessively drained soils formed in alluvium, weathered primarily from granitic sources. These soils are found on floodplains and alluvial fans with slopes of 0 to 9 percent (Figure 3-2). This soil type is characteristic of much of the western San Fernando Valley (Natural Resources Conservation Service [NRCS] 2012).

Other soil types found in the study area and displayed in Figure 3-2 include:

- **Altamont Clay Loam:** This soil series consists of deep, well drained soils that are formed from the weathering of sandstone and shale found on gentle slopes to very steep upland areas. This soil type is found on the right bank of Reaches 4-6, on the gradually sloping to steep sloped areas of the northeastern fringe of the Santa Monica Mountains, and above the left bank along the Repetto Hills.
- **Upper Los Angeles River:** These soils are located above the right bank on the slopes of the Santa Monica Mountains.
- **Hanford Fine Sandy Loam:** These soils are very deep, well drained soils that are formed in moderately coarse textured granitic alluvium. Hanford soils are usually found on stream bottoms, floodplains, and alluvial fans that have slopes of 0 to 15 percent. Hanford fine sandy loams can be found in this reach above the left bank at the base of the Repetto Hills. From the Arroyo Seco confluence to the end of Reach 8, the dominant underlying soil type is Hanford fine sandy loam.
- **Yolo Loam:** These soils consist of fine silty alluvial material, primarily found on nearly level, or flat sloped alluvial fans. Yolo loam is found in Reaches 4-6 in drainages along the River and upper drainage areas.
- **Ramona Clay Loam:** These soils are fine-loamy, mixed soils formed in alluvium derived from granitic and related rock sources. Ramona soils are located on nearly level to moderately sloping terraces and fans. Ramona soils are found in Reaches 4-6 at various locations along the Elysian and Repetto Hills.
- **Chino Silt Loam:** These soils are somewhat poorly drained silty loam soils found in basins and floodplains. Chino soils are found along the base of the Repetto Hills.
- **Hanford Gravelly Sandy Loam:** These soils are very deep, well drained soils that are formed in moderately coarse textured granitic alluvium. Hanford soils are usually found on stream bottoms, floodplains, and alluvial fans that have slopes of 0 to 15 percent (NRCS 2012). Hanford gravelly sandy loam occurs at the Arroyo Seco confluence in Reach 7 (LADPW 2006).

A preliminary review by the California Geological Survey (CGS) indicates that most of the project area is located on lands classified MRZ-2 for Portland cement concrete-grade aggregate (Busch, pers. comm., 2012). This classification occurs in areas where adequate information indicates that significant mineral deposits are present, or where it is judged that a high likelihood exists for their presence. However, the project footprint is not in an area designated by the State Mining and Geology Board as containing significant mineral resources.

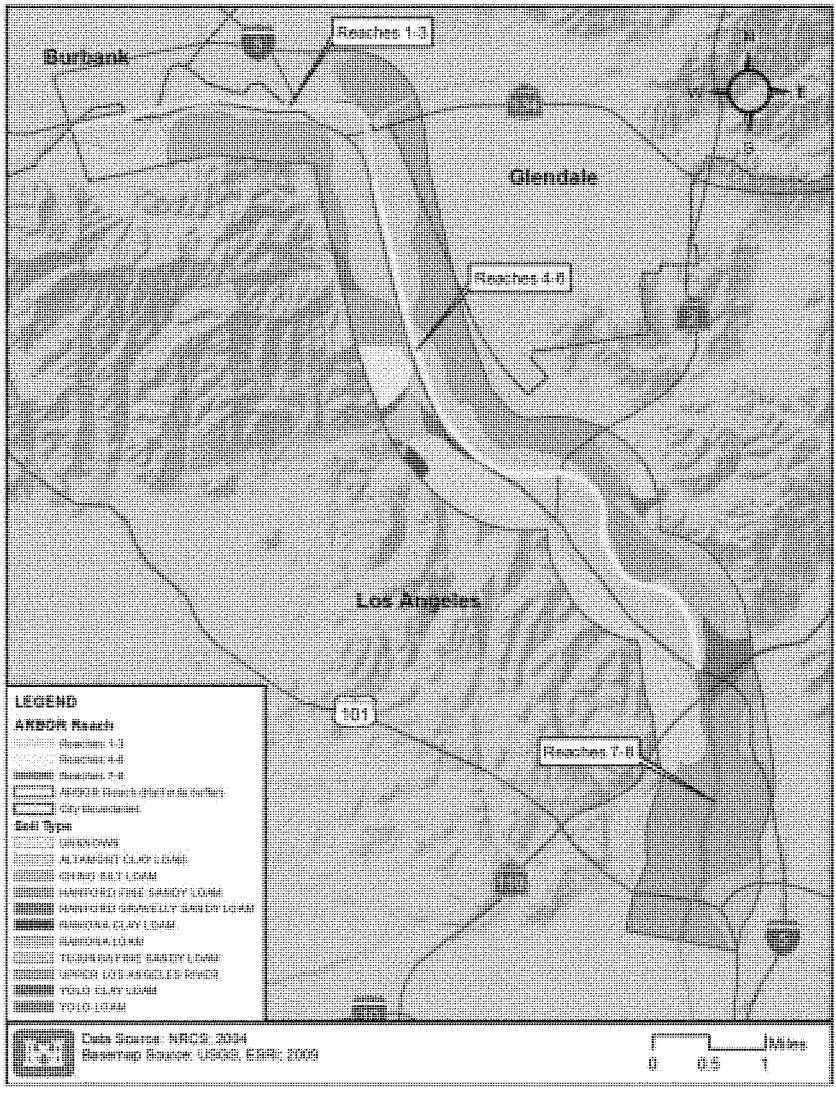


Figure 3-2 Soils

3.1.2 Seismicity, Faults, and Landslides

The study area is located in an active seismic zone where approximately 30 earthquakes of generally low Richter magnitude occur daily (below 2.0). The last appreciable earthquake in the Los Angeles area was in January 1994 when the Northridge Earthquake hit the San Fernando Valley at a magnitude of 6.7 (USGS 2012).

Faults in the project area are shown in Figure 3-3. The San Andreas Fault, located 30 miles to the northeast of the study area, forms the boundary between the North America and Pacific Tectonic Plates, and is the most significant fault in the area (Figure 3-3). It runs along the base of the San Bernardino and San Gabriel Mountains (Harden 1998). Other nearby faults include the San Fernando Fault Zone and the Verdugo Fault, which occur within 2 miles of the northern end of the project area. Faults that pass through the project area include the Elysian Park, Raymond, and Hollywood Faults. The Verdugo Fault has a minimum uplift rate of 1.1 millimeters per year (mm/yr) (Arkle and Armstrong 2009). The Elysian Park anticline forms a segment of the southern boundary of the Transverse Ranges and has an estimated time-average rate of slip of 0.8 to 2.2 mm/year (Oskin et al. 2000). The Raymond Fault, which runs through Reach 5 upstream of Glendale Boulevard, is about 16 miles long, with a slip rate of between 0.10 and 0.22 mm/yr (Southern California Earthquake Data Center 2006). It has been identified by the California Alquist-Priolo Earthquake Zoning Act as an active surface fault or fault that has been active in the past 11,000 years (California Department of Conservation [CADC] 2012a). The Hollywood Fault is about 9.3 miles long and has a slip rate of between 0.33 mm/yr and 0.75 mm/yr. The San Fernando Fault Zone is about 10.5 miles long and runs from the area of Big Tujunga Canyon north to the San Fernando Valley. The slip rate is not well known but is believed to be about 5 mm/yr. The last major rupture was February 9, 1971, and is known as the Sylmar or San Fernando Earthquake, which had a magnitude of 6.6. The rupture was roughly 12 miles long, with a maximum slip of 6 feet (Southern California Earthquake Data Center 2012).

Ground shaking is the primary cause of earthquake damage in Southern California rather than the creation of fissures, ground ruptures, or landslides. The intensity of the ground shaking is related to the magnitude of the earthquake, type of fault, depth of the quake, and distance from the epicenter. Buildings on poorly consolidated and thick soils typically incur more damage than buildings on consolidated soils and bedrock. Areas near major active faults generally experience stronger seismic shaking more frequently (Los Angeles County 2005).

In addition to causing property damage and the loss of human life, seismic events have the potential to cause liquefaction, modify surface water courses, and depending on the time of year and ambient weather conditions, may be the catalyst for landslides.

Liquefaction is caused when the ground shakes wet granular soil and changes it to an unstable liquid state. Areas prone to liquefaction have thick alluvial soils that are poorly consolidated. Areas with high liquefaction potential in the study area include all lowland areas along the Los Angeles River and tributaries. In addition there is high liquefaction potential along the foothills of the Santa Monica Mountains in Reaches 1-3, along the base of the Elysian and Repetto Hills in Reaches 4-6, and along the base of the Elysian Hills in Reaches 7 and 8.

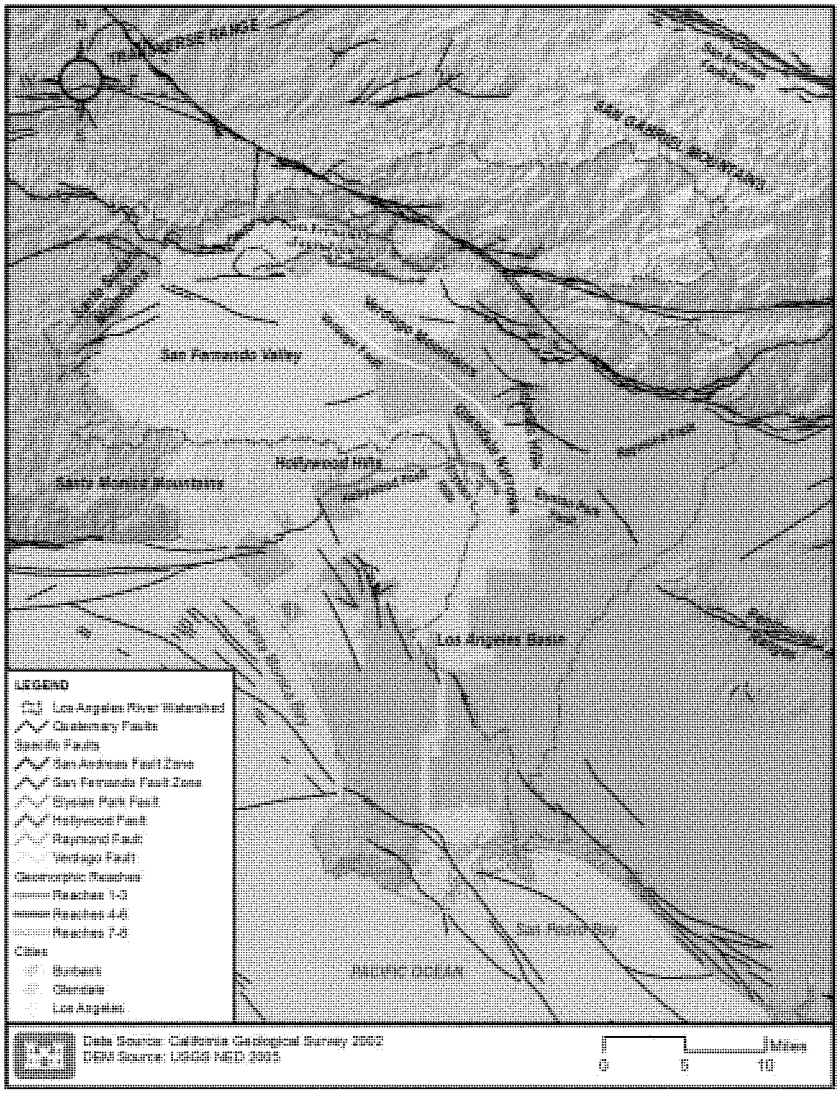


Figure 3-3 Seismicity and Faults

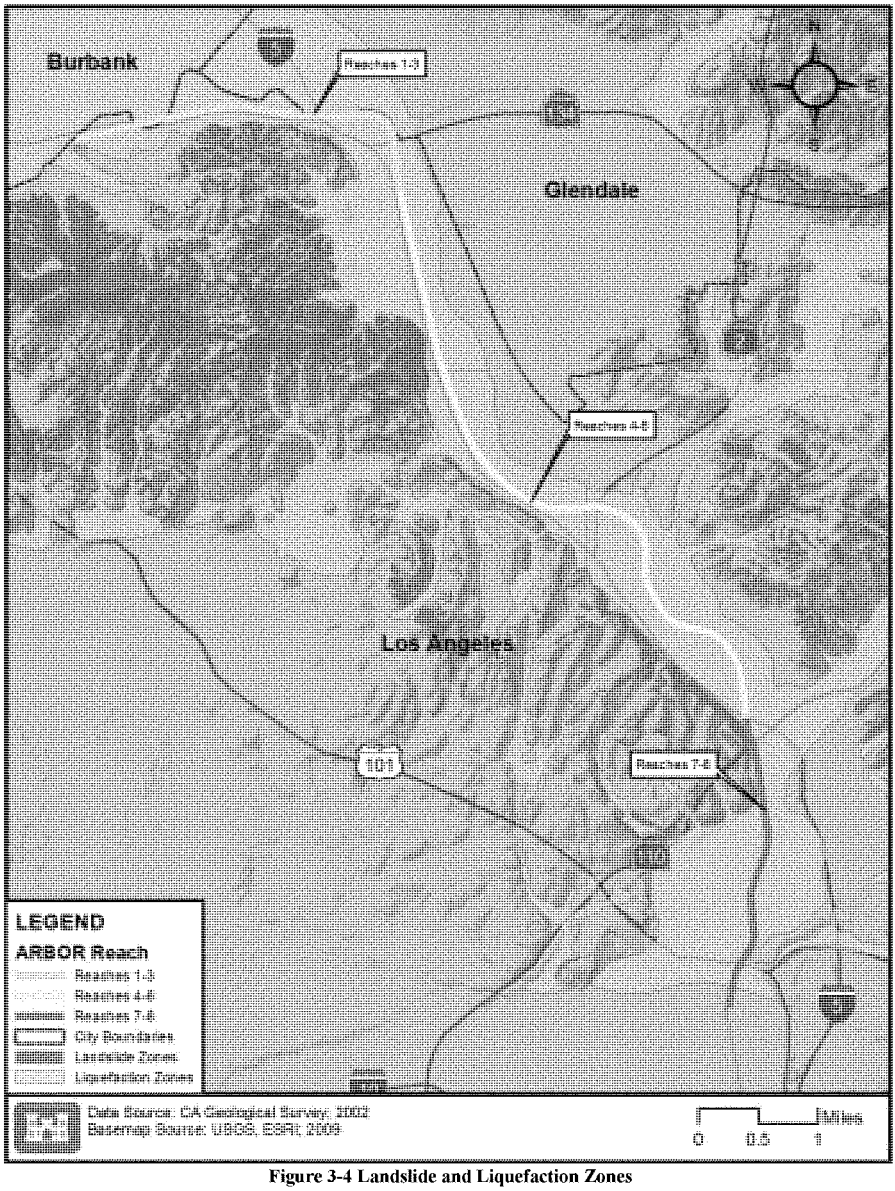


Figure 3-4 Landslide and Liquefaction Zones

Landslides are rated a moderate priority natural hazard in Los Angeles County, especially along hillsides (Los Angeles County 2005). Factors that affect slope failure are angle, substrate, climate (e.g., precipitation), and seismic shaking. Mudslides due to heavy precipitation are more localized in small gullies. These are typically shallow landslides, where the surface material becomes saturated and begins to flow downhill. Debris flows are known to start on slopes as low as 15 degrees but are more likely to develop on steeper slopes. Within the study area, landslide potential occurs along the eastern Santa Monica Mountains (Reaches 1-6), Elysian Hills (Reaches 4-8), and Repetto Hills (Reaches 4-6).

3.2 AIR QUALITY AND GREENHOUSE GASES

This section describes the existing setting for ambient air quality and discusses the applicable air quality regulations in the study area.

3.2.1 Environmental Setting

Area of Influence

The study area is located within the South Coast Air Basin (SCAB) under the jurisdiction of the South Coast Air Quality Management District (SCAQMD). Emissions from construction and operation of the proposed project would affect air quality in the immediate Project area and the surrounding region. The air quality area of influence for the proposed project is included in the SCAB, which consists of the urbanized areas of Los Angeles, Riverside, San Bernardino and Orange Counties, and the ocean offshore of the South Coast waters. The SCAB onshore area covers 6,000 square miles.

Climate and Meteorology Conditions

The SCAB lies within the semipermanent high-pressure zone of the eastern Pacific Ocean. The climate of the region is classified as Mediterranean; the climate is generally characterized by warm, dry summers and mild winters with moderate rainfall. Prevailing daily winds in the region are westerly, with a nighttime return flow. This pattern is typically broken five to ten days a year when strong northeasterly winds, commonly known as "Santa Ana Winds," sweep down from the desert.

The SCAB's climate and topography are conducive to the formation of ozone (O_3). The heaviest concentrations of O_3 occur during the summer months when there are warm temperatures, stagnant wind conditions, high solar radiation, and an inversion layer at lower elevations. An inversion layer forms when cooler, denser air is trapped by warmer, lighter air. Sea breezes transport air pollutants to adjacent air basins, such as the Mojave Desert Air Basin and the SSAB. Carbon monoxide (CO) concentrations are highest during the winter, when relatively stagnant air conditions result in an accumulation of this pollutant. Highest CO concentrations are found near heavily traveled and congested roadways (SCAG 1994). However, in the case of particulate matter, maximum concentrations may occur during high wind events or near man-made ground-disturbing activities, such as vehicular activities on roads and earth moving during construction activities.

Winds across the study area are an important meteorological parameter as they control both the initial rate of dilution and direction of pollutant dispersion. Winds blowing from the west are dominant during February and April, and the prevailing winds during March and summer (May through July) blows from the south. During August through January, dominant winds blow from the west-northwest.

Regional and Localized Air Quality

Air pollutant emissions in the SCAB are generated from stationary, mobile, and natural sources. Stationary sources can be divided into two major subcategories: point and area sources. Point sources occur at an identified location and usually are associated with manufacturing and industry. Examples are

boilers or combustion equipment that produce electricity or generate heat. Area sources are distributed widely and produce many small emissions. Examples of area sources include residential and commercial water heaters, painting operations, portable generators, lawn mowers, agricultural fields, landfills, and consumer products such as barbeque lighter fluid and hair spray. Construction activities that create fugitive dust such as excavation and grading also contribute to area source emissions. Mobile sources refer to emissions from on- and off-road motor vehicles, including tailpipe and evaporative emissions. On-road sources may be operated legally on roadways and highways. Off-road sources include aircraft, trains, and construction equipment. Mobile sources account for the majority of the air pollutant emissions within the air basin. Air pollutants also can be generated by the natural environment such as when fine dust particles are pulled off the ground surface and suspended in the air during high winds.

To protect the public health and welfare, the Federal and state governments have identified five criteria air pollutants and a list of air toxics and have established ambient air quality standards through the Federal Clean Air Act and the California Clean Air Act. The air pollutants for which Federal and state standards have been promulgated and that are most relevant to air quality planning and regulation in the air basins include ozone (O_3), carbon monoxide (CO), suspended particulate matter (PM), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and lead (Pb). PM comes in a range of sizes. PM emissions are regulated in two size classes: Particulates up to 10 microns in diameter (PM_{10}) and particulates up to 2.5 microns in diameter ($PM_{2.5}$). PM_{10} and $PM_{2.5}$ are so small that they can enter the lungs and cause serious health problems.

Ozone (O_3) is a problematic air contaminant in the SCAB. O_3 is formed from the precursor pollutants volatile organic compounds (VOC) and nitrogen oxides (NO_X). VOC and NO_X react to form O_3 in the presence of sunlight through a complex series of photochemical reactions. As a result, unlike inert pollutants, O_3 levels usually peak several hours after the precursors are emitted and many miles downwind of the source.

Nitrogen dioxide (NO_2) is a byproduct of combustion, such as fuel combustion in power plants and internal combustion engines. Carbon monoxide (CO) is a product of inefficient combustion, principally from automobiles and other mobile sources of pollution. In many areas of California, CO emissions from sources such as wood-burning stoves and fireplaces also can be measurable contributors during cold-weather months. Industrial sources of pollution generally contribute less than 10 percent of ambient CO levels. Peak CO levels occur typically during winter months because of a combination of seasonal contributions from home heating devices and stagnant weather conditions. Sulfur dioxide (SO_2) is produced when any sulfur-containing fuel is burned. Chemical plants that treat or refine sulfur or sulfur-containing chemicals also emit SO_2. Because of the complexity of the chemical reactions that convert SO_2 to other compounds (such as sulfates), peak concentrations of SO_2 occur at different times of the year in different parts of the state, depending on local fuel characteristics, weather, and topography. In moist environments, SO_2 may combine with water to form sulfuric acid, a component of acid rain.

Particulate matter in the air is composed of windblown fugitive dust; particles emitted from combustion sources (usually carbon particles); and organic, sulfate, and nitrate aerosols formed in the air from emitted hydrocarbons, sulfur oxides, and oxides of nitrogen. Lead is found in old paints and coatings, plumbing, and various other materials.

Typically, air pollutants are classified as primary or secondary pollutants. Carbon monoxide, nitrogen dioxide, particulate matter, sulfur dioxide, and lead are considered primary pollutants because they are emitted directly into the atmosphere. Ozone is considered a secondary pollutant because it is formed through a photochemical reaction in the atmosphere with VOCs and NO_X in the presence of sunlight.

Both the Federal and state governments have established ambient air quality standards for outdoor concentrations of various pollutants to protect public health, as shown in Table 3-1. These standards have been set at levels whose concentrations could be generally harmful to human health and welfare and that protect the most sensitive persons from illness or discomfort with a margin of safety.

Table 3-1 Ambient Air Quality Standards

Pollutant	Averaging Time	California Standards [1]		Federal Standards [2]		
		Concentration [3]	Measurement Method [4]	Primary [3,5]	Secondary [3,6]	Measurement Method [7]
Ozone (O_3)	1 Hour	0.09 ppm (180 µg/m³)	Ultraviolet Photometry	—	Same as Primary Standard	Ultraviolet Photometry
	8 Hours	0.070 ppm (137 µg/m³)		0.075 ppm (147 µg/m³)		
Respirable Particulate Matter (PM_{10})	24 Hours	50 µg/m³	Gravimetric or Beta Attenuation	150 µg/m³	Same as Primary Standard	Inertial Separation and Gravimetric Analysis
	Annual Arithmetic Mean	20 µg/m³		—		
Fine Particulate Matter ($PM_{2.5}$)	24 Hours	No Separate State Standard		35 µg/m³	35 µg/m³	Inertial Separation and Gravimetric Analysis
	Annual Arithmetic Mean	12 µg/m³	Gravimetric or Beta Attenuation	12 µg/m³	15 µg/m³	
Carbon Monoxide (CO)	8 Hours	9.0 ppm (10mg/m³)	Non-Dispersive Infrared Photometry (NDIR)	9 ppm (10 mg/m³)	None	Non-Dispersive Infrared Photometry (NDIR)
	1 Hours	20 ppm (23 mg/m³)		35 ppm (40 mg/m³)		
	8 Hours (Lake Tahoe)	6 ppm (7 mg/m³)		—	—	—
Nitrogen Dioxide (NO_2)	Annual Arithmetic Mean	0.03 ppm (56 µg/m³)	Gas Phase Chemiluminescence	0.053 ppm (100 µg/m³)	Same as Primary Standard	Gas Phase Chemiluminescence
	1 Hour	0.18 ppm (339 µg/m³)		100 ppb (188 µg/m³)	None	
Sulfur Dioxide (SO_2)	24 Hours	0.04 ppm (105 µg/m³)	Ultraviolet Fluorescence	0.14 ppm (for certain areas)	—	Ultraviolet Fluorescence; Spectrophotometry (Pararosaniline Method)[9]
	3 Hours	—		—	0.5 ppm (1300 µg/m³)	
	1 Hour	0.25 ppm (655 µg/m³)		75 ppb (196 µg/m³)	—	
	Annual Arithmetic Mean	-		0.030 ppm	-	
Lead (Pb) [8]	30 Days Average	1.5 µg/m³	Atomic Absorption	—	—	—
	Calendar Quarter	—		1.5 µg/m³ (for certain areas)	Same as Primary Standard	High Volume Sampler and Atomic Absorption
	Rolling 3-Month Average	—		0.15 µg/m³		

Pollutant	Averaging Time	California Standards [1]		Federal Standards [2]		
		Concentration [3]	Measurement Method [4]	Primary [3,5]	Secondary [3,6]	Measurement Method [7]
Visibility Reducing Particles	8 Hours	Extinction coefficient of 0.23 per kilometer, visibility of ten miles or more (0.07-30 miles or more for Lake Tahoe) due to particles when relative humidity is less than 70%. Method: Beta Attenuation and Transmittance through Filter Tape.		No Federal Standards		
Sulfates (SO_4)	24 Hours	25 µg/m³	Ion Chromatography			
Hydrogen Sulfide	1 Hour	0.03 ppm (42 µg/m³)	Ultraviolet Fluorescence			
Vinyl Chloride[8]	24 Hours	0.01 ppm (26 µg/m³)	Gas Chromatography			

[1]California standards for ozone, carbon monoxide (except Lake Tahoe), sulfur dioxide (1 and 24 hour), nitrogen dioxide, suspended particulate matter (PM_{10}, and $PM_{2.5}$) and visibility reducing particles, are values that are not to be exceeded. All others are not to be equaled or exceeded. California ambient air quality standards are listed in the table of Standards in Section 70200 of Title 17 of the California Code of Regulations. [2]National standards (other than ozone, particulate matter, and those based on annual averages or annual arithmetic mean) are not to be exceeded more than once a year. The ozone standard is attained when the fourth highest eight-hour concentration in a year, averaged over three years, is equal to or less than the standard. For PM_{10}, the 24-hour standard is attained when the expected number of days per calendar year with a 24-hour average concentration above 150 µg/m³ is equal to or less than one. For $PM_{2.5}$, the 24-hour standard is attained when 98% of the daily concentrations, averaged over three years, are equal to or less than the standard. [3]Concentration expressed first in units in which it was promulgated. Equivalent units given in parentheses are based upon a reference temperature of 25°C and a reference pressure of 760 torr (760 torr equals to 1 atmospheric pressure). Most measurements of air quality are to be corrected to a reference temperature of 25°C and a reference pressure of 760 torr; ppm in this table refers to ppm by volume, or micromoles of pollutant per mole of gas. [4]Any equivalent procedure that can satisfy the California Air Resources Board (CARB), which gives equivalent results at or near the level of the air quality standard, may be used. [5]National Primary Standards: The levels of air quality necessary, with an adequate margin of safety to protect the public health. [6]National Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant. [7]Reference method as described by the USEPA. An "equivalent method" of measurement may be used but must have a "consistent relationship to the reference method" and must be approved by the USEPA. [8]CARB has identified lead and vinyl chloride as 'toxic air contaminants' with no threshold level of exposure for adverse health effects determined. These actions allow for implementing control measures at levels below the ambient concentrations specified for these pollutants. Source: CARB 2010a, CARB 2010b, SCAQMD 2007.

While ambient air quality standards have been developed specifically for O_3 and NO_X, there is no state or Federal Ambient Air Quality Standard (AAQS) for VOCs. VOCs include many compounds of carbon. There are certain classes of carbon compounds that are not VOCs, including: carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, ammonium carbonate, and methane, among others. While the state and Federal government agencies have not established ambient attainment levels for VOCs, they have for O_3. Because VOCs react with NO_X through photochemical reactions to form ozone, air districts, including SCAQMD, have provided VOC significance thresholds for study level analysis in order to further limit the levels of VOCs in the atmosphere that could be converted to ozone.

A state or region is given the status of "attainment" or "unclassified" if ambient air quality standards have not been exceeded. A status of "nonattainment" for particular criteria pollutants is assigned if the ambient air quality standard for that pollutant has been exceeded. Once designated as nonattainment, attainment status may be achieved after three years of data showing non-exceedance of the standard. When an area is reclassified from nonattainment to attainment, it is designated as a "maintenance area," indicating the requirement to establish and enforce a plan to maintain attainment of the standard.

California classifies areas of the state as attainment, nonattainment, nonattainment-transitional, extreme or unclassified with respect to the state AAQS.

State and Federal attainment status designations for the SCAB are summarized in Table 3-2.

Table 3-2 Federal and State Attainment Status Designations for the South Coast Air Basin

Air Pollutants	State	Federal
Ozone (1-Hour)	Extreme[1]	-
Ozone (8-Hour)	Nonattainment	Nonattainment – extreme
$PM_{2.5}$	Unclassified	Nonattainment
PM_{10} (24-Hour)	Unclassified	Attainment/Maintenance
PM_{10} (Annual)	Unclassified	Unclassified
NO_2	Attainment	Attainment/Maintenance
CO	Unclassified	Attainment/Maintenance
SO_2	Attainment	Attainment
Lead	Nonattainment	Nonattainment[2]
Particulate Sulfate	Unclassified	-
Hydrogen Sulfide	Unclassified	-
Visibility Reducing Particles	Unclassified	-
[1]CARB classification of ozone ambient concentration exceeding 0.2 ppm. Source: CARB 2011, USEPA 2010. [2]EPA classification of the Los Angeles area as nonattainment for the 2008 lead standard on November 8, 2011		

Air quality problems in the SCAB include periodic violations of Federal and state air quality standards for ozone, PM_{10}, and $PM_{2.5}$. The frequency with which ozone standards have been exceeded has declined significantly over recent decades.

Ambient Air Monitoring Stations

The State and Local Air Monitoring Network Plan provides the results of the annual review of the air monitoring stations in California. These stations house monitoring instruments that measure ambient levels of air pollutants. The closest air monitoring stations to the study area include: (1) Reseda Air Monitoring Station, which is about two miles north of the study area; (2) Burbank West Palm Avenue Air Quality Monitoring Station, which is about 0.5 miles west of the study area; and (3) Los Angeles-North Main Street Air Quality Monitoring Station, which is about 0.5 miles west of the study area. Table 3-3 presents the exceedance data for 2011 at these three air quality monitoring stations. All other pollutants measured at these stations were below threshold.

Table 3-3 Ozone Exceedances at Air Quality Monitoring Stations (2011)

Pollutant	Measurement	Standard	Reseda	Burbank West Palm Avenue	Los Angeles-North Main Street
Ozone	Highest 1-hour observation, ppm	0.09	0.130	0.120	0.087
Standard set by SCAQMD (2010) and USEPA (2010).					

Toxic Air Contaminants

Toxic air contaminants (TACs) are a diverse group of air pollutants that can affect human health, but without established AAQS. This is not because they are fundamentally different from the pollutants discussed above, but because their effects tend to be local rather than regional. Major sources of TACs are typically industrial plants, which are commonly located near populated centers and impacts from TACs emissions are thus considered local effects.

CARB has designated nearly 200 air contaminants as toxic. Additionally, CARB has implemented control measures for numerous compounds that pose high risks and show potential for effective control. The majority of the estimated health risks from TACs can be attributed to a relatively few compounds, the most important of which are toxic ingredients in the form of particulate matter from diesel-fueled engines. Other TACs include benzenes, toluene and xylene.

Reactive Organic Gases (ROG) ROGs are organic compounds that can react with nitrogen oxides in the atmosphere to form ozone under direct sunlight. Major source of ROG are coatings and solvents.

Secondary PM2.5 Formation

Within the SCAB, PM2.5 particles are directly emitted into the atmosphere (i.e., primary particles) and are formed through atmospheric chemical reactions from precursor gases (i.e., secondary particles). Primary PM2.5 includes diesel soot, combustion products, road dust, and other fine particles. Secondary PM2.5 is formed from reactions with directly emitted NOX, sulfur oxides (SOX), VOCs, and ammonia some distance downwind of the emission sources. However, the air quality analysis in this EIR/EIS focuses on the effects of direct PM2.5 emissions and their ambient impacts. This approach is consistent with the recommendations of the SCAQMD.

Sensitive Receptors

The impact of air emissions on sensitive members of the population is a special concern. Sensitive members of the population include those that may be more negatively affected by poor air quality than other members of the population, such as children, the elderly, or the infirm. Schools, hospitals, and convalescent homes are considered sensitive land uses because children, the elderly, and the infirm are more susceptible to respiratory distress and other air-quality-related health problems than the general public.

Greenhouse Gases

Gases that trap heat in the atmosphere are often called greenhouse gases (GHGs). GHGs are emitted by natural processes and human activities. Examples of GHGs that are produced both by natural processes and industry include carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O). Examples of GHGs created and emitted primarily through human activities include fluorinated gases (hydrofluorocarbons [HFCs] and perfluorocarbons [PFCs]) and sulfur hexafluoride (SF6).

The accumulation of GHGs in the atmosphere regulates the earth's temperature. Without these natural GHGs, the earth's surface would be about 61°F cooler (AEP 2007). However, emissions from fossil fuel combustion for activities such as electricity production and vehicular transportation have elevated the concentration of GHGs in the atmosphere above natural levels. According to the Intergovernmental Panel on Climate Change (IPCC 2007), the atmospheric concentration of CO2 in 2005 was 379 ppm compared to the pre-industrial levels of 280 ppm. In addition, the Fourth U.S. Climate Action Report concluded, in assessing current trends, that CO2 emissions increased by 20 percent from 1990 to 2004, while methane and nitrous oxide emissions decreased by 10 percent and 2 percent, respectively.

There appears to be a close relationship between the increased concentration of GHGs in the atmosphere and global temperatures. Scientific evidence indicates a trend of increasing global temperatures near the earth's surface over the past century due to increased human-induced levels of GHGs. GHGs differ from criteria pollutants in that GHG emissions do not cause direct adverse human health effects. Rather, the direct environmental effect of GHG emissions is the increase and/or change in global temperatures, which in turn has numerous indirect effects on the environment and humans. For example, some observed changes include shrinking glaciers, thawing permafrost, later freezing and earlier break-up of ice on rivers and lakes, a lengthened growing season, shifts in plant and animal ranges, and earlier flowering of trees (IPCC 2001). Other, longer term environmental impacts of global warming may include sea level rise, changing weather patterns with increases in the severity of storms and droughts, changes to local and regional ecosystems including the potential loss of species, and a significant reduction in winter snow pack (for example, estimates include a 30 to 90 percent reduction in snow pack in the Sierra Nevada mountain range). Current data suggest that in the next 25 years, in every season of the year, California could experience unprecedented heat, longer and more extreme heat waves, greater intensity and frequency of heat waves, and longer dry periods. More specifically, the California Climate Change Center (Roland-Holst 2006) predicted that California could witness the following events:

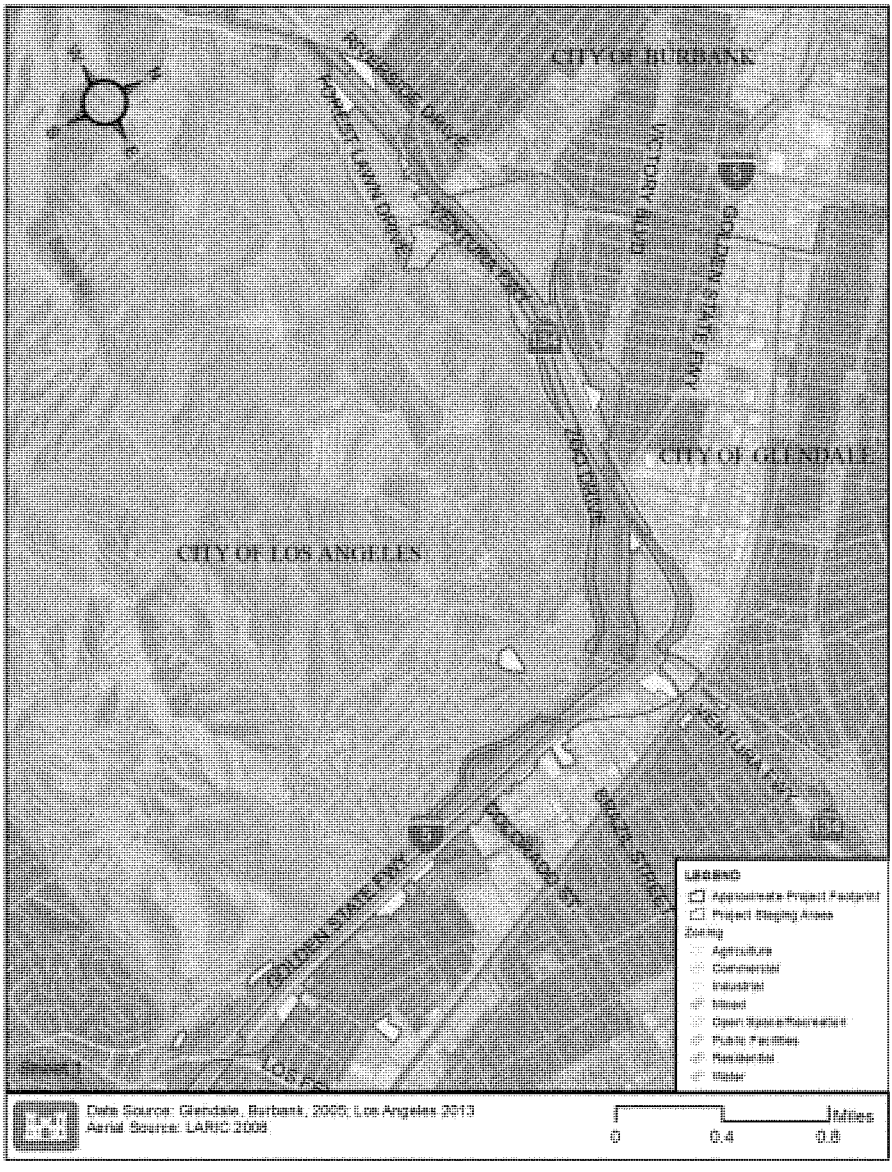
- Temperature rises between 3 to 10.5°F
- 6 to 20 inches or more of sea level rise
- 2 to 4 times as many heat-wave days in major urban centers
- 2 to 6 times as many heat-related deaths in major urban centers
- 1 to 1.5 times more critically dry years
- 10 to 55 percent increase in the risk of wildfires

3.3 LAND USE

This section discusses the land use within and near the study area. Land uses typically include habitation, economic production, institutional uses, recreation, and natural resources conservation. The River channel flows through the central corridor of the study area, flanked by maintenance roads. The SR-134 and I-5 Freeway run close alongside the river for much of its length in the study area. A LADWP utility corridor runs alongside the north and east side of the channel. Other surrounding land uses include Griffith Park, state and local parks including Los Angeles State Historic Park and Taylor Yard, industrial areas at LATC and the mouth of Verdugo Wash, and residential areas near Bette Davis Park and Pollywog Park. Land uses are displayed in Figure 3-5 through 3-7.

Land use is guided and influenced by management plans, policies, zoning ordinances, and regulations that determine the types of uses allowable and occur at the Federal, state, regional, and local levels. The City of Los Angeles and other municipalities have regulatory authority for land use within the study area. Regional land use management is provided by the Southern California Association of Government (SCAG) Regional Comprehensive Plan and Guide. Local management is found in various land use plans and policy documents such as the General Plans of the Cities of Los Angeles, Glendale, and Burbank and the associated Community Plans and Specific Plans for those communities that fall within and adjacent to the study area. These guidelines and regulations are discussed below.

Management of land uses in the study area includes the USACE and the LACFCD if those uses have potential to affect the flood risk management function of the LACDA system. The water is owned by the local jurisdiction, the Los Angeles Department of Water and Power, a subdivision of the City of Los Angeles, through long-held pueblo rights that have been subject to numerous legal interpretations over the years and will not be further discussed in this section.



1 **Figure 3-5 Land Use, Reaches 1-3**

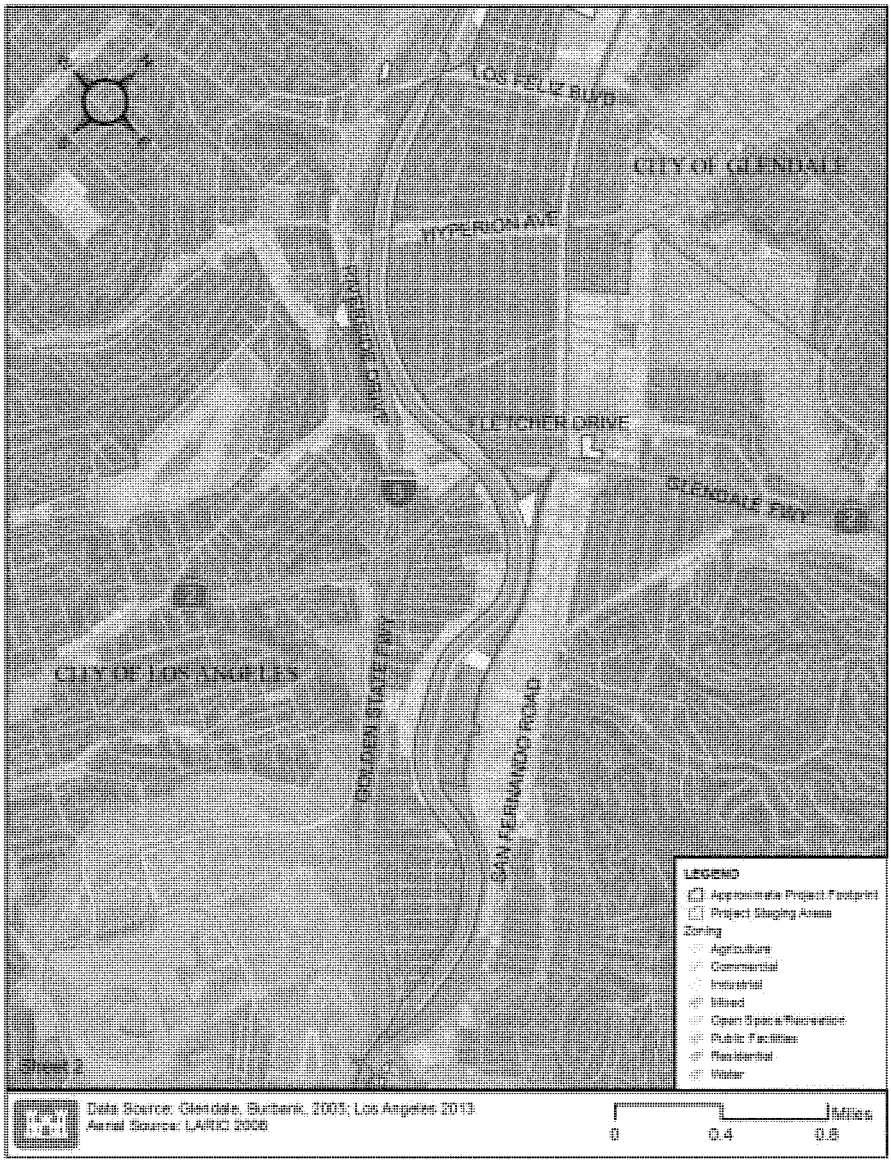
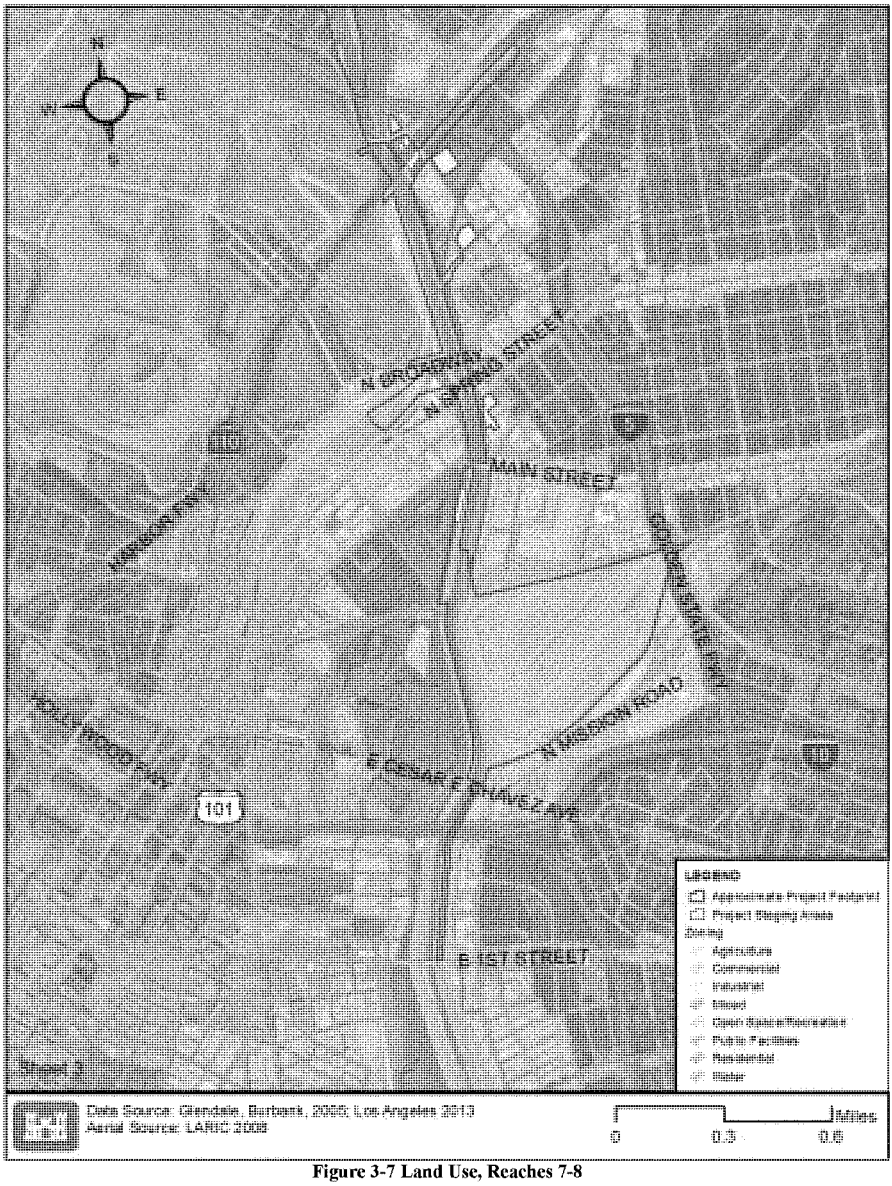


Figure 3-6 Land Use, Reaches 4-6



1 **Figure 3-7 Land Use, Reaches 7-8**

3.3.1 Land Management and Administration Agencies and Organizations

The USACE and Los Angeles County have jurisdiction over the River and its major tributaries for flood risk management. These agencies maintain service roads along the channels for inspection and study area maintenance activities. The current Los Angeles River channel and Verdugo Wash channel were constructed by USACE and the County as part of the LACDA. USACE has operation and maintenance responsibility for the portion of the Los Angeles River within the study area and for its confluence with Verdugo Wash. LACDPW maintains the Verdugo Wash upstream of the USACE portion of maintenance responsibility. Although USACE maintains the identified portions of the Los Angeles River, it does not own the lands in the river itself. The lands in the channel are largely owned by the LACFCD and by the City of Los Angeles, along with others. Where entities other than LACFCD own the fee interest, LACFCD generally holds an easement for construction and operation of the flood risk management project. Operation and maintenance of the Los Angeles River and Verdugo Wash for flood risk management purposes is conducted in accordance with the LACDA OMRRR Manual. Construction activities, channel modifications, and other uses of and within the river channel and wash may not conflict with the flood risk management purpose and flood risk management operation and maintenance needs. The Arroyo Seco, another direct tributary to the Los Angeles River within the study area, was channelized by local interests in the 1930s with the assistance of state funds and the Works Progress Administration. It is maintained by LACDPW.

Sponsored by the LACFCD, the Integrated Regional Water Management Plan is intended to define a clear vision and direction for the sustainable management of water resources in the greater Los Angeles County region through at least the year 2025, to present the basic information regarding possible solutions, and the costs and benefits of those solutions, and to inspire the region and potential funding partners outside the region that these solutions make sense, are good for the community, and are economically feasible. The draft plan was released for comment in 2006, and is still in draft form to date. The plan includes proposed projects within the study area and identifies priority projects for initial funding and implementation (Los Angeles County 2006, 2012).

The Rio de Los Angeles State Park (247 acres) extends into Reach 5 and is jointly managed by California State Parks and the Los Angeles Department of Parks and Recreation. The Los Angeles State Historic Park along Reach 7 (32 acres) is under development with funds from the California State Parks system (California State Parks 2009).

SCAG is the primary regional planning agency for Southern California. SCAG represents six counties, including Los Angeles County, and approximately 18 million people. SCAG's Intergovernmental Review section is responsible for performing consistency review of regionally significant local plans, projects, and programs with SCAG's adopted regional plans. SCAG's criteria for determining regional significance include any proposed local General Plan, element, or amendment thereof for which an EIR was prepared.

The LACFCD developed the Los Angeles River Master Plan for the entire 51-mile reach of the River in 1996. It provides planning for the optimization and enhancement of aesthetic, recreational, flood risk management, and environmental values by creating a community resource, enriching the quality of life for residents and recognizing the River's primary purpose for flood risk management (LACDPW 1996). The master plan also includes published guidelines for landscaping (LADPW 2004b) and signage (LADPW 2003). This plan and its associated goals, objectives, and design guidelines serves as a guide to the development of subsequent River planning and development efforts.

The City of Los Angeles developed and adopted the Los Angeles River Revitalization Master Plan in 2007. The plan is a 20- to 50-year planning document for revitalizing the first 32 miles of the River

that flow through the City of Los Angeles (and which flow along the cities of Burbank and Glendale in the study area). In an effort to explore the potential for expanded revitalization of the River, the plan identified community revitalization measures as well as natural resource, recreation, and open space opportunities in a manner that reflects the unique geographic and existing land use patterns of these areas and, for the first time, called for changes to the river's concrete channel. The Plan's proposed community reinvestment opportunities were designed with local communities in mind to achieve economic redevelopment and revitalization objectives that include, but are not limited to, replacing aging infrastructure and addressing land uses changes to ameliorate blight, encourage the attraction and retention of family-sustaining jobs and foster stability in existing neighborhoods. This plan is further described elsewhere in this IFR.

3.3.2 Applicable General Plans

California state law (Government Code Section 65300 et seq.) requires that each city prepare and adopt a comprehensive, long-term General Plan for its future development. The General Plans must contain seven elements, including land use, circulation, housing, conservation, open space, noise, and safety. In addition to these, state law permits cities to include optional elements in their General Plans, thereby providing local governments with the flexibility to address the specific needs and unique character of their jurisdictions. In the City of Los Angeles, the General Plan contains citywide elements for all topics except land use for which community plans establish policy and standards for each of the 35 community planning areas. The General Plans of the Cities of Glendale and Burbank also include land use elements. More specifically, Government Code Sections 65860, 66473.5, and 656474 require that zoning ordinances and subdivision and parcel map approvals be consistent with the General Plan (State of California 2012).

Table 3-4 Community Planning Areas within or near the Study Area

Community Planning Area	Reaches
Hollywood	1-5
Northeast Los Angeles	3-6
Silverlake/Echo Park/Elysian Valley	5-6
Central City North	6-7
Central City	7-8
Boyle Heights	7-8

The land use element of the City of Los Angeles General Plan is composed of 35 Community Plans. These plans are the official guide to future development in the City, and are intended to promote an arrangement of land uses that foster economic growth, as well as the social and physical health of the people who live and work in these communities. The Community Plan Areas within the study area are shown in Table 3-4.

Additionally, specific plans are sometimes developed to describe allowable land uses, to identify open space, and to detail infrastructure availability and financing for a portion of a community. Specific plans implement, but are not technically a part of, the General Plan. Los Angeles, Glendale, and Burbank have various specific plans throughout their cities. A specific plan may not be adopted or amended unless the proposed plan or amendment is consistent with the General Plan pursuant to State Code (65454). Zoning, subdivision, and public works projects must be consistent with the General Plan and specific plan pursuant to §65455 (State of California 2012).

3.3.3 Land Use Plans Under Development

Located within the Central City North and Northeast Los Angeles Community Plans is the Cornfield Arroyo Seco Specific Plan (effective 8/13/13) created as a direct result of the LARRMP (City of Los Angeles 2007). Reflecting many of the recommended changes put forth in the LARRMP, the plan changes much of the existing zoning from industrial to new zoning designations and zoning districts. One example of a new zoning designation would be Hybrid Industrial. The use of zoning districts is based on development intensity and use mix instead of segregated land use zones. The zoning districts would include Greenway, Urban Center, Urban Innovation, and Urban Village.

The City of Los Angeles completed a Vision Plan and Economic Development Strategy for the Northeast Los Angeles Riverfront District (www.mylariver.org). The boundaries of this district contain the Verdugo Wash at the northernmost point and the Los Angeles State Historic Park at the southernmost point. The Vision document aims to highlight the northeast Los Angeles River landscape by creating a continuous, linear, recreational experience. The purpose of the Vision document is to provide a shared community-wide vision framework that informs elected officials long with various City, State, and Federal agencies of future economic and recreational investment priorities. A grant from the HUD-DOT-EPA Partnership for Sustainable Communities supported this effort. Goals also include building off of river revitalization efforts to ensure that the adjacent riverfront neighborhoods co-benefit along the Los Angeles River.

The Los Angeles River Improvement Overlay (LA-RIO) District is a special use district that was adopted by the Los Angeles City Council in 2014. The LA-RIO would implement many of the design and land use goals proposed in the LARRMP. The purpose of the overlay district, which includes approximately 2,500 feet on either side of the River, is to support the goals of the LARRMP, contribute to the environmental and ecological health of the City's watersheds, establish a positive interface between river adjacent property and river parks/ and or greenways, promote pedestrian, bicycle and other multi-modal connections between the River and its surrounding neighborhoods, provide native habitat and support local species, provide an aesthetically pleasing environment for pedestrians and bicyclists accessing the River area, and promote the river identity of river adjacent communities. The LA-RIO establishes landscaping and urban design standards that will be required of all future development projects within the LA-RIO District. All of the study's reaches are within the LA-RIO District.

3.3.4 Land Use in the Study Area

Land uses in the study area include parkland, residential, industrial, and commercial. It is also a major transportation corridor, with the I-5 and SR-134 adjacent to much of the river corridor. The areas upstream of the study area have similar uses. Descriptions of general land use designations are shown in Table 3-5. Within the study area, open space/recreation is the most prevalent type of land use in the study area followed by industrial, at approximately 59 and 25 percent, respectively (Table 3-5). These are the primary land use categories potentially most affected by implementation of the proposed project.

As documented in the City's 2006 – 2014 Housing Element of the General Plan (City of Los Angeles 2009), the study area is essentially built out. Nearly all new housing development activity will involve recycling of land, and no large-scale changes to land use patterns are anticipated. Annual growth in population for the study area is projected to decline to less than 0.3% over the next 25 years, with primary land use changes limited to redevelopment (LAEDC 2012).

Table 3-5 Land Use Acreages and Percent of Total in Study Area

Land Use Category	Types of Land Uses in Category	Acres	Percent
Commercial	Retail uses, professional offices, business parks.	1.69	0.24%
Industrial	Manufacturing activities, warehouse and storage, utilities and substations, freight operations.	195.96	25.24%
Open Space/Recreation	Environmentally sensitive habitat, wildlife refuge/preserve, river, stream or floodplain, coastal bluff, vacant urban land. State, county, city parks or beach, recreation facility, cultural center, golf course, campground.	455.61	58.68%
Public Facilities	Major facilities built and maintained for public use such as civic buildings, airports, military installations, hospitals, water and sewer facilities, maintenance yards, roads, freeway, and river channels.	113.78	14.84%
Residential	Single and multiple family residential, condominium and apartment, mobile homes, hillside management area.	9.76	1%
Total Study Area		**776.80**	**100.00%**

Open Space/Recreation

The study area contains many existing recreational amenities. Reaches 1-3 include portions of one of the City of Los Angeles' oldest and largest park, Griffith Park. With a wide variety of uses from large preserved open space to the zoo and golf courses, Griffith Park affords many opportunities for wildlife and habitat enhancement. Reaches 4-6 contain some of the City's newest parks including Rio de Los Angeles State Park at Taylor Yard, and the City's oldest park, Elysian Park. There are a number of small "pocket parks" adjacent to the River in these reaches that have been developed by various agencies as part of the overall effort to green the River and make it more accessible. In Reaches 7-8, the Los Angeles State Historic Park is on a site formally known as the Cornfields. The Los Angeles River bikeway runs along the west side of the River (from Zoo Drive near Griffith Park to Barclay Street in Elysian Valley- approximately 10 miles) directly connecting some of the smaller parks; the bikeway is a multi-year effort to connect the entire River from the San Fernando Valley to Long Beach. There are plans currently underway to expand or build parks on parcels adjacent to the River; this trend is likely to continue even without alterations to the River flood conveyance infrastructure.

Residential

Residential neighborhoods line many parts of the River and include both single and multiple family dwellings. Downtown Los Angeles (Reaches 7-8) has seen an increase of residences due to a change in zoning laws promoting residential uses and many buildings are being re-purposed as residences. Despite being stalled by the recession beginning in 2008, the number of people residing in Downtown Los Angeles is likely to increase. As other parts of the study area are already built out, some increase in density may occur as the result of rehabilitating or changing housing stock, but uses are unlikely to dramatically change.

Industrial

At some locations, industrial enterprises are directly adjacent to the River, especially near SR 134 in Reaches 1-3, the neighborhoods of Atwater Village and Elysian Valley in Reaches 4-6, and south of Elysian Park as the River flows into downtown LA. Many of the older industrial facilities in all the study areas may be ripe for conversion to other purposes. However, because there is a desire on the part of the cities to preserve jobs, changes to zoning may not be forthcoming in the near future. Heavy rail, rail yards and utility lines are adjacent to the River on its east side, most notably LATC (Mission Yard) in Reaches 7-8. Rail lines are found on both sides of the River south of the confluence with the Arroyo Seco.

Public Facilities

In addition to recreation, the City of Los Angeles owns and maintains a number of parcels in the study area for various purposes. In Reaches 1-3 these include the Los Angeles/Glendale Water Treatment Plant, which treats sewage to advanced tertiary treatment and discharges to the River. Just downstream of the plant on the east side, LA Department of Recreation and Parks have a large maintenance facility-the Central Service Yard. Adjacent to the confluence of the River and Arroyo Seco in Reaches 4-6, the City operates a trash and recycling center transfer facility. Downstream of the area on the east side is the old City Jail in Lincoln Heights and a tow yard facility at the corner of Pasadena Avenue and Avenue 19. The LADWP facility at Main Street and the River has a maintenance yard used for repairs to both water and power infrastructure. Some of these parcels have been in discussion for conversion to other uses; however, the costs of relocating such facilities and finding other suitable sites for these activities have been severely limiting factors. Major freeways in the area include I-5 and SR-134.

3.4 WATER RESOURCES

3.4.1 Los Angeles River

The Los Angeles River watershed has a total drainage area of 570 square miles at its downstream study area boundary at First Street. The principal tributaries of the study area include Burbank Western Channel, Verdugo Wash, and Arroyo Seco. The main channel of the River is 51 miles long, and the study area has a stream length of 11.5 miles. Its tributaries have an aggregate length of 40.6 miles (from their headwaters). Stream slopes range from very steep in the mountain tributaries with slopes commonly over 200 feet per mile (3.8 percent) to approximately 3 feet per mile (less than 1 percent) in the River mainstem and coastal plain.

Impervious drainage in the study area is estimated to be 32 percent of ground cover, based on assumptions of impervious areas of each land use type in the River watershed (LADPW 2005). Due to the high amount of impervious surfaces in the drainage area, water makes its way to the storm drains, creeks, and eventually to the River in a short time. Flood hydrographs from single storm events are typically of less than 12 hours duration and are almost always less than 48 hours duration. An example of the quick response (flashiness) to excess rainfall occurred in February 1980 when the flow rate increased from approximately two-thirds of the channel capacity (86,000 cfs) to full (129,000 cfs) in the River at Wardlow, located 0.5 miles downstream of the 405 Freeway, in less than an hour (USACE 1991).

Shallow surface soils, impervious bedrock, fan-shaped stream systems, steep gradients, and occasional denudation of the area by fire result in intense debris-laden floods. However, flood and debris flows are regulated at dams and debris basins.

Flooding

The Los Angeles River is a central component in the LACDA flood risk management project. Federal flood risk management improvements in the reach of the Los Angeles River being studied in this IFR were first authorized for construction under Emergency Relief Acts, then authorized by the Flood Control Act of June 1936, as amended by the Flood Control Acts of 1937 and 1938, as well as the Flood Control Act of 1941. Modifications to the Los Angeles River channel have been addressed in later Flood Control Acts. Design discharges of the Los Angeles River range from 40,000 ft^3/s to 104,000 ft^3/s within the study area. A complete list of design flows for all eight reaches in the study area can be found in Table 14 of the Hydrology and Hydraulics Appendix (Appendix E).

The Los Angeles River as originally constructed within the study area from the 1930s to the 1950s was designed to convey a design flood, not a specific frequency event such as the 1 percent ACE (100-year)

event. The Corps studied improvements to flood risk management conveyance capacity along the Los Angeles River in its 1992 LACDA Review. The 1992 LACDA Review Feasibility Study showed that the LACDA channel and dam flood control system had a relatively low level of flood protection for a metropolitan area. This low level of protection was and is attributable to the following factors: (1) the original design storm, which was based upon the Capital Flood/Standard Project Flood concept in use in the 1930s was too small; (2) modern day freeboard requirements for flood control channel design means that the safe conveyance capacity of a portion of the Los Angeles River is significantly lower than the original design capacity with a lower freeboard; and (3) the increased runoff response of the watershed due to intensive urbanization produces a higher peak discharge for the same rainfall event.

Although Congress authorized the Corps to upgrade flood risk management features for the Los Angeles River downstream of the Rio Hondo confluence to provide for the 0.8 ACE event (133 year), Congress did not authorize upgrades for the upper Los Angeles River including the ARBOR reach. Flood risk management upgrades within the study area were not found to be economically justified in the 1992 review. Therefore, the flood risk management design conveyance capacity remains far less than the 1 percent ACE. Existing vegetation within the channel further decreases the conveyance capacity below that of design.

As described in the Hydrology and Hydraulics Appendix, inundation mapping was generated for the 4 percent ACE (25-year), 2 percent ACE (50-year), 1 percent ACE (100-year), and the 0.2 percent ACE (500-year) events using the most current survey data. The floodplain maps show significant floodplain areas for all the flood events that were analyzed. The channel has two major breakout areas within the ARBOR reach in the non-concrete bottom reaches. The upstream area with extensive overbank flooding is between Barham Boulevard and the confluence with Verdugo Wash and has an average floodwater depth of 5.2 feet in the overbank areas during the 1 percent ACE (100-year) event. The downstream area with extensive overbank flooding is from the Verdugo Wash confluence to the Golden State Freeway, where the in-channel vegetation ends, and has an average floodwater depth of 3.9 feet in the overbank areas during the 1 percent ACE (100-year) event. Floodplain mapping can be found within Appendix E.

Levees

The National Levee Database indicates that five levees are within the study area. Each of these levees is maintained by the Federal government. These include LAR 2, LAR 3, LAR 5, LAR 6, and LAR 7 and are found in Reaches 1 to 5, and Reaches 7 and 8. Additional information pertaining to the levees is found in Section 6.2.2 and Appendix D, Geotechnical.

3.4.2 Los Angeles River Study Area Tributaries

The Burbank Western Channel originates in La Tuna Canyon in the northern end of the Verdugo Mountains and conveys 25 square miles of drainage to its confluence with the Los Angeles River at the downstream portion of Reach 1 (Figure 3-1). As seen in Table 3-6, the Burbank Western Channel adds 15,000 cfs during design flows. The channel's design flows are between the 200-year (0.5 percent annual exceedance chance) and 500-year (0.2 percent annual exceedance chance) event frequency discharges.

As the River bends to the south, the Verdugo Wash joins from the east in Reach 3 (Figure 3-1). Draining approximately 28.8 square miles, including the City of Glendale, the Verdugo Wash is a concrete-lined channel. Maximum daily peak flows in the lower reaches of Verdugo Wash are typically less than 400 cfs, with many years actually measuring peaks of considerably less than 100 cfs. However, maximum daily peak flows have occasionally exceeded 1,000 cfs. As seen in Table 3-6, Verdugo Wash adds 42,900 cfs during design flows. The channel's design flows are well above the 0.2 percent ACE (500-year) frequency discharge. Downstream of the confluence of Verdugo Wash, the River flows through what is

colloquially known as the Glendale Narrows. All of the water from the San Fernando Valley funnels through this narrow passage between the hills.

The 22-mile-long Arroyo Seco drains the southwestern section of the San Gabriel Mountains. Starting high in the San Gabriel Mountains and running through Pasadena near the Rose Bowl, it continues through South Pasadena to meet the River at Reach 6 just north of downtown Los Angeles (Figure 3-1). The Arroyo Seco flows through the communities of La Canada-Flintridge, Altadena, Pasadena, South Pasadena, and northeast Los Angeles with a watershed of approximately 47 square miles (Figure 3-1). The upper Arroyo Seco watershed is in the Angeles National Forest and is managed for recreation, watershed protection, and wildlife conservation. The upper watershed is generally undeveloped, whereas the lower portion is highly urbanized. As seen in Table 3-6, Arroyo Seco adds 43,000 cfs during design flows; the Arroyo Seco channel's design flows are well above the 0.2 percent ACE (500-year) frequency discharge.

Table 3-6 Tributary Frequency Discharges

Arbor Reach	RS	2-year	5-year	10-year	25-year	50-year	100-year	200-year	500-year	Design
Burbank Western	18+04	2,150	4,320	4,990	7,040	8,360	12,400	14,200	16,900	15,000
Verdugo Wash	12+62	3,790	7,550	8,720	12,700	15,100	23,200	26,500	30,300	42,900
Arroyo Seco	9+26	1,500	3,200	4,190	10,200	12,500	17,700	22,200	26,400	43,000

Source: USACE 2012a.

3.4.3 Surface Water Quality

Water quality in the study area is affected by point source and non-point source pollution entering tributaries and the main channel of the River. The River is an effluent-dominated waterbody. Nearly 70 percent of the volume in the River is from Water Reclamation Plant tertiary-treated effluent discharged outside of storm events (Ackerman 2003). Although groundwater interactions exist (particularly in the Glendale Narrows and Arroyo Seco tributary), the majority of storm drain discharges are believed to arise from urban discharges.

Stormwater runoff and associated contaminants found in the study area are from surrounding urban areas and are the prominent sources of water quality degradation. Runoff from pervious and impervious areas (i.e., streets, parking lots, lawns, golf courses and agricultural land) carry accumulated contaminants (i.e., atmospheric dust, trace metals, street dirt, hydrocarbons, fertilizers and pesticides) directly into receiving waters. The Southern California Coastal Water Research Project (SCCWRP) conducted a stormwater sampling program over five seasons (2000 through 2005) to characterize the effect of stormwater on water quality. Constituent concentrations were measured over entire storm durations from eight different land use types over 11 storm events in five watersheds in the greater Los Angeles region (SCCWRP 2007). These data were collected to better characterize contributions of specific land use types to loading of bacteria, trace metals, and organic compounds and to provide data for watershed model calibration.

The 2007 SCCWRP study found that all pollutants were strongly correlated with high levels of total suspended solids (TSS), and the highest concentrations of TSS were correlated with urbanized land uses and degraded watershed habitat. Stormwater sampling revealed that TSS concentrations were higher in early season storms (October – December) than late season storms (April-May), which suggests that the amount of time available for pollutant buildup affects the magnitude of pollutants; there is a longer period of time (summer months) before early season storms in comparison to late season storms.

Stormwater runoff from watershed and land use-based sources is a significant contributor of pollutant loading and often exceeds water quality standards. Results indicate that urban stormwater is a substantial source of a variety of constituents to downstream receiving waters. Substantially high constituent concentrations were observed throughout the study, and constituent concentrations frequently exceeded water quality criteria.

All constituents were strongly correlated with TSS. High TSS loads in rivers contribute to water quality impairments, habitat loss, and excessive turbidity, resulting in impairments in recreational, fish/wildlife, and water supply designated uses of the rivers. These results suggest that controlling TSS at specific land uses may reduce other particle-bound constituents.

Land use-based sources of pollutant concentrations and fluxes varied by constituent. No single land use type was responsible for contributing the highest loading for all constituents measured. Industrial land use sites contributed higher trace metals than other land use types. Recreational (horse) land use sites contributed significantly higher storm fluxes for E. coli, while agricultural land use sites contributed the highest TSS fluxes. Substantially higher TSS fluxes were also observed at the industrial sites.

Stormwater runoff of trace metals from the urban watersheds in this study produced a similar range of annual loads as those from other point sources such as large publicly owned treatment plants. Stormwater runoff concentrations improved over time when compared with the Nationwide Urban Runoff Program. Results showed an improvement in water quality between constituent concentrations reported by the program in 1983 and those observed in this study. Long-term overall trends of decreasing median constituents were observed at all land uses with the exception of total zinc, which showed an increase over the course of the studies. For example, lead concentrations have exhibited a 10-fold reduction over the last 20 years. The decreasing concentrations of lead observed in these studies can most probably be attributed to regulations banning the use of leaded gasoline.

Peak concentrations for all constituents were observed during the early part of the storms. For all storms sampled, the highest constituent concentrations occurred during the early phases of stormwater runoff (first flush) with peak concentrations usually preceding peak flow. In all cases, constituent concentrations increased rapidly, stayed high for relatively short periods, and often decreased back to base levels within one to two hours.

Because the Los Angeles region is so densely populated and industrialized, the quality of its surface water runoff is typically degraded. Baseflow in the River is substantially affected by permitted discharges associated with industry and municipal water treatment. The Clean Water Act National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. Industrial, municipal, and other facilities must be permitted if their discharges go directly to surface waters. There are two general types of permits: individual permits are specifically tailored to an individual facility based on the type of activity, nature of discharge, and quality of receiving water while general permits cover multiple facilities within a specific category and region (USEPA 2006).

Section 303(d) of the CWA requires states to develop lists of impaired waters that do not meet established water quality standards (State Water Resources Control Board [SWRCB] 2010a). Water quality standards are developed in order to protect existing watershed beneficial uses identified by the SWRCB, and designated in specific regions by local regional boards. The Los Angeles Regional Water Quality Control Board has designated over 25 beneficial uses for the Los Angeles region, ranging from recreation and wildlife to resource extraction and hydropower (SWRCB 1994). Specific to the study area the following surface water beneficial uses have been designated for the mainstem and tributaries:

- Municipal (MUN) Water used for military, municipal, individual water systems, and may include drinking water.
- Recreation 1 (REC1) Uses of water body for recreational activities, where skin contact with water is probable, and the potential for ingestion of water is possible (swimming, wading, surfing, fishing, etc.).
- Recreation 2 (REC2) Recreational activities are near water body, but skin contact with water body is unlikely (picnicking, sunbathing, beachcombing, camping, hiking, sightseeing, etc.).
- Warm Freshwater Habitat (WARM) Uses that support warm water ecosystems for preservation or enhancement of aquatic habitats, vegetation, fish, wildlife, and aquatic invertebrates.
- Coldwater Habitat (COLD) Uses of water that support cold water ecosystems for the preservation and maintenance of aquatic habitat and wildlife species (flora and fauna).
- Wildlife Habitat (WILD) Uses of water that support terrestrial ecosystems.
- Wetland Habitat (WET) Uses of water that support wetland habitat.

The CWA requires the states to establish priority rankings for waters on the lists and to develop total maximum daily loads (TMDLs) for these waters. A TMDL specifies the maximum amount of a pollutant that a water body can receive and still meet water quality standards and allocates pollutant loadings among point and nonpoint pollutant sources. The USEPA must approve or disapprove lists and TMDLs. All three major tributaries converging with the River within the study area are water quality impaired. Water quality impairments within the study area tributaries include indicator bacteria, in-stream health (benthic macro-invertebrate indicators), metals (copper, lead, and selenium), cyanide, and trash.

The study area mainstem on the River is also listed as impaired for a number of pollutants: ammonia, copper, cyanide, indicator bacteria, lead, benthic macroinvertebrates, nutrients (algae), oil, selenium, and trash. Some of these constituents are of concern throughout the watershed. TMDLs in the River watershed, which includes upstream of and within the study area, have been developed and implemented for bacteria, metals, nutrients, and trash pollutants. Following is a summary of each TMDL.

The bacteria TMDL came into effect on March 23, 2012 due to high levels of bacteria not protective of beneficial uses. Bacteria levels are used to indicate the potential for human and non-human sources of pathogens and pollutants. The watershed, which includes all tributaries in the study area, upstream of the study area, and the southern study area from Figueroa downstream to First Street, is highly contaminated by bacteria (SWRCB 2010b). Bacteria impairments are not supportive of REC1 and REC2 uses, which include swimming, wading, fishing, picnicking, sunbathing, beachcombing, camping, hiking, and sightseeing.

In June 2005, the Regional Water Quality Control Board (RWQCB) adopted the TMDL for metals. Reaches of the River, which includes the entire study area and tributaries, are listed as impaired for copper, cadmium, lead, zinc, aluminum, and selenium. Numeric water quality targets are based on the numeric water criteria established by the California Toxics Rule (SWRCB 2005).

The current TMDL for trash was adopted by the RWQCB in September 2008 and is applicable for the study area and tributaries. Trash impairments are not protective of REC1, REC2, WARM, WILD, COLD, and WET beneficial uses (SWRCB 2007).

The nitrogen TMDL became effective on March 23, 2004 for the River main channel and tributaries due to impairments from nitrogen compounds and related effects, such as algae, pH, odor, and scum. These reaches were listed because water quality objectives for nitrogen compounds and related effects were exceeded, thereby impairing freshwater, wildlife habitats, and recreational uses. The principal source of nitrogen compounds is from Publicly Owned Treatment Works. Discharges from the Donald C. Tillman Water Reclamation Plant upstream of the study area, and the Los Angeles-Glendale and the Burbank

Water Reclamation Plants are contributors to the River, contributing 20, 15.5, and 6.4 million gallons per day, respectively, or 31, 24, and 10 cfs, respectively (City of Burbank 2013a). During dry weather periods, these major Publicly Owned Treatment Works contribute 84 percent of the total dry weather nitrogen load. Urban runoff, stormwater, and groundwater discharge also contribute to the nitrogen loadings (SWRCB 2003). Nitrogen impairments are not protective of aquatic life beneficial uses, which include WARM, COLD, and WET (SWRCB 1994).

In summary, the River is an effluent-dominated waterbody. Nearly 70 percent of the volume in the River is from Water Reclamation Plant tertiary-treated effluent discharged outside of storm events (Ackerman 2003). Although groundwater interactions exist (particularly in the Glendale Narrows and Arroyo Seco tributary), the majority of storm drain discharges are believed to arise from urban discharges.

3.4.4 Groundwater

The project area and tributaries sit above two major groundwater basins: the San Fernando Valley and the Coastal Plains of Los Angeles Central Groundwater Basins (see Groundwater Figure 3-8). Groundwater is a major component of the water supply in the Los Angeles metropolitan area and is also used by private industries, as well as a limited number of private agricultural and domestic users. Local groundwater provides about 15 percent of the total water supply and has provided nearly 30 percent of the total supply in drought years. Of this 15 percent, 86 percent comes from the Upper Los Angeles River Area (ULARA) and the Coastal Plains of Los Angeles Central Groundwater Basin. The remaining water for the city comes from the Los Angeles Aqueduct system and supplemental water purchased from the Metropolitan Water District of Southern California (City of Los Angeles 2005).

Groundwater in the study area is encountered at shallow depths form 15 to 30 feet along the upper banks of the river channel and at ground surface within locations of the channel. Additonal detail pertaining to groundwater in the study area can be found in Appendix D Geotechnical. A large portion of the River channel in the ARBOR reach has an unlined bottom because of close proximity of the groundwater to the surface. This section of the river has almost always been perennial because of this; that is why the Native Americans chose this area to settle. The treated effluent does not change the hydrologic condition from ephemeral to perennial in this section of the river. In fact, the current perennial condition may be more akin to historic conditions prior to extensive groundwater pumping. The proposed restoration features will also not change the perennial hydrologic flow conditions in the ARBOR reach, changes would only be in areas where concrete is removed and overbank is restored to river channel level.
The shallow groundwater currently supports riparian vegetation in several soft bottom reaches of the river. It is assumed based on observations of existing conditions that there is sufficient water to both support existing vegetation and restored areas within the river channel.

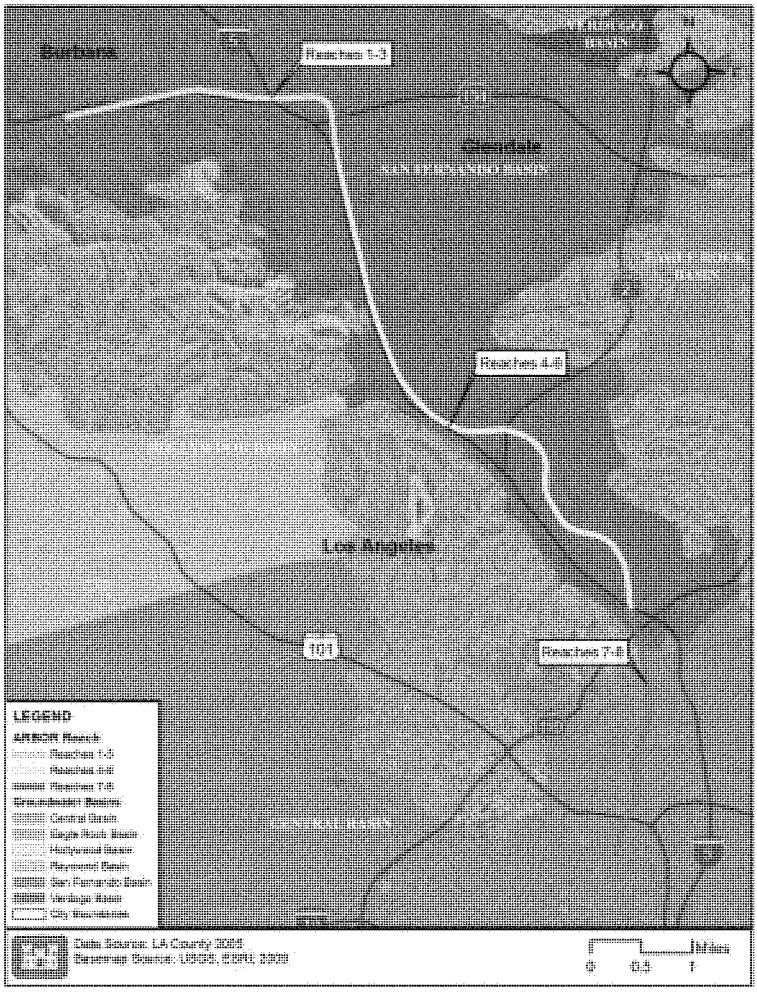


Figure 3-8 Groundwater Basins

San Fernando Valley Groundwater Basin

The San Fernando Valley Groundwater Basin is part of the ULARA, which also includes the Sylmar, Verdugo, and Eagle Rock Basins. The ULARA was adjudicated in 1968 after a court decision to grant water rights to the City of Los Angeles. It is under management by an administrative committee, which consists of representatives from the cities of Burbank, Glendale, San Fernando, Los Angeles, and the Crescenta Valley Water District, who oversee and advise the ULARA watermaster (ULARA 2013). The

primary job of the ULARA watermaster is to determine optimum water levels in the management area's groundwater basin.

The San Fernando Valley Groundwater Basin has a surface area of 145,000 acres, or 226 square miles, and includes water-bearing sediments beneath the San Fernando Valley, Tujunga Valley, Browns Canyon, and the alluvial areas surrounding the Verdugo Mountains near La Crescenta and Eagle Rock (DWR 4-12). As detailed in Section 4.1.1, surficial topographic features (mountains and hills) are abundant in this reach of the project (Reaches 1-6 and associated tributaries), and bound the San Fernando Valley. These same surficial topographic features extend underground, creating geologic boundaries that define the extent of the San Fernando Valley Groundwater Basin and sub-basins.

The storage capacity of the San Fernando Valley Groundwater Basin was calculated to be 3,670,000 acre-feet, which includes the total of the San Fernando, Sylmar, Verdugo, and Eagle Rock Basins. Groundwater levels have undergone a general decline during recent years due to an increase in urbanization (runoff leaving the basin before it can infiltrate), reduced artificial recharge, and continued heavy pumping (ULARA 2013). The San Fernando Valley Groundwater Basin is recharged by the spreading of imported water and runoff occurring in the Pacoima, Tujunga, and Hansen spreading grounds (ULARA 1999). Runoff includes natural mountain streamflow, precipitation, reclaimed wastewater, and industrial discharges (DWR 4-12).

Groundwater monitoring efforts in the San Fernando Valley Groundwater Basin, including responsible agencies, parameters, number of wells, and the frequency of measurements, are summarized in Table 3-7 (DWR 4-12). Water quality in public supply wells has also been used to characterize groundwater quality in the Central Basin. Table 3-8 displays constituent groups, number of wells sampled, and number of wells sampled in exceedance of water quality standards (DWR 4-12). The number of wells sampled represents the distinct number of wells sampled as required under the California Regulatory Compliance Title 22 program from 1994 through 2000. The program requires the monitoring of drinking supply wells to ensure compliance with drinking water standards for public health.

Accordingly, the Los Angeles Region Water Quality Control Plan has identified groundwater beneficial uses, which serve to establish protective use criteria common to both the San Fernando and Central Basins, including:

- Municipal and Domestic Supply (MUN) Water used for military, municipal, individual water systems, and may include drinking water.
- Industrial Process Supply (PROC) Uses of water for industrial activities that depend primarily on water quality.
- Industrial Service Supply (IND) Uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well re-pressurization.
- Agricultural Supply (AGR) Uses of water for farming, horticulture, or ranching including, but not limited to, irrigation, stock watering, or support of vegetation for range grazing.

Table 3-7 San Fernando Valley Groundwater Basin Monitoring Efforts

Agency	Parameter	Number of Samples and Frequency of Monitoring
ULARA	Groundwater Level and Water Quality	19 daily, monthly, and quarterly
EPA	Water Levels	1,379 daily, monthly, yearly, and quarterly
EPA	Water Quality	2,366 daily, monthly, yearly, and quarterly
Department of Health Services and Cooperators	Title 22 Water Quality	126 wells annually

Source: DWR 4-12

Table 3-8 San Fernando Valley Public Supply Wells Water Quality

Constituent Group	Wells Sampled	Wells Above Maximum Concentration Level
Inorganics, Primary	129	6
Radiological	122	13
Nitrates	129	44
Pesticides	134	3
Volatile organic compounds and semi-volatile organic compounds	134	90
Inorganics, Secondary	129	17

Source: DWR 4-12

It should be noted that each well confirmed with a concentration above Maximum Concentration Level (MCL) was confirmed with a second detection above MCL. This does not indicate the type of water quality that is delivered to the consumer, but the characteristics of contamination in the groundwater basin. Following is a detailed description of each water quality parameter.

- Inorganics Primary and Secondary Inorganics primarily include antimony, asbestos, barium, beryllium, mercury, chromium, cyanide, and thallium. Primary inorganics have a wide variety of health effects in humans and aquatic wildlife including kidney problems, cancer, nervous system disorders, and circulatory problems. Secondary inorganics include copper, aluminum, pH, chloride, color, fluoride, silver, zinc, and total dissolved solids. Secondary inorganics can cause poor taste in drinking water and cause teeth discoloration to consumers.
- Radiological constituents naturally occur at extremely low levels in groundwater basins and include radon, gross alpha, and uranium.
- Nitrates Though nitrates are classified as inorganic, they are one of California's leading contaminants, and are therefore addressed separately. High levels of nitrates can cause serious drinking water health risks to humans and can impair aquatic ecosystems. Natural levels of inorganic nitrogen are found in surface waters. However, the majority of nitrogen impairments originate from mismanaged agricultural land, where livestock are overcrowded or fertilizers are heavily applied. When nitrogen percolates its way down from the surface water to groundwater it becomes nitrate.
- Pesticides can have damaging effects on plants and aquatic life that were not originally targeted (RWQCB 1995).
- Volatile and Semi-volatile Organic Compounds VOCs are chemical compounds that vaporize at normal temperature and pressure, typical of the lighter fuels and gasoline. Semi-volatile organic compounds (SVOCs) are heavier hydrocarbon compounds/oil products, which are less mobile in the environment and tend to cling to soils. SVOCs and VOCs are introduced into the environment

by industrial activities, are carcinogenic and hazardous in drinking water, and detrimental to the health of aquatic organisms.

Specific VOCs and SVOCs include trichloroethylene (TCE) and perchloroethylene (PCE) (USEPA 2006). These contaminants are from numerous companies improperly disposing of chemicals. In spite of the presence of these contaminants, the LADWP performs the necessary actions to ensure that the city's drinking water meets or exceeds water quality standards. These actions include water quality monitoring of contaminant plumes, management of production well operations, operation of groundwater treatment facilities, and capital improvements (LADWP 2005).

The San Fernando Valley Superfund Site (SFVSS) (Areas 2 and 4) is near the Crystal Springs and Pollock Well Fields. The San Fernando Valley Superfund Site (SFVSS) (Areas 2 and 4) runs under the majority of the of study area, except most of Reaches 7-8, and is near the Crystal Springs and Pollock Well Fields. The Pollock and Crystal Springs Well Fields are part of the San Fernando Groundwater Basin. Groundwater is contaminated with various chlorinated VOCs, specifically TCE and PCE. Since the contamination was discovered, residents have been provided with alternate drinking water supplies, including imported water or groundwater mixed with imported water (USEPA 2006). This site is currently being remediated by the USEPA via a series of pumps and treatment wells that are strategically located along the plume. Treatment has been ongoing for approximately 10 years and has effectively stabilized much of the higher HTRW concentration; however, groundwater treatment is anticipated to be ongoing for approximately 50 years.

Coastal Plains of Los Angeles Central Groundwater Basin

The Coastal Plains of Los Angeles Central Groundwater Basin is one of four sub-basins found in the larger Coastal Plains of Los Angeles Groundwater Basin. The Central Basin has a surface area of 177,000 acres, or 277 square miles (DWR 4-11.04), only a small portion of which is located within the project area. As detailed in Section 4.1.1, Project Reaches 7-8 and associated tributaries are bound by the Elysian and Repetto Hills. The geology of these hills extends underground, creating impermeable boundaries that define the groundwater basin's extent within the project area.

The Central Basin was adjudicated in 1965 and the California Department of Water Resources (DWR) was appointed as the Watermaster, allowing DWR to regulate water rights in the sub-basin (DWR 4-11.04). Water levels in the basin have varied over a range of 25 feet from 1961 to 1977 and 5 to 10 feet since 1996. In 1999, water levels were shown to be in the upper range of historical trends. The total storage capacity of the Central Basin is 13,800,000 acre-feet (DWR 4-11.04).

The Central Basin is recharged through surface and subsurface flows by percolation of precipitation, stream flow, and groundwater recharge management activities (DWR 4-11.04). Natural replenishment of the groundwater basin is primarily from surface infiltration, and secondarily from underflow through the Whittier Narrows from the San Gabriel Valley. Artificial recharge activities, located at the Rio Hondo and San Gabriel spreading grounds, utilizes purchased imported water (DWR 4-11.04).

Groundwater monitoring efforts in the Central Basin, including responsible agencies, parameters, number of wells, and the frequency of measurements are summarized in Table 3-9 (DWR 4-11.04). Water quality in public supply wells has also been used to characterize groundwater quality in the Central Basin. Table 3-10 displays constituent groups, number of wells sampled, and number of wells sampled in exceedance of water quality standards (DWR 4-11.04). The number of wells sampled represents the distinct number of wells sampled as required under the California Regulatory Compliance Title 22 program from 1994 through 2000. The program requires the monitoring of drinking supply wells to ensure compliance with drinking water standards for public health.

Table 3-9 Central Groundwater Basin Monitoring Efforts

Agency	Parameter	Number and Frequency of Monitoring
U.S. Geological Survey	Groundwater Level	90 wells annually
California Department of Water Resources	Groundwater Level	87 wells annually
Los Angeles County Public Works	Groundwater Level	212 wells bi-monthly
U.S. Geological Survey	Miscellaneous Water Quality	64 wells annually
Department of Health Services and Cooperators	Title 22 Water Quality	294 wells annually

Source: DWR 4-11.04

Table 3-10 Central Groundwater Basin Public Supply Wells Water Quality

Constituent Group	Wells Sampled	Wells Above Maximum Concentration Level
Inorganics, Primary	316	15
Radiological	315	1
Nitrates	315	2
Pesticides	322	0
Volatile organic compounds and semi-volatile organic compounds	344	43
Inorganics, Secondary	316	113

Source: DWR 4-11.04

As seen in Table 3-10, all constituent groups listed excluding the pesticides group were in exceedance of the MCL at least once. It should be noted that each well confirmed with a concentration above MCL was confirmed with a second detection above MCL. This does not indicate the quality of water that is delivered to the consumer, but the characteristics of contamination in the groundwater basin. Several sites along the study area may also contain localized groundwater contamination as discussed in the HTRW Survey Report (Appendix K). A detailed description of each parameter can be found under the San Fernando Valley Groundwater Basin discussion in this section.

3.4.5 Water Budget

A water budget was prepared for this project and is described in Appendix E, Hydrology and Hydraulics, Section 10. That water budget characterizes the current conditions along the ARBOR reach of the Los Angeles River and provides comparison to each of the alternatives. It is a systematic presentation of the data and use of water for specific periods of time. The pertinent factors presented in the guidance are included and both an annual and a seasonal period were analyzed.

The water budget was calculated by determining the volume of water available from the sources and comparing to the water demands. The water sources include surface water and precipitation. The water demands include infiltration, evaporation, and evapotranspiration. Groundwater, although very important, was not included at this time so a conservative estimate of the water sources and demands could be assessed. As detailed in the appendix the water sources are estimated to provide 211,000 acre feet/year annually. This includes from both streamflow and rainfall runoff.

3.5 BIOLOGICAL RESOURCES

Biological resources within the proposed study footprint are limited due to channelization and intense development along the River and its tributaries. The River is mostly confined to a concrete-lined channel surrounded by urbanized areas and much of it is virtually devoid of any natural vegetation. Exceptions include Reaches 4-6 in the study area, roughly from Brazil Street to the Glendale Freeway. Few areas exist where transportation, commercial, recreational, or residential development has not completely filled the adjacent areas that were once the riparian zone and floodplain. Therefore, riparian and aquatic habitat for fish and wildlife is extremely degraded and often non-existent.

3.5.1 Vegetation

The River corridor is located in a Mediterranean climate region, which is characterized by hot, dry summers and mild, wet winters. This climate is found only in 5 locations around the world, one of which is California. The limited extent of the Mediterranean climate region (2 percent of the Earth's land surface) and its isolation provide for a high biodiversity and high endemism of uniquely adapted plant species.

A recent review of baseline habitat was conducted to determine habitat benefits based on the Combined Habitat Assessment Protocol (USACE 2012b). This study provides the most up-to-date inventory of vegetation conditions in the River corridor. Details regarding classification of community types and acreages can be found in the CHAP report (Appendix G), and a summary description of each appears below. Habitat types include eucalyptus, open water/riverine, pasture agricultural, perennial grassland, valley foothill riparian, and urban (high density and low density). Structural conditions included: grass-forb, shrub, and tree layers along with constrained river channel and urban with various levels of impervious surfaces.

Valley Foothill Riparian Dominant species include cottonwood, western sycamore, and willows. Forest understory may consist of shrubby willows and mule fat with herbaceous species including sedges, rushes, and mugwort. Scrub habitat has less vertical structure, with shorter willows dominant. These communities occur on sub-irrigated and frequently overflowed lands along rivers and streams. This is considered a very valuable habitat type as it provides habitat for a wide variety of species, including threatened and endangered species.

Eucalyptus Several species of eucalyptus including blue gum, red gum, and silver gum are established in dense, pure stands and are typically adjacent to urban areas and non-native grasses. Eucalyptus is a non-native species that was introduced for ornamental purposes and to provide wood for rail construction.

Pasture Agricultural Characterized primarily by Bermuda grass.

Perennial Grassland Dominant species include introduced annual grasses such as wild oats, bromes, and fescues. Non-native forbs including filarce and clovers may be present. Native species may also be present.

Open Water Intermittent or continually running water distinguishes river and stream communities. In the higher velocity stretches of natural streams, riffle/pool complexes are dominant and vegetation includes water moss and filamentous algae that are attached to rocks. In slower moving waters, with increasing temperatures, decreasing velocities, and accumulating bed sediment, emergent freshwater marsh vegetation, such as rushes, sedges, and cattails, is established along river banks (Mayer and Laudenslayer 1988).

Urban This category includes landscapes dominated by urban structures, residential units, industrial areas, highways, and other such structures. Park areas may include alternately categorized vegetation such as ornamental or hardwood mixture.

Low Density Urban This is composed of urban uses such as parks, recreational fields, golf courses, and other such urban open space areas.

Vegetation within the River channel can inhibit the channel's capacity to convey floodwaters. The channel is designed to be maintained free of vegetation to avoid impacts to flood conveyance and channel structures. However, lack of funds for maintenance has resulted in substantial vegetation growing within the channel. Due to limited funds available to maintain vegetation in the channel, USACE has focused on removing non-native vegetation using both herbicide and mechanical means. Non-native plants often out-compete natives, degrading the ecological vitality and productivity of native habitats. The most prevalent non-native and invasive plant is giant reed (*Arundo donax*). It spreads quickly, has little habitat value, and contributes to fire hazards through fuel loading. Other invasive species targeted by removal efforts include tree of heaven (*Ailanthus altissima*), Mexican fan palm (*Washingtonia robusta*), castor bean (*Ricinus communis*) and eucalyptus (*Eucalyptus* spp.) (California Coastal Conservancy 2002).

Vegetation community types present in Reaches 1-3 include pasture, perennial grasses (invasives), eucalyptus, and valley foothill riparian (Figure 3-9). Riparian communities are narrow and disturbed throughout these reaches and occupy only small and disconnected areas. Several small patches of riparian habitat are located within the River channel and are subject to occasional mechanical removal by the USACE, with most recent efforts focused on non-native removal. The vast majority of the study area uplands in these upper reaches are composed of urban or residential landscaped vegetation. A sizeable patch of pasture agricultural habitat is present at Pollywog Park in Reach 1. Much of this land is ruderal or weedy. Staging areas between Forest Lawn Drive and Zoo Drive are bordered by perennial invasive grasses. The eucalyptus community stretches along Zoo Drive near Ferraro Fields (Reach 3).

Vegetation becomes established in the River channel where sediment tends to accumulate. As gravel, mud, and debris become trapped in the channel bed, vegetation can become rooted and contribute to additional gravel, mud, and debris collection. This process can result in sizeable areas of vegetation establishment, including native and non-native grasses, trees, and shrubs within the non-concrete (or "soft river bottom") channel bed in Reach 2. In Reaches 1 and 3, where concrete bed exists, minimal accumulation of sediment occurs and supports hummocks of herbaceous vegetation, which are typically washed out during high flows. Vegetation growth at Verdugo Wash has become a concern for inhibiting water flow and all vegetation is periodically mechanically removed in Reach 3.

Habitat value of these vegetation communities is degraded due to disturbance, small size, continuous noise of the adjacent highways, and presence of humans. Riparian vegetation does provide a visual buffer between highways and the River, as well as small islands of habitat within the open water area. However, overall, vegetation is limited and degraded in these reaches.

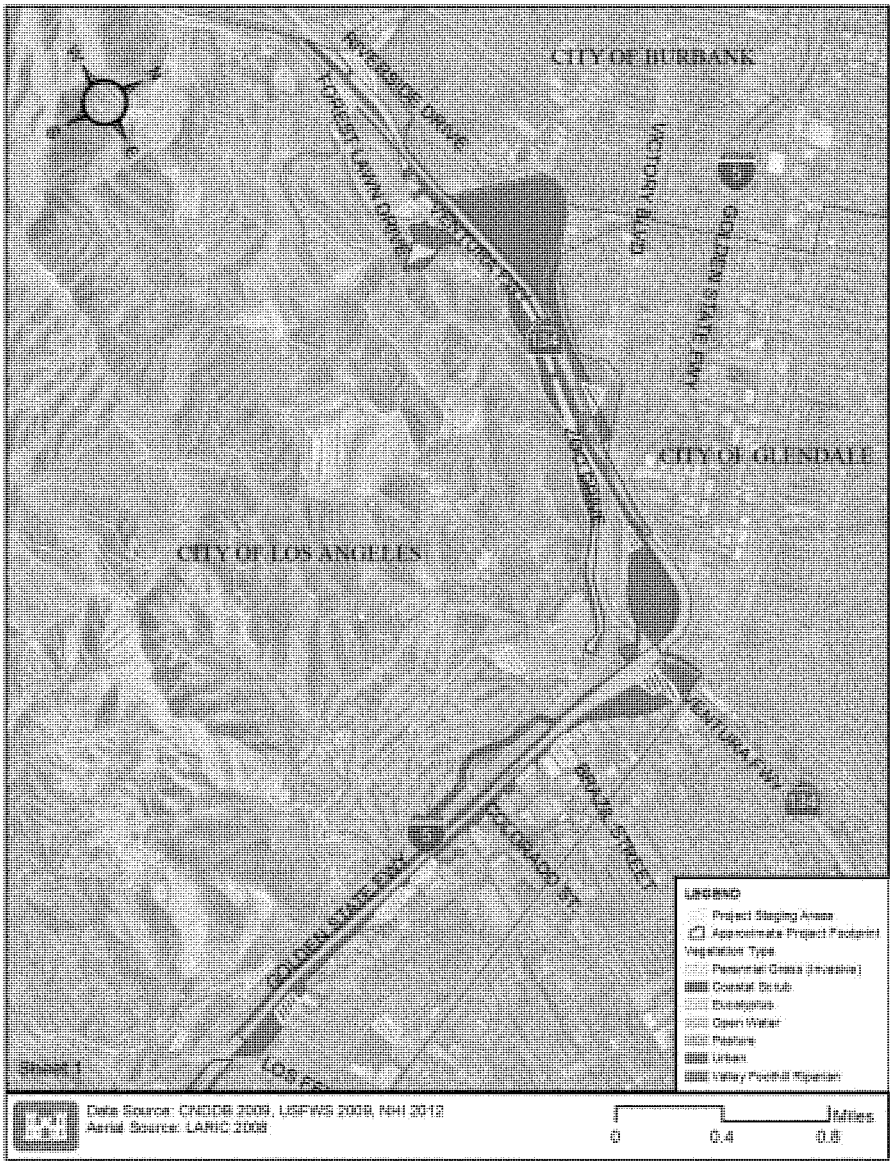
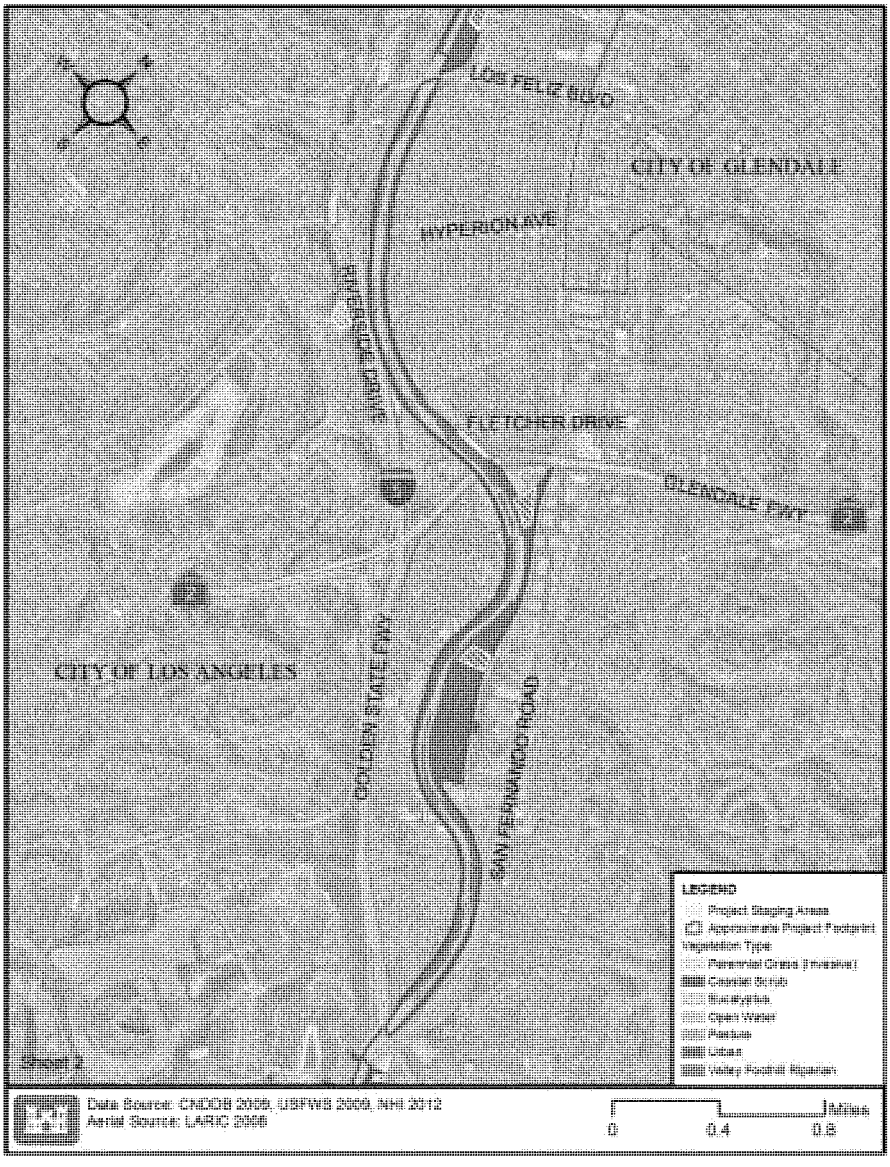


Figure 3-9 Biological Resources, Reaches 1-3

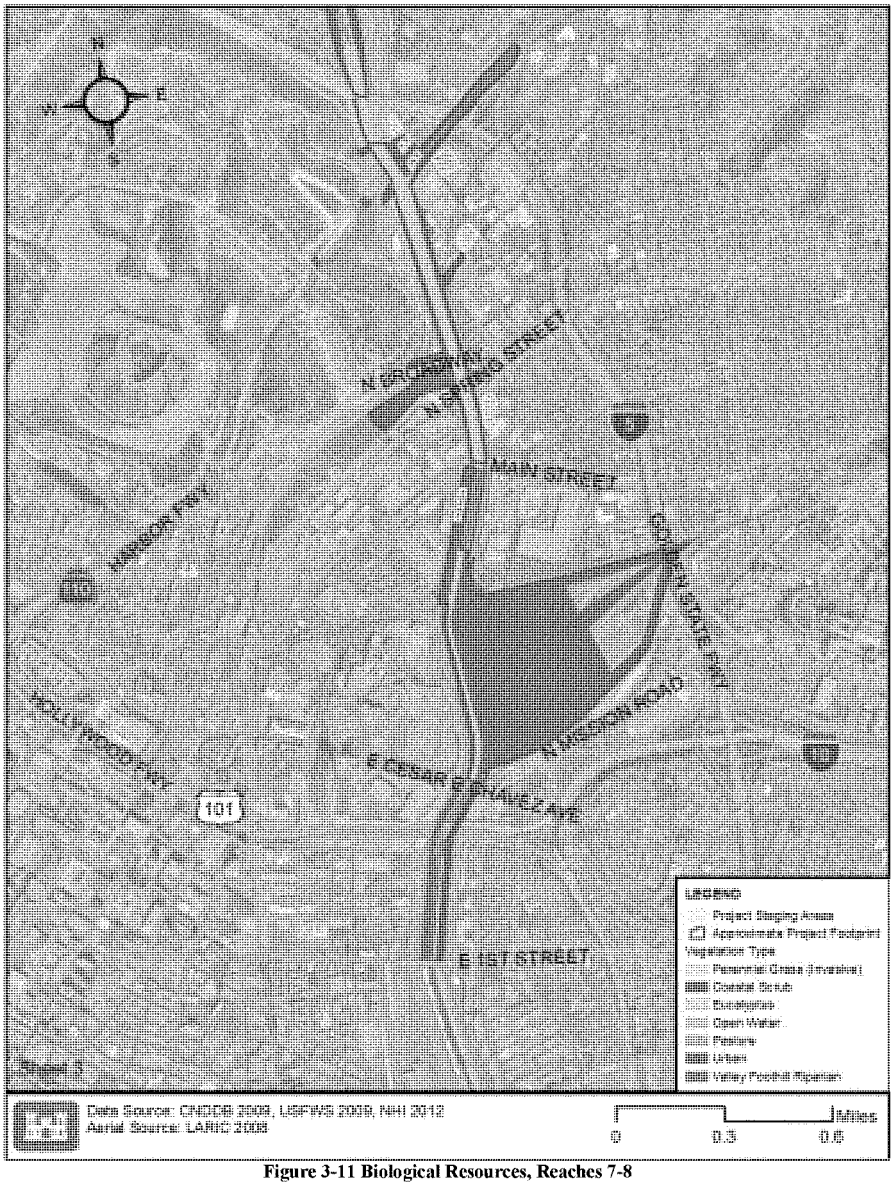
Habitat types present in Reaches 4-6 includes valley foothill riparian, urban, and open water (Figure 3-10). This reach is unique in that the bed of the channel is natural. Just downstream of SR-134, roughly parallel with Brazil Street in Glendale, the entirely concrete channel transitions to a soft bed channel with concrete trapezoidal walls. Because of this natural bottom, plants become more readily established. As a result, vegetation occupies much of the channel in these reaches, forming a nearly continuous strip of riparian habitat composed of native and non-native grasses, shrubs, and trees. In contrast to most of the upper reaches, vegetation that grows beneath the overpasses has been removed. In particular, extended bridge piers beneath Hyperion and Los Feliz Boulevards require vegetation removal to allow adequate flow conveyance. Riparian communities continue south throughout the reaches and stop just upstream of the I-5 overpass, where the channel bed becomes concrete once again.

Herbaceous and woody species in these unlined reaches consist of low elevation mats and large islands of southern willow scrub vegetation. Some of these vegetated areas are so overgrown that physical access to and through them is quite restricted. Dominant species include: black willow (*Salix gooddingii*), Fremont cottonwood (*Populus fremontii*), and arroyo willow (*Salix laevigata*). Emergent marsh is dominated by cattail and bulrush. Exotic species include giant reed and non-native species of ash (*Fraxinus* spp.). While scouring during high floods has at times cleared some of the understory vegetation in these reaches, well-rooted willows have persisted.

No other vegetation community types have been identified in these reaches (USACE 2012b).
The River in Reaches 7-8 is virtually devoid of vegetation within the channel, and has extremely limited community types outside the channel within the study area and its staging locations (Figure 3-11). A small area of riparian habitat occurs along the top of the left bank of the Arroyo Seco channel, but no instream vegetation occurs. Any vegetation within the main River channel is composed of weedy species that have become rooted in the cracks of the channel walls or hummocks of vegetation that grow on the minimal accumulated sediment and wash out with high flows. Outside the channel, a small patch of coastal scrub habitat occurs just north of Broadway Street on the west side of the channel. This community is part of the relatively undeveloped hills near the neighborhood of Solano Canyon. Urban land uses dominate the overbanks of the downstream reaches and any vegetation is ruderal or ornamental.



1 **Figure 3-10 Biological Resources, Reaches 4-6**



1 **Figure 3-11 Biological Resources, Reaches 7-8**

3.5.2 Wildlife

Because of the study area's scarce vegetation, minimal connection to other habitat areas, and extremely limited riparian communities, wildlife species that are the most tolerant of human activity and the extremely modified landscapes inhabit the study area. Common mammals include opossum (*Didelphis virginiana*), black rat (*Rattus rattus*), raccoon (*Procyon lotor)*, California ground squirrel (*Spermophilus beecheyi*), fox squirrel (*Sciurus niger*), striped skunk (*Mephitis mephitis*), coyotes (*Canis latrans*), and several species of bats (CDFW 1993).

Though abundance of native bird species is limited by habitat quantity and quality along the River, diversity of native birds in the study area fluctuates with seasonal migration and can be relatively high. Resident birds use the existing small and intermittent pockets of vegetation along the waterway to nest, roost, as a base for feeding, and to take cover. Birds commonly found along the River corridor include American robin (*Turdus migratorius*), red-winged black bird (*Agelaius phoeniceus*), house sparrow (*Passer domesticus*), killdeer (*Charadrius vociferous*), mallard (*Anas platyrhynchos*), northern mockingbird (*Mimus polyglottos*), common yellowthroat (*Geothlypis trichas*), swallows (e.g., *Hirundo* spp. and *Petrochelidon* spp.), and yellow warbler (*Dendroica petechia*) (Bureau of Reclamation 2004). In addition, bird species commonly seen in the city are also found within the study area including: rock dove (*Columba livia*), mourning dove (*Zenaida macroura*), American crow (*Corvus brachyrhynchos*), European starling (*Sturnus vulgaris*), and house finch (*Carpodacus mexicanus*). Migratory species include shorebirds, wading birds, and ducks of the Pacific Flyway. These species are primarily found roosting or feeding. The least Bell's vireo has been observed within the study area near Taylor Yard (USACE 2009).

Herpetofauna in the Los Angeles Watershed consists of a variety of amphibians and reptiles. Four salamanders that may occur within the study footprint include Pacific slender salamander (*Batrachoseps pacificus*), arboreal salamander (*Aneides lugubris*), ensatina (*Ensatinae schscholtzii*), and black-bellied slender salamander (*Batrachoseps nigriventris*). Three frogs may occur in the study area including western toad (*Bufo boreas*), Pacific tree frog (*Hyla regilla*), and bullfrog (*Rana catesbeiana*). Six lizards potentially occur within the study area including: California legless lizard (*Anniella stebinsii*), western whiptail (*Cnemidophorus tigris*), western skink (*Eumeces skiltonianus*), southern alligator lizard (*Gerrhonotus multicarinatus*), western fence lizard (*Sceloporus occidentalis*), and side-blotched lizard (*Uta stansburiana*). Finally, six snakes are considered to occur within the study area including western rattlesnake (*Crotalus viridis*), ringneck snake (*Diadophis punctatus*), common kingsnake (*Lampropeltis getulus*), California whipsnake (*Masticophis lateralis*), gopher snake (*Pituophis melanoleucus*), and two-striped garter snake (*Thamnophis hammondii*) (CDFW 1993).

3.5.3 Fish

Seven species of fish historically occurred in the freshwaters of the River including the now endangered species of southern California Distinct Population Segment of steelhead (*Oncorhynchus mykiss*) and unarmored threespine stickleback (*Gasterosteusaculeatus williamsoni*), the now threatened species of Santa Ana sucker (*Catostomus santaanae*) and arroyo chub (*Gila orcuttii*) in its native habitat, the species of concern Pacific lamprey (*Lampetra tridentata*), and the non-listed species Pacific brook lamprey (*Lampetra pacifica*) and Santa Ana speckled dace (*Rhinichthys osculus*) (CDFW 1993; FoLAR 2008).

The City of Los Angeles conducted a fish survey of the River in September 2004 (LADWP 2004) with a 1-day field survey at Balboa Boulevard (upstream of study site), Los Feliz Boulevard (Reach 4), and near SR-2 (Reach 2). Six non-native species were collected, including mosquitofish (*Gambusia affinis*), green sunfish (*Lepomis cyanellus*), bluegill (*Lepomis macrochirus*), black bullhead (*Ameiurus melas*), fathead minnow (*Pimephales promelas*), and tilapia (*Oreochromis* spp.). Mosquitofish and green sunfish were the most prevalent species captured. No native fishes were collected. The timing of the survey was ideal to

determine the presence or absence of native species such as Santa Ana sucker, arroyo chub, and speckled dace; none were collected. It is unlikely that species such as steelhead, lamprey, or stickleback exist. The report's authors also concluded that it is unlikely any endangered species or species of special concern inhabit the areas sampled (LADWP 2004).

In the late summer and fall of 2007, the Friends of the Los Angeles River conducted a fish study in the Glendale Narrows (Reaches 4-6), at four sites and on four occasions both before and after significant rainfall events. This study collected eight non-native fish species including fathead minnow, carp (*Cyprinus carpio*), black bullhead, Amazon sailfin catfish (*Pteroplichthys pardalis*), green sunfish, mosquito fish, tilapia, and largemouth bass (*Micropterus salmoides*). A total of 1,214 individuals were collected, with mosquitofish and tilapia being the most abundant (FoLAR 2008). No native fish were collected.

3.5.4 Special Status Species

The greater Los Angeles Basin includes portions of the Angeles National Forest, the Santa Monica Mountains, and coastal areas where a number of sensitive plants and animals may occur. Sensitive species include plants or wildlife listed as threatened or endangered under the Federal Endangered Species Act (ESA) or as threatened, endangered, fully protected, or a species of concern under the state Endangered Species Act (CESA). Special status species also include plant species designated by the California Native Plant Society (CNPS) as presumed extinct in California (List 1A); plants designated as rare, threatened, or endangered in California and elsewhere (List 1B); and plants designated as being rare, threatened, or endangered in California but more common elsewhere (List 2).

The complete list of species that may occur in the study area was compiled by reviewing Federal, state, and other databases and comparing the habitat requirements of the species found in these lists to the types of habitat that occur in riparian areas of southern California waterways. These databases include the California Natural Diversity Database (CNDDB), which reports verifiable occurrences of sensitive species by USGS topographic quadrant (CNDDB 2012); U.S. Fish and Wildlife and California Department of Fish and Wildlife sensitive species lists for Los Angeles County (USFWS 2012a, and CDFW, 2012, respectively); and sensitive plant species lists developed by the California Native Plant Society (CNPS 2012). From this initial list, those species that could occur in habitats that were identified in the CHAP appendix (Appendix G) were considered in greater detail. Species for which suitable habitat occurs in the study area are discussed in the following paragraphs. All others were identified as "not likely to occur" and are listed in Appendix H.

Although several special status plant species have historically occurred in the study area or environs (24 total), none of these species are expected to occur within the project footprint. Habitat conditions needed for listed plant species to grow are either not available or are in degraded condition and not suitable. Special status plant species that have historically occurred in the project area are reported, along with their preferred habitat types, in Appendix H.

There are a total of 28 special status wildlife species with the potential to occur in the greater Los Angeles Basin (Appendix H). However, of these special status species, only least Bell's vireo (*Vireo bellii pusillus*)(federally endangered, State endangered) has been sighted within the project area in recent years. There is low potential for the southwestern willow flycatcher (*Empidonax traillii extimus*)(federally endangered, State endangered) and the coastal California gnatcatcher (*Polioptila californica*)(federally threatened) to use the study area. In general, the study area is unlikely to contain Federal or state listed endangered or threatened species or species of concern due to the degraded conditions.

Protocol level surveys for least Bell's vireo, southwestern willow flycatcher, and California gnatcatcher were completed during the 2005 and 2007 bird-breeding season at USACE-managed areas within Los Angeles County. Least Bell's vireo were documented in the vicinity at Hansen Reservoir and Santa Fe Reservoir, and in the lower Sepulveda Reservoir/Los Angeles River above and downstream of Burbank Boulevard. Within the study area, vireo were reported in Reach 6 near the Taylor Yard area. In 2009, no least Bell's vireo were detected (USACE, 2009). An incidental observation of an unpaired male vireo near Taylor Yard was documented in April 2013 during a one-day nesting bird survey of the area. However, a similar one-day nesting survey of the area in May 2013 did not detect vireo (Cooper 2013a, 2013b).

Within the study area, marginal habitat for least Bell's vireo exists. The only riparian vegetation exists in Reach 2 and in the Glendale Narrows Reaches 4, 5, and 6. This vegetation is linear and confined, lacks suitable adjacent foraging habitat, and is unlikely to support nesting. No breeding pairs were documented in the study area during the most recent protocol surveys, and were not detected during 2013 observations.

No flycatchers or gnatcatchers were found during these studies, and the most recent documented occurrence of the southwestern willow flycatcher was over 13 miles west of the project area in the Angeles National Forest. The gnatcatcher, which generally occupies coastal scrub habitat, is unlikely to occur since there is less than 1 acre of this habitat type in the corridor.

3.5.5 Waters of the United States/Waters of the State

The study area encompasses waters of the United States as defined under the Clean Water Act: the Arroyo Seco, Los Angeles River, and Verdugo Wash. These jurisdictional areas also include wetlands and other special aquatic sites. The discharge of dredged or fill materials into waters of the United States is regulated pursuant to Section 404 of the Clean Water Act. Preliminary findings of compliance with Section 404 has been documented in the draft Section 404(b)(1) analysis included with this Final IFR. A final Section 404(b)(1) evaluation will be included with the Record of Decision for this project.

The Los Angeles River has been identified as a traditionally navigable waterway (TNW), a term established by the Supreme Court in its Rapanos decision. The Los Angeles River has been protected by the CWA as a water of the United States since its passage in 1972. In 2008, in light of the Rapanos decision, the Corps further determined that two reaches of the river, within the Sepulveda Basin and the tidally influenced portion of the river, were TNWs. On August 17, 2008, EPA invoked procedures established in a memorandum of agreement between the agencies, designating the Los Angeles River as a "special case" to allow EPA to make the final determination of its jurisdictional status. On December 3, 2008, the EPA affirmed that available evidence supported the Corps' TNW determinations for the two study reaches. In 2010, EPA determined that the entire mainstem, including the study area, constitutes a TNW. None of the TNW determinations changed the applicability of the CWA to the Los Angeles River, because the Los Angeles River, as a tributary of the Pacific Ocean, would also meet the Rapanos plurality test or the Kennedy test. The importance of a TNW determination for the CWA is generally in its relation to its tributaries.

No wetland delineation has been completed to date to identify jurisdictional wetlands. For planning purposes, CHAP and National Wetland Inventory information was consulted. Riverine wetlands were the only wetland type found during the habitat assessments conducted for the CHAP. Additional wetland data were reviewed using the USFWS National Wetland Inventory (NWI) maps. Although NWI maps are not definitive with regard to the presence or absence of wetlands, they are useful as an initial planning tool. NWI mapping shows the presence of six different types of wetlands within the study area. These wetlands occur within the River channel only and include R2UBH (lower perennial riverine), PSSC (palustrine scrub-shrub, seasonally flooded), PSSF (palustrine scrub-shrub, semi-permanently flooded), PSS/EMC

(palustrine shrub/emergent), PFOC (palustrine forested, seasonally flooded), and PEMC (palustrine emergent, seasonally flooded) (USFWS 2012b).

Aerial mapping backdrops to NWI data indicate that emergent, shrub, and forested communities within the River channel have already migrated and are no longer in the locations shown on the wetland mapper. As a result, wetlands have not been shown in habitat mapping for this report. Existing in-channel vegetation was most recently mapped in the CHAP process and shown in Figures 3-8 to 3-10. Overall, wetlands within the study area are assumed to be only within the Los Angeles River channel. These areas are under the jurisdiction of the USACE and subject to modification for operation and maintenance of the flood risk management channel. There are no other special aquatic sites in the study area as defined under the CWA.

Waters of the State of California are defined more broadly than waters of the United States, and include all waters of the United States, and all surface waters that are not waters of the United States such as non-jurisdictional wetlands, groundwater, and territorial seas. In this instance, waters of the state include the portions of the bank above the ordinary high water mark (below which is found waters of the United States) and overbank riparian areas that may be dependent on moisture found in the bank to bank area. Waters of the State are found throughout the top-of-bank to top-of-bank portion of the study area.

3.5.6 Significant Ecological Areas

The City of Los Angeles, through its General Plan, established Significant Ecological Areas that include a wide variety of ecological communities (City of Los Angeles 1995). Within the study area, the expansive Griffith Park is the only Significant Ecological Area. This park, located at the east end of the Santa Monica Mountains along Reaches 1-4, supports coastal scrub, chaparral, riparian, and oak woodland habitats. The area also includes the Hollywood Reservoir. Griffith Park is considered an important habitat island for migrating birds, as well as a reservoir for native species. Though the highly urbanized cities of Burbank and Glendale separate Griffith Park from the Verdugo Mountains, Griffith Park is an important extension of the Santa Monica Mountains and offers the nearest natural habitats to the Verdugo Mountains, which are adjacent to the much larger expanse of native habitats in the San Gabriel Mountains. Birds and larger mammals in particular utilize this area as a corridor. The Department of Recreation and Parks manages a portion of Griffith Park as a bird sanctuary.

3.5.7 Wildlife Corridors

A wildlife corridor is a strip of habitat that connects two otherwise separated larger habitat areas (Santa Monica Mountains Conservancy 1990). Connecting isolated habitats helps to reduce population isolation, increases the species' range, and allows for greater survival of the population. The combination of the River channel with adjacent highways and development has effectively blocked much of the wildlife movement that would have historically occurred between the Santa Monica Mountains to the west and Verdugo Mountains and San Gabriel Mountains to the east. Additional development further blocks wildlife passage between the Verdugo Mountains and the much larger Angeles National Forest.

Due to the urbanized environment, wildlife movement through and beyond the study area is limited to urban adapted species and opportunities for passage are disconnected. Bats and birds are less restricted by development, though human occupation may discourage passage through the study area. Ground dwelling animals that occur in the study area are migrating into the project area via the extremely limited pathways available. These pathways can be composed of narrow riparian strips, but more often are provided by culverts, paved pathways along the River, and concrete tunnels beneath highways. Despite the man-made nature of these pathways, wildlife are known to utilize them. A study in the Simi Valley found that tunnels, equipment passages, corrugated culverts, paved roadways, and pathways were utilized by skunks,

opossum, raccoons, grey fox, coyote, mule deer, mountain lions, and bobcats (LSA 2004). Movement in the study area is currently being studied by USGS. Some wildlife, including coyotes, are known to use equestrian tunnels under the freeways. However, movement is most limited by human presence and development. Portions of the river that are unvegetated with a concrete bottom also limit movement through the river channel.

Existing equestrian tunnels near Griffith Park in Reaches 1, 2, and 4 are expected to support regional movement of wildlife to and from the project area to this portion of the Santa Monica Mountains. Recent studies using wildlife cameras indicate these tunnels have been used by coyote and deer, with one bobcat sighting. The tunnels are primarily used at night, when human presence is decreased. Other species that could use the tunnels, if presence of appropriate habitat were available surrounding them, include raccoons, skunks, and gray foxes. While these species are known in the vicinity of the project area, they were not specifically documented using the tunnels during the studies. Use of these tunnels to move to and from the study area provides regional connectivity for wildlife with Griffith Park and the Santa Monica Mountains. On-going restoration plans at the Headworks site (Corps/City of LA DWP) adjacent to Reach 1, as well as the outlet of Sennet Creek (FoLAR/North East Trees) upstream of Reach 1, will contribute to connectivity between Griffith Park and the LA River study area. Access to the LA River from these sites is available through the existing equestrian tunnel downstream of the Headworks site.

3.6 CULTURAL RESOURCES

This section is an overview of cultural resources that may be present within the study area. Cultural resources are artifacts of human activity, occupation, or use. They include expressions of human culture and history in the physical environment, such as archaeological sites, historic buildings and structures, or other culturally significant places.

Archaeological resources refer to surface or buried material remains, buried structures, or other items used or modified by people. Prehistoric archaeological resources predate European presence in Los Angeles, and can include villages or campsites, food remains, basketry fragments, shell and stone tools and tool-making debris. Ethnohistoric or protohistoric archaeological resources are those that can be attributed to native cultures, but include evidence of European contact, such as trade beads in a site that otherwise appears to be prehistoric. Historic archaeological sites are those deposits that post-date European contact.

Historic building and structures generally must be over 50 years old and are typically identified through archival and library research, followed by field reconnaissance and recordation. Historic buildings and structures are architecturally, historically, or artistically important individual and groups of residential, commercial, industrial, and transportation properties.

Traditional cultural properties (TCP's) are places associated with the cultural practices or beliefs of a living community. The significance of these places is derived from the role the property plays in a community's cultural identity, as defined by its beliefs, practices, history, and social institutions. Examples include natural landscape features, plant gathering places, sacred sites, and Native American burial locations. They can also include urban neighborhoods whose structures, objects, and spaces reflect the historically rooted values of a traditional social group.

3.6.1 Cultural Resource Identification

USACE consulted with the State Historic Preservation Officer (SHPO) staff by telephone in June of 2013 on the reasonable level of effort for cultural resource identification during the feasibility study. The SHPO agreed to the use of existing information from the records and literature search, and acknowledged that

further compliance actions under Section 106 of the National Historic Preservation Act (NHPA) could occur in the next phase of the project, under terms laid out in a Programmatic Agreement (PA) (Dibble 2013). Project-specific PAs are often recommended when the preferred alternative is complex, will consist of multiple undertakings or when the alternatives under consideration consist of corridors or large land areas where access to properties is restricted. More information on the NHPA Section 106 process and PA are provided in Chapter 5.6.

Consequently, the USACE, in consultation with the SHPO, the City of Los Angeles, the California Department of Parks and Recreation and affected tribal organizations have developed a PA in accordance with 36 C.F.R. § 800.14, to fulfill their obligations under Section 106 of the NHPA (Appendix O). Prior to study implementation or construction, the PA establishes additional cultural resource identification efforts to be conducted, which are appropriate to the proposed measures at each location. Identification efforts would include additional archaeological and historical surveys, test excavations, trenching, archival research, and construction monitoring for unanticipated discovery.

In order to compare alternatives and identify potential impacts to cultural resources, the USACE has established the likely presence of historic properties within the Area of Potential Effects (APE) through background research, visual inspections of the APE, and tribal consultation. Specific identification efforts for this undertaking are discussed below. The APE identified by the USACE includes the proposed project footprint and physical disturbance areas for river channel and bank alterations, storm drain outlet conversions to natural stream confluences, creation of freshwater marshes, diversions of river flow into side channels, riparian planting, invasive species management, re-vegetation, construction of elevated railroad trestles, and all potential temporary construction staging areas. The APE takes into account a reasonable and good faith effort to capture the potential for visual, auditory, and other non-direct effects. Ground disturbance will occur mostly in areas that were previously disturbed by construction of the concrete-lined flood control project. There are, in fact, virtually no undisturbed ground surfaces in this highly urbanized environment for the entire reach of the project. Some undisturbed and intact subsurface deposits may, however, still be present in and in association with old river terraces. The vertical APE varies from a few inches to several feet; or to the maximum height of constructed features eligible to the NRHP, such as bridges. Horizontally, the APE includes a 1/8-mile (660-foot) buffer around each depicted feature for noise and visual impacts. On September 5, 2014, the USACE consulted with the SHPO on the appropriateness of the APE. By letter dated October 3, 2014, the SHPO did not object to the defined APE.

The record search and literature review conducted by Tetra Tech Inc. for the Los Angeles River Revitalization Master Plan EIS/EIR provided the basic overview information for this IFR (City of Los Angeles 2007). An updated cultural resource records and literature search was conducted by staff of the South Central Coastal Information Center at California State University, Fullerton, in August 2012, focusing on footprints and disturbance areas specific to the feasibility study and the River corridor, with an added 50-meter (164-foot) buffer. The South Central Coastal Information Center is the regional repository for the California Historical Resources Information System. The record search there included archaeological site records and reports, California Points of Historical Interest, California Historical Landmarks (CHL), the California Register of Historical Resources (CRHR), the National Register of Historic Places (NRHP), the California Historical Resources Inventory, the City of Los Angeles Historic-Cultural Monuments (LAHCM), and the Caltrans Historic Bridge Inventory. The record search only includes the results of previous archaeological or historical surveys and other investigations. Most of the parcels in the APE have not been fully inventoried, and further identification methods would need to be tailored to the specific locations. No new fieldwork to identify historic properties was conducted to support the feasibility study, such that unrecorded and buried cultural resources may be present. Many Los Angeles River containment and flood risk management facilities, moreover, are now of historic age and may be eligible for listing on the NHRP and CRHS, including structures making up the LACDA

corpus of flood risk management facilities. They have not been formally documented as such however, or evaluated for inclusion on the NRHP or the CRHR.

The USACE contacted the California Native America Heritage Commission (NAHC) for a search of the Sacred Lands Inventory file to determine if there is any record of sensitive sites or TCPs in the APE, and to obtain the most current list of Native American contacts for consultation. The NAHC responded that there were Native American cultural resources present, and provided a list of tribal contacts for the USACE to consult on these resources. The USACE contacted these tribal representatives by letter in September of 2012 (Appendix O), and requested information about TCPs and resources of concern within the APE. To date no responses have been received by the USACE. The USACE will continue efforts to inform and consult with tribal representatives on any cultural concerns they may have. A copy of the draft Integrated Feasiblity Report and EIS, with the PA, was provided to the tribal contacts for their review in December 2014. No responses or other comments have been received by the USACE.

3.6.2 Cultural Resource Setting

Archaeologists have placed the earliest occupations of southern California at roughly 12,000 to 10,000 years before present (BP), based primarily on data from coastal and desert sites around Holocene or recent era marshes, lakes, and streams. As in all arid and semiarid lands, water sources and river systems are centers for settlement and food procurement. Prior to channelization, wetlands and marshes were associated with the changing course of the free-flowing Los Angeles River. Soils in the floodplain were periodically enriched by sediment deposition, and an abundant variety of plant and game resources were available to native populations. At the time of contact, the Spanish encountered native populations organized in villages with social elites, well-established trade networks and elaborate mortuary customs. Local Tongva or Gabrielino oral traditions speak of the importance and use of rivers in the inland San Gabriel and San Fernando valleys, and named settlements have been documented along nearly every river and ephemeral stream. Although missionization, disease, and colonization decimated organized Tongva villages along the Los Angeles River, some Native American use of the River persisted throughout the nineteenth century.

The original Pueblo of Los Angeles was founded along the Los Angeles River by Spanish settlers, who immediately constructed a ditch system to irrigate their crops. Land grants were later made to soldiers and other settlers, and used primarily for grazing sheep and cattle. This trend continued through the duration of Mexican rule and into the time after California was annexed into the United States. In the latter half of the nineteenth century, large land grants in the San Fernando Valley were broken up, and large-scale agriculture for both domestic and international markets gradually replaced ranching. Rail lines and stations were constructed that paralleled old river travel routes across the southland. Beginning in the 1880s, residential and industrial development along the Los Angeles River grew rapidly. This growth required a more reliable water supply than the river could provide, and measures to protect life and property from periodic ravaging floods. In 1913, Owens River water was brought from Central California to Los Angeles via an aqueduct. After heavy storms that same year, however, the Los Angeles River broke out and flooded nearly twelve thousand acres of land and washed out roads, bridges, and rail facilities, which even then were aligned along the River. Such periodic devastating floods continued until 1959, when the River had been completely contained in a series of concrete channels, flood risk management reservoirs, and debris basins under the Los Angeles County Drainage Area (LACDA) project.

LACDA project features are present throughout the study area. Although not yet formally documented or evaluated for historic significance, the containment and flood risk management facilities on the Los Angeles River and its tributaries may be eligible for listing on the NRHP due to their association with important events and for their engineering innovation, as further described in Section 5.6.3. The

containment and flood risk management facilities together represent a major engineering effort that greatly contributed to the development of the Los Angeles area and is one of the most extensive flood risk management system ever constructed to protect a metropolitan area (LACDA Feasibility Report 1992). The features within the study area were constructed from the 1930s to the 1950s.

The following paragraphs provide an overview of the past use of each of three geomorphic reach groupings of the river, as well as a summary of the results of the record search and a table of recorded cultural resources. Despite past disturbances potential remains for buried archaeological resources, as well as for unrecorded and unevaluated buildings and structures. It should be emphasized that no new field work was conducted for this feasibility study phase. In addition to the investigations summarized below, there are 54 historic property investigations have been conducted that identified potential resources that have not been mapped due to insufficient or unconfirmed locational information. These 54 prior investigations range from very early 20th century investigations, reconnaissance level surveys, or "windshield" type historic building surveys where it is impossible to ascertain the extent of the investigation.

Reaches 1-3

The Los Angeles River in the upstream Reaches 1-3 flows to the east at the southeast end of the San Fernando Valley, and then makes a sharp turn to the south at its confluence with the Verdugo Wash. It defines the border between two pre-1800 Spanish land grants: Rancho Los Feliz on the west side and Rancho San Rafael on the east. Jose Vicente Feliz and José María Verdugo were military officers who served Spain in the establishment of their colony in Alta California. A large portion of Rancho Los Feliz remains intact, and was donated to the City of Los Angeles in 1896 by Griffith J. Griffith. As such it is now known as Griffith Park. Rancho San Rafael was broken up in 1869 and includes most of the City of Glendale extending into Pasadena.

The study area in Reaches 1-3 includes the confluence of the River with the Burbank Western Channel and the Verdugo Wash. The City of Los Angeles purchased surface water rights in this reach from Mr. Griffith in 1885, allowing the City to better control and to use this resource. Historic maps show little urban development in the immediate vicinity of the River prior to 1921, while Glendale, Burbank, and Los Angeles were experiencing a residential boom. Agricultural land uses north and east of the River were eventually replaced, as the river was channelized from the 1920s through the early 1960s, by industrial development primarily related to aeronautical engineering, the movie industry, and manufacturing. Many structures from that era remain, including the Republic/Universal, Warner Brothers and Walt Disney studios. The channelization beginning in the late 1930s allowed for even denser development of all kinds closer to the River.

The former location of the Griffith Park Aerodrome (later the California National Guard Airport), which operated from 1912 to 1939, is south and west of the River. It encompassed Ferraro Fields, the I-5 (Golden State Freeway), theSR-134 (Ventura Freeway) interchange, and the current Gene Autry Museum and zoo parking lot. The Glendale Airport (later the Grand Central Airport) operated from 1923 to 1959 just north of the River. Grand Central was the first official airline terminal for the Los Angeles area. Also adjacent to the River on the east side is the former site of the Roger Jessup Dairy, which operated from the 1920s through the 1960s. Channelization and construction of the Golden State Freeway in 1947, and the Ventura Freeway in 1962, took out portions of Griffith Park and separated the River and some parkland from recreational facilities at Griffith Park, including extensive equestrian facilities (City of Los Angeles 2007).

The record search confirmed 11 cultural resource investigations, reports, or inventories that have been conducted in or adjacent to reaches 1-3 in the study area. From the summary of available reports, it

appears that the immediate River corridor through Reaches 1, 2, and 3 has been minimally investigated for cultural resources. Los Angeles River containment and flood risk management facilities have not been documented or evaluated. Bridges across the River, however, have been inventoried and evaluated for historic significance. Pollywog Park has not been inventoried. Ferraro Fields has been surveyed for archaeological resources and approximately two-thirds of the Verdugo Wash study area has been inventoried for historic structures. No cultural resources have been identified at Ferraro Fields or in the Verdugo Wash Study Area. Table 3-11 lists the recorded cultural resources present or adjacent to the Reach 1-3 study area.

Table 3-11 Recorded Cultural Resources in Reaches 1-3

Resource Designation	Resource Type	Listing or Status [1, 2]	Notes
Old House of Lopez P-19-150415	Historic Place – no physical remains are apparent.	Not located or evaluated	Mapped location of structures occupied in 1868. Structure destroyed. Near Reach 1 and Polliwog Park.
Griffith Park P-19-175297	District	NRHP CRHR LAHCM #942	1896 -1944 – Large urban park with contributing buildings and designed and natural landscapes. Not all areas or features fully documented evaluated. Includes Bette Davis Park, Ferraro Fields, Adjacent to Reaches 1, 2 and 3.
Riverside-Zoo Drive Bridge, 53C1298 P-19-187573	Bridge	NRHP CRHR LAHCM #910	1938 – Concrete bridge. Bette Davis Park, Reach 1 and 2.
The Little Nugget	Object	LAHCM #474	1937 – Stationary display – Railroad passenger car at Travel Town, Griffith Park. Reach 1

[1]CRHR: California Register of Historical Resources – Eligible, NRHP: National Register of Historic Places – Eligible, CHL: California Historic Landmark, LAHCM #: Los Angeles Historical-Cultural Monument and monument number, Not Evaluated: Resource has been recorded but not been evaluated for historic significance, Not eligible: Resource has been evaluated and there has been some level of determination that it does not meet eligibility criteria.
[2] Note: Eligible properties are not necessarily formally listed on the NRHP or the CRHR, but have been evaluated and meet the criteria for listing and consideration in the planning process.

Reaches 4-6

The River in Reaches 4-6 continues south and then southeast, bordered by the Golden State Freeway (I-5) and Griffith Park on the west and mostly industrial and commercial properties on the east. Adjacent to the River on the east side is the Los Feliz 3-Par Golf Course developed in 1962, which is still operating. The River through Reaches 5 and 6 travels southeast through portions of the Los Angeles neighborhoods of Atwater Village, Silver Lake, Glassell Park, Elysian Valley, and Cypress Park. The River in this area was always a natural transportation route, even in prehistoric times. What became San Fernando Road along the River through this reach, and to the north, was part of El Camino Real linking Los Angeles with Mission San Fernando and northern coastal settlements through the Cahuenga Pass; and on to the San Joaquin and Central Valleys via the Tejon Pass. Later, the Butterfield Overland Mail line passed through these reaches. Rail transportation through Reaches 4-6 began in 1876, connecting to the east coast via San Francisco; and with a second transcontinental line added in 1886. Very quickly the old ranches were broken up and new residential communities were laid out to accommodate the influx of people from the east, and the growth of Los Angeles. Channelization of the River and freeway construction increased the industrial nature of adjacent land use through this reach. Table 3-12 lists recorded cultural resources present or adjacent to the Reach 4-6 study area.

As rail traffic increased, it was necessary to construct a number of rail yards along the River north of downtown Los Angeles. In 1888 the Southern Pacific established a freight storage yard adjunct at what is now known as the Cornfields site in Reach 7. In 1925 the Southern Pacific Railroad shifted supervision of

its entire Los Angeles freight handling operations from the Cornfields site to a new freight facility at Taylor Yard adjacent to the east side of the River in the southern part of Reach 6. The yard operated 24 hours a day and for much of its history; nearly all freight rail transport in and out of downtown had to pass through Taylor Yard. The workers would disassemble and reassemble as many as 60 freight trains a day.

Table 3-12 Recorded Cultural Resources in Reaches 4-6

Resource Designation	Resource Type	Listing or Status[1, 2]	Notes
Griffith Park P-19-175297	District	NRHP CRHR LAHCM #942	1896 -1944 – Large urban park with contributing buildings and designed and natural landscapes. Not all areas or features fully documented evaluated. Reaches 4 and 5.
Glendale-Hyperion Viaduct, P-19-180674, 53C1069	Bridge	NRHP CRHR LAHCM #164	1926- 1929 – Large multiple arch span concrete bridge with simplified classical elements. Reach 5.
Arroyo Seco Parkway, P-19-179645 SR110, Pasadena Freeway	Linear Transportation Facility, Bridges	NRHP CRHR	1940 – The first controlled-access freeway in the West. Arroyo Seco confluence, Reach 6 and 7 (boundary).
Riverside-Figueroa Street Bridge 53C0160	Bridge	NRHP CRHR LAHCM #908	1928, 1939 – Concrete and steel truss bridge. Scheduled for reconstruction. Reach 6.
Fletcher Drive Bridge P-19-173432	Bridge	NRHP CRHR LAHCM #332	1927 – Concrete bridge over the River. Reach 5.

[1]CRHR: California Register of Historical Resources – Eligible, NRHP: National Register of Historic Places – Eligible, CHL: California Historic Landmark, LAHCM #: Los Angeles Historical-Cultural Monument and monument number, Not Evaluated: Resource has been recorded but not been evaluated for historic significance, Not eligible: Resource has been evaluated and there has been some level of determination that it does not meet eligibility criteria.
[2] Note: Eligible properties are not necessarily formally listed on the NRHP or the CRHR, but have been evaluated and meet the criteria for listing and consideration in the planning process.

Repairs and maintenance of rail cars and engines were also done on site. Improvements and updates were continually made to yard facilities. Because Taylor Yard was situated above the River's natural floodplain and was protected by a levee, it was spared from extensive damage during the worst flood in the City's history, in 1938, which led to channelization of the River. Taylor Yard continued as the City's major railway hub and employed hundreds of workers in surrounding communities until 1973. The completion of a modern freight yard in the City of Colton later reduced the importance of Taylor Yard as a rail center. The Southern Pacific Railroad closed out most operations at the yard in 1985 and the land was eventually cleared (CDPR 2005a). Metrolink now operates a rail maintenance facility on a portion of the site. Other parcels have been developed into the Rio de Los Angeles State Park, offices, and educational facilities, although large parcels remain undeveloped.

The record search confirmed 15 cultural resource investigations, reports, or inventories that have been conducted in or adjacent to the Reach 4-6 study area. The actual River corridor through Reaches 4, 5, and 6 has been minimally investigated for cultural resources and there are no documented surveys of lands adjacent or parallel to the River. River containment and flood risk management facilities have not been documented or evaluated. Bridges across the River have been inventoried and evaluated for historic significance. There have been no surveys of the two golf courses in Reach 4. There have been cultural

resource surface surveys on adjacent parcels and along the edge of the Taylor Yard, but no inventory of the study area or subsurface excavation has been recorded.

Reaches 7-8

The River continues south through Cypress Park and Lincoln Heights and past the confluence with the Arroyo Seco toward downtown. Adjacent to and crossing the River are mostly industrialized zones and heavily used transportation corridors. The Arroyo Seco historically added substantial inflows to the River from the San Gabriel Mountains and was a major water supply for the growing city in the late 19th Century. In 1870 the Buena Vista Reservoir was built in the hills of Elysian Park immediately west of the confluence of the Arroyo Seco and the River. In the 1880s the reservoir was expanded and other facilities were constructed to tap the River for a rapidly growing population. In 1904 William Mulholland and Los Angeles completed the southernmost of this series of diversion facilities, the Narrows Gallery, to capture more water. A 1,178-foot tunnel was drilled at a depth of 115 feet through the bedrock beneath the River and up the Arroyo Seco. Nine wells were drilled to allow water to percolate into the tunnel where it was then collected and conveyed through the Zanja Madre to downtown Los Angeles. The Zanja Madre was the main irrigation ditch supplying water to Los Angeles (Brick 2012).

The Cornfields site at the Los Angeles State Historic Park is located west of the River on the former location of the Southern Pacific River Station and freight yard. The River Station was the first Southern Pacific facility in Los Angeles, and site of the first transcontinental railroad station and depot in the region from 1876 through 1888. It served as the center of railroad freight operations for the Southern Pacific in Los Angeles until 1925, and continued to serve as a freight yard until its closing in 1992. The railroad facility included a two-story depot and hotel, a large freight house, round house, turntable, ice house, and maintenance shops. No standing structures remain, but extensive archaeological resources have been recorded. Cornfields is immediately north of the site where Los Angeles was founded. Some of the earliest recorded Euro-American agriculture (1805) in Los Angeles was conducted in the River floodplain in this area, and remnants of the original Zanja Madre have also been found. Much of the early industrial development of Los Angeles occurred here, and it is surrounded by some of the original ethnic neighborhoods in Los Angeles (CDPR 2005b).

Farther south, on the east side of the River is the Los Angeles Transfer Container Facility or LATC. A rail maintenance facility was established here by the Union Pacific in the early 1900s. Historic maps show a roundhouse and structures that comprised "general shops", where heavy repairs and building of freight cars took place. The need for general shops on all railroads decreased when they changed from steam engines to diesels in the 1940s and 1950s. It evolved, therefore, to become a place to load truck trailers "piggyback" onto railroad flat cars, as well as a site for two or three big freight forwarder operations (FoLAR 2012).

The record search identified 46 cultural resource investigations, reports, or inventories that have been conducted in or adjacent to Reaches 7-8 in the study area. Given the intense urban development in this reach and transportation corridors on the edges of the concrete River channel, few of the investigations involve block surveys of open land. Many of the references are literature reviews and record searches focusing on the built environment and rail system or monitoring reports conducted for ground disturbing activities involving utilities and infrastructure. Los Angeles River containment and flood risk management facilities have not been documented or evaluated. Bridges across the River have been inventoried and evaluated for historic significance. There have been previous cultural resource investigations at the Arroyo Seco confluence site. The Cornfields site has been surveyed for cultural resources and limited subsurface excavations have been conducted locating features of the past uses. There have been no investigations of the LATC study area. Table 3-13 lists the recorded cultural resources present in or adjacent to Reaches 7-8 in the study area

1 **Table 3-13 Recorded Cultural Resources in Reaches 7-8**

Resource Designation	Resource Type	Listing or Status[1, 2]	Notes
CA-Lan-3100 P-19-003100	Archaeological site	Not Individually Evaluated	Historic artifact scatter, within the River Station Area/Southern Pacific Railroad LAHCM #82 – Cornfields
CA-Lan-3101 P-19-003101	Archaeological site	Not Individually Evaluated	Historic artifact scatter, within the River Station Area/Southern Pacific Railroad LAHCM #82 – Cornfields
Cornfield/River Station P-19-003120	Archaeological site	LAHCM #82	Historic structural/rail yard remains and artifacts within the River Station Area/Southern Pacific Railroad. Cornfields. Reach 7.
Richmond Junction P-19-003685	Archaeological site	Not Evaluated	Historic artifact scatter – 1880s to present. Adjacent to LATC. Reach 8.
1800 Baker Street Yard, P-19-100881	Isolate – 3 artifacts	Not Evaluated	Historic artifacts. Adjacent to Cornfields. Reach 7.
First Street Viaduct P-19-150195 53C1165	Bridge	NRHP CRHR	1927-28 –Neo-Classical style concrete bridge. Reach 8.
1709 North Spring Street, P-19-150244	Building	Not Eligible	Heavily altered 1895 brick commercial/industrial building. Adjacent to Cornfields. Reach 7.
1701 North Spring Street P-19-150245	Building	Not Eligible	Heavily altered 1894 commercial/industrial building. Adjacent to Cornfields. Reach 7.
1635-1639 North Spring Street P-19-150246	Building	Not Eligible	Heavily altered 1894 industrial building. Adjacent to Cornfields. Reach 7.
San Antonio Winery P-19-167098	Building	LAHCM #42	1917-1950 Building complex of the last remaining winery in Los Angeles. Near LATC and Reach 8.
Portola Trail Campsite #1 P-19-174919	Historic Place-historic location, no physical remains.	CHL	1769, location where Portola camped and where the first Catholic Mass was celebrated in Los Angeles. Near Cornfields and Reach 7.
Department of Water and Power, General Services Headquarters P-19-176368	District	NRHP CRHR	1923-1944 grouping of municipal/industrial structures – adjacent to Reach 8.
Arroyo Seco Parkway, SR110, Pasadena Freeway P-19-179645	Historic Transportation Facility, Bridges	NRHP CRHR	1940 – The first controlled-access freeway in the West. Arroyo Seco confluence, Reach 7.
Union Pacific Railroad P-19-186110	Historic Transportation Route	Not Evaluated	1870-present – Railway corridor in continuous service. Adjacent to the River. Reaches 7 and 8.
Southern Pacific Los Angeles Division; Union Pacific P-19-186112	Historic Transportation Route	Not Eligible	1874-present – Railway corridor. Adjacent to LATC, crosses Reach 8.
Arroyo Seco Flood Control Channel P-19-186859	Linear Water Conveyance Feature	Unknown	1937 – Concrete open flood risk management channel – appears eligible for the NRHP, but no concurrence. Arroyo Seco confluence. Reach 7.
P-19-187085	Linear		Missing record – requested
North Broadway Bridge, Buena Vista Viaduct 53C0545 P-19-188229	Bridge	NRHP CRHR LACHM #907	1910 – Beaux Arts details – first viaduct and the longest and widest concrete bridge in California at that time. Adjacent to the Cornfields, Reach 7.
Mission Tower, AT&SF[3] Tower P-19-188246	Building	NRHP CRHR	1916 – Enlarged 1938. Railroad Traffic Control Tower. Adjacent to Reach 8 across the River from LATC.

Resource Designation	Resource Type	Listing or Status[1, 2]	Notes
Cesar Chavez-Macy Street Bridge	Bridge	NRHP CRHR LACHM #224	1926 – Concrete bridge in the Spanish Colonial Revival style to commemorate its location along the El Camino Real. Reach 8 near LATC.
North Main Street Bridge 53C1010	Bridge	NRHP CRHR LACHM #901	1910 – Concrete arch bridge. Reach 7 and 8 boundary.
North Spring Street Bridge 53C0859	Bridge	NRHP CRHR LACHM #900	1928 – Concrete arch bridge. Reach 7 near Cornfields.

[1]CRHR: California Register of Historical Resources – Eligible, NRHP: National Register of Historic Places – Eligible, CHL: California Historic Landmark, LAHCM #: Los Angeles Historical-Cultural Monument and monument number, Not Evaluated: Resource has been recorded but not been evaluated for historic significance, Not eligible: Resource has been evaluated and there has been some level of determination that it does not meet eligibility criteria.
[2] Note: Eligible properties are not necessarily formally listed on the NRHP or the CRHR, but have been evaluated and meet the criteria for listing and consideration in the planning process.

3.7 TRAFFIC AND CIRCULATION

3.7.1 Transportation

The roadway system in the study vicinity consists of a dense network of Federal and state highways and city streets. Federal and state highways include interstates, U.S. and state routes, and are managed and maintained by the California Department of Transportation (Caltrans). The Los Angeles Department of Transportation (LADOT) manages the approximately 6,500 miles of city streets (LADOT 2009). These streets generally carry less traffic than state highways and are managed and maintained by the city in which they are located.

Federal and state highways in the study area generally have three to five lanes of travel in each direction and experience very high traffic volumes. Such highways cross the River in six locations within the study area Figure 3-12). Interstate 5 runs alongside the channel between Reaches 3 and 6, and SR 134 runs very close to the channel in Reach 3. Rail lines servicing passenger and freight carriers run along the overbank area of the River in Reaches 7 and 8.

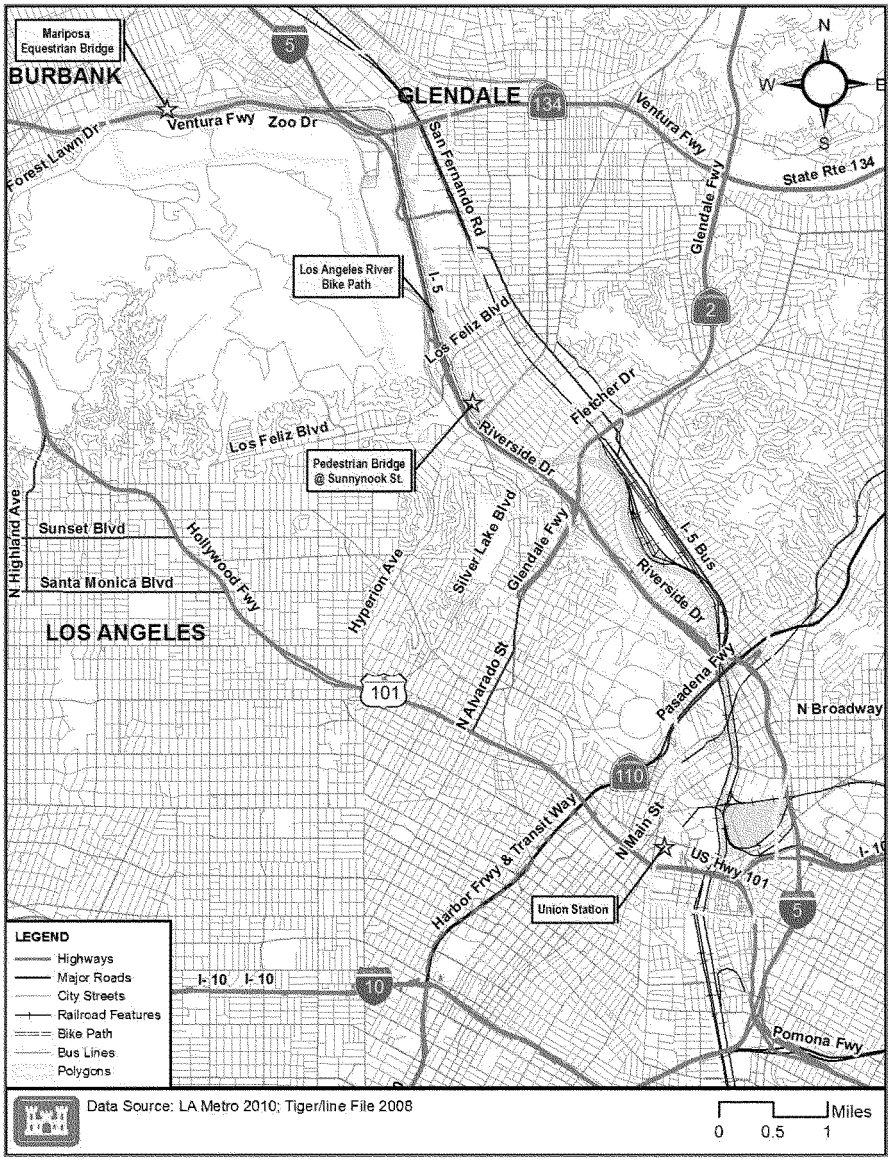


Figure 3-12 Traffic and Circulation

Table 3-14 Federal and State Highways in the Study Area

Route	Alternate Name	2011 Annual Average Daily Traffic[1]
State Route 2 (SR-2)	Glendale Boulevard, Glendale Freeway	156,000
Interstate 5 (I-5)	Santa Ana Freeway, Golden State Freeway	237,000
Interstate 10 (I-10)	Santa Monica Freeway, San Bernardino Freeway	207,000
U.S. Highway 101 (Hwy 101)	Hollywood Freeway, Ventura Freeway	209,000
State Route 110 (SR-110)	Pasadena Freeway, Harbor Freeway	123,000
State Route 134 (SR-134)	Ventura Freeway	112,000

[1]Total number of vehicles, both directions. In some cases, annual average daily traffic counts were not available in or near the study area for some state highway segments. In these cases, the traffic count location nearest the study area was chosen for inclusion in this table. Source: Caltrans 2011.

City streets are designed to accommodate various amounts of traffic and assigned one of five classifications. In descending order of traffic capacity, the five classifications are: major highway class I (126-foot right-of-way), major highway class II (104-foot right-of-way), secondary (90-foot right-of-way), collector (64-foot right-of-way), and local (60-foot right-of-way). Class I, class II, and secondary streets generally have four to eight lanes of travel (two to four in each direction) while collector and local streets have two lanes (one in each direction). There are no Class I streets in the study area (City of Los Angeles 1997). Glendale and Burbank use somewhat different terms for classifying city streets; however, the classifications serve the same purpose as the City of Los Angeles' classifications (City of Glendale 1998; City of Burbank 2013b). Selected roadways and intersections in the study area with their annual average daily traffic are shown in Table 3-15.

Table 3-15 Selected Roadways in the Study Area

Roadway	Annual Average Daily Traffic[1]	Cross Street Where Annual Average Daily Traffic Counted	Reach
Forest Lawn Drive	23,834	Zoo Drive	1-3
Zoo Drive	9,934	Zoo Drive N	1-3
Victory Boulevard	44,778	Laurel Canyon Blvd	1-3
Los Feliz Boulevard	35,485	Western Avenue	5
Hyperion/Glendale Boulevard	1,389	Hoover	5
Silver Lake Boulevard	25,331	Van Pelt Pl.	5
Fletcher Drive	38,707	Glendale Blvd	5
Riverside Drive	23,569	San Fernando Drive	5-7
Cypress	4,756	Jefferies	6-7
North Main Street	13,716	Gibbons Street	7
North Avenue 18	2,345	Pasadena Avenue	7
North Broadway	12,310	Avenue 18	7
Mission Road	23,315	Cesar E. Chavez Avenue	8
Cesar Chavez Avenue	28,566	Mission Road	8
First Street	10,468	Alameda Street	8

[1]Total number of vehicles, both directions) In some cases, annual average daily traffic counts were not available in or near the study area for some state highway segments. In these cases, the traffic count location nearest the study area was chosen for inclusion in this table. All roadways shown are classified as Local Neighborhood. Source: LADOT 2010.

Traffic congestion is an ongoing issue throughout Los Angeles; however, due to constraints to roadway expansion, local and regional governments have shifted focus to utilizing existing roadways more efficiently. Approximately 50 percent of the County's Federal and state highways and 20 percent of major arterials currently experience congestion in morning and evening commute periods. Because commuting patterns are more complex than the traditional suburban to urban regions, congestion can occur in both directions simultaneously (Metro 2010). Easing congestion has been addressed by the addition of carpool lanes and synchronization of traffic signals. Focus has also shifted to alternative means of travel such as public transit and non-motorized transport, as well as to encouraging land use development patterns where residents live close to public transit and job opportunities (City of Los Angeles 1997).

Caltrans is currently constructing a high occupancy vehicle lane (or carpool lane) in each direction on I-5 between SR-134 and Magnolia Boulevard across Burbank and Glendale in the study area, as well as sound and retaining walls. The project is expected to be completed in 2015 (Caltrans 2012).

3.7.2 Public Transit

Metro is the regional transportation planning agency for all of Los Angeles County and is the largest provider of mass transit in the study area. Metro develops and oversees transportation plans, policies, funding programs, and short-term and long-term solutions that address the County's increasing mobility, accessibility, and environmental needs. Metro also operates 200 bus lines, 2 heavy-rail subway lines (Red and Purple Lines), and 4 electric-powered light rail lines (Expo, Blue, Green, and Gold Lines).

LADOT separately provides local transit services including DASH, Commuter Express, and CityRide. LADOT's fleet consists of nearly 400 vehicles that accommodate approximately 30 million passenger boardings per year (LADOT 2012a). DASH provides bus service 7 days a week, while Commuter Express service generally operates Monday through Friday during peak commute hours. CityRide provides point to point service for citizens 65 years of age or older.

Overall, the usage of the transit system in the Los Angeles area is relatively stable or increasing. Metro's ridership statistics for the period of June 2010 and June 2012 indicate that monthly bus boardings decreased slightly from 30.9 million to 29.7 million while rail boardings increased from 8.7 million to 9.3 million (Metro 2012b). For the portion of the transit network evaluated in the Los Angeles County Congestion Management Program (including services within the study area), passenger throughput (a measure that combines the number of people moved and the speed at which they move) increased 44 percent and network speed increased about 6 percent from 1992 to 2009 (Metro 2010).

3.7.3 Railroads

The Los Angeles River corridor is one of the City's main rail transportation corridors (Figure 3-12). Railroad lines run immediately adjacent to both banks in Reaches 7 and 8. Major rail operators in the study area are Union Pacific, Burlington Northern Santa Fe Railway (BNSF), Southern California Regional Rail Authority (Metrolink), and Amtrak. Union Pacific, BNSF, and LACMTA operate freight service, while Metrolink, Amtrak, and LACMTA provide passenger rail service over Union Pacific and BNSF tracks (City of Los Angeles 2007). Demand for both passenger and freight rail capacity is at or near capacity in portions of Los Angeles and the surrounding area, and demand is expected to continue to grow. The closer the system operates to capacity, the more congested tracks become and delays become longer and more frequent (City of Los Angeles 2007; Wilbur Smith Associates 2008).

Union Pacific carries goods for import and export and operates over 100 freight trains per day in its Los Angeles service area, which passes through the study area. BNSF rail lines in the Los Angeles area transport passengers and a variety of freight, including intermodal containers, raw materials, and finished

goods. They operate over 100 trains per day in the area, approximately 40 percent of which are passenger trains operated on behalf of Amtrak and Metrolink. BNSF tracks enter Los Angeles County from the north and pass through Union Station to three major rail yards. The study area includes the LATC rail yard operated by UPRR. First established as a rail maintenance facility in the early 1900s, today it serves as an intermodal facility mainly handling domestic cargo. UPRR reports that it receives, sorts, and distributes approximately 240,000 cargo containers per year, ninety-five percent of which are domestic (UPRR 2013). LATC is one of four intermodal facilities operated by UPRR in the Los Angeles Basin. The next closest rail yard to the study area is 3 miles south of the study area on Washington Boulevard (City of Los Angeles 2007). Metrolink is a regional commuter rail system that operates seven lines, six of which originate from Union Station. Metrolink has a 512-mile route network, operates 55 stations, and serves approximately 40,000 weekday riders (Metrolink 2012). Amtrak operates several long-distance passenger trains and also partners with the State of California to operate the Pacific Surfliner (City of Los Angeles 2007). In 2011, Amtrak served 1,606,121 passengers in Los Angeles (Amtrak 2012).

3.7.4 Parking

There are no public parking areas dedicated to River access, and public parking with nearby access to the River is limited. On-street parking is available near Reach 1 in Burbank and Reach 3 in Glendale. Public parking lots that are near the River in Reaches 1-3 are located in Griffith Park along Zoo Drive, at the Griffith Dog Park, at Ferraro Soccer Fields, south of Harding Golf Course at the Crystal Springs Picnic Area, and on the left bank at Atwater Park. There is also a large parking lot in Griffith Park between the Los Angeles Zoo and Autry National Center. In Reaches 4-6, public parking is found near the right bank of the River at the south end of Griffith Park near the Griffith Park swimming pool and William Mulholland Memorial Fountain and on the left bank of the River at the Rio de Los Angeles State Park. Street parking on the right bank of the River along Fletcher Drive, Ripple Street, and Crystal Street is frequently used by recreational users. Parking is also available at the following Mountains Recreation and Conservation Center parks that are near the River in the project area: Mark Park, Elyria Canyon Park, Elysian Valley Pocket Park, Vista Hermosa Natural Park, and the Los Angeles River Center and Gardens.

3.7.5 Airports

The nearest airport to the study area is the Bob Hope Airport, which is approximately 3 miles north of the study area in Burbank. The Los Angeles International Airport is the largest airport in Los Angeles, but is well outside the study limits, approximately 12 miles southwest.

3.7.6 Non-Motorized Transportation

Walking and biking are the primary means of non-motorized transportation in the study vicinity (Figure 3-12). The Los Angeles River Bike Path, also called the Los Angeles River Greenway Trail, follows the right bank of the River through much of the study area and is used by bicyclists and pedestrians (LADOT 2012c). Other streets in the study vicinity provide bike lanes. Most of the streets in the vicinity have sidewalks and sidewalks are provided on several bridges that cross the River. The Los Angeles River Bike Path follows the right bank of the River from the Riverside Drive Bridge at Bette Davis Park through the entire length of the study area, ending at North Figueroa Street. The Mariposa Equestrian Bridge and the Sunnynook Drive Pedestrian Bridge provide crossing points.

3.8 NOISE

This section presents information on existing noise conditions in the study area and identifies the noise sensitive receptors that are present.

Noise is measured in decibels (dB) and then frequencies are weighted based on the human response to sound, denoted as dBA. In general, a difference of more than 3 dBA is a perceptible change in environmental noise, while a 5 dBA difference typically causes a change in community reaction. An increase of 10 dBA is perceived by people as a doubling of loudness (USEPA 1974). Metrics used to describe sound pressure levels in this document include the L_{eq}, L_{max}, and CNEL:

L_{eq}: Conventionally expressed in dBA, the L_{eq} is the energy-averaged, A-weighted sound level for the complete time period. It is defined as the steady, continuous sound level over a specified time, which has the same acoustic energy as the actual varying sound levels over the specified period.

L_{max}: The maximum A-weighted sound level as determined during a specified measurement period. It can also be described as the maximum instantaneous sound pressure level generated by a piece of equipment.

CNEL: Community Noise Equivalent Level (CNEL) is another average A-weighted Leq sound level measured over a 24-hour period; however, this noise scale is adjusted to account for some individuals' increased sensitivity to noise levels during the evening and nighttime hours. A CNEL noise measurement is obtained after adding 5 dB to sound levels occurring during evening hours (7:00 p.m. to 10:00 p.m.) and 10 dB to sound levels occurring during nighttime hours (10:00 p.m. to 7:00 a.m.).

The ambient acoustic environment within 500 ft of the study area represents the limits of this acoustical analysis and encompasses a variety of noise sources. The assumed existing primary source of noise is from high traffic arterials, which generate consistent noise patterns in the study area. Other major noise sources include railways, industrial yards, events at Dodger Stadium, and surface street use.

Noise sensitive receptors are located within 500 ft of the study area. Generally, noise sensitive receptors are locations where people sleep or where noise can affect the function of the receptor. Examples of noise sensitive receptors include, but are not limited to, residential dwellings, schools, parks, community centers, public facilities, hotels, hospitals, places of worship, and office buildings. Noise sensitive receptors within the area studied are inventoried below.

Ambient noise conditions are documented in this report primarily through qualitative assessment of potential noise sources in the study area. Noise monitoring was not conducted as a part of this EIS/EIR. Instead baseline ambient noise levels were established by using referenced ambient noise levels as defined by the Los Angeles Department of City Planning which were a result of the City's monitoring program in 1998 and updated in 2012, see Table 3-16 (City of Los Angeles 1998b, City of Los Angeles 2012b).

Table 3-16 Presumed Ambient Noise Level by Zone within Los Angeles

Zone	Day (7:00 a.m.–10:00 p.m.)	Night (10:00 p.m.–7:00 a.m.)
Agricultural, Suburban, Residential including Single and Multiple Family Homes (A1, A2, RA, RE, RS, RD, RW1, RW2, R1, R2, R3, R4, and R5)	50 dBA	40 dBA
Parking Areas and Commercial (P, PB, CR, C1, C1.5, C2, C4, C5, and CM)	60 dBA	55 dBA
Limited and Restricted Light Industrial (M1, MR1, and MR2)	60 dBA	55 dBA
Light and Heavy Industrial (M2 and M3)	65 dBA	65 dBA

Source: City of Los Angeles 2012b.

Wildlife species are also sensitive to noise. Animals rely on meaningful sounds for communication, navigation, avoiding danger and finding food. Behavioral and physiological responses of wildlife to noise have the potential to cause injury, energy loss, decrease in food intake, habitat avoidance and abandonment, and reproductive losses (National Park Service 1994). Studies have reported noise impacts to least Bell's vireo from highway noise (Barrett 1996), and to other grassland and forest dwelling birds (AASHTO 2008). These species have the potential to occur in the study area and are subject to the effects of noise.

3.8.1 Reaches 1-3

Highway road noise is generated immediately adjacent to the River through much of its length in the upper reaches. Reaches 1-3 are paralleled by either Highway 134 or I-5 and have little or no noise buffer between them. These highways are major transportation arterials for commuters and commercial trucking. Industrial areas contribute noise from the east bank of the River, just south of the Highway 134 overpass.

Sensitive receptors within 500 ft of the study area include Griffith Park and its recreational facilities, specifically the Los Angeles Zoo and Botanical Gardens, Autry National Center, and Forest Lawn Cemetery. Other sensitive facilities include the Los Angeles Equestrian Center, Ferraro Fields, Disney Studios, Glendale Meditation House, and Bette Davis Park (Figure 3-13). There are no hospitals, schools, motels, libraries or retirement homes in the area. There are a few residential neighborhoods within 500 ft of the study area with the nearest neighborhood, Riverside Rancho, located north of Highway 134.

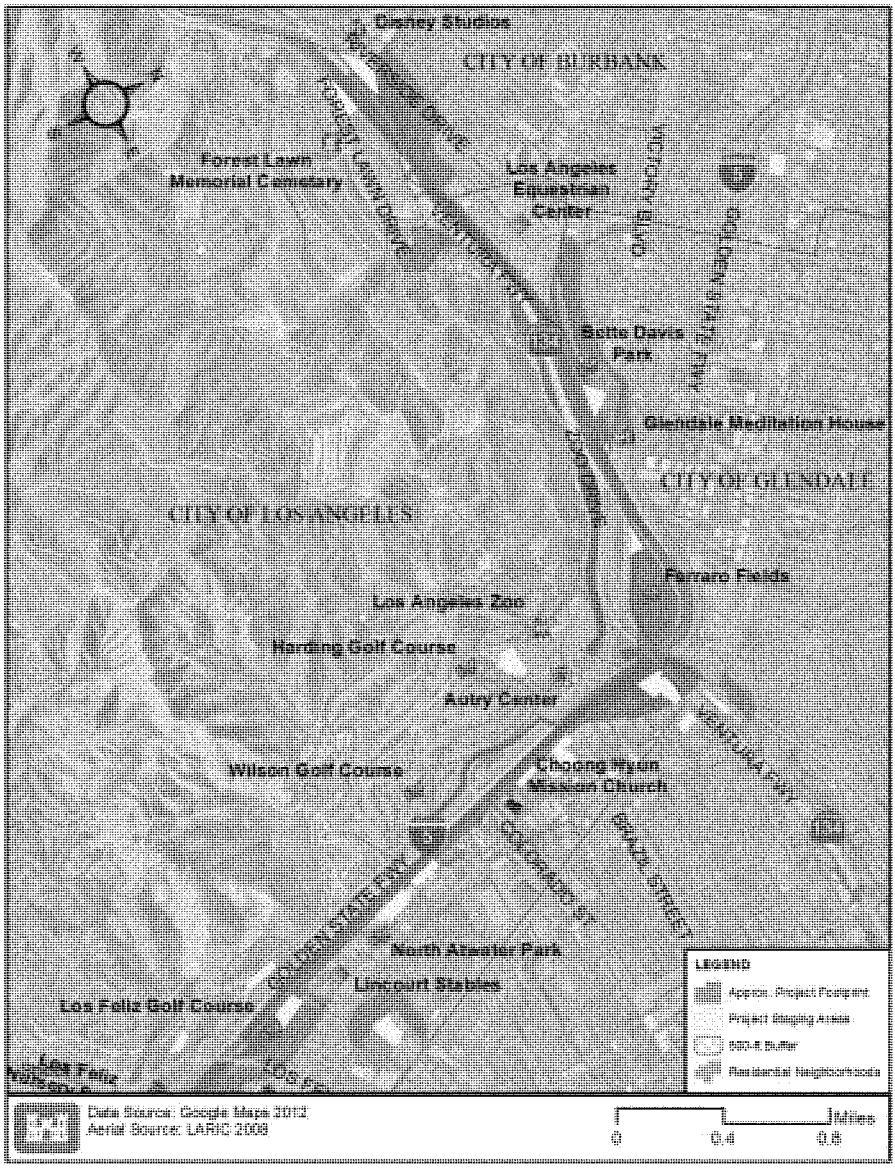
3.8.2 Reaches 4-6

Reaches 4 and 5 are immediately adjacent to I-5 and have little or no noise buffer between them. Reach 6 is separated from I-5 by a residential neighborhood, but is still within audible distance of the highway. Other noise sources include rail lines and yards immediately adjacent to Reach 6 on the east side of the river.

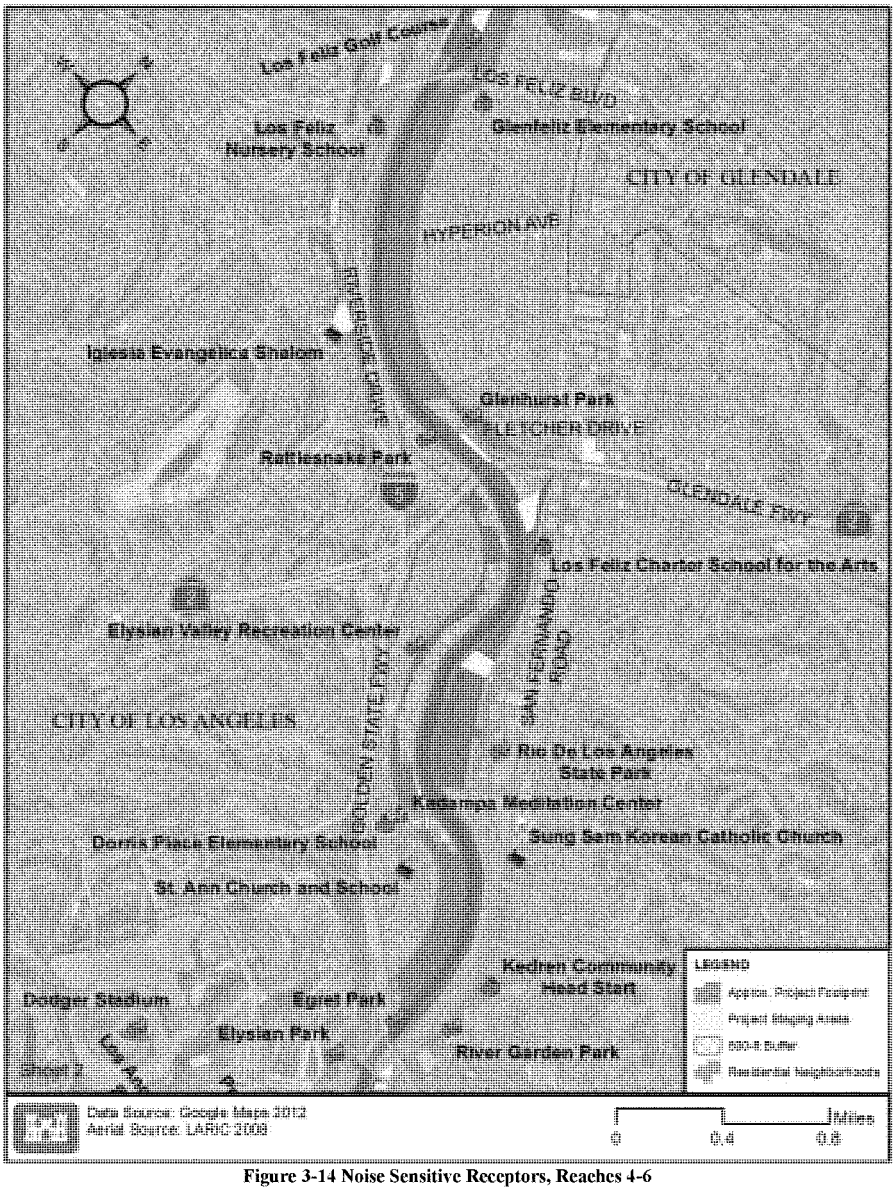
Sensitive receptors within 500 ft of the study area include Harding Golf Course, Griffith Park and its many recreational facilities, North Atwater Park, Los Feliz Golf Course, Rattlesnake Park, Glenhurst Park, Rio De Los Angeles State Park, Lincourt Stables, River Garden Park, Egret Park, Elysian Park, Kadampa Meditation Center, Dorris Place Elementary School, Glenfeliz Elementary, Los Feliz Nursery School, Los Feliz Charter School for the Arts, Kedren Community Head Start, Choong Hyun Mission Church, Iglesia Evangelica Shalom, Sumsang Korean Catholic Church, St. Ann Church and School, and Elysian Valley Recreation Center (Figure 3-14). There are no hospitals, motels, libraries or retirement homes in the area. Several residential neighborhoods are located within 500 ft of the study area including those of Atwater Village, Los Feliz, and Elysian Valley.

3.8.3 Reaches 7-8

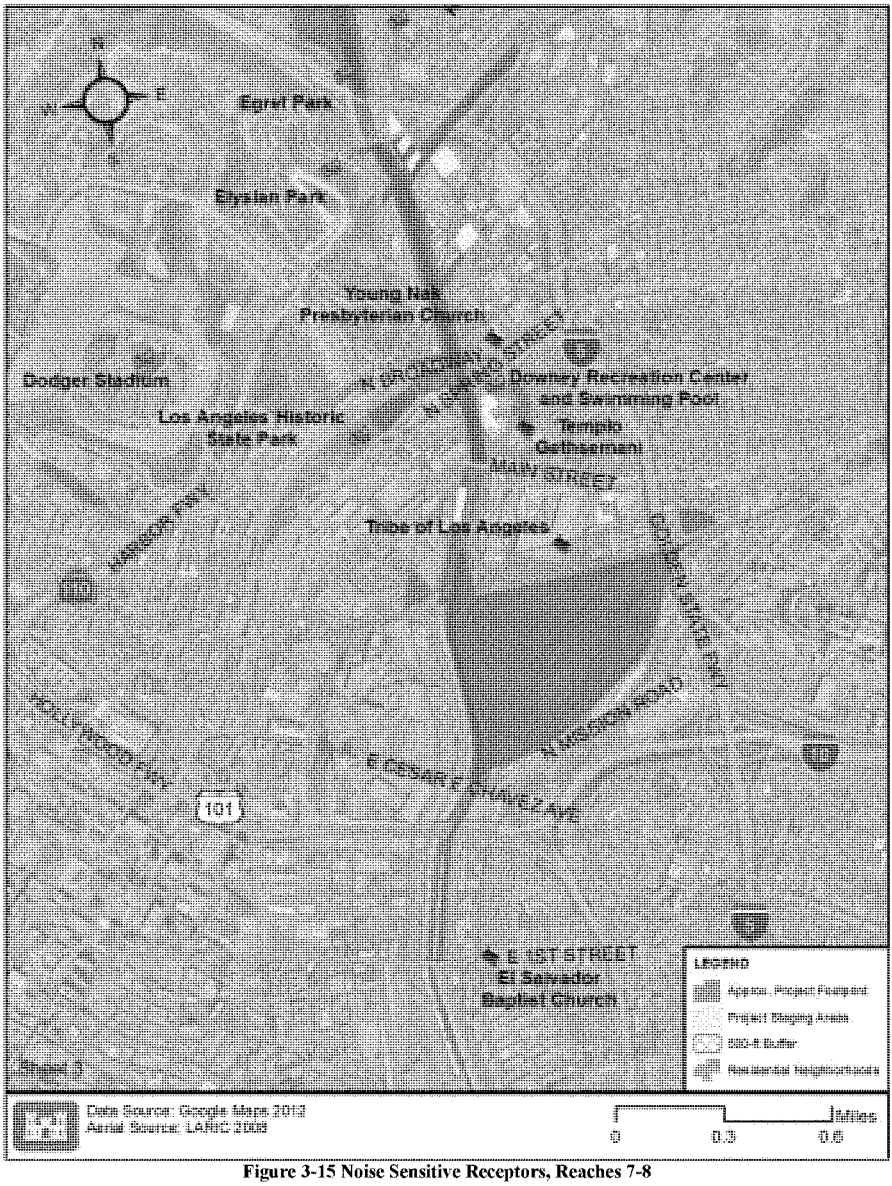
Railroad lines run immediately adjacent to both banks in Reaches 7 and 8. Highways, surface streets, and industrial areas also contribute to the acoustic environment. Sensitive receptors within 500 ft of the study area include Elysian Park, the Downey Recreation Center and Swimming Pool, Los Angeles Historic State Park (Cornfields), Young Nak Presbyterian Church, Temple Gethsemani, Tribe of Los Angeles, and El Salvador Baptist Church (Figure 3-15). There are no hospitals, hotels, nursing homes, schools, or libraries within the area. Residential neighborhoods include portions of Lincoln Heights and Chinatown.



1 **Figure 3-13 Noise Sensitive Receptors, Reaches 1-3**



1 **Figure 3-14 Noise Sensitive Receptors, Reaches 4-6**



1 **Figure 3-15 Noise Sensitive Receptors, Reaches 7-8**

3.9 RECREATION AND PUBLIC ACCESS

For this analysis, the recreation resource area is defined as being a half-mile buffer on either side of the River. The inventory of larger regional parks and other resources that exist outside the study area are beyond the geographic scope of this assessment other than to demonstrate the lack of regional parks and open space available within the greater Los Angeles area.

3.9.1 Regional Context and Demand

The City of Los Angeles has approximately 24,000 acres of parks, with approximately 15,899 acres of parkland under the jurisdiction of the Department of Recreation and Parks. Other agencies managing parklands include the Los Angeles Department of Water and Power, Mountains Recreation and Conservation Authority, the Santa Monica Mountains Conservancy, California State Parks, and the County of Los Angeles. In all, this equates to a city-wide average of 6.26 acres of park per 1,000 residents (Trust for Public Land 2011). The City of Glendale has 39 developed parks comprising 280 acres, or about 1.4 acres per 1000 residents (City of Glendale 2012c). The City of Burbank operates 26 park facilities covering over 700 acres, equating to approximately 7.1 acres of parkland per 1,000 residents (City of Burbank 2013b). Including all parks identified in the assessment presented below, the recreation resource area has an estimated 5,000 acres of park, or 38.77 acres per 1,000 residents. This value is high compared to the city-wide average due to the presence of some larger than average parks near the study area, such as Griffith Park (the largest park at 4,210 acres) and Elysian Park (575 acres).

Much of Los Angeles is considered to be park deficient which refers to any geographic area that provides less than 3 acres of green space per 1,000 residents, as defined by California law (GreenInfo Network 2010). In particular, the industrial areas surrounding Reaches 7-8 have the least parkland, with fewer than 3 acres per 1,000 people. Other areas, particularly on the southwest side of Reaches 1-3, have greater than 3 acres of parkland per 1,000 residents, which is due to the presence of Griffith Park. In general, access to parks and acres of parkland per 1,000 residents is lowest in areas that have the highest number of families below the poverty line of $47,331.

According to Southern California Association of Governments (SCAG), public parks are intended to serve all residents, but not all neighborhoods and people have equal access to these public resources. SCAG calls for a multiagency effort and public transportation to improve access for all to parks throughout Southern California (SCAG 2008). The City Project, a local nonprofit research organization was founded to find ways to improve park availability for all neighborhoods, regardless of ethnicity or income level (Garcia et al. 2009).

Residents of Los Angeles place a high priority on the quality of natural and environmental resources. In a study from 2000, 75 percent of those surveyed said that preserving wetlands, rivers, and environmentally sensitive areas would be either "somewhat effective" or "very effective" at improving their quality of life. There is also strong support for protecting cultural resources and for environmental education (Public Policy Institute of California 2000).

3.9.2 Recreation Opportunities in the Study Area

Approved uses of the River in the study area are generally limited to pedestrian, cyclist, and equestrian trails along the banks. Some Two areas of the River's watershed have recently been permitted for seasonal recreation, fishing or canoeing/kayaking on a year-to-year basis. These include the (Sepulveda Basin Recreation Zone (not in the Study Area, but a USACE facility) and the Elysian Valley Recreation Zone, which is found), were approved in Reach 6, between Fletcher Dr. and Egret Park, The Elysian Valley Recreation Zone has successfully operated in was authorized in within the study area in summer 2013 and 2014 (Memorial Day to Labor Day), as a Los Angeles River Pilot Recreational Zone authorized

by the City of Los Angeles and was administered by the Mountains Recreation and Conservation Authority, a state agency, in coordination with the USACE and the County of Los Angeles. This zone permitted vendor-operated kayaking and canoeing, bird watching, walking, and fishing within the riverbed, through entry at designated points from Fletcher Drive to Steelhead Park, subject to clear weather conditions in the watershed and other safety restrictions. The pilot recreational zone function will be assessed by the coordinating agencies after summer 2013 for determination of future seasonal in-channel recreation in that zone. Outside the seasonal recreation zone, where public use is not currently authorized, citations are not often issued for fishing, which takes place mostly in the soft bed areas of the River (Los Angeles 2011a). Other activities along the River include bird watching, sightseeing, and tours by local interest groups. There are no areas approved for swimming in the study area, and instances of swimming and wading are likely low due to water quality concerns; local agencies and interest groups typically advise users to stay out of the water (Los Angeles River Revitalization Corporation [LARRC] 2011b).

Small parks along the River's pathways provide an improved pedestrian recreation experience with facilities such as benches and grassy areas. These parks are a combination of city parks and small pocket parks funded by local non-profit groups seeking to develop a greenway along the River (Santa Monica Mountains Conservancy and Mountains Recreation Conservation Authority 2007).

The Los Angeles River Bike Path is a Class I Bike Path (off-roadway, paved), and runs along the right bank of the River from Griffith Park through Glendale Narrows to Elysian Park, offering an off-roadway route for pedestrians and cyclists. This route is managed by the City of Los Angeles' Department of Transportation. Another route between Griffith Park and Elysian Park relies on a combination of bike lanes and bike routes (on-roadway) but does not follow the River, making it a Class III Route, less appropriate for recreation and more of a transportation route. This route is managed by Los Angeles County Metro. Both routes are included in the City of Los Angeles Bicycle Plan (Metro 2012d). Class I-III bike routes are also found near or adjacent to the study area within the City of Burbank. See Appendix H, Supplemental Baseline Conditions, for a list of recreational resources in the study area.

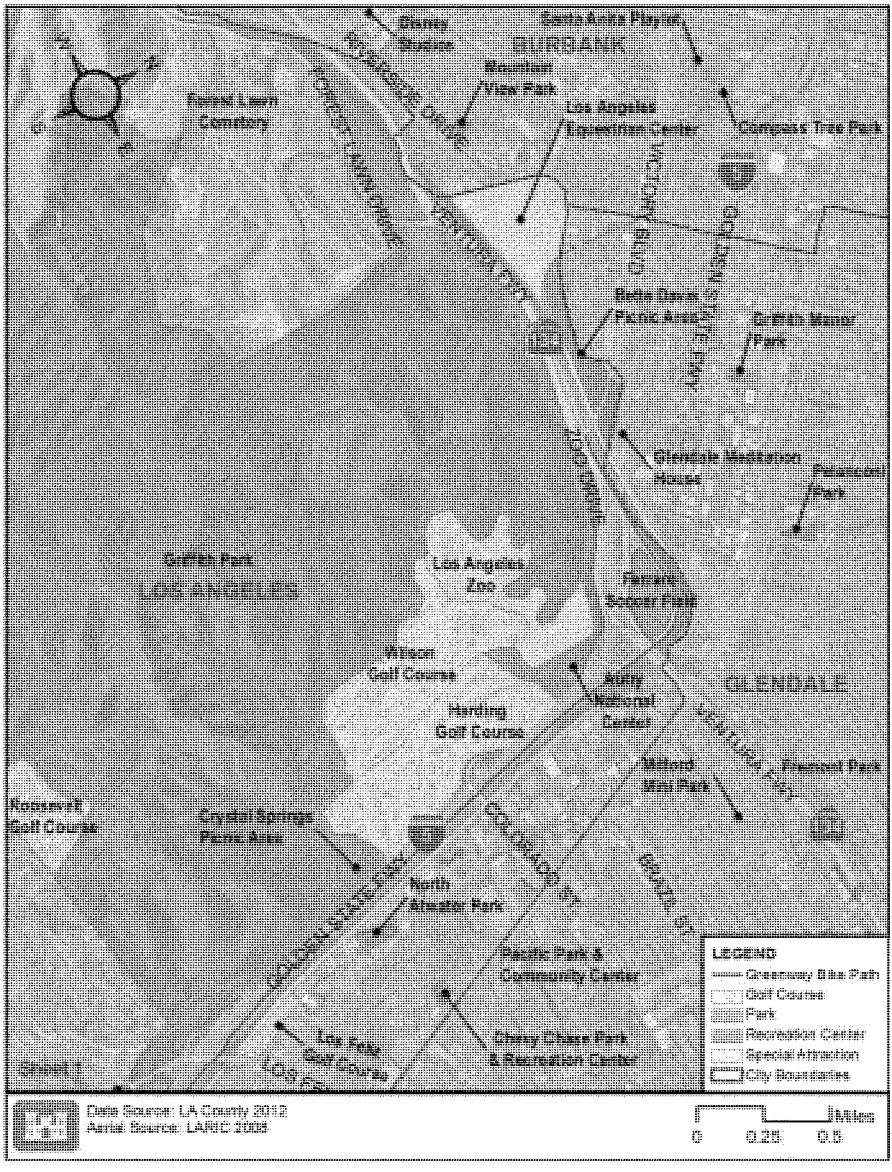
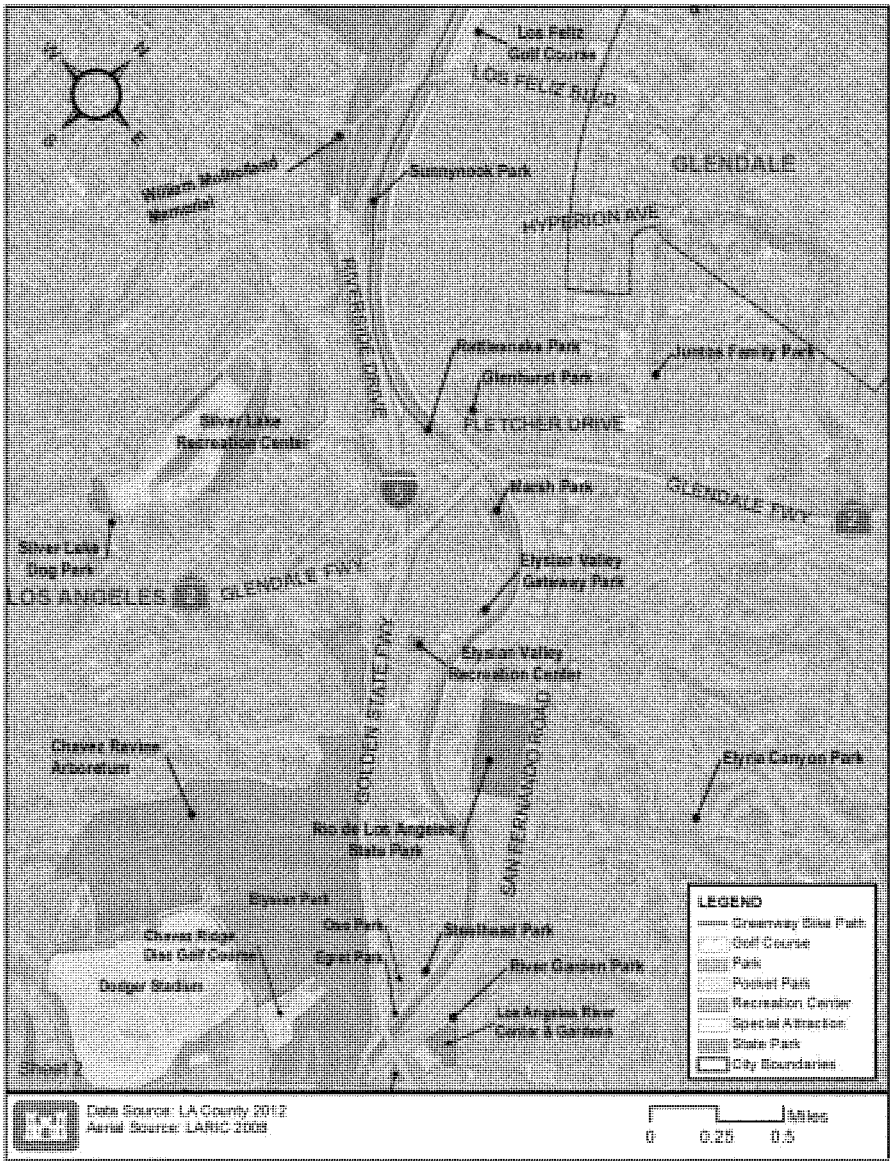


Figure 3-16 Recreation, Reaches 1-3



1 **Figure 3-17 Recreation, Reaches 4-6**

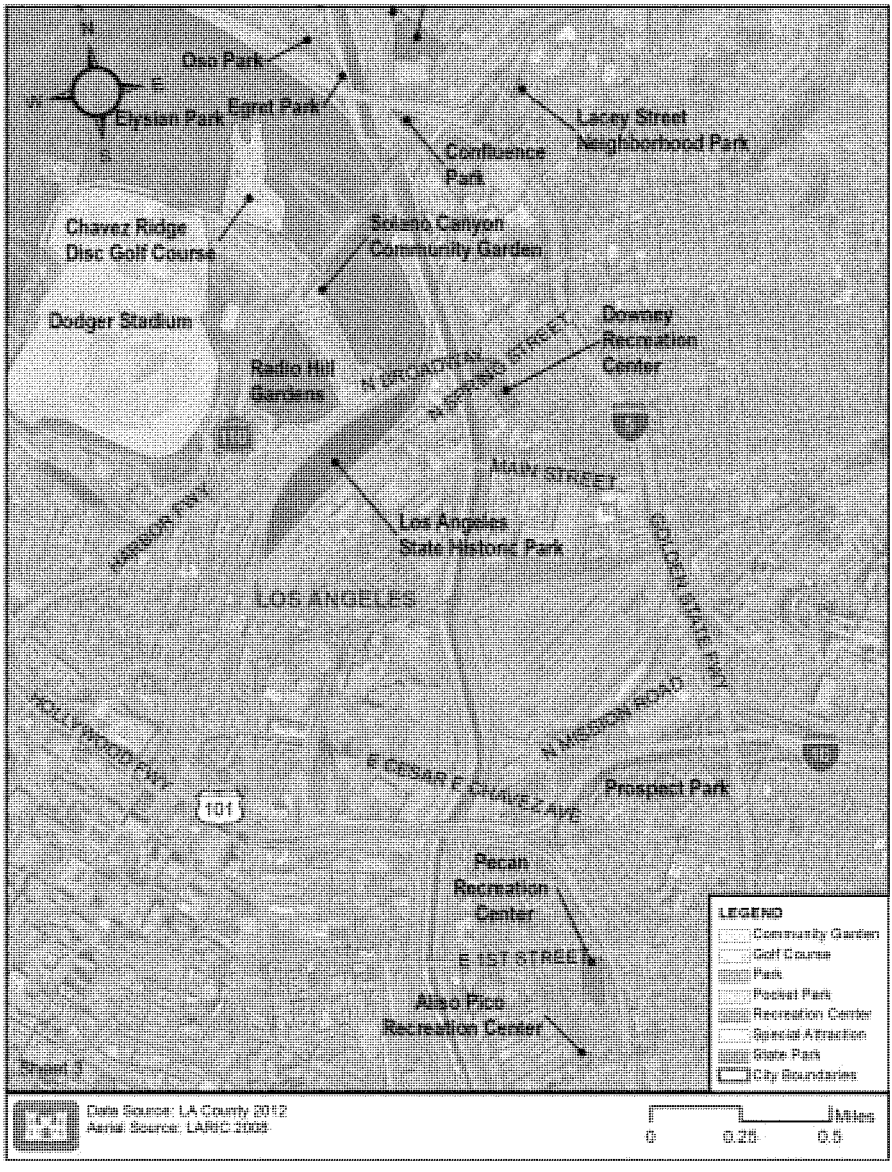


Figure 3-18 Recreation, Reaches 7-8

3.10 AESTHETICS

Aesthetic resources are generally defined as both natural and built features of the landscape that contribute to the public experience and appreciation of the environment. These include the urban and scenic characteristics which are observable from within the study area and which can be seen when looking at the area from the surrounding space. For the purposes of this report, visual resources in the study area include the channel of the River, its surrounding areas of residential, commercial, and industrial development, and open space, as well as the more distant areas that can be viewed from the River, including downtown Los Angeles, Griffith Park, Elysian Park, and the Verdugo Hills. This section will also consider the olfactory conditions that currently exist in the study area. The aesthetics of the study area affect local residents and visitors, those employed in or visiting adjacent buildings, recreationists at adjacent parks and golf courses, and travelers on the many surrounding highways, railways, surface streets, bikeways, and sidewalks.

Visually, the River and floodplain have changed dramatically from their historic appearance. The once free-flowing River has been channelized and surrounded to a large extent by impervious surfaces and highly urbanized areas. Sand banks and willow riparian zones have been widely replaced with concrete, stone, and asphalt. Roadways, homes, industrial areas, businesses, rail yards, parks and golf courses have replaced the historic floodplain.

Within the River, aesthetics are dominated by the trapezoidal concrete or hardened channel, urban development at the top of the banks, fluctuating water flows, debris and graffiti, and intermittent vegetation within the channel. The entire length of the study area has concrete or hardened walls, intermittently broken by stormwater outfalls or confluences with tributaries. The majority of the reaches within the study area also have a concrete bottom. This vast concrete expanse attracts graffiti artists and homeless encampments, which compromise the visual quality of the area for many residents. Homeless encampments are common within the river channel within the study area, particularly in Reaches 6 and 7.

Businesses, neighborhoods, and parks along the River are generally not oriented to view the River, and it is difficult to see the River from just beyond the top of the bank. The lack of visual connection to the River facilitates continued vandalism and camping, and also contributes to the River as a dumping ground for debris. Plastic bags, shopping carts, and beverage containers are just a few of the types of litter that are abundant within the River in all reaches, though reaches with vegetation tend to retain litter and debris more efficiently than other areas.

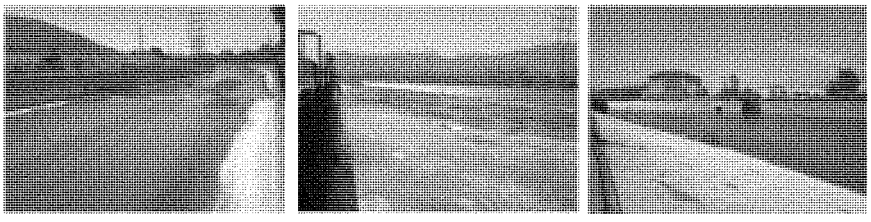
In general, water fluctuations change the view of the River from a flowing stream several feet deep in the winter and spring months to a shallow trickle in the summer. However, where non-concrete river bed is present, water levels can fluctuate in comparison to concrete bottom areas throughout the year. Water from the Tillman Treatment Plant and the Los Angeles/Glendale Water Reclamation Plant, and stormwater from surrounding cities, are discharged into the River. During the summer months these inputs may be the only source of water in the River and as a result, water levels may change several inches throughout the day based on these releases. The effluent released from the Tillman Plant that is the primary source of water is tertiary treated, reducing nutrient levels in the water. Trash, industrial air and water discharges, and motor vehicle exhaust occasional contribute to odors within the area.

Vegetation has become established within the study area including both those areas with a natural river bed and those that have been fully channelized. As cracks develop in the concrete or channel hardening materials, or as debris becomes lodged in the River, plant seeds are caught and vegetation begins to grow. Wide swaths of vegetated areas have become common.

Around the River are the Cities of Los Angeles, Glendale, and Burbank and their associated development, traffic, and utility corridors. In some cases, utilities pass over the River or utilize its path as a corridor. Green spaces are composed primarily of parks and golf courses, which are most abundant in the upstream reaches and diminish in size and quality moving downstream. From the River, views may extend out to include portions of downtown Los Angeles, the hills of Elysian Park and Griffith Park, and on a clear day, the distant Verdugo Mountains. Views from the upper reaches often include Griffith Park in particular, which rises above the study area to the west and offers a hilly, forested backdrop to the local views. Lighting in the area is provided along the River bike path, the surrounding surface streets, parks and sports fields. The River itself is lighted only where lighting incidentally broadcasts over the River. Continual fluctuations in nighttime lighting occur due to motor vehicle headlights.

3.10.1 Study Area Details

The aesthetic resources of Reaches 1-3 include views within the River of concrete channel walls in trapezoidal and box configurations, overpasses, utilities, and sparse vegetation. From the channel overbank areas, views are generally from the bike path and are largely limited to the channel, power lines on the right bank, Los Angeles Equestrian Center, Bette Davis Park, Ferraro Soccer Fields, and highway infrastructure. Views into the River are briefly afforded to passing motorists along SR-134 and I-5.



Left to right: River channel looking upstream near Pollywog Park (Reach 1). Looking southwest toward hills of Griffith Park (Reach 2). View from Ferraro Fields (Reach 3) to the northeast looking over the River.

Cyclone fencing runs along much of the length of both banks and very little vegetation is present in the historic riparian zone. Graffiti, trash, debris, and encampments are most abundant where the Riverside Drive and I-5 overpass pilings back up debris and trash, and allow vegetation to become established. Verdugo Wash was recently scraped to remove all vegetation at the confluence with the River. In some places, long range views are accessible from the study area in these reaches. Where there are no obstructions to the view, the green hills of Griffith Park can be seen and the even more distant Verdugo Mountains are sometimes visible.

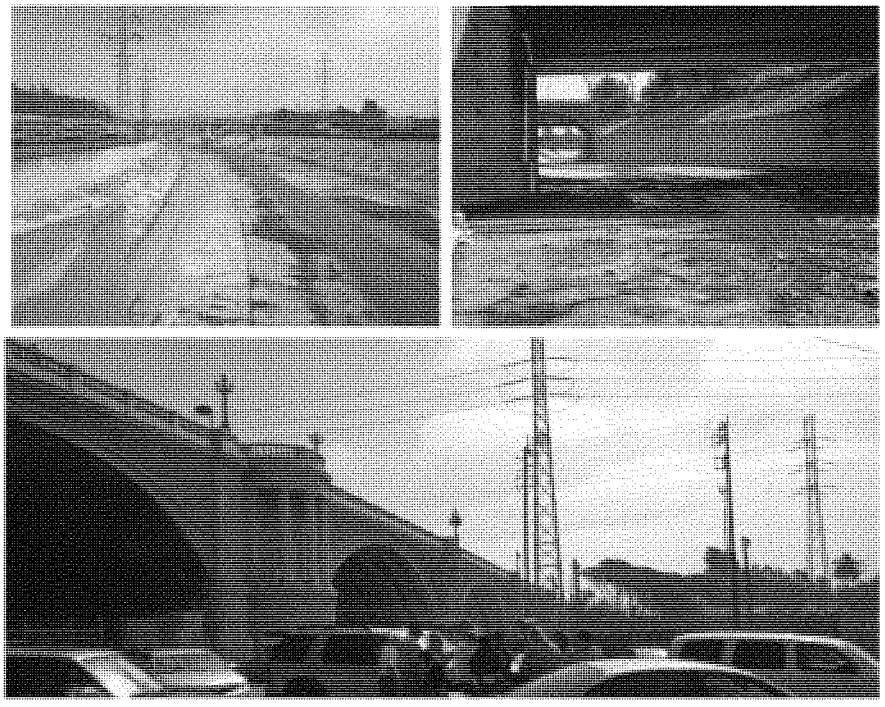
Reaches 4-6 are generally soft bed and have amassed enough vegetation to create habitat within the channel. The channel through this area appears more natural than other areas; thick growths of cottonwoods and willows occur along the margins of the channel, and both low elevation mats of vegetation and large trees islands occur within the channel. Trapezoidal hardened banks occur throughout the length of these reaches.

Again, visual conditions within the channel and overbank area are generally limited to the immediately adjacent area. The bike path offers the best access and from here views are dominated by the channel itself, the vegetation within the channel, trash, debris, graffiti, power lines, and roadway infrastructure. Views of the River are possible from overpasses and adjacent roads including Colorado Boulevard, Los Feliz Boulevard, Hyperion Avenue, Fletcher Drive, SR-2, and I-5.

Top Left: Vegetation mats growing in the soft bed channel near Los Feliz (Reach 4). Top Right: Hardened trapezoid banks (Reach 4). Bottom: Channel along Taylor Yard overgrown with non-native giant reed and fan palms (Reach 6).

In some areas, the forested and scrub-shrub habitats of Griffith Park and Elysian Park can be seen rising in the west, though they are both separated from the River by roads and other development. Atwater Park just south of Chevy Chase Drive is the only overbank park with an open connection to the River. All other green spaces are fenced off from the channel area.

Moving south, Taylor Yard on the left bank comprises a large area of Reach 6 and dominates much of the visual landscape from within the River channel here. Long range views from unobstructed areas allow visitors to glimpse the distant Verdugo Mountains on a clear day. From some spots within these reaches, it may be possible to also view the skyscrapers rising from downtown Los Angeles.



Top left: Looking north from First Street downtown (Reach 1). Top right: Looking upstream into the Arroyo Seco confluence (Reach 7). Bottom: North Broadway Bridge near Cornfields (Reach 7).

South of I-5, Reaches 7 and 9 are once again a concrete trapezoidal channel with a concrete bottom. Decreasing vegetation and increasing industrial areas give this reach a dominantly urban aesthetic; rail yards, warehouses, parking lots, and overpasses are abundant. The lack of vegetation, both within the River and along the overbank areas, contributes to this apparent absence of any natural areas. Graffiti, trash, and encampments further deteriorate the appearance.

Aesthetic value is provided by a series of Art Deco and Classical Revival style bridges that span the River, including those at North Broadway, North Spring Street, and Main Street, which are also the most publicly accessible areas from which to view the River (Los Angeles County 1996). Other architectural samples or cultural resources are sparse. Businesses and industry in this reach have opted to orient away from the River, or have been disconnected from the River by railways. Views of the River itself are not currently an attractive value for businesses. Views of downtown Los Angeles buildings are possible from these downstream reaches. However, flat elevations and the urban infrastructure around the study area generally obstruct much of the downtown view, as well as long range views of surrounding mountain ranges.

The section of SR-110 in the area has been designated as a National Scenic Byway by the Federal Highway Administration (FHWA) due to its historic significance (U.S. Department of Transportation

2012). Built prior to 1945, the California Streets and Highways Code lists this section of highway as a Historic Parkway (Section 280).

3.11 PUBLIC HEALTH AND SAFETY INCLUDING HAZARDOUS, TOXIC AND RADIOACTIVE WASTE

This section is a discussion of conditions in the study area related to public health and safety. The public health and safety topics of concern for this evaluation are: water safety; wildfire; methane zones; vector borne-diseases; and hazardous, toxic and radioactive waste (HTRW).

3.11.1 Public Health and Safety

Los Angeles River Water Safety

Under normal conditions, the River usually contains a low volume of slow-moving water which is often restricted to a concrete slot in the centerline of the channel bottom or a shallow depth in soft bottom reaches. However, during periodic storms, the channel volume increases with rapidly-moving water from the upper watershed and stormwater runoff. During and following these storms, water levels and flow velocities in the River channel rise quickly, without warning, dramatically increasing the risk of accidental death and injuries to people and animals venturing into the channel. Much of the River is fenced and signed to prevent accidental injury or death.

The Los Angeles Fire Department (LAFD) has a Swiftwater Rescue team of personnel specially trained and equipped to respond to water-related emergencies (LAFD 2012). The Glendale Fire Department, Burbank Fire Department, and the Los Angeles County Fire Department also have swiftwater rescue capabilities (Glendale Fire Department 2012, Burbank Fire Department 2011, Los Angeles County Fire Department 2012).

Access points to the River corridor in Reaches 1-3 include Griffith Park, Bette Davis Park, and at Los Feliz Blvd., where pedestrians and cyclists are able to enter through gates onto the paved paths along the River. Access at Reaches 4-6 is offered near North Atwater Park, the pedestrian bridge at Sunnynook St., and residential areas that border the River. Access points along the more industrial downstream reaches (7-8) are limited by private and commercial properties, though surface streets do come near the River.

Wildfire

Portions of the study area are designated as very high, high, or moderate fire hazard severity zones (Figure 3-19). Fire is more likely to occur in these areas than in other areas due to the type of vegetation, topography, weather, and other conditions. Fire hazard severity zones are established by city ordinance. Such zones are prone to incidence of wildfires, which may be caused either by natural forces, such as lightning, or by human negligence or mischief. Very high, high, and moderate fire hazard severity zones are present in the study area throughout much of Griffith Park and Elysian Park. No very high, high, or moderate fire hazard severity zones are present in Reaches 7-8.

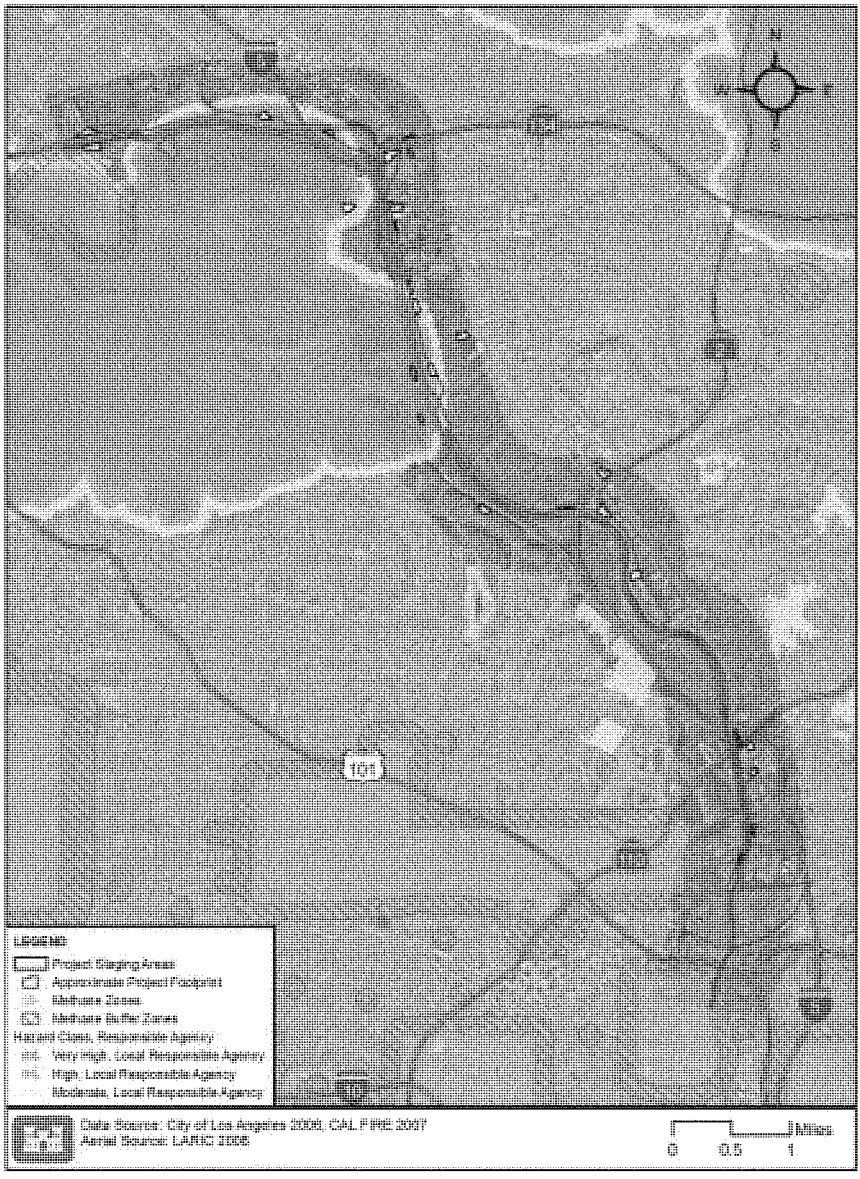


Figure 3-19 Fire Hazard and Methane Zones

Methane Zones

Methane gas is found below ground in proximity to methane gas sources such as former landfills and naturally-occurring petroleum deposits. Methane gas can be harmful if inhaled or can cause a fire or explosion under certain conditions. The City of Los Angeles has established methane gas zones and methane gas buffer zones under LAMC Section 91.7101 *et seq.* Portions of the study area are in such zones, as shown in Figure 3.18. Projects occurring in these zones must test for methane gas prior to construction and mitigation measures may be required to reduce health and safety hazards.

Methane zones occur east of I-5 and south of SR-134 and the buffer zone for this area overlaps the River (Reach 1). Methane zones may be present in Glendale or Burbank; however, a map of these zones was not available. There are no methane zones in Reaches 4-6. In Reach 7 a methane zone that overlaps the study area is located south of the intersection of I-110 and I-5. Several small methane zones overlap the study area in Reach 8 between Alhambra Ave. and the southern end of the study area at 1st St.

Vector-Borne Diseases

A vector is an animal or insect such as a rodent or mosquito that can transmit a disease to another animal or to humans. Vector-borne diseases are diseases that can be transmitted to humans from contact with a vector. The Greater Los Angeles County Vector Control District (GLACVCD) is a public health agency that works to keep the area in its jurisdiction free of vector-borne health threats. The GLACVCD is one of five mosquito and vector control districts in Los Angeles County serving approximately 6 million residents in a 1,330 square mile area that includes Los Angeles and Glendale. The GLACVCD provides mosquito abatement, disease surveillance, and public health outreach (GLACVCD 2012a).

Mosquitoes, black flies, and midges breed in water and may be found in the study area, though black flies and midges are not disease vectors in California. Mosquito-transmitted diseases that are of concern in Southern California are West Nile virus, Saint Louis encephalitis, western equine encephalomyelitis, malaria, and heartworm (heartworm affects dogs and cats, but rarely humans). With the exception of West Nile virus, incidences of these diseases are rare (GLACVCD 2012a). In 2011, there were 44 human cases of West Nile virus and 2 fatalities in the GLACVCD's jurisdiction (GLACVCD 2012b). As of September 2012, 12 human cases of West Nile virus and no fatalities have occurred (California West Nile Virus Website 2012).

3.11.2 Hazardous, Toxic and Radioactive Waste (HTRW)

The USACE prepared an HTRW survey report for the proposed project as required by Engineering Regulation 1165-2-132 (Appendix K). The study area is in a densely populated area with a history of manufacturing and industrial land use. A large number of HTRW cases listed in regulatory databases were initially identified. From these, 22 open cases were determined to overlap the study area. One additional site of localized groundwater contamination in remediation at the Comfields site was determined through other document searches. The LATC site is also anticipated to contain HTRW contamination, based on its similarity in historical use to Taylor Yard, for a total of 22 known and 1 likely HTRW sites in the study area. The site locations are depicted on figures found in Appendix K. As shown in Table 3-17, 3 of the 23 relevant HTRW sites have a high impact within the study area due to the larger size of the contaminated area compared to the others and their likelihood of overlapping with project features. The three high impact sites are the San Fernando Valley Superfund Site and Taylor Yard sites G1 and G2. The LATC site is also a site of concern with potentially high levels of contamination based on its historical uses, although there are no public records available for that site. The USACE determined that the other 19 sites are of low impact and have a moderate amount of overlap within the study area; they are in various stages of remediation, and contamination is not as widespread at those sites. Each of the three known and one suspected high impact site is discussed below.

Table 3-17 Relevant HTRW Sites

Site*	Database in which Case is Listed	Extent of Overlap with Study Area
San Fernando Valley Superfund Site	NPL	High
Taylor Yard G1	DTSC	High
Taylor Yard G2	DTSC	High
Former Manufactured Gas Plant	DTSC	Moderate
Former Manufactured Gas Plant	DTSC	Moderate
Bortz Oil	DTSC	Moderate
San Fernando Consolidated Facility	LARWQCB	Moderate
Three Chevron Gasoline Stations	LARWQCB	Moderate
Former Bortz Oil	LARWQCB	Moderate
Shell Gas Station	LARWQCB	Moderate
Former Triangle Gasoline Station	LARWQCB	Moderate
Former Hawkes Finishing	LARWQCB	Moderate
Mount Sinai Forest Lawn Cemetery	LARWQCB	Moderate
Former Albion Dairy	LARWQCB	Moderate
Burlington-Northern Santa Fe Tower	LARWQCB	Moderate
Valspar Corporation	LARWQCB	Moderate
Chromal Plating and Grinding Company	LARWQCB	Moderate
Infinity Outdoor Company	LARWQCB	Moderate
Gannett Outdoor System, Inc.	LARWQCB	Moderate
Metropolitan Transportation Agency	LARWQCB	Moderate
Morton International Whittaker Corporation	LARWQCB	Moderate
Union Pacific Railroad – Cornfield Yard	LARWQCB/DTSC	Moderate

Source: USACE 2013

* Although some sites have similar names, each listing in the table represents a different regulatory case.

DTSC = (California) Department of Toxic Substances Control; LARWQCB = Los Angeles Regional Water Quality Control Board; NPL = National Priorities List

The San Fernando Valley Superfund Site overlaps parts of the northern portion of the study area from Reach 1 to Reach 4. Shallow groundwater in the area is contaminated with various chlorinated VOCs, specifically TCE and PCE. The Environmental Protection Agency (EPA) completed a basinwide remedial investigation and is working with state and local agencies and other responsible parties to prevent exposure to contaminated groundwater, provide alternate sources of drinking water, determine the extent of the contamination, and address contamination through remediation and monitoring. Remedies to address VOC contamination have been operating since 2000. Several areas of known groundwater contamination near the River are being treated by extracting groundwater and treating it at the surface. Groundwater extraction wells near the project area are at the Glendale and Pollock Treatment Plants and the Los Angeles Reclamation Plant. Although contaminant levels have been substantially reduced in many places, contaminants remain above safe drinking water levels and remediation is ongoing (CH2M Hill, Inc. 2009; EPA 2013). Investigation of chromium contamination are ongoing. Remediation is anticipated to continue for the next 50 years. The project site primarily overlaps the outer portions of the groundwater plumes, where contaminant concentrations are lower. The lateral extent of groundwater contamination from these contaminants is shown on figures in Appendix K.

Taylor Yard is a 243-acre rail yard that was used for about 100 years. The G1 (19 acres) and G2 (50 acres) sites are portions of this rail yard. At the G1 site, four areas with elevated levels of lead and arsenic in soil were identified. These were remediated to meet site remediation goals that satisfy human health standards for industrial properties but not ecological or recreational standards and the property was sold to the California Department of Parks and Recreation (Camp Dresser & McKee Inc. 2011).

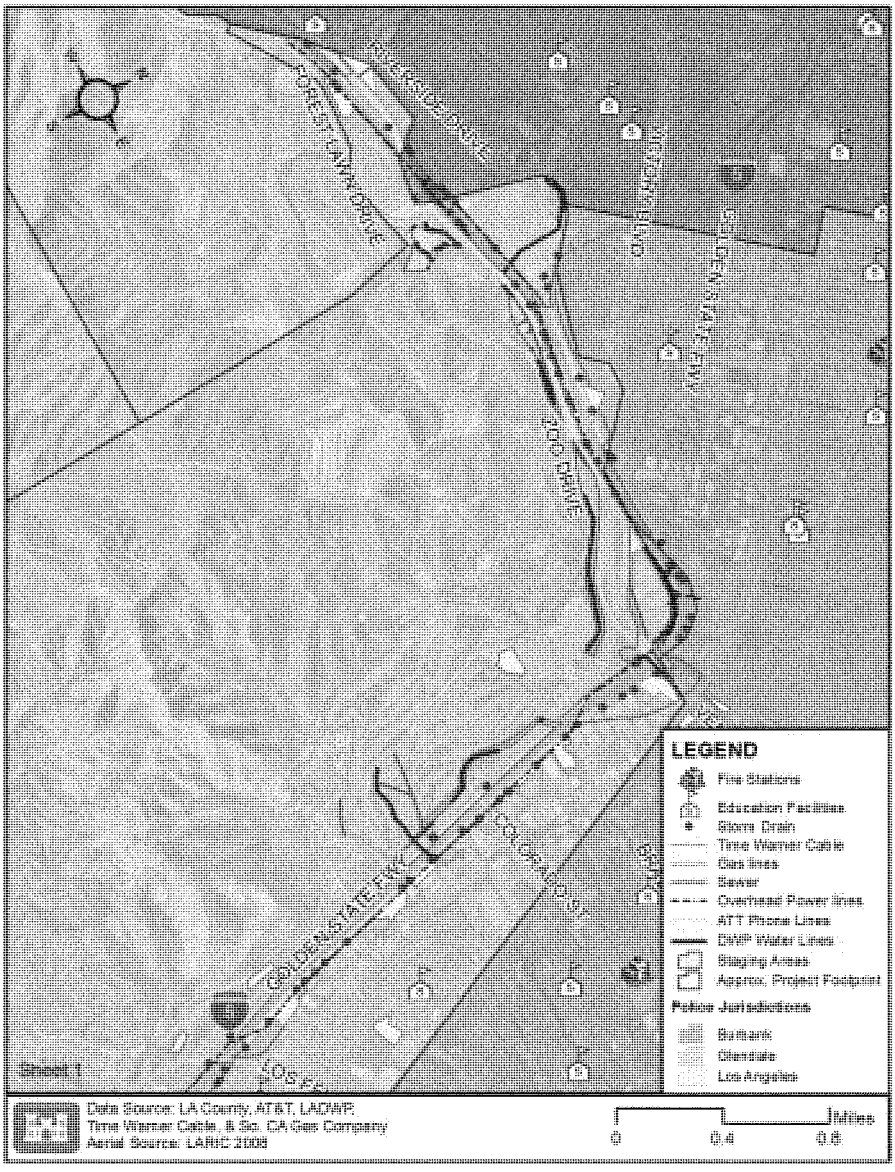
Remediation at the Taylor Yard G2 site is ongoing. The primary contaminants of concern at this site are metals, volatile organic compounds, semi-volatile organic compounds, and petroleum products. The contaminants are present in soil and groundwater. Remedial activities that have already occurred at the site include soil removal and soil vapor extraction. The Department of Toxic Substances Control (DTSC) approved a Feasibility Study for site remediation of the site in August 2012 (DTSC 2012). The project proponent will then prepare a remedial work plan and conduct additional remediation. When remedial activities are complete, soil with residual levels of contamination will remain beneath caps and building foundations. The site remediation goals will satisfy human health standards for industrial properties but not ecological or recreational standards (Camp Dresser & McKee Inc. 2011).

LATC is a modern railroad freight transfer yard. The USACE's HTRW survey found no records of any active or open CERCLA HTRW concerns or actions associated with this property. However, the City of Los Angeles has indicated that there are remaining HTRW concerns regarding the LATC property. In a 1953 USGS topographic map, a portion of LATC is identified as a railroad maintenance yard, the same identifier used for Taylor Yard. Because LATC and Taylor Yard were in use as railroad maintenance yards at the same time, similar activities likely occurred on both properties. Also, historical maintenance activities were the source of much of the contamination at Taylor Yard. Therefore, although there is no record confirmation of HTRW issues at LATC, some HTRW is likely to exist at the site.

Despite a records review to identify HTRW sites of concern, it is possible that additional contaminated soil or groundwater is present in the study area, and the study area will be subject to further investigation as described in the HTRW appendix. Because the current configuration of the channel was created by both deepening and widening the natural channel, any contaminated sediments in the channel prior to construction of the flood risk management structures are likely to have been removed by these grading operations. Discharges into the river today from storm drains are regulated by permits issued by the Regional Water Quality Control Board . However, no investigation or sampling has been conducted of channel sediments at this time.

3.12 UTILITIES AND PUBLIC SERVICES

This section discusses the utilities infrastructure and public services in the study area. Utilities addressed in this section are electricity, water supply, sewer and wastewater treatment facilities, stormwater, natural gas, and telecommunications. An overview of utilities in the study area is shown on Figure 3-20 to Figure 3-22. Nearly all the utilities in the study area are in Los Angeles; only a fraction of the utilities are in Glendale or Burbank. Accordingly, information about utilities in Glendale and Burbank is limited to a description of those utilities that are found in the study area.



1 **Figure 3-20 Utilities, Reaches 1-3**

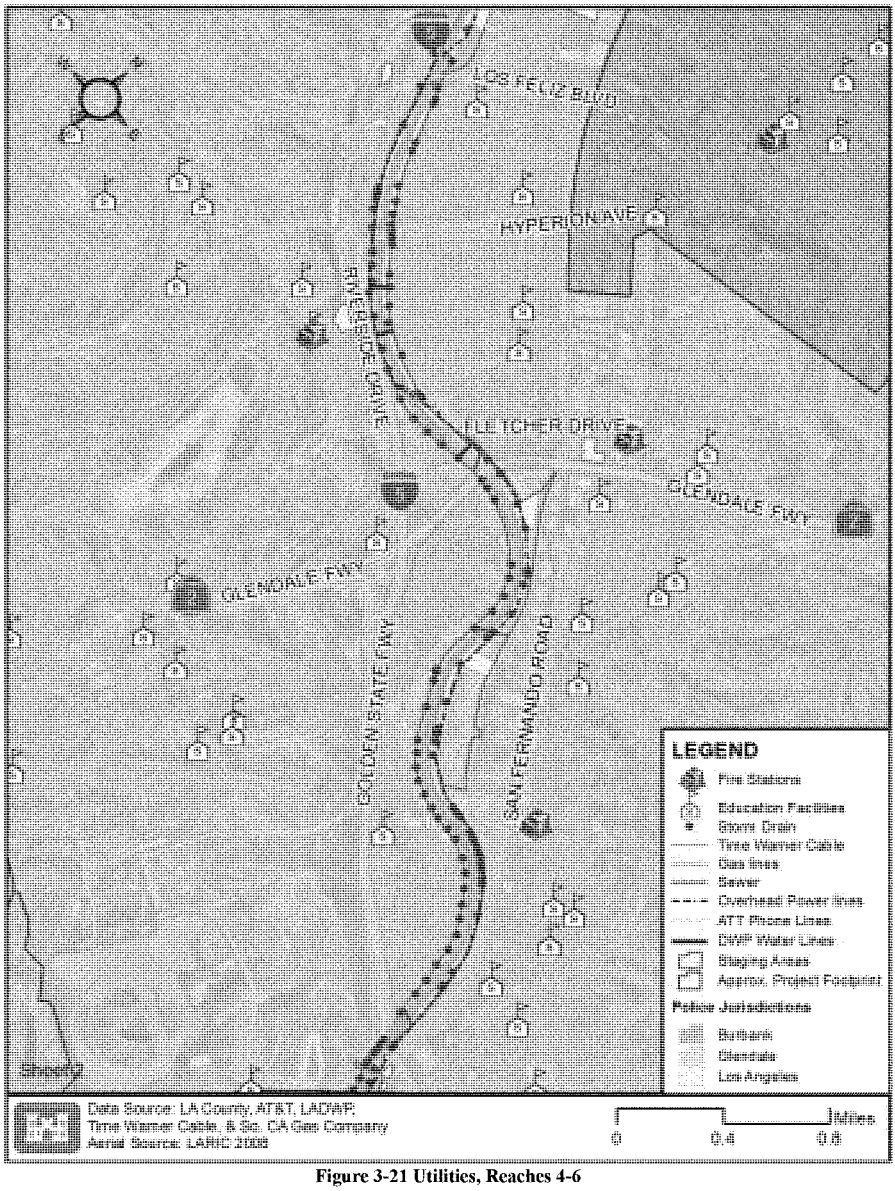


Figure 3-21 Utilities, Reaches 4-6

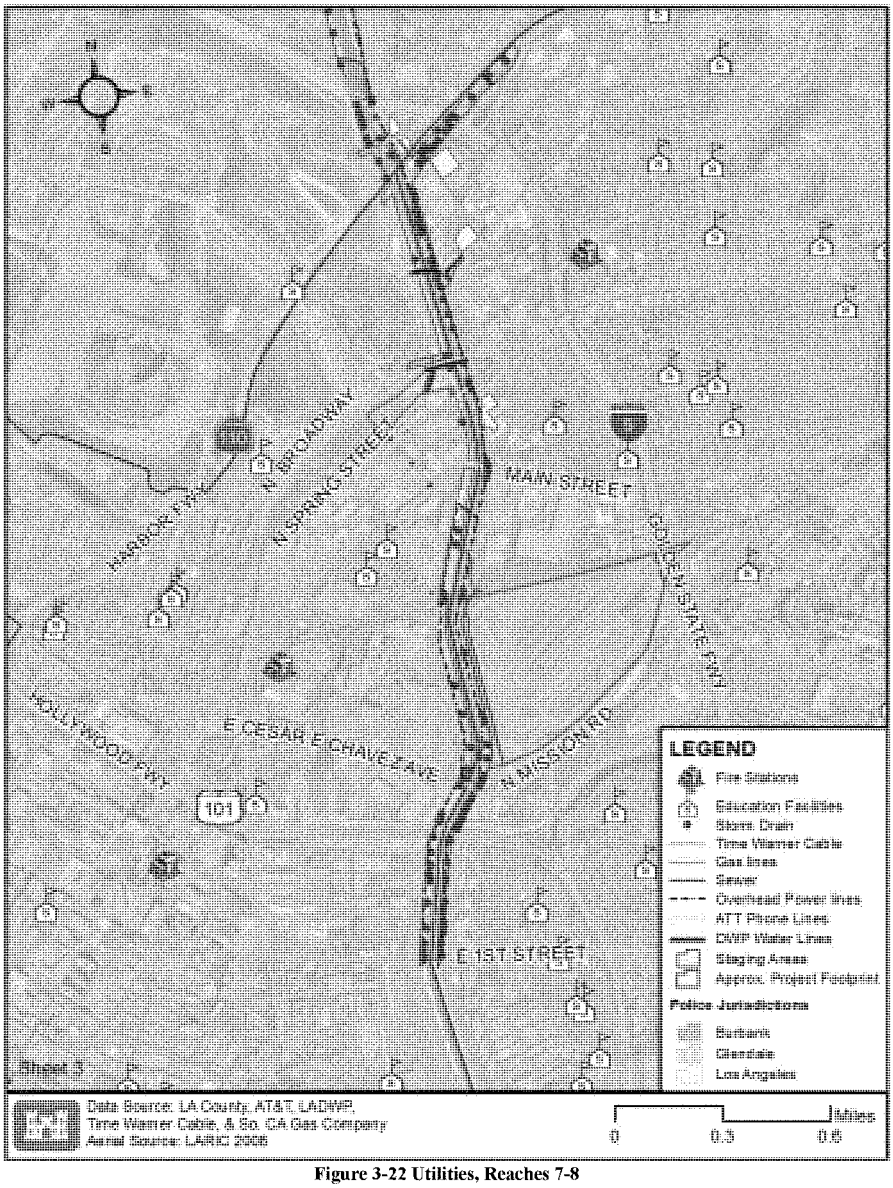


Figure 3-22 Utilities, Reaches 7-8

3.12.1 Electric Power

LADWP provides power to 3.9 million people in a 465-square-mile service area that includes Los Angeles. In addition to serving residents and businesses in their territory, LADWP uses its electricity to light public roads and power the water supply system.

LADWP holds powerline easements and rights-of-way along the River in the study area. Easements sometimes coincide with County ownership and flood risk management easements. Aboveground transmission lines run along the River through nearly all of the study area. Substations and service buildings are also present in the study area.

Reaches 1-3 LADWP above-ground transmission lines run along one bank of the River or the other through this portion of the study area. The transmission lines cross the River at five locations: near the equestrian bridge in Burbank, just downstream of the equestrian center, near the intersection of I-5 and SR-134, near Brazil Street, and just north of Los Feliz Boulevard. Although these lines are physically in Burbank for a short stretch in Reach 1 near the equestrian bridge, they are owned by LADWP. An electrical power plant and substation are in Reach 3 in Glendale on the left bank of the River south of Flower Street (City of Los Angeles 1996).

Reaches 4-6 LADWP above-ground transmission lines run along the right bank of the River, cross the River just north of Fletcher Drive, and then run along the left bank of the River for the remainder of this portion of the study area. An electrical substation is on the left bank of the River at the south end of Reach 5 just north of Fletcher Drive (City of Los Angeles 1996).

Reaches 7-8 LADWP above-ground transmission lines run along the right bank of the River until just south of Main Street, where the lines cross the River and run along both banks for the remainder of this portion of the study area. No electrical power plants or substations are in or near this portion of the study area (City of Los Angeles 1996).

3.12.2 Water Supply

LADWP provides water to Los Angeles's residents and businesses, over 60,000 fire hydrants, and for irrigation and recreation. Water supply and demand are central issues in arid and heavily populated Southern California. In Los Angeles, mandatory water conservation measures implemented in 2009 have reduced demand; at the same time, the increasing population increases demand. Overall, the demand for water is still increasing, although at a slower rate than before water conservation became a widespread practice. Los Angeles's 2010 Urban Water Management Plan projects a 1 percent average annual water demand growth rate over the next 25 years. Projected water demand can vary up to 5 percent from the baseline forecast depending on weather (LADWP 2011, 2012d). Water supply lines are present throughout the study area. The water lines range in diameter from 6 inches to 69 inches and cross the River in 13 locations (Figure 3-20 to Figure 3-22).

Los Angeles's Integrated Resources Plan, adopted in 2006, recognizes that water supply, wastewater (including recycled or reclaimed water), and stormwater are interdependent systems and provides an integrated approach to infrastructure planning and management. The plan establishes the water infrastructure requirements to adequately serve the City's residents given projected population growth (Bureau of Sanitation and LADWP 2006). The Greater Los Angeles County Region Integrated Regional Water Management Plan, which takes an even wider view at integrating the region's approach to addressing its extremely complex water quality and water supply issues and planning for appropriate infrastructure (Leadership Committee of Greater Los Angeles County Integrated Regional Water Management Plan 2006).

Water lines cross the River in five locations: in Burbank near the equestrian bridge, at the equestrian center, near Flower Street, at SR-134, and near Goodwin Avenue All of the crossings are below the River, with the exception of the SR-134 crossing, which is part of the street bridge.

Reaches 1-3 Burbank Water and Power (BWP) is the municipal utility that provides drinking water to the portion of study area in Burbank. BWP's supply consists of imported water purchased from the Metropolitan Water District of Southern California, groundwater, and recycled water that is produced at the Burbank Water Reclamation Plant. Burbank's water system is composed of approximately 280 miles of pipelines ranging in size from 1.5 to 30 inches in diameter as well as booster pumps, reservoirs, and wells (BWP 2011). A water supply line in the study area briefly traverses a portion of Burbank in Reach 1 near the equestrian bridge.

Reaches 4-6 Water supply lines run along the left bank of the River in some places. Water lines cross the River in three locations: at Tyburn Street, just south of Garcia Street, and between Fletcher Drive and SR-2. The Tyburn Street water line is above-ground while the other two crossings are under the River.

Reaches 7-8 Water supply lines cross the River in three locations: at the North Figueroa Street Bridge, near the railroad bridge near Humboldt Street, and at the North Broadway Bridge. The crossing near the railroad is under the River while the other two crossings are part of the street bridges.

3.12.3 Wastewater

The Los Angeles Bureau of Sanitation is responsible for installing, operating, and maintaining the City's wastewater infrastructure. The Bureau's wastewater program provides collection, conveyance, treatment, and disposal of 550 million gallons of wastewater per day for over four million people in a 600-square-mile area. Treatment plants near the River contribute the bulk of the daily flow. Though Tillman Treatment Plant is not within the study area, it contributes 291 cfs to the River on average throughout the year. This plant is a tertiary treatment nitrification/denitrification, disinfection, and dechlorination facility. This is highly treated effluent and suitable for use in irrigation, in lakes and in discharge to the river. The Bureau maintains over 6,500 miles of sewer pipelines between 6 inches and 12 feet in diameter. Wastewater entering the sewer system is routed to and treated at one of four treatment and water reclamation plants including the Los Angeles-Glendale Water Reclamation Plant in the study area (Bureau of Sanitation 2012a).

A major sewer line, the Northeast Interceptor Sewer, runs near the River from south of SR-2 to the southern end of the study area and crosses beneath the River bed just north of the Glendale Freeway through part of study area in Reaches 4-8. Another major piece of sewer infrastructure, the North Outfall Sewer, runs the length of the study area. Service access shafts for these major sewer lines are within a half mile of the River (LADPW 2012a).

Sanitary sewer lines that transport wastewater to treatment plants are present in the study area. The sewer lines range in diameter from 6 inches to 96 inches and cross the River in seven locations.

Multiple sewer lines are near the equestrian center, crossing the River several times. Sewer lines are near SR-134 in Griffith Park and cross the River along the SR-134 overcrossing near the intersection with I-5. A sewer line runs west of I-5 at Harding Golf Course.

The Glendale Department of Public Works is responsible for the sewer infrastructure in the study area within Glendale. Glendale's sewer system has approximately 360 miles of sewer lines (Glendale Department of Public Works 2012). A sewer line in the study area briefly traverses the River in a portion of Glendale in Reach 3 near SR-134.

The Burbank Department of Public Works owns and operates the sewer infrastructure in the study area within Burbank. A sewer line in the study area traverses the River in a portion of Burbank in Reach 1 near the equestrian bridge.

The Los Angeles-Glendale Water Reclamation Plant is in the study area on the left bank of the River south of Colorado Boulevard. The plant serves the eastern San Fernando Valley, portions of Los Angeles, and the Cities of Glendale, Burbank, and La Crescenta. The plant treats approximately 20 million gallons of wastewater per day. The stringent treatment process results in some water that is suitable for reuse for irrigation and industrial processes, which conserves over a billion gallons of potable water per year (LADPW 2012b).

Sewer lines run near the left bank of the River from Fletcher Drive to SR-2, crossing the River just north of SR-2. Sewer lines also cross the River at Newell Street and just upstream of I-5.

Sewer lines run near the left bank of the River from SR-110 to Humboldt Street and in LATC area (from the railroad overcrossing west of Alhambra Street to Cesar E Chavez Avenue). Sewer lines are near the right bank of the River near North Broadway. No sewer lines cross the River in this portion of the study area.

3.12.4 Stormwater System

The primary purpose of the stormwater system is to manage stormwater runoff to prevent flooding. Los Angeles's stormwater system consists of a network of approximately 35,000 catch basins (points where water enters the system), over 1,500 miles of underground pipes, and 100 miles of open channels. The stormwater system is mostly separate from the sewer system and much of the water that enters the stormwater system is not treated or filtered, although the City operates low-flow diversions in selected locations which direct dry weather urban runoff to the sanitary sewer system for treatment. Stormwater is captured in local catch basins, travels through local pipes, drains into larger channels such as the River and Ballona Creek, and eventually is discharged to the Pacific Ocean (City of Los Angeles Stormwater Program 2012).

The City's stormwater system averages 100 million gallons of water flow on days without rain. When it rains, the amount of water flowing through the system can increase to 10 billion gallons (City of Los Angeles Stormwater Program 2012). Portions of the City's stormwater system do not have the required capacity to handle a 10-year rain event, which is the maximum volume of rain expected to occur once in a 10-year period (Troyan 2003).

There are 283 stormwater outfalls throughout the study area that allow stormwater to enter the River. They range in size from 2 inches to 108 inches in diameter. The outfalls include multiple types of pipes, spillways, flap gates, and drainage ditches.

There are 70 stormwater outfalls along Reaches 1-3, ranging in size from a 12-inch-diameter pipe to a 15-foot by 15-foot box. Stormwater features along these reaches include pipes, spillways, and flap gates constructed of clay and reinforced concrete. Four stormwater outfalls are in Burbank and three are in Glendale. The Glendale and Burbank Departments of Public Works manage their respective stormwater infrastructure. There are 104 stormwater outfalls along Reaches 4-6, ranging in size from 6-inch-diameter pipe to a 12-foot by 11-foot box. Stormwater features along these reaches include pipes, spillways, flap gates, and ditches constructed of plastic, steel, and reinforced concrete. Reaches 7-8 have 109 stormwater outfalls along this section, ranging in size from 2-inch-diameter pipe to two 8-foot by 8-foot square boxes. Stormwater pipes along these reaches are constructed of iron, steel, and reinforced concrete.

3.12.5 Natural Gas

The Southern California Gas Company provides natural gas to 20.9 million people in a 20,000-square-mile service area that includes the study area through a series of transportation, distribution, and storage facilities. Its operations are regulated by the California Public Utilities Commission (Southern California Gas Company 2012).

Natural gas lines cross the River at Victory Boulevard, Fletcher Drive, North Figueroa Street, East Cesar E. Chavez Avenue, and just north of First Street via dedicated utility crossing. No natural gas lines run north-south along the banks of the River in the study area.

3.12.6 Telecommunications

Telecommunications infrastructure consists of both wired and wireless means of providing telephone, television, and internet service. Wired services include both overhead and underground lines. Wireless infrastructure includes towers containing antennas, and satellites that transmit wireless signals.

Time Warner Cable aerial lines are near the equestrian center in Reach 1, where they run along the left bank for 1,800 feet and then cross the River to the right bank. Time Warner Cable lines again cross the River just south of Fletcher Drive and at I-5. AT&T telephone lines cross the River at North Figueroa Street, North Broadway, North Spring Street, and Main Street.

3.12.7 Public Services

Public services relevant to the project area are police and fire protection, emergency medical services, and schools. Los Angeles, Glendale, and Burbank each have police departments, fire departments, and public school districts that provide those services to their respective cities. The city fire departments also provide emergency medical services (i.e., ambulance or paramedic services), swift water rescue, search and rescue, and hazardous materials response. Fire stations near the project area are shown in Figure 3-20 through Figure 3-22.

3.13 SOCIOECONOMICS AND ENVIRONMENTAL JUSTICE

The study area is in a densely populated area of Los Angeles County with centers of substantial commercial and industrial activities. The study area contains a wide range of land uses and economic activities. Census tract and community level socioeconomic and demographic data are presented in this section. At the community level, data for the Cities of Los Angeles, Glendale, and Burbank are presented. Figure 3-23 displays the 35 census tracts, covering approximately 25.1 square miles, which are used to compute census tract level statistics. These census tracts were chosen by creating a 0.5 mile buffer on either side of the River and then including all census tracts that lie wholly or partially within it.

The description of the without-study economic conditions contained in the various sections below is based on the 2008-2012 American Community Survey as well as other regional and local data as available (U.S. Census Bureau 2012).

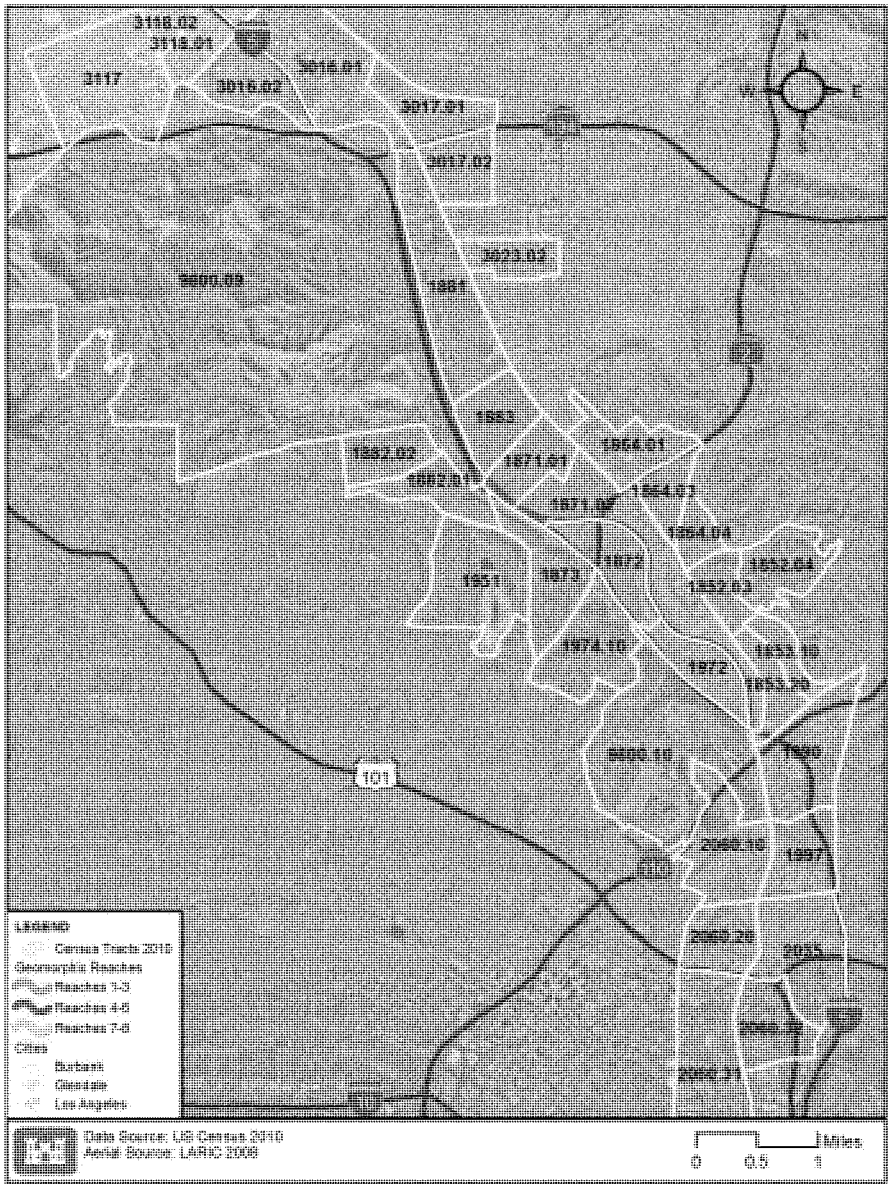


Figure 3-23 Study Area Census Tracts

3.13.1 Population and Housing

Los Angeles County spans over 4,700 square miles and has approximately 10 million residents (U.S. Census Bureau 2010b). Within the 35 census tracts in the assessment area, total population is estimated at approximately 127,000 residents, equating to an average density of 5,077 residents per square mile, about three times denser than the County as a whole. The population, density, and racial profile of the assessment area compared to adjacent communities and the County are provided in Table 3-18.

Table 3-19 show the recent and projected population for the County and Cities in the study area. For both, the rate of annual growth has generally been declining, and the County and City population rate of growth is projected to be around 0.3 percent by 2040 (Los Angeles County Economic Development Corporation [LAEDC] 2012).

Because the extent to which redevelopment and increased density will affect population in the socioeconomic assessment area has not been quantified, it is assumed that conditions in the assessment area will generally follow the same trends as the County and the City, with overall growth slowing throughout the period of analysis.

Housing in the socioeconomic assessment area is summarized in Table 3-20, which includes household, housing, and ownership metrics. Among the 35 census tracts, total housing units range from 0 to 2,707, with a total of 46,246 units in the assessment area, and an overall vacancy rate of 6.45 percent. The vacancy rate in the assessment area is 0.4 percent less than the City of Los Angeles, and 0.2 percent less than the County. Additionally, the assessment area contains a larger proportion of rental units, with only 33 percent owner-occupied units, compared to 38 percent in the City of Los Angeles and 47 percent in the County.

Table 3-18 Population, Density, and Race

Area	2010 Population[1]	Density (per square mile)	% White	% Black	% Hispanic	% Asian	% Other
City of Burbank	103,340	5,890	58	3	25	12	3
City of Glendale	191,719	6,405	62	1	17	16	3
City of Los Angeles	3,792,621	8,092	29	10	49	11	3
Los Angeles County	9,818,605	2,397	27	9	48	15	1
Assessment Area Tracts[1]	127,269	5,077	32	4	48	16	0

[1]The most recent complete data source was the 2008-2012 American Community Survey. Race information derived from tables "Hispanic or Latino and Race," where Hispanic includes all those identifying as Hispanic or Latino, and races are one-race statistics (White-Alone, Black-Alone, etc.) [1]Population is a sum. Race profile totals are weighted averages using population as the weights. Source: U.S. Census Bureau 2012.

Table 3-19 Population by Year

Year	Compound Annual Growth Rate (1)	Population (thousands)			
		Los Angeles County	City of Los Angeles	City of Burbank	City of Glendale
2000	-	9,540	3,695	100	195
2005	-	9,810	3,731	100	195
2010	-	9,819	3,796	103	192
2015[1]	0.65%	10,140	3,917	107	194
2020[1]	0.70%	10,500	4,056	110	205
2030[1]	0.59%	11,140	4,303	117	217
2040[1]	0.27%	11,450	4,423	120	224

(1) Growth rate from LAEDC 2012 and applied to area cities
Source: LAEDC 2012 and U.S. Census 2012

Table 3-20 Housing in the Study Area (2010)

Area	# Households	# Housing Units	% Vacant	% Owner-Occupied
City of Burbank	41,940	44,309	7.8	44.0
City of Glendale	70,710	76,269	7.3	39.2
City of Los Angeles	1,317,663	1,413,995	6.8	38.0
Los Angeles County	3,218,511	3,444,342	6.6	47.3
Assessment Area Tracts	43,262	46,246	6.5	33.0

Source: U.S. Census Bureau 2012.

3.13.2 Employment and Income

Los Angeles County has a highly diverse economy, with a gross annual product in 2010 of approximately $544 billion (LAEDC 2012), or approximately 29 percent of the gross annual product for all of California. Table 3-21 shows some of the basic economic indicators at the county and state level compared to the assessment area. Socioeconomic conditions in the assessment area are likely to reflect similar trends as the county and state. Trends over the last decade largely mimic the effects of the Great Recession that began in 2008 and has had national impact. California still has one of the highest unemployment rates in the nation, and this is reflected in parts of the assessment area, though on the whole, the most recently evaluated unemployment rate in the assessment area is about 2 percent lower than the unemployment rate for Los Angeles County (12.4 percent) and 2.6 percent lower than the City of Los Angeles. Within the census tracts making up the environmental justice communities, the unemployment rate ranges from 6.2 to 21.8 percent, with an average of 12.6 percent, nearly 50 percent higher than in the study area as a whole.

According to the Los Angeles County Economic Development Corporation (2012), Los Angeles County's economic base (based on the concept of exports of goods and services), in order of importance, resides in the entertainment, trade (transportation, logistics, distribution), business services, knowledge creation, and fashion industry clusters. While Los Angeles County had an estimated non-farm employment of 3.77 million in 2010, the Great Recession resulted in the loss of over 350,000 jobs and contributed to the high unemployment rate. Like the state overall, the LAEDC forecasts a slow but steady recovery for Los Angeles County.

Table 3-22 provides the aggregated employment by industry for the 35 census tracts in the socioeconomic assessment area. These data illustrate that while the largest industries in the County are entertainment and trade, employment in the assessment area is driven by the education, health care, social services, and professional and scientific industries.

Table 3-21 Comparison of Southern California County Economic Indicators (2010)

Area	Median Household Income	2010 Unemployment Rate	2010 Poverty Rate	2010 Median Home Value
City of Burbank	$67,693	9.2	8.5	$570,500
City of Glendale	$54,369	12.7	12.9	$597,000
City of Los Angeles	$49,745	13.0	21.2	$470,000
Los Angeles County	$56,241	12.4	17.1	$443,400
All of California	$61,400	12.8	15.3	$383,900
Assessment Area Tracts	$53,072	10.4	18.4	$485,100 (1)

(1) Average of assessment area tracts
Sources: U.S. Census Bureau 2012, U.S. Census Bureau 2011, LAEDC 2012.

Table 3-22 Assessment Area Employment by Industry (2010)

Industry	Percent
Educational services, and health care and social assistance	18.4
Professional, scientific, and management, and administrative and waste management services	13.3
Retail trade	10.8
Arts, entertainment, and recreation, and accommodation and food services	10.6
Information	9.3
Manufacturing	8.6
Construction	6.2
Other services, except public administration	5.3
Finance and insurance, and real estate and rental and leasing	4.9
Transportation and warehousing, and utilities	4.7
Public administration	3.7
Wholesale trade	3.7
Agriculture, forestry, fishing and hunting, and mining	0.5

Source: U.S. Census Bureau 2010b.

3.13.3 Environmental Justice

This section provides a discussion of environmental justice in accordance with Executive Order (EO) 12898 and the protection of children from environmental health risks in accordance with EO 13045. The ethnic data from the 2008-2012 American Community Survey and the 2010 Census (U.S. Census Bureau 2010a, 2012) for the census tracts comprising the assessment area, as well as Los Angeles County, are described below.

As outlined in a 2009 City of Los Angeles report, *Los Angeles River Access and Use: Balancing Equitable Actions with Responsible Stewardship*, "Many local organizations have stressed the importance of making sure that the River's revitalization addresses environmental justice issues (See, e.g., the City

Project's work at: www.cityprojectca.org.). Of key concern in Los Angeles is the growing disparity of access to and use of open space resources, including parks, ball fields, and natural areas by those living in low-income communities of color."

Within the census tracts that encompass the study area, the Hispanic or Latino population was the dominant group, with about 50 percent of the population. The Caucasian population was second, with about 30 percent of the population. Third was the Asian population, with 14 percent, followed by the Black population at 4 percent, and other races at 2 percent. Largely similar, the City of Los Angeles reported 49 percent Hispanic, 29 percent White, 11 percent Asian, 10 percent Black, and 1 percent other races. In the County, some differences become apparent, where the population is 60 percent White, 25 percent Hispanic, 10 percent Asian, 2 percent Black, and 1 percent other races.

In 2010, approximately 25 percent of the state's population was made up of children (those under 18 years old). Approximately 24 percent of the population in Los Angeles County was under 18 years of age (U.S. Census Bureau 2011). Within the 28 census tracts of the assessment area, approximately 22 percent of the population was under 18 years of age (U.S. Census Bureau 2010a).

As shown in Table 3-23, below, about two-thirds of the population's primary language spoken at home is a language other than English. About 41 percent of the population in the study area tracts speaks Spanish at home, 35 percent speak English, and the remaining 24 percent speak other languages. The substantial Spanish-speaking population is consistent with the demographic information summarized previously.

Table 3-23 Language Spoken at Home (Percentage in 2010)

Area	English Only	Other than English	Spanish	Other Indo-European languages	Asian and Pacific Islander languages	Other languages
Study Area Tracts	34.7	65.3	41.2	10.6	12.9	0.5
Los Angeles County	43.9	56.1	39.6	5.3	10.2	1.0
Burbank	55.9	44.1	20.1	16.0	6.3	1.7
Glendale	32.7	67.3	15.2	37.8	12.8	1.5
Los Angeles	40.3	59.7	43.6	6.7	8.1	1.4

Source: U.S. Census 2010, 2010a, and 2012. Percentages for study area tracts are based on a weighted average using population as the weights.

As shown in Table 3-24, below, poverty in the study area is generally consistent with regional data. Poverty in the study area is slightly lower than the City of Los Angeles, but about 3 percent higher than in the whole County. The portions of Burbank and Glendale within the study area have higher poverty rates than those cities do overall.

Table 3-24 People in Poverty (Percentage in 2010)

Area	All People	Under 18	18 to 64	Over 64
Study Area Tracts	18.5	28.0	16.2	15.6
Los Angeles County	15.4	22.1	13.5	10.7
Burbank	8.3	9.7	8.3	5.8
Glendale	12.3	16.4	10.8	13.1
Los Angeles	19.1	27.9	16.7	13

Source: U.S. Census 2010, 2010a, and 2012. Percentages for study area tracts are based on a weighted average using population as the weights.

Table 3-25 presents the percentage of people with disabilities in Los Angeles County, the City of Los Angeles, Burbank, and Glendale, as well as in the project area. The proportion of people with disabilities in the project area is 10 percent greater than in the County or City as a whole, 20 percent higher than Burbank, and slightly higher than Glendale. The proportion is also higher in all age groups than the corresponding rates in the County and the three cities.

Table 3-25 People with Disabilities (Percentage in 2010)

Area	All People	Under 18	18 to 64	Over 64
Study Area Tracts	10.4	3.2	7.3	41.8
Los Angeles County	9.3	2.8	7	38.1
Burbank	8.1	1.7	4.4	34.1
Glendale	10.1	0.9	6.4	44
Los Angeles	9.4	3	6.9	40.1

Source: U.S. Census 2010, 2010a, and 2012.

The information above does not illustrate the differences in race, poverty, and disabilities among the communities along the river. Census tracts with poverty rates above the Los Angeles City and County averages are found in the southern portion of Reach 6 and in most of Reaches 7 and 8, and along both sides of the Los Angeles River. Census tracts with percentages of non-white population above the City and County average are generally concentrated in Reaches 4 through 8, and generally along the eastside of the river (both sides in portions of Reaches 7 and 8). Finally, a look at disabled populations show a focus again in Reaches 6 through 8 (both sides of the river), as well as in Zones 2, 3, and 4 (east side of the river). When all of these factors are taken into account, the Environmental Justice communities can generally be found in the southern reaches of the project (Reaches 7 and 8), as illustrated in Figure 3-24. h Table 3-26 highlights the variables in the environmental justice communities compared to the study area, City of Los Angeles, and Los Angeles County.

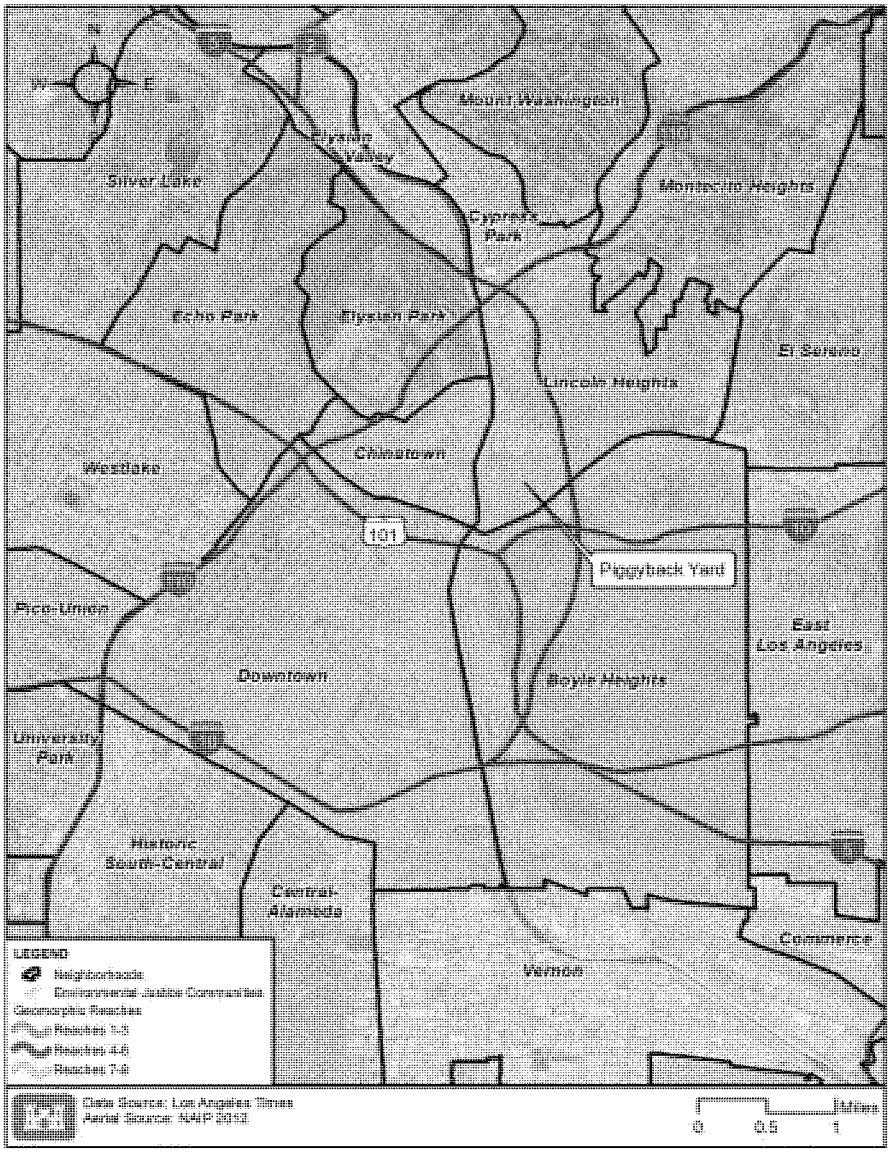


Figure 3-24 Environmental Justice Communities

1 **Table 3-26 Environmental Justice Criteria, Select Census Tracts (Percentages in 2010)**

Location	% Poverty	% Disabled	% Non-White
Los Angeles City	19.1	9.4	71
Los Angeles County	15.4	9.3	73
Study Area	18.5	10.4	70
Environmental Justice Community Census Tracts			
1853.10	**29**	9	**97**
1853.20	13	**13**	**96**
1990	**39**	**11**	**97**
1997	**40**	**13**	**94**
2035	**28**	**13**	**98**
2060.10	**49**	**11**	**96**
2060.31	**31**	**12**	59
2060.32	**37**	**13**	**97**
9800.1	**32**	**13**	60

Source: U.S. Census 2012
Note: Percentages in **bold** are above Los Angeles City and Los Angeles County averages.

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4 FORMULATION OF ALTERNATIVE PLANS

4.1 PLAN FORMULATION PROCESS

This Integrated Feasibility Report (IFR) has followed the USACE's Six-Step Plan Formulation Process to develop, evaluate, and compare the array of potential alternatives that could solve identified problems described in the previous section. As described elsewhere in the IFR, plan formulation was implemented using the following six steps:

1. Specify problems and opportunities relevant to the study area. Identify planning constraints and establish planning objectives (Chapters 2 and 4).
2. Inventory and forecast conditions. Identify and document existing and future without project conditions Chapter 3 (existing) and Chapter 4 (future without project)).
3. Formulate alternative plans. Develop alternatives comprising differing sets of measures to address the identified problems and planning objectives for ecosystem restoration (Chapter 4). A public involvement program sought separate public input in this process (Chapter 8).
4. Evaluate alternative plans. Evaluate each of the ecosystem restoration alternatives derived from Step 3 for overall effectiveness, efficiency, completeness, and acceptability (Chapters 4 and 6). Impacts of the alternatives were evaluated using the USACE Code of Federal Accounts Framework. Topics included National Economic Development; Environmental Quality; Regional Economic Development; and Other Social Effects, as specified in the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (U.S. Water Resources Council 1983) and the Planning Guidance Notebook ER 1105-2-100 (USACE 2000).
5. Compare alternative plans. Compare each of the ecosystem restoration alternatives in terms of cost effectiveness (Chapters 4 and 6) and other considerations. Cost effectiveness and incremental cost analysis (CE/ICA) modeling was used to prioritize and rank ecosystem restoration alternatives.
6. Select recommended plan. Based on the information and results from the previous steps, select recommended plan for ecosystem restoration (Chapter 6 and 7). Prepare documentation to justify the plan selection.

4.2 PLANNING OBJECTIVES

The USACE is authorized to carry out civil works water resources projects for ecosystem restoration, flood risk management, recreation, and water supply as well as navigation, storm damage prevention, and hydroelectric power. Planning for Federal water resources projects constructed by the USACE is based on the *Economic and Environmental Principles and Guidelines for Water and Land Related Resources Implementation Studies* adopted by the Water Resources Council (U.S. Water Resources Council 1983). These principles and guidelines represent the "rules" that govern how Federal agencies evaluate proposed water resource development projects. They state that the primary Federal objective of water and related land resources project planning is to contribute to National Economic Development (NED) consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. Ecosystem restoration is one of the primary missions of the Corps of Engineers Civil Works program. The Corps objective in ecosystem restoration planning is to contribute to national ecosystem restoration (NER). Contributions to national ecosystem restoration (NER outputs) are increases in the net quantity and/or quality of desired ecosystem resources.

Assessing potential contributions to NER is based upon a system developed by the USACE for measuring changes in ecological resource quality as a function of improvement in habitat quality or quantity which are expressed quantitatively in physical units or indexes (non-monetary units). Contributions to NED, on the other hand, typically apply to projects such as flood risk management that result in increases in the net value of the national output of goods and services, expressed in monetary units.

This IFR is charged with determining the Federal interest in ecosystem restoration opportunities within the ARBOR reach and how these opportunities can help meet the USACE mission and the Federal objective. This will be accomplished by developing a recommended NER plan composed of environmental restoration measures that reasonably maximize ecosystem benefits compared to costs. Recreation may provide benefits to meet the NED Federal objective, and incidental flood risk management benefits may accrue. Sufficient passive recreation will be needed to manage the human impacts to the restoration project within this highly urban area. Regional Economic Development Benefits (RED) and Other Social Effects (OSE) will also be considered in plan selection.

4.2.1 Specific Planning Objectives

The national objectives are general statements and not specific enough for direct use in plan formulation. The water and related land resource problems and opportunities identified in this study are specific planning objectives that provide focus for the formulation of alternatives. These planning objectives address the problems and opportunities and represent desired positive changes.

Based on the problems and opportunities identified for Los Angeles River study area, the USACE, sponsor, and key agencies and stakeholders developed specific planning objectives to guide the formulation and evaluation of alternatives and the development of the recommended plan. Objectives development began during the without project conditions phase of study and were consistent with ongoing state and local efforts within the watershed, including the Los Angeles River Revitalization Master Plan published by the City of Los Angeles in 2007.

The objectives were refined throughout the formulation process, resulting in the following study objectives for the 11-mile reach of the River extending from Pollywog Park (north of Griffith Park) to First Street in Downtown Los Angeles, which includes approximately 6.4 miles of soft bottom channel and 4.5 miles of concrete channel (ARBOR reach).

1. ***Restore Valley Foothill Riparian Strand and Freshwater Marsh Habitat:*** Restore valley foothill riparian wildlife habitat types, aquatic freshwater marsh communities, and native fish habitat within the ARBOR reach throughout the period of analysis[3], including restoration of supporting ecological processes and biological diversity, and a more natural hydrologic and hydraulic regime that reconnects the River to historic floodplains aud tributaries, reduces velocities, increases infiltration, and improves natural sediment processes.

Sub-objectives for Objective 1 are:

a) Restore and support ecological processes (i.e., biogeochemical processes, nutrient cycling).

[3] The period of analysis is the period of time over which any alternative plan would have significant beneficial or adverse effects. The period of analysis is 50-years. (ER 1105-2-100)

b) Increase biological diversity.
c) Restore a more natural hydrologic and hydraulic regime with reconnections to floodplains and tributaries, areas of reduced velocities, increased infiltration, and improved natural sediment processes.

Meeting requirements for the sub-objectives for restoring valley foothill riparian strand and freshwater marsh will restore ecological processes, increase biological diversity and reduce the scarcity of this ecosystem in the region.

2. ***Increase Habitat Connectivity:*** Increase habitat connectivity between the River and the historic floodplain, and increase nodal habitat connectivity for wildlife between restored habitat patches and nearby significant ecological zones such as the Santa Monica Mountains, Verdugo Hills, Elysian Hills, and San Gabriel Mountains within the ARBOR reach throughout the period of analysis.

Sub-objectives for Objective 2 are:

a) Increase habitat connectivity to floodplains to reduce fragmentation of the river ecosystem.
b) Increase nodal habitat connectivity locally within the river ecosystem and regionally to nearby significant ecological zones such as the Santa Monica Mountains, Verdugo Hills, Elysian Hills, and San Gabriel Mountains within the ARBOR reach throughout the period of analysis to address patterns of habitat fragmentation, restore habitat corridors and remove barriers to wildlife movement.

Meeting sub-objectives for increased habitat connectivity will increase sustainability of the restored system areas and initiate regional opportunities for connectivity to nearby ecological zones. Areas have a greater interaction when they are larger and closer together (Lineham et al. 1995). The study used the connectivity definition in ER 1105-2-100, paragraph E.37.c.4, as follows:

> *"(4) Connectivity. This is a measure of the potential for movement and dispersal of species throughout a given area or ecosystem, and should be considered in the context of an entire landscape or watershed. The variation and quality of links between habitats in a landscape or watershed determine the level of connectivity. Landscape spatial patterns that affect the level of connectivity include the existence and suitability of habitat corridors, the degree and pattern of habitat fragmentation, and the presence of natural and man-made barriers. Often, rivers, waterways, and riparian forests serve as highly functional habitat corridors, and aquatic ecosystems inherently serve a connective function to other waterways and terrestrial landscapes. Corps planners may recognize as technically significant those restoration alternatives that serve to improve connectivity by creating or re-establishing habitat corridors; eliminating or addressing the pattern of fragmentation; or removing barriers, such as dams and other water blockages, that disrupt otherwise contiguous habitats."*

3. ***Increase passive recreation that is compatible with the restored environment in the ARBOR reach through the period of analysis.*** Recreation features at an ecosystem restoration project are permissible if they are compatible with the restoration and economically justified. Recreation elements are cost shared 50 percent Federal/50 percent non-Federal (ER 1105-2-100).

a. Provide connections to existing recreation infrastructure.
b. Increase environmental education opportunities.
c. Increase trail system to coincide with restored area.

Alternatives will be evaluated and compared to determine how well they meet the above ecosystem restoration objectives 1 and 2, and to what degree they result in restoration of a functioning, self-sustaining ecosystem within the study area. Then a recreation plan will be developed to complement and support the features of the tentatively selected alternatives. Recreation alternatives will be analyzed using a cost/benefit analysis.

4.2.2 Objectives Performance Criteria

While the extremely urbanized nature of the Los Angeles River watershed will prevent complete restoration of a natural, meandering river and floodplain, there are several opportunities to restore ecosystem functions on a limited scale. Alternatives considered for this study were considered minimally successful when they met the performance criteria below.

Since the minimum critical size of an ecosystem has not been determined for any region (Noses 1986), the following criteria were developed to evaluate and compare alternative plans. Quantitative criteria are based on review of scientific literature and the use of classes of animals (birds, reptiles, amphibians) as a proxy for the habitat requirements of other species.

Minimal performance criteria for meeting these objectives and success of a proposed project alternative are provided below:

1. Restore Valley Foothill Riparian and Freshwater Marsh Habitat

Each alternative carried forward must achieve each of the following criteria within restored aquatic areas:

a) Restore a minimum of two aquatic habitat nodes with a natural hydrologic connection to the river and riparian communities with a minimum distance of 150 meters from the water's edge to create areas capable of functioning as core habitat and refuge for native reptiles and amphibians (Semlitsch and Bodie 2003) and to minimize the risk of localized extinction due to natural disasters (i.e., flood, fire, drought) (Schippers et al. 1996; Dunning et al. 1995).
b) Removal and management of invasives to less than 10 percent within 5-7 years post-construction of each feature.
c) Restore seasonal overbank flooding to river adjacent areas within 5-10 years post-construction.

For Valley Foothill Riparian Habitat:

a) Restore structurally diverse riparian habitat consisting of herbaceous (e.g., herbaceous vine cover), shrub (e.g., shrubby willow thicket), and tree (e.g., mature cottonwood-willow trees) layers in a minimum of five reaches resulting in three contiguous reaches. Restore riparian habitats with a varying number of structural layers (one, two, and three layers) to support survival and reproductive requirements for riparian obligate and transient wildlife species, including food, water, shelter, breeding, migration, and dispersal (Krueper 1995).
b) Within 5-10 years of construction, restore and maintain dense, structurally diverse riparian habitat sufficient to maintain survival and reproductive needs of wildlife. Restore a minimum of one habitat node with a minimum width of 250 meters (820 feet) to support high frequencies of the Federally endangered least Bell's vireo (Kus 2002).

For Freshwater Marsh and Fish Habitat:

a) Restore functioning freshwater marsh habitat consisting of emergent herbaceous vegetation (i.e., cattails, rushes, sedges) adapted to saturated soil conditions.
b) Restore aquatic habitat to support survival and reproductive requirements for fish and wildlife species, including food, water, shelter, breeding, migration, and dispersal.

c) Restoration of natural channel geomorphic character in at least one concrete reach support refugia for native fish including the Federally threatened Santa Ana sucker.

For a More Natural Hydrologic and Hydraulic Regime:

a) Expand the River into at least one large, contiguous river adjacent area within the study area that promotes natural hydrologic connections to the floodplain and overbank areas.
b) Accommodate additional meandering of the River in at least one reach.
c) Connect river hydrologically (with assistance through culverts or naturally) to overbank with at least one such connection per reach.
d) Within the main stem of the river, reduce velocity to less than 12 feet per second (ft/s) and ideally 8 ft/s.
e) Restore seasonal overbank flooding to river adjacent areas to support riparian floodplain habitat.

2. Increase Habitat Connectivity

Each alternative carried forward must achieve each of the following criteria:

a) Restore riparian and wetland aquatic wildlife habitat at tributary confluences to create habitat connectivity to similar upstream habitats on the tributaries with ultimate nodal connection to the aquatic habitats in the San Gabriel and Verdugo Mountains (at least one major tributary connection should be restored.)
b) Restore wildlife habitat on channel banks to support movement along the river channel.
c) Improve aquatic habitat connectivity within the ARBOR area through restoration of habitat nodes with wetland and riparian habitat that are naturally hydrologically connected to the river corridor upstream and downstream of the Glendale Narrows.
d) Restore habitat corridors between large nodes in the ARBOR area to maximize connectivity for wildlife movement and dispersal on the local scale and minimize the risk of habitat sinks in an urban environment (Hilty et al. 2006; Hanski & Thomas 1994; Rudd 2002; Noss 1983), and to provide opportunities for regional wildlife movement.
e) Lengthen the extent of contiguous vegetated pathways for reptile and small/medium mammal movement (currently limited to Reaches 4 to 6), to achieve upstream and/or downstream connections to at least one additional tributary or habitat area that is currently isolated from the soft-bottom reach.
f) Reconnect the natural hydrologic process between the river and at least one main tributary to support regional habitat connectivity to nearby significant ecological areas.

Ideally, the alternatives will also achieve the following:

a) Expand riparian and wetland habitat into large, contiguous river adjacent lands within the study area to support higher abundance of wildlife and support more significant nodal connections to nearby ecological zones. Provide habitat connectivity (via contiguous or near-contiguous vegetated movement pathways) between all of the reaches within the study area.
b) Include Reach 7 to provide nodal connections to San Gabriel Mountains via Arroyo Seco Confluence and/or other smaller tributaries and to provide potential for future direct connections to the mountains via other projects upstream on Arroyo Seco.

4.3 PLANNING CONSTRAINTS AND CONSIDERATIONS

4.3.1 Planning Constraints

Planning constraints represent significant barriers or restrictions that limit the physical or policy-related aspects of formulated plans. An example of a constraint related to flood risk is that alternative which add vegetation to the channel must also: (1) increase conveyance capacity, or (2) reduce the peak flows

through detention or storage, otherwise, high velocities will rip out planted vegetation. Currently, flows vary in the reach between 15 to 19 ft/s, with some flows in the downtown areas potentially reaching 30 ft/s. The target velocity to sustain planted vegetation is closer to 8 to 12 ft/s or soft-bottomed channels areas. Several constraints apply specifically to this study. These are:

- HTRW sites will be avoided whenever practicable.
- Potentially contaminated groundwater plumes must be considered and avoided whenever practicable.
- Surrounding urbanization and infrastructure such as roads, highways, rail lines and power facilities must be avoided whenever practicable.
- The sponsor must be able to provide lands for the potential project area.
- The sponsor must provide lands for the project that have been cleared for HTRW (etc.).
- Existing levels of flood protection must be maintained.
- Restoration must avoid conflicts with the existing engineering policies for flood risk management projects, e.g., vegetation must not increase existing water surface elevations or floodplain extent.

In addition, there are several considerations specific to the study area. These are as follows:

- Limited water sources within the project reach will influence the sustainability of ecosystems, and alternatives will be formulated with understanding of the regional climate and understanding of water resources. Appropriate vegetation will be proposed to ensure future sustainability.
- Existing flood risk management project includes hardened bed and banks with levees that are important to maintain flood protection. If a measure shows induced flooding, mitigation may be required.
- In areas of existing habitat, construction must avoid nesting season, flood season, and minimize impacts to native vegetation where possible. Clearing of vegetation prior to construction would be performed outside of the bird breeding season, to the maximum extent practicable, to avoid impacts to nesting birds. Once vegetation is cleared outside of the breeding season, construction may occur year-round with the implementation of mitigation measures such as buffers around adjacent habitat or sound-buffering fencing, as necessary.
- Restoration must avoid cultural or historic sites when possible. If unavoidable, mitigation requirements pursuant to the Programmatic Agreement must be complied with.
- Recreation must not degrade restored areas. Recreation measure locations must be limited to land identified for the project.

During the formulation of measures for inclusion in the alternatives, constraints and considerations are one basis for assessing and screening out measures.

For the current plan formulation effort, the highly urbanized nature of the floodplain limits opportunities for land acquisition, due to competing land uses. USACE policies limit land acquisition costs as a percentage of the total project cost, further limiting the scope of the project area. The study team identified potential restoration locations opportunistically, based in large part on the availability of lands and the ability to acquire significant large parcels of floodplain lands.

Another important consideration in plan formulation is the funding authority of the USACE. The categories of project features that can be Federally cost-shared include ecosystem restoration and passive recreation such as trails; however, active recreation feature costs are a non-Federal sponsor responsibility. Further, the USACE cannot pay for upland restoration unless it is necessary for project success. Operation and maintenance is a non-Federal sponsor cost following project completion, except that there is an adaptive management and monitoring program of up to 10 years that is cost-shared with the Federal government. HTRW response and remediation are 100 percent non-Federal sponsor responsibility and

100 percent non-project cost. The sponsor will remediate, or ensure the remediation of, any HTRW contamination to the standards required to support the restoration project. No construction on sites with soil contamination will occur prior to the completion of remediation activities at those sites. At this time, it is anticipated that the City will need to remediate contamination at two Taylor Yard sites and the LATC site prior to Federal construction at those sites. For groundwater contamination that cannot be addressed prior to construction, the City would be responsible for addressing such contamination during construction dewatering activities, including proper handling, treatment, and disposal, at 100 percent non-project cost. Water supply to the project (irrigation) is an associated non-Federal cost.

4.4 ALTERNATIVE DEVELOPMENT AND EVALUATION PROCESS

The alternatives formulated during this study followed requirements for a USACE Feasibility Report and the NEPA process. The alternatives described in the report are not plans for actual construction, nor are they of sufficient design detail to be constructed. Detailed design analysis and preparation of plans and specifications would begin following the completion of the Integrated Feasibility Report (which incorporates the EIS). Alternatives were formulated to a level of detail sufficient to determine economic feasibility and potential cost-sharing, technical feasibility, environmental feasibility, and resource issues associated with implementation and other criteria necessary to make an informed decision by the parties involved in its implementation. The selected ecosystem restoration plan must:

- Comply with NEPA and other environmental laws and regulations.
- Meet study objectives performance targets.
- Maintain (or improve) existing conveyance of flood flows and ensure that project implementation would not increase flood flows or worsen flooding conditions in existing developed areas.
- Produce NER benefits.
- Provide decision-makers, both Federal and local, with information that may be utilized to help determine plan selection and a balance between various competing interests.
- Blend existing and proposed improvements where possible. These improvements would take advantage of local projects, and provide consistency with the future master planning efforts of the local community.

a. Measures were developed based on the expert opinions of Federal, State, and local agencies, the Corps PDT, and the Sponsor PDT.

b. The measures were combined along the potential project area based on the problems, opportunities and objectives, the expert opinions of Federal, State, and local agencies, the Corps PDT and Sponsor PDT, and the practicability of implementation of each measure at each site given the constraints and land uses along the river.

c. This produced a preliminary array of 19 alternatives. Typical designs, costs, and habitat benefits were developed for the elements of these alternatives.

d. The habitat benefits and costs for the 19 alternatives were divided by reach for the cost effectiveness and incremental cost analysis (CE/ICA analysis). The IWR Planning Suite software was utilized to conduct the CE/ICA, which determined the best plans for each of the reaches in the 19 alternatives. The CE/ICA analysis formulated 21 Best Buy plans and over 171 cost effective plans for selection of the final array.

e. The final array was selected from the best buy plans based on the CE/ICA analysis and the study objectives.

4.4.1 Local Involvement in Plan Development

Public input and local expertise with similar restoration projects was incorporated throughout the plan formulation process. The primary areas of local concern identified during the study include: (1) technical considerations based upon the specifics of the study area; (2) maintaining or improving the existing level of flood risk management; and (3) coordinating recommended plans with ongoing development and local efforts in ecosystem restoration within the study area.

The plan formulation process has included extensive involvement by the non-Federal sponsor, agencies, and key stakeholders. Plan formulation workshops were conducted during the feasibility study to identify problems and opportunities, develop and refine measures and alternatives, address specific problems, and select the recommended plan.

To focus these efforts on ecosystem restoration, the USACE held a 3-day plan formulation charrette on December 2, 3, and 4, 2009. The charrette engaged stakeholders in a collaborative brainstorming process to expedite the development of plans, alternatives, and/or management measures to address study objectives. The purpose of the workshop was to receive input for the formulation of plans. The purpose of the plans was restoration of ecosystem function to the highest level possible within the Los Angeles River, with an emphasis on ecosystem restoration for development of the NER plan.

The charrette included a 6-hour field outing to critical locations within the study area with discussion of specific problems and opportunities at each site. It engaged the participants in organized brainstorming that developed long lists of problems and measures as well as personal vision statements. It also grouped teams of experts in the disciplines of economics, biology, engineering, hydraulics, landscape architecture, geotechnical/soils engineering, planning, and recreation. These teams were able to apply their expertise—along with the information gathered from the public and other stakeholders during the City's Los Angeles River Revitalization Master Plan outreach efforts—to the focused charrette process.

Participants in the charrette workshop included representatives from the USACE, the City of Los Angeles as the non-Federal Sponsor, the U.S. Fish and Wildlife Service, the Los Angeles County Department of Public Works, the California Coastal Conservancy and the Mountains Recreation and Conservation Authority, the Audubon Society, California State Parks, the City of Glendale, non-governmental agencies such as the Friends of the Los Angeles River, The River Project, the Los Angeles and San Gabriel Rivers Watershed Council (now the Council for Watershed Health), and other stakeholders and experts having interest and knowledge about the Los Angeles River. Sixty-eight participants attended the workshop for either one or more of the three days.

During the charrette, group brainstorming activities included problem identification and validation of problems, opportunities, and objectives. Participants were divided into teams that developed measures and alternatives. Those brainstorming ideas from the diverse group of participants were a starting point for additional formulation.

4.4.2 Measure Development

Measures are the building blocks of alternatives. The identified environmental restoration measures consist of one or more actions or features in a particular location that are intended to solve specific problems or help meet the identified planning objectives. Measures were initially developed at the charrette described above. During this workshop, the participants considered refinement of the study objectives, and a wide variety of measures that could be combined into alternatives meeting the planning objectives. The process included assessment of each measure to determine whether to carry it forward into the alternatives. The public was given the opportunity to provide additional input to alternative

formulation at public meetings held by the City of Los Angeles. As the study progressed, the USACE's study team, the Sponsor, and the habitat team have screened out those measures that did not meet objectives, were excessive in cost, were technically infeasible, conflicted with constraints, or did not meet performance criteria.

4.4.3 Measure Screening

Decision criteria for evaluation, comparison, and selection of measures were based on application of evaluation criteria established under Principles and Guidelines (U.S. Water Resources Council 1983) and the USACE Institute for Water Resources (IWR) Planning Manual (USACE 1996). These are effectiveness, completeness, efficiency, and acceptability, as defined below. Additional criteria considered were technical, environmental, and public acceptance feasibility. These criteria were applied in the first screening of measures and were considered iteratively as more was known about each site and measure. This section compares the retained and screened measures, and the criteria used to evaluate them.

Effectiveness

Effectiveness is the extent to which an alternative plan alleviates specified problems or achieves opportunities. It is defined as follows: "Effectiveness is the extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities." (P&G Section VI.1.6.2(c)(2)) Measures that did not address any objectives were screened out. Measures that did not accomplish their intended purpose were screened out.

Completeness

Completeness is defined as follows: "Completeness is the extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects. This may require relating the plan to other types of public or private plans if the other plans are crucial to realization of the contributions to the objective." (P&G Section VI.1.6.2(c)(1)) Measure completeness in this early stage of the study considered whether a measure could be implemented to realize planned effects. Consideration was given to its technical feasibility and whether constraints were too burdensome to implement the measure at a particular location (e.g., given current land use and known intensive infrastructure obstacles/constraints). For the purposes of the initial evaluation of alternatives, completeness was related to the level at which the measures included in the alternative met objectives and the possibility of implementation of the measure. Evaluation of the implementability of the measure considered whether it was possible on sites within the historic floodplain, whether property is in public ownership or expected to become available, level of impacts to infrastructure, and technical feasibility of the requirements to implement the measure successfully. Dropped features were those that were technically infeasible or conflicted with Federal or local law and policy. Features that were not sustainable without extreme measures were screened out, such as a 9-mile tunnel under the City of Los Angeles, and removal of all of the concrete in the channel while maintaining the same channel depth and width. In addition, features that were not feasible because of intense infrastructure or current or expected future land use conflicts were also screened out.

Efficiency

Efficiency is "the extent to which an alternative plan is the most cost-effective means of alleviating the specified problems and realizing the specified opportunities, consistent with protecting the Nation's environment." (P&G Section VI.1.6.2(c)(3)) Cost effectiveness analysis answers the question: "Does the measure accomplish the objective with the least cost?" Efficiency evaluation of the initial array included consideration of technical feasibility and constraints. The resulting array was further evaluated for efficiency through Cost Effectiveness and Incremental Cost Analysis (CE/ICA).

Acceptability

"Acceptability is the workability and viability of the alternative plan with respect to acceptance by State and local entities and the public and compatibility with existing laws, regulations, and public policies." (P&G Section VI.1.6.2(c)(4) If there was a known conflict with Federal, state, or local laws or policies, the measure was screened out. Public acceptability was considered qualitatively.

4.4.4 Screened Measures Descriptions

Some measures were intended for implementation along the entire reach of the project area, and some sites along the project reach were screened from further consideration during the course of plan formulation. Eliminated measures are described below along with the reasons for their elimination.

1. **Create Underground Basins for Attenuation -- ineffective, inefficient, and incomplete.** Install underground basins to store floodwaters, and provide temporary water supply for restoration. Potential locations where basins could be constructed are identified throughout the study area. These are storm-type water storage modules, which are developed for subsurface stormwater detention or infiltration systems. Installation would require excavation of the site, which would then be covered with geotextile and filled with crushed stone; existing land uses would be returned to the site. The system design is to be utilized under parking lots, athletic fields, parks, etc. The estimated depth of the tank would be 11.3 feet.

   a) Six areas were identified as potential sites and would have provided a total storage of 3,128 acre-feet. These are the Equestrian Center, Bette Davis Park, Ferraro Fields, Griffith Park Golf Course, Taylor Yard, and LATC.
   b) Assuming basins are constructible and a structure could be designed to perfectly take the flow off the top of the design flow hydrograph (based on the frequency hydrographs from the 1992 LACDA study), flows would be "diverted" and adjusted downward downstream based on the size of the potential basin. In the preliminary analysis, there was some peak flow reduction showing some flood risk management benefit, but the amount of diversion was not enough to reduce the need for diversion of flow into tunnels sufficiently to reduce their size significantly nor did it allow for an adequate increase in vegetation within the channel (ineffective). This reduction assumes that the upstream basins are also in operation (incomplete). Because this analysis showed that the basins would be largely ineffective for attenuation and would provide little to no additional habitat value for the associated costs of their implementation (inefficient), this measure was dropped.
   c) Use of the basins for water conservation would present difficulty in offloading because of the slope of the river. In addition, groundwater recharge would be difficult due to the existing high groundwater levels in the area and the distance to other spreading basins far upstream and/or downstream.

2. **Tunnels/Culverts -- ineffective.** Construction of tunnels or large culverts to divert storm season flows around the project reach. This would require excavation and construction of culverts that would need to be sized and designed based on results of hydraulic modeling. The culvert measure would include a culvert from Headworks to the LATC diagonally across the City to move storm flows around the project area. Culverts would divert storm flows into underground basins.

   A tunnel diversion at Headworks would need to contain approximately 40,000 cfs of flow. Moving downstream, the diversion amount required increases. At Cornfields, a diversion to accommodate approximately 104,000 cfs would be required with an associated 42-foot-diameter tunnel. This means the tunnel would need to follow the River's alignment so additional flow could be added. As

additional flow volume is diverted, tunnel sizing would need to be increased downstream – taking on additional volume at Verdugo and Arroyo Seco, etc. where additional flows are being added to the system.

The CE/ICA analysis showed that this measure would be excessive in terms of construction costs and lands, easements, rights-of-way, and disposal sites (LERRDS) because the preliminary alternative plans that included the measure provided only an 8 percent (643 habitat unit) increase in habitat benefit for at least a 113 percent ($1.8 billion) increase in total cost (inefficient). Given this, the measure was deemed ineffective and inappropriate at this time. Moreover, construction and operational impacts of the tunnel infrastructure were determined to be unacceptable to the Sponsor and the public because of anticipated cumulative adverse impacts with respect to priorities to preserve existing open spaces and to avoid creating another engineered channel for the river.

a) ***Freeway Water Bypass.*** This measure would have widened the river under the freeways. Similar to the tunnel measure, it would have been used to pass storm flows through the restored reach. It was eliminated for the same reasons the tunnel measure was eliminated and due to the expense and difficulty of installing a tunnel under the freeway (inefficient).
b) ***Culvert under the Los Angeles River for Diversion of Storm Flows.*** While it would be potentially cheaper than a diversion tunnel across the City of LA, the inlet and outlet for storm flows to the underground or under-river diversion structure would be cost prohibitive so the measure was eliminated (inefficient).

3. **Wildlife Bridges -- ineffective and incomplete.** These measures were deleted based on the assumption that bridges may facilitate the movement of wildlife into urban areas where wildlife would not benefit (i.e., bobcats/coyotes in urban LA would likely be killed in urban neighborhoods and could be a danger to pets and children). The preliminary analysis determined that bridges would not lead to any substantial/beneficial habitat to support any introduced wildlife.

4. **Widen Channel/cantilever Channel Bank -- ineffective and incomplete**. This includes widening of the channel by converting trapezoidal slopes to vertical walls, and installing a cantilevered section extending out over the channel from the top of the vertical wall. It was proposed in portions of Reaches 7 and 8. The measure would include excavation and rebuilding of the channel and adjacent infrastructure. The associated overhang would likely be walkways or promenades tied to hiking trails and adjacent streets. The cost of modifying and reconstructing the channel was determined to be too expensive when evaluated with respect to the habitat benefit that would result from this measure.

5. **Wildlife Tunnels -- ineffective.** Existing equestrian tunnels are located within the study area and are known to be used by wildlife. Additional tunnels in other locations were deleted based on the expert advice of the biologists on the team and wildlife agencies participating in the habitat evaluation. They advised that wildlife would likely not use the tunnels in other proposed locations due to the projected length and size of the tunnel being too small to accommodate wildlife comfortably.

6. **Pervious Parking on Streets and in Lots Outside the ARBOR in the Watershed – ineffective and unacceptable.** This measure was eliminated because it did not address the objectives and is outside the USACE's authority for aquatic ecosystem restoration. However, it is a "best management practice" that would facilitate long-term watershed health and expanded ecosystem restoration and could be implemented by other projects.

7. **Tujunga Channel System Modification -- ineffective.** The Tujunga is a tributary located upstream and outside of the study reach. Much is already being done to restore this stream's ecosystem including a project built by the USACE. This measure suggested modifications on the Tujunga

Channel System to divert storm flows and slowly return water to the river system. It was eliminated because it is over 6 miles upstream, which is too far upstream to be effective.

8. **Relocate/Bury Railroads or Other Utilities – not a measure.** This measure was eliminated as a stand-alone measure because it is a design consideration rather than a restoration measure but would be employed as part of LERRD if the subject facilities could not be avoided.

9. **Deepen Entire Channel to Gain Capacity – ineffective.** This measure would remove concrete within the entire project area and deepen the channel to carry the design flows. It requires modifications to over 20 bridges, 3 confluences, and numerous storm drains. There are unknown quantities of utilities that run directly beneath or cross the existing channel. The depth of the channel would have to more than double to convey the same design flow with concrete removed and vegetation included. The trapezoidal sections could not be deepened enough and would require conversion to vertical wall configuration. It would require a gradual deepening as it approached the restored areas and a gradual return to the invert grade at the downstream end of the project area. For these reasons, this measure was determined to be ineffective.

10. **Modify Upstream Dams – ineffective, unacceptable, and incomplete.** Three types of modifications were considered.

    a) ***Deepening or raising dams to modify capacity.*** Sepulveda Dam and Hansen Dam are the only two possible dams to consider for modifications. USACE believes that these dams are too far upstream of the study reach to have a significant impact on flow reduction. The amount of storage required greatly exceeds the amount that can reasonably be acquired. There is a significant cost issues regarding raising dams, which include modifications to unrated outlets, spillway gates, and other pertinent structural features. Modifications to increase storage raise a number of other significant issues that include impacts on past, current, and future restoration projects within the reservoir as well as recreation uses within the reservoir (incomplete). This measure would also require mitigation for other approved uses within the reservoir (ineffective and unacceptable)

    b) ***Modification to dam operations.*** Re-operation to reduce downstream discharges is not a viable option. Sepulveda Dam currently does not provide the authorized level of protection. There is insufficient storage in both reservoirs to accommodate the volume of water necessary to reduce downstream releases sufficiently (unacceptable and ineffective).
    Re-operation to provide water through the dryer months of the year is not necessary. There is enough water flowing into the project reach in the Los Angeles River to sustain any proposed ecosystem restoration configurations (ineffective).

11. **Modify Pool Riffle Complex in Existing Soft-Bottom Channel Restoration - ineffective.** This measure would have reshaped existing soft bottom channel for pool riffle complexes. The soft-bottom beds in the ARBOR study reach are in good geomorphic health and behave like a natural river. The natural geomorphic character of the river bed within soft bottom reaches does not need restoration. Removal of this measure does not mean that bank restoration, invasive species removal, and trash removal are eliminated.

4.4.5 Retained Ecosystem Restoration Management Measures

As noted above management measures for alternative formulation consisted of ecosystem restoration measures to address Objectives 1 and 2, and recreation measures will address Objective 3. Ecosystem restoration measures were formulated based on input from the USACE technical team, the City, the general public outreach, and local expertise from Federal, state, and local agencies, other cities within the

study area, academic experts, non-governmental organizations, and consultants. Ecosystem restoration management measures retained for inclusion in alternatives are described below.

The environmental restoration measures identified consist of one or more actions or features in a particular location that are intended to solve specific problems or help reach particular planning objectives. Measures are broken out into six major categories as described below:

1. **Adjacent or off channel modifications**. These include restoration measures both immediately adjacent to and **separated** from the main river channel. Features include establishment of riparian, wetland, or open water areas.

   a) ***Major tributary channels/widen channel (Objectives 1, 2)***. Widening tributary channels removes a significant amount of concrete and overlaps with concrete removal measures on the mainstem (see Section V). It consists of removal of existing structures, including on properties adjacent to the channel, and excavation/grading to expand the tributary channel and tie into adjacent lands. Bank modifications include terraces and gradual slopes to allow creation of habitat.

   b) ***Restore riparian and marsh by daylighting streams (Objectives 1, 2)***. River systems naturally have a large number of small channel tributaries as well as large tributaries contributing flow. In urban areas, many of the river's smaller tributaries are now in underground pipes or storm drains. Daylighting in this instance is defined as opening these underground pipes and storm drains near their confluence with the River to restore them to a natural stream channel. This would include opening and daylighting storm drains and developing riparian and marsh habitat within the new channel. Existing storm drains are gated and would likely need to remain gated after modification, except where wildlife passage is designed (see Section 3). Design of the outlet and adjacent wetlands are site specific and depend on sizing, discharge, and available right-of-way. For the purpose of cost and habitat analysis, it was assumed that at least 1 acre of aquatic wetland would be created at the mouth of each of these daylighted storm drains.

   c) ***Create a more natural geomorphic character and plant for freshwater marsh in adjacent side channel (Objectives 1, 2)***. Side channels would be created in River-adjacent areas to allow flows to meander off of the river channel mimicking a more natural braided river system. Shallow water (less than 6 feet deep) will be required for freshwater marsh. Freshwater marsh will be interspersed with open water and riparian vegetation. Modifications include removal of concrete, excavation to create uneven riverbed bottom with pools and shallow zones, stabilization of the off-channel area with boulders or weirs, and planting of wetland and riparian vegetation. The existing River soft bottom reaches that include wetlands and pools/riffles, such as those found within Reach 4, will be a prototype for what can be created in remaining reaches. Water quality is sufficient to support vegetation. The wetland plant palette will include plants from Table 4-1 below.

Table 4-1 Wetland Plant Palette for Freshwater Marsh

Scientific Name	Common Name
Carex praegracilis	clustered field sedge
Cyperus odoratus	fragrant flatsedge
Eleocharis parishii	Parish's spikerush
Juncus effusus	common rush
Mimulus cardinalus	scarlet monkeyflower
Schoenoplectus californicus	California bulrush
Typha angustifolia	narrow leaved cattail
Typha latifolia	common cattail

d) ***Grade areas adjacent to the channel to lower elevation for habitat, floodplain reconnection, and offline detention (Objectives 1, 2).*** This measure includes lowering of sites adjacent to the channel to allow for retention of water and habitat creation. It would include excavation to create basins or terraces that tie into the channel and adjacent topography. These would be terraced or have slopes at a 3 to 1 transition ratio or more gradual and be interspersed with freshwater marsh (retention basins) and riparian vegetation.

e) ***Create a more natural geomorphic character for open water adjacent to the channel (combined with measure 3) (Objectives 1, 2).*** Water deeper than 6 feet would remain open water and not allow for vegetation growth. Modifications to accomplish this measure could include removal of concrete, excavation to restore uneven bottoms, bank stabilization, and creation of pool and riffle habitat through installation of boulders or weirs.

f) ***Rebuild a more natural geomorphic character for historic wash (Objectives 1, 2).*** A wash is an intermittent or ephemeral stream subject to flashy flows during seasonal rains associated with riparian dependent upon groundwater or seasonal wetland vegetation dependent upon groundwater. This measure restores historic washes through grading and excavation. Detailed channel design will depend on any discharge expected within the wash. The restored historic wash would likely be a shallow channel with gradual (3:1 or less) slopes and terraces with both riparian and buffer vegetation. It would reconnect with its upstream areas as well as the River channel. It is different from daylighting streams (measure 2) because these historic washes were not necessarily put into the storm drain system. Development has occurred around them, and the historic washes have been directed to other parts of the drainage system.

2. **Attenuation**. These measures include capture of flows from the main channel, storm drains, and tributaries into side channels or detention basins.

a) ***Creation of attenuation basin with wetlands (Objectives 1, 2).*** This measure includes slowing input of storm flows, restoring wetlands, and creating a confluence with the River (overlaps with off channel measures in Section 1). This measure would require connection to the River. Wetland attenuation basins would be sized to capture runoff from the local area (not the main channel) and would include a basin surrounded by terraced slopes. The basin would slow down flows before they enter the mainstem of the River system and would provide seasonal wetland habitat. There would be a trade-off between the wetland and attenuation. This measure would provide some incidental water quality and recharge benefits. Preliminary design includes excavation of a basin that would have an impermeable layer of either geotextile or fine materials installed. The basin would then be planted with wetland vegetation. Average depth of the basin is assumed to be 3 feet and there would be some deeper areas up to10 feet deep. It was assumed that this measure would provide 25 percent riparian habitat and 75 percent wetland habitat, resulting in one to two structural layers.

3. **Wildlife access.** These measures provide access and crossings for wildlife between the River and adjacent landscape. They include bridges, undercrossings, access slopes, or tunnels. This measure was later determined as one that would be common to all alternatives and added where possible and reasonable. The basis for design will be based on the wildlife expected to benefit in that location.

a) ***Bridge undercrossing for wildlife (Objectives 2).*** Paved bridge undercrossings act as an impediment to some wildlife movement. To reduce this impediment, modify or install corridors along the bank, which would allow wildlife to cross below bridges within the river.

b) ***Wildlife access from River to bank (Objectives 2).*** Create slopes suitable for ingress/egress of wildlife (generally 3:1 or more gradual slopes) in areas with vertical banks (this would include access to safety ramps in vertical walled channel areas).

c) ***Wildlife passage (Objectives 2).*** Modify storm drains and culverts to allow wildlife passage from existing and created natural habitat areas into the river. For example, daylighted storm drain culverts that pass through the levee would be widened to accommodate wildlife passage. They would also be modified to create appropriate side slope angles for wildlife passage and to remove storm drain grates to allow passage between the river and daylighted streams. The team assumed wildlife passage would only be created to connect wildlife to habitat areas; this measure should not connect wildlife to urban areas that would not be beneficial to their survival.

4. **Planting**. Planting includes measures to restore vegetation within various locations throughout the study area. Measures included revegetation of wetland, riparian, and buffer zones including bioengineering of channel walls where possible. Valley foothill riparian and freshwater marsh habitat will be planted in the following ways: restructuring and planting walls, planting in overbank corridors, planting alongside channels, planting in concrete terraces, and planting on natural terraces and slopes. Planting efforts would include invasives removal.

a) ***Restructure/vegetate River concrete channel walls (Objectives 1, 2).*** This measure includes modification of the concrete channel walls to allow the growth of vegetation. This herbaceous layer is one component of a riparian/wetland habitat complex. Its addition as a stand-alone element in the form of overhanging vines between larger, multi-canopy restoration areas will provide several important functions. As the vines and other herbaceous vegetation mature, this feature will provide shading, cover, potential nesting habitat, and foraging opportunities in areas that are now bare concrete. The habitat would attract and be utilized by many species, including insects (key food source for other wildlife), amphibians, lizards, birds, and small mammals. This vegetation could also provide visual cues and extended segments of greenway that would encourage wildlife movement toward larger restored parcels, downstream or upstream of these reaches. The team assumed the composition would be 50 percent herbaceous riparian (i.e., vines) and 50 percent concrete, resulting in one structural layer of vegetation. Geotextile fabric has been proposed for design of this measure at this time. The fabric, which can be planted with vegetation (grasses and forbs), is reported to withstand velocities of up to 25 ft/s and shear stress of up to 15 lb/ft^2. Depending on the site specific conditions this measure could be accomplished using a range of features including:

- Notching,
- Vegetated terraces with hardened erosion protection,
- Vegetated sidewalls,
- Vegetation hanging from the top of bank, or
- Plantings in or at the tops of channel walls (requiring supplemental irrigation for drought conditions).

Detailed analyses of the Selected Plan will take place during final design phase (PED). Channel protection products will be evaluated to ensure they meet Corps specifications and surpass all hydraulic, geotechnical, and structural criteria. For the plans, Taylor Yard offers the only opportunity within the existing channel to employ High-Performance Turf Reinforcement Mats (HPTRMs), or alternate channel protection products. HPTRMs present higher uncertainties with respect to maintenance, repair, and/or replacement and may need to be augmented by more traditional channel protection measures. Features of the plans located adjacent or outside the existing channel offer greater opportunities for HPTRMs. The work will follow Corps guidance and regulations and utilize existing information including any available testing results.

The plans call for the use of HPTRMs to resist the effect of erosion. This soft approach is highly compatible with the ecosystem restoration concept, but its inability to resist erosion in the same manner as a hard protection system such as concrete or grouted rock is obvious. At some level, a

soft armored slope bank, which may be compatible with ecosystem restoration, will not be effective in resisting erosion. The ability of HPTRMs or other soft methods to resist erosion will need to be fully evaluated before they are incorporated in a final design. It is anticipated that site-specific data that includes results of subsurface investigation and engineering analysis will be necessary to complete this evaluation. As such, this work is anticipated to be completed during PED.

During PED, if it is determined that HPTRMs alone will not meet the Corps requirements, additional measures will be evaluated. These additional structural elements are likely to consist of hardened elements such as riprap, soil cement, sheet pile walls, secant walls, stone or other slope protection materials buried behind a soil slope that is soft armored with HPTRMs or other soft erosion protection methods. The remedial methods utilized must be integrated with the minimal grades and channel configurations required for hydraulic capacity.

b) ***Habitat corridors/riparian planting on overbanks of the main channel or tributaries (Objectives 1, 2).*** This measure includes planting riparian vegetation on the overbanks of the River to establish habitat corridors. Species lists proposed for riparian and transitional zones are provided below in Table 4-2. The team assumed that this measure would restore 50 percent riparian trees and 50 percent riparian shrubs, resulting in two to three structural layers. Development of a detailed site specific planting plan will be completed during the design phase (species and densities). Temporary irrigation of overbank areas will be used for establishment period and in cases of extreme drought. The City is committed to providing necessary water for the project.

Table 4-2 Riparian and Buffer/Transitional Plant Palette

Riparian Tree & Shrub	
Ambrosia psilostachya	western ragweed
Artemisia douglasiana	mugwort
Baccharis salicifolia	mulefat
Mimulus cardinalis	scarlet monkeyflower
Platanus racemosa	western sycamore
Populus fremontii	Fremont's cottonwood
Salix laevigata	red willow
Salix lasiolepis	Arroyo willow
Buffer/Transitional (minimal acreage)	
Artemisia californica	California sagebrush
Eriogonum fasciculatum	California buckwheat
Eschscholzia californica	California poppy
Helianthus annuus	sunflower
Leymus condensatus	giant wild rye
Lotus scoparius	deerweed
Malacothamnus fasciculatus	chaparral mallow
Malosma laurina	laurel sumac
Rhus integrifolia	lemonade berry
Salvia apiana	white sage
Vines	
Marah macrocarpa	wild cucumber
Vitis girdiana	Southern California grape/desert grape
Vitis Californica	California wild grape
Cuscuta californica	California dodder
Calystegia macrotegia	Island morning glory
Rubus ursinus	California blackberry

c) ***Terrace concrete banks/planting built into modified channel walls (Objectives 1, 2).*** This measure modifies existing concrete walls by adding structures able to support vegetation. It includes planting vegetation in the structures. This could include terraces with erosion protection such as concrete liners, or openings in the concrete where vegetation is planted on terraces or slopes. Terrace dimensions and/or types and density of vegetation would be refined to accommodate wildlife habitat where appropriate with available space. Vegetation is assumed to be riparian with two to three structural layers.

d) ***Invasives Removal and Replanting (Objectives 1, 2).*** An initial removal of 90 percent of invasives and trash in soft bottom reaches, and replanting of native vegetation (if needed and if the reach is included within the selected alternative).

e) ***Buffer Zone (Objective 1).*** A buffer zone between human activities area and restored areas would be provided with native vegetation ***consistent*** with the surrounding ecosystem.

5. **Remove concrete or naturalize channel bed and/or banks**. Concrete removal measures include modifying the channel by removing concrete and/or grouted stone. Erosion control would accompany removal and removal would include modifications to the channel bed, terracing of the banks, etc.

a) ***Lower channel banks (Objectives 1, 2).*** This measure lowers the channel banks to connect with adjacent areas, setting back levees or providing berms as needed per site to avoid inducing flood damages.

b) ***Widen channel banks (Objectives 1, 2).*** This measure widens the channel, removing concrete and reconstructing channel banks with site-appropriate erosion control to create more capacity, support more habitats and natural river processes, as well as tying into adjacent areas.

c) ***Lowering banks and widening the channel (Objectives 1, 2).*** The measure includes lowering channel walls and widening the channel, linking the River to adjacent areas. These combined measures could involve construction of levees or berms to contain flood flows; this is assumed to be limited and will require hydraulic modeling to determine if necessary.

d) ***Channel bed deepening (Objective 1).*** This measure excavates the channel to create more capacity and allow for additional aquatic habitat in the channel where concrete currently exists. It would require removal of concrete or grouted rock substrate and excavation of the channel to desired depth. The channel would need to be stabilized either by replacing the grouted rock/concrete bed or grade control structures or both to maintain channel integrity.

e) ***Terraces with earthen banks (Objective 1, 2).*** This measure requires site-specific measurement of available space and dimensions adjusted accordingly. Channel banks would be terraced to provide a gradual slope and transition between the channel and top of bank. Terraces would be earthen and stabilized for flood flows and safety. Dimension of the terraces will need to consider wildlife movement with gentler slopes sufficient for transit by wildlife. It is similar to measure the design providing for concrete lined terraces in the banks, without the use of concrete stabilization.

f) ***Create a more natural geomorphic character and plant for freshwater marsh in main River channel (Objective 1).*** This measure includes modification of the existing concrete River channel to allow suitable bed conditions for restoration of freshwater marsh. Shallow water (less than 6 feet) will be required for freshwater marsh, which will be interspersed with open water and riparian vegetation. Modifications to the channel include removal of concrete, excavation to create an uneven riverbed with pools and shallow zones, stabilization of the channel with boulders or weirs, and planting of wetland and riparian vegetation. Native fish such as Santa Ana sucker and arroyo chub, although currently extirpated from the project area, could be reintroduced into restored areas with appropriate habitat such as freshwater marsh in combination with existing open water. These species are supported on tributaries to the LA River in the most upstream reaches (FoLAR 2008). Rainbow trout (non-anadromous steelhead), which are also present in upstream reaches may also be reintroduced into appropriate habitat.

4.4.6 Recreation Management Measures

ER 1105-2-100 lists recreation measures, which may be cost shared in recreation developments as Ecosystem Restoration Projects. These measures address Objective 3:

- Access and Circulation: Roads, turnarounds, trails (multiple-use), parking, footbridges, and culverts;
- Structures: Sanitation – (e.g., toilets, comfort stations, shelters for picnicking and trail-related uses);
- Utilities: Water supply – (e.g., municipal system, drinking fountains and faucets, sewage and waste water disposal – storm drainage, public telephone);
- Site Preparation/Restoration: Clearing and grubbing, grading and land form;
- Park Furniture: Picnic tables, trash and recycling receptacles/holders, bicycle racks;
- Signs: Entrance directional markers, traffic control (vehicular and pedestrian), instructional (includes fire danger notices), wayfinding;
- Interpretive Guidance and Media: Display boards, interpretive markers (natural, historical, archeological, etc.), bulletin board; and
- Protection, Control, Health and Safety: Gates and barricades, walls and fencing, guardrails, entrance stations, lighting, and handrails.

This list of recreation measures assumes the following:

- Facilities to be cost shared are limited to standard designs consistent with the natural environment of the surrounding area, but should not include embellishments, elaborate designs, or be ostentatious.
- Footbridges are to be austere and used only when other crossings methods are impractical. Footbridges that are the central recreation experience are to be a non-Federal cost. Pedestrian bridges at highways or railroads are normally a non-Federal cost; however, if they are integral to the recreation feature and the most cost effective alternative, they may be cost shared.
- Connections to an existing municipal system for water supply and sanitation needed. Recreation measures suited only to rural settings (e.g. vault toilets) are excluded.

4.5 DEVELOPMENT OF ALTERNATIVES

During the planning charettes, alternatives were developed based on expertise from Federal, state, and local agencies, university and environmental organizations, the USACE, and the Sponsor. These are referred to as the preliminary array of alternatives. The alternatives were formulated for the entire study area during the planning charrette with additional alternatives formulated during public outreach, and individual team efforts including the USACE design team, City design team, and the habitat team, which was formed to work together on the habitat evaluation.

4.5.1 Real Estate Considerations

The selection of the areas of land in the study area where ecosystem restoration alternatives might reasonably and appropriately be implemented was accomplished through an iterative process by the project team composed of USACE personnel, the non-Federal Sponsor, and their respective technical specialists and consultants. The team considered advice of local non-profits with an interest in River restoration, City Council representatives, and agencies including U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife (CDFW), and the California Regional Water Quality Board (CRWQB). Geographic Information System (GIS) mapping resources, recent aerial photographs, field inspections, and the local knowledge base and professional opinion were the tools applied in the delineation of a rational area within which alternatives could be formulated.

The team presumed that the River channel, confluences with major tributaries, and areas of open space adjacent to these watercourses within the study area would be available for restoration features. Lands within associated historic floodplains were considered for the restoration alternatives. Vacant parcels located within the historic floodplain and close to existing watercourses were evaluated on a case-by-case basis. If portions of privately owned lands could be acquired without impact to residential structures, they were considered. The following strategy assisted in identifying the area for alternatives formulation:

- Publicly owned lands were favored over privately held lands.
- Existing residential buildings, commercial and institutional developments, and currently utilized freeway, street and road rights of way were avoided as potential areas for implementation of a project unless plan objectives could not be met within the reach without those lands and there was potential for acquisition. Vacant lands presently zoned for residential or commercial development were considered available for the project.
- Some known utility corridors were included because they tended to follow the tributaries and were unavoidable. The project would not relocate the utility lines themselves unless there were unavoidable access or engineering requirements directing the need for a particular location.

This delineated area included the land most suitable for ecosystem restoration within the River study area. The area included selected portions of the channel itself, the river right-of-way, the confluence and some area upstream on major tributaries, and open space areas along the channel. Table 4-3 provides a summary of land ownership in those areas considered for inclusion in the project. While over 3,000 acres were considered in the initial potential project area, evaluation of the location and availability for river restoration resulted in a smaller potential project area of 973 acres.

A total of 316 parcels within the study area were included in the preliminary array of alternatives. Of those parcels, 81 were found to be improved with buildings. Preliminarily, 188 parcels are government owned, at least 22 parcels are owned by railroad companies, and the remaining parcels are privately owned.

Table 4-3 Land Zoning in the Project Area

Zoning	Acres
Unknown (misc) District Plan	23
Agricultural (A2)	13
Commercial Manufacturing (CM)	36
Industrial (M1-M3, MR2)	235
Open Space & Public Facilities (OS, PF)	2,788
Residential (All Rs)	33
TOTAL	3,128

4.5.2 Publically Owned Lands Screened from the Potential Project Area

The team continued to consider plan efficiency as it related to land availability, costs, and other lands, easements, rights-of-way, relocations, and disposal sites (LERRD). Under the ecosystem restoration project authority, cost sharing for such projects is 65 percent Federal to 35 percent non-Federal. Although permissible under law, land costs above the Sponsor's share are disfavored under USACE policy, which provides a 25 percent target for maximum percentage of land value for a restoration project. This is, in part, to ensure that the USACE is engaging in a true restoration project, increasing habitat functions and

services rather than serving as an avenue for land acquisition. The USACE's Planning Guidance Notebook states the policy:

"Land acquisition in ecosystem restoration plans must be kept to a minimum. Project proposals that consist primarily of land acquisition are not appropriate. As a target, land value should not exceed 25 percent of total project costs. Projects with land costs exceeding this target level are not likely to be given a high priority for budgetary purposes" (ER 1105-2-100, Appendix E, para. E-30f).

Real estate and potential relocation costs are known to be exceptionally high in the Los Angeles area and these costs will likely compose a substantial portion of the potential restoration alternative costs. Mindful that real estate costs would be high for any alternative that involved urban Los Angeles lands, the study examined, as described above, lands already included in the river right of way (LACDA project boundary), open space lands adjacent to the existing LACDA boundary, and other parcels that would support restoration goals such as connectivity.

Other lands considered for inclusion in the project (in addition to being located within or adjacent to the river right of way) would preferably be in Federal or local government ownership wherever possible. Private lands were included only if restoration benefits in that reach could not be accomplished any other way. In some cases, inclusion of an entire identified site was considered infeasible in the highly urban context because very few other appropriate areas are available for relocation of the current uses, but in some cases, a portion of the site can be utilized. Appendix H includes a list of lands considered for the project.

4.5.3 Preliminary Array of Alternatives

As described above, the charrette teams, the USACE, and other habitat team members initially assembled alternative plans composed of the measures above (including measures later eliminated). In the discussion below, the preliminary array of 19 alternatives is ordered by the number of acres included within each and range from Alternative 1 Comprehensive with 621 acres to Alternative 19 Taylor Yard with 102, not including the main channel. These are described briefly in the table below (Table 4-4) and further detailed in the Alternative Matrix (Table 4-5) with sub-reaches described in the following section. Elimination of the tunnel measure, as identified above, resulted in elimination of all but three complete preliminary alternatives to carry forward for further analysis: Preliminary Alternative 16 "Side Channels Only," Preliminary Alternative 18 "Comprehensive Pockets," and Preliminary Alternative 19 "Taylor Yard." However, the other alternatives' reach plans that did not require a tunnel were also carried forward and recombined to create additional alternatives as described below.

Table 4-4 Preliminary Array of 19 Alternatives

No.	Alternative	Description
0	No Action	Future Without-Project Conditions
1	Comprehensive A	Includes development of freshwater marsh, open water ponds, fish refugia, and riparian corridors, exposing storm drain outlets and converting to natural stream confluences, diversion of flow into side channels lined with habitat, underground basins and culverts to attenuate flow, bioengineering of channel walls, channel modification to increase width by terracing, channel widening, and/or modification of channel walls, connections to green streets, modification along tributary confluences to more natural habitat, and wildlife crossings.
2	Atwater to Cornfields	Implements all of the above within the Atwater to Cornfields part of the reach.
3	Banks & Tributaries Only	Leaves the flood risk management channel bed primarily "as is" and restores floodplain by creating side channels in open areas along the river with freshwater marsh and riparian corridors and restoring tributary confluences. Includes modification of storm

No.	Alternative	Description
		drain outlets and bank terracing.
4	Comprehensive B	Includes most of measures included in Alt 1 Comprehensive A with fewer locations, less terracing and side channels, and omits elevating railroads on trestles, bioengineering walls, open water, and modifying trap channel to vertical.
5	Los Feliz to Arroyo Seco	Implements all measures within Los Feliz to Arroyo Seco reach.
6	Comprehensive C	Includes most of measures included in Alt 1 Comprehensive A with fewer locations and omits railroad elevation, bioengineering walls, open water, and modifying trap channel to vertical. Includes more terracing and storm drain modifications and different locations for wildlife crossings than Alt 4 Comprehensive B.
7	Channel Reshaping A	Focus is on channel reshaping and attenuation of flow – detention, bypass and widening. Using culverts and underground basins to attenuate flows, the channel is geomorphically changed to a wider, softer channel, naturalized storm drain outlets, and some restored riparian corridors.
8	Habitat Variation	Maximizing habitat restoration for a species diversity, including fish, motivated formulation of alternative. Attenuation or reduction in flow is included in each reach as well as freshwater marsh, riparian and aquatic habitat measures.
9	Soft Bottom Channel & Associated Banks	This alternative focuses restoration in reaches that already have a soft riverbed. Where open areas are adjacent to the river, the river will be widened rather than terraced. Storm drains are converted to natural stream confluences and restored with vegetation. Habitats include aquatic, freshwater marsh and riparian areas.
10	Channel Modifications with least structural and engineering impacts and public acceptability	This alternative implements measures in locations with the least impact to infrastructure and engineering challenges, while still including measures in all reaches to attenuate flow, restore riparian and freshwater marsh habitat and tributary confluence restoration.
11	Habitat Connectivity	This alternative focuses on bank to bank and upstream to downstream connections for wildlife, linkages to wildlife areas, channel widening and terracing.
12	Hydrologic Connection Improvements	This alternative focuses on lowering grade for adjacent large open areas, improved hydrologic connections between the banks, storm drains and the river. It also intends to increase wildlife movement between the river and adjacent open areas.
13	Channel Reshaping B	Using culverts to attenuate flows, the channel is geomorphically changed to a wider, softer channel, naturalized storm drain outlets, and restored riparian corridors. Includes bioengineering of channel walls, side channels and has more riparian and freshwater marsh replanting than Channel Reshaping A.
14	Channel Widening	This alternative focuses on widening the channel. Attenuation is accomplished with culvert bypasses. Includes planting of freshwater marsh and riparian corridors.
15	Bypass with Bank and Tributary Confluence Restoration	Reduces flow using culvert bypass to allow for terracing and channel bank softening. Improves freshwater marsh habitat in soft bottom area and adds riparian habitat to downstream locations on the river overbank. Emphasizes widening and restoration at tributary confluences.
16	Side Channels Only	Leaves the flood risk management channel bed and banks primarily "as is," and restores floodplain by creating side channels in open areas along the river with freshwater marsh and riparian corridors and restoring tributary confluences.
17	Opportunity area restoration with channel widening at tributaries	Restores wetlands on the overbank and major tributaries at River Glen - Verdugo Wash confluence, Griffith Park, Bowtie/Taylor Yard, Arroyo Seco confluence, Burbank Western Channel, Cornfields (Los Angeles Historical Park) and the LATC (Mission Yard). Widens the river at Verdugo, Arroyo Seco and Burbank Western Channel.
18	Opportunity area restoration to large open areas	Leaves flood risk management channel bed and banks "as is" and restores wetlands on the overbank and major tributaries at River Glen - Verdugo Wash confluence, Bowtie/Taylor Yard, Arroyo Seco confluence, and Cornfields (Los Angeles Historic Park).
19	Taylor Yard	Restores wetlands on the overbank and widens the river at this single key location on the river (includes the Bowtie parcel).

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Table 4-5 Preliminary and Sub-Reach Plans

Reach	Measure Type	Sub-measure	Alternative																		
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. Pollywog Park	I. Adjacent or off channel modifications	Create a more natural geomorphic character and plant (pool/riffle system)	X		X	X					X	X				X	X	X	X		
		Restore storm drain to natural stream confluence	X		X			X			X	X				X		X			
	II. Attenuation	Side channels	X		X			X		X	X	X						X			
		Create underground basin for attenuation	X		X			X			X					X		X		X	
		Tunnels to divert flood flows	X		X	X		X	X	X	X						X		X		
	IV. Planting	Restructure channel walls & plant vines	X							X					X						
		Riparian corridors	X		X	X		X		X	X	X	X	X	X	X	X	X	X	X	
	V. Remove concrete	Channel banks mainstem/widen channel (implies erosion control)	X													X					
		Deepen channel bed	X			X		X		X	X	X		X		X					
		Widen tributary channel	X		X			X			X										
		Terrace banks	X		X			X		X	X	X		X	X	X			X		
	VI Reshape Channel	Modify trap channel to vertical sides	X			X			X						X						
2. Bette Davis Park	I. Adjacent or off channel modifications	Create a more natural geomorphic character and plant (pool/riffle system)	X		X	X					X	X				X	X	X	X		
		Restore storm drain to natural stream confluence	X		X			X			X	X						X			
	II. Attenuation	Side channels	X		X			X		X	X	X						X			
		Tunnels to divert flood flows	X		X	X		X	X	X	X						X		X		
	IV. Planting	Restructure channel walls & plant vines	X							X					X						
		Riparian corridors	X		X	X		X	X	X	X	X	X	X	X	X	X	X			
	V. Remove concrete	Deepen channel bed				X			X												
		Terrace banks	X					X		X	X	X		X							
	VI Reshape Channel	Modify trap channel to vertical sides	X			X			X						X						
3. Ferraro Fields/ Verdugo	I. Adjacent or off channel modifications	Create a more natural geomorphic character and plant (pool/riffle system)	X		X	X					X	X			X	X		X		X	
		Restore storm drain to natural stream confluence	X	X	X			X		X	X							X	X		
	II. Attenuation	Side channels	X		X	X				X	X	X	X	X				X		X	
		Tunnels to divert flood flows	X	X	X	X		X	X	X	X				X		X		X		
	IV. Planting	Restructure channel walls & plant vines	X	X						X					X						
		Riparian corridors	X	X	X	X		X	X	X	X	X	X	X	X	X		X		X	
		Open water	X								X								X		
	V. Remove concrete	Lower channel banks			X						X		X		X					X	
		Deepen channel bed		X		X			X												
		Widen channel mainstem	X					X		X	X		X	X	X	X	X			X	
		Terrace banks	X		X			X			X		X		X						

Reach	Measure Type	Sub-measure	Alternative																		
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	VI. Reshape Channel	Modify trap channel to vertical sides	x	x		x			x					x	x						
4. Griffith Park	I. Adjacent or off channel modifications	Create a more natural geomorphic character and plant (pool/riffle system)	x	x	x	x			x	x		x						x	x		
		Restore storm drain to natural stream confluence	x	x	x	x	X	x	x	x	x	x		x			x	x	x		
		Grade adjacent areas to lower level for offline detention and habitat	x	x	x	x		x	x			x		x							
	II. Attenuation	Side channels	x	x	x	x	x	x	x	x		x			x			x			
		Create underground basin for attenuation	x		x					x				x	x			x			
		Tunnels to divert flood flows	x	x	x	x	x	x	x	x	x						x		x		
	III. Wildlife Access	Bridge undercrossings for wildlife	x	x													x				
	IV. Planting	Restructure channel walls & plant vines	x	x			x			x					x						
		Riparian corridors	x	x		x	x	x	x	x			x	x	x			x			
	V. Remove concrete	Widen channel mainstem	x	x		x		x	x					x		x					
		Deepen channel bed		x		x	x		x												
		Terrace banks	x	x	x	x		x	x	x	x	x	x		x	x					
	VI Reshape Channel	Modify trap channel to vertical sides	x	x		x	x		x						x						
5. Riverside Drive	I. Adjacent or off channel modifications	Create a more natural geomorphic character and plant (pool/riffle system)	x	x	x		x			x		x	x		x						
		Restore storm drain to natural stream confluence	x	x			x	x			x							x			
	II. Attenuation	Tunnels to divert flood flows	x	x	x	x	x	x	x	x	x						x		x		
	III. Wildlife Access	Wildlife access from river to bank (in daylighted storm drain)	x	x			x	x		x		x					x				
	IV. Planting	Restructure channel walls & plant vines	x	x			x			x					x						
		Riparian corridors	x	x		x	x	x	x	x			x	x	x			x			
	V. Remove concrete	Deepen channel bed		x		x	x		x												
		Terrace banks	x	x	x		x						x								
	VI Reshape Channel	Modify trap channel to vertical sides	x	x		x	x		x						x						
Reach 6. Taylor Yard	IV. Planting	Restructure channel walls & plant vines	x	x			x			x					x						
		Riparian corridors	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x
		Planting built into channel walls	x	x	x		x					x	x	x	x					x	
	V. Remove concrete	Lower bank to channel level (riparian)	x	x	x	x	x	x			x				x	x	x			x	x
		Widen channel	x	x	x	x	X	x	x				x	x	x	x	x		x	x	x
		Deepen channel bed		x		x	X		x												
		Terrace banks	x	x	x		X	x		x	x	x	x	x			x		x	x	x
	VI Reshape Channel	Modify trap channel to vertical sides	x	x		x	X		x						x						
7. Cornfields/ Arroyo	II. Attenuation	Side channels	x	x	x										x			x		x	
		Creation of wetlands flood risk management basin	x	x	x			x					x							x	

Reach	Measure Type	Sub-measure	Alternative																	
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Seco		Tunnels to divert flood flows	x	x	x	x	x	x	x	x	x						x		x		
	IV. Planting	Restructure channel walls & plant vines	x	x			x			x					x						
		Riparian corridors	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x		x	
		Planting built into channel walls	x	x	x		x					x	x	x	x					x	
	V. Remove Concrete	Widen channel mainstem	x	x	x	x	x	x				x	x	x	x	x	x		x	x	
		Deepen channel bed	x	x		x	x		x			x	x		x	x					
		Widen tributary channel		x	x	x	x	x	x	x		x	x				x			x	
		Terrace banks	x	x	x		x	x		x		x	x		x						
	VI Reshape Channel	Modify trap channel to vertical sides	x	x		x	x		x						x						
8. LATC	II. Attenuation	Side channels	x		x	x		x							x			x	x		
		Tunnels to divert flood flows	x		x	x		x	x	x	x						x		x		
	IV. Planting	Restructure channel walls & plant vines	x							x					x						
		Riparian corridors	x		x	x		x	x	x		x	x	x	x	x	x	x			
	V. Remove concrete	Widen channel mainstem	x		x			x					x	x		x					
		Deepen channel bed	x			x			x			x	x			x					
		Terrace banks			x			x					x								
	VI Reshape Channel	Modify trap channel to vertical sides	x			x			x						x						

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4.6 DESIGNS

Conceptual designs were developed based on the measures described and existing channel geometries in the ARBOR reach. These designs were developed to have enough detail to estimate quantities and costs only and do not account for scour analysis, geotechnical investigation, or other more detailed analysis to be completed during design. Additional information, including figures, is found in Appendix A, Design. The project team made several assumptions pertaining to the designs, including the following:

- Daylighting streams would result in a riparian area and freshwater marshes at their confluences.
- Grade control structures would be used to stabilize the bed of the river when concrete was removed.
- Erosion control would be included where banks were modified to allow for planting.
- Invasives removal and management would be included throughout the project area.
- Levees would be modified with protection maintained as necessary.
- Maintenance requirements for levees, riverbed, and banks would be met.

4.7 COSTS

Cost estimates were developed based on the conceptual designs developed for the measures, as described above. Appendix C, Cost, describes assumptions, unit costs, and price levels developed for the measures and alternatives.

Cost estimates for the Preliminary Array ranged from a high of $3.9 billion dollars for Preliminary Alternative 1: Comprehensive, which included $1.5 billion in estimated tunneling costs (the tunneling estimate did not include LERRD for tunneling) to $211 million for Alternative Preliminary 19: Taylor Yard. These estimates were done for each preliminary alternative and each reach. They included construction, mobilization (7.5 percent), tunneling costs if any (without associated LERRD), a 25 percent contingency for construction, preliminary engineering, and design with engineering during construction estimated at 11 percent, and supervision and administration costs of 6.5 percent. The real estate cost estimate was based on the GIS mapping for each alternative and included business relocations cost for Verdugo Wash and LATC and a 20 percent contingency. Operations and maintenance costs were estimated and annualized for each alternative and reach. A matrix displaying the costs of each of the 19 preliminary alternatives by reach is shown in the Cost appendix.

4.8 FORMULATION OF SUB-REACH PLANS

Once the preliminary array of alternatives was formulated, the team used the geomorphic reaches within the study area to divide each of the alternatives in the preliminary array into sub-reach plans. Each of the 19 preliminary alternatives incorporated combinations of measures that varied substantially by location from upstream to downstream, based upon existing geomorphic character and opportunities and constraints within these sub-area reaches. Hence, each alternative represented a combination of alternative features, which varied from reach to reach, to ensure that the best possible combination of features was identified, based upon cost effectiveness and incremental cost analysis criteria. While not all of these 19 alternatives included features in all eight reaches, they were connected between reaches. Sub-reach plans would consist of the measures included in each geomorphic reach of each alternative in the preliminary array. This allowed recombination of the sub-reach plans and comparison of those newly formed hybrid plans to the preliminary plans in the economic analysis to ensure that the most efficient plans were carried forward into the final array.

Table 4-5 above summarizes the sub-reach plans and shows their relationship to the preliminary array. Measures common to all alternatives are not included, but assumed and were considered for costs and benefits. Each of the 19 preliminary plans are shown with an "x" indicating included measures by reach or sub-reach plan.

4.9 HABITAT ANALYSIS

USACE guidance requires that the ecosystem related benefits of proposed alternatives be subjected to detailed economic analysis, allowing an explicit comparison of the costs and benefits associated with the alternatives. Consequently, it is necessary that the environmental benefits of the alternatives be based on some quantifiable unit of value. Since restoration value is difficult to monetize, instead of calculating benefits in monetary terms, USACE ecosystem restoration projects calculate the value and benefits of restored habitat using established habitat assessment methodologies. Comparing the alternatives in this manner facilitates the determination of the most cost-effective restoration alternative that meets restoration goals (USACE 2000).

For this study, benefits (or outputs) have been quantified using the Combined Habitat Assessment Protocols (CHAP) approach for the existing, future without project, and future with project conditions. The CHAP has been approved for single use on this study (21 June 2013).

The CHAP output is in the form of Habitat Units (HUs). HUs are derived from the U.S. Fish and Wildlife Service's (USFWS) methodology known as the Habitat Evaluation Procedures (USFWS, 1980). The preliminary output of the HEP model is a habitat suitability index (HSI), which ranges from 0 (poor habitat quality) to 1.0 (optimum habitat quality). Habitat value is finally calculated in terms of HUs by multiplying the HSI by site acreage.

Unlike HEP, where the preliminary output (HSI) ranges from 0 to 1[4], CHAP's per-acre values are not limited to this range. In this way, where the HUs in HEP are dependent on acreage (HSI x acreage = HU; i.e., more acreage = more HUs), the HUs generated by CHAP are not dependent on acreage and reflect the value of a particular habitat type as based on species, functions, and habitat. Average Annual HUs are ultimately used in an economic analysis to generate cost effective and best buy restoration alternatives.

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[4] HEP assumes a linear relationship between habitat suitability and species response. In other words, HEP assumes that as HSI increases the wildlife population should also increase. This implies that the model has the ability to predict population response without errors (NHI 2007).

Furthermore, the single species method assumes that an entire community is represented by that species, which may result in a narrow representation of habitat quality (NHI 2007). The single species method does not account for substantial benefits that are afforded by the ecosystem as a whole, which includes multiple species and multiple habitats. Furthermore, it does not account for all functions or habitat components potentially present at a site.

Throughout the U.S. there is a shift towards assessing restoration and other conservation activities at the ecosystem level (Perkins 2002). Determining habitat structure and functional integrity of an area for all species potentially using it is more supportive of an ecosystem management approach. A habitat assessment methodology that measures functionality, which is critical to the success of many restoration projects, should incorporate multiple components such as vegetation, structure, surrounding landscape, and habitat size and shape (Breaux et al. 2005; Store and Jokimaki 2003).

4.9.1 Methods

The CHAP method quantifies habitat value and generates HUs based on an assessment of multiple species, habitat features, and functions by habitat type. CHAP incorporates the HAB methodology, developed by the Northwest Habitat Institute (NHI). HAB involves a triad assessment of species, habitat, and functions (O'Neil et al. 2005), and includes an inventory of habitat components and their relationship to ecological functions performed by species.

In the HAB approach, fish and wildlife species with the potential to occur at a given site are identified. Potential species are determined using range maps in conjunction with information on vegetation types and habitat types, structural conditions, and habitat elements, also known as Key Ecological Correlates (KECs). KECs represent habitat elements (physical and biological) that are known to most influence a species distribution, abundance, fitness, and viability. KECs include habitat elements such as down wood, snags, litter layer, shrub layer, flowers, burrows, boulders, or riffles and pools. For the Master list of CHAP KECs see Appendix G.

Habitat is defined as "the place, including physical and biotic conditions, where a plant or animal usually occurs" (Johnson and O'Neil 2001). Habitat types are often characterized by a dominant plant form or physical characteristic. Structural conditions of the habitat are also considered.

Function refers to the principal way organisms influence the environment, also known as Key Ecological Functions (KEF) (NHI 2007). KEFs refer to the principal set of ecological roles performed by each species in its ecosystem (NHI 2007). More specifically, KEFs refer to the main ways organisms use, influence, and alter their biotic and abiotic environments. KEFs include functions that organisms perform in the environment, such as a grazer, sap feeder, carrion feeder, seed disperser, nest parasite, primary cavity excavator, or impounds water by creating dams. For the Master list of CHAP KEFs see Appendix G. While other methods consider few to many habitat components, the HAB approach considers over 350 different KECs and over 100 KEFs.

Over 175 species were evaluated in CHAP for the study including fish, amphibians, reptiles, birds, and mammals. Approximately 140 bird species were evaluated. With project, restored riparian habitat could support the Federally endangered least Bell's vireo, yellow-breasted chat, and yellow warbler (State Species of Concern). Many other charismatic bird species were evaluated including the hooded and Bullock's oriole, lazuli bunting, blue grosbeak, western tanager, several species of woodpeckers, owls, many species of ducks (cinnamon teal, ring-necked duck, northern pintail), hawks (sharp shinned hawk, osprey), and shorebirds (great blue heron, spotted sandpiper, black necked stilt). The evaluation also included top predators such as bobcat and coyote, among other small mammals. For a complete list of species evaluated in CHAP, see Appendix G.

The HAB approach, which is largely spatially based, uses Geographic Information Systems (GIS) to delineate habitat polygons[5] and map habitat types (cross-walked with associated vegetation types) within the Study area. These habitat type classifications are based on the California Wildlife Habitat Relationships (CWHR) habitat classification scheme, derived from the CDFG publication titled "A Guide to Wildlife Habitats of California" (Mayer and Laudenslayer 1988). For each habitat polygon, wildlife

[5] In GIS, a polygon is a map feature that bounds an area at a given scale, such as a county on a world map or a district on a city map. In habitat mapping, the polygon bounds a specific habitat type.

species associated with these CWHR habitat types are linked to key environmental correlates (KECs) (i.e., habitat elements) and key ecological functions (KEFs)(i.e., functions performed by species), which are derived from NHI's Interactive Habitat and Biodiversity Information System (IBIS) database[6] (Johnson and O'Neil 2001).

The accounts for species, habitat, and function are combined to generate a quantitative per-acre HAB value. This HAB value is then combined with elements of HEP (i.e. multiplication by acres) to generate HUs as the output (Per Acre HAB Value x Acres = HUs). This combined approach (HAB + HEP) is referred to as CHAP (Combined Habitat Assessment Protocol) (NHI 2007). The detailed steps of the CHAP analysis and calculations are outlined in Appendix G.

HUs were generated for existing, future without project, and future with project conditions for the 19 preliminary alternatives. HUs were calculated for the base year, 25-year, and 50-year time horizons (for summary of HUs see Appendix G). HUs capture the habitat value of a given polygon based on the elements that compose the habitats (KECs), the species that inhabit them, and the functions that those species provide in the ecosystem (KEFs). In this way, the HU output provides a quantitative means of comparison of habitat value. The gain in HUs for the future with project is compared to the future without project, in order to determine the increase in habitat value of a given alternative over the habitat value resulting from taking no action.

For this study, the HUs generated by CHAP does not capture all benefits associated with restoration of an ecosystem. No model captures every element for consideration. The HU output for this study measured habitat value as described above, but did not give greater weight to the value of in-channel habitat and hydrologic connectivity or habitat connectivity for wildlife movement. In-channel habitat and natural hydrologic connections are more sustainable, supporting sediment and nutrient exchange with floodplain habitats, however in-channel habitat was given equal weight to habitat on the overbanks that is supported by assisted watering (such as pipes or pumps). The level of such connectivity was not captured in the CHAP output for this study, as higher levels of connectivity were not given weighted benefits. Restoration of habitat patches and vegetated corridors to link them improves connectivity for the movement of wildlife within the study area and to nearby ecological areas. The CHAP assessment was used to identify the final array of alternatives. Additional comparisons were made to assess restoration of hydrologic and hydraulic function and nodal and regional habitat connectivity. A comparison of attainment of hydrologic function and habitat connectivity for the final array was performed to assess how the alternatives met the hydrologic component of Objective 1 and the habitat connectivity objective (Objective 2). This comparison is provided in Section 6.3.

4.9.2 Results

Habitat types currently existing in the potential project area include eucalyptus, open water riverine, agriculture, perennial grassland, valley foothill riparian, and urban. Mapping of habitat types for baseline existing conditions shows that approximately 67 percent of the study area (564.85 acres) is urban (including low density and golf course), providing an average 4.64 HUs per acre. Existing riparian habitat accounts for only 7 percent of the study area (62.42 acres); however, it provides 16.84 HUs per acre. These riparian areas occupy nine times fewer acres than the urban areas, yet provide almost four times

[6] The datasets for KECs and KEFs have been developed through a multiple expert panel process. IBIS is an extensively peer reviewed system that contains current ecological information on more than 1,000 fish and wildlife species, organized in searchable databases.

more HUs per acre. The open water areas also provide substantial HUs per acre, totaling 22 percent of the study area (182.21 acres) and providing 11.89 HUs per acre. Other habitat types account for less than 4 percent of the study area.

Total baseline HUs equaled 6,119. For the 50-year future without project condition HUs fell to 5,291, (Figure 4-1). This reflects a 14 percent decrease in value without project in this already degraded environment. The gain in HUs over the 50-year future without project was calculated for the 19 preliminary alternatives. The detailed CHAP calculations for the preliminary alternatives are described in detail in Appendix G.

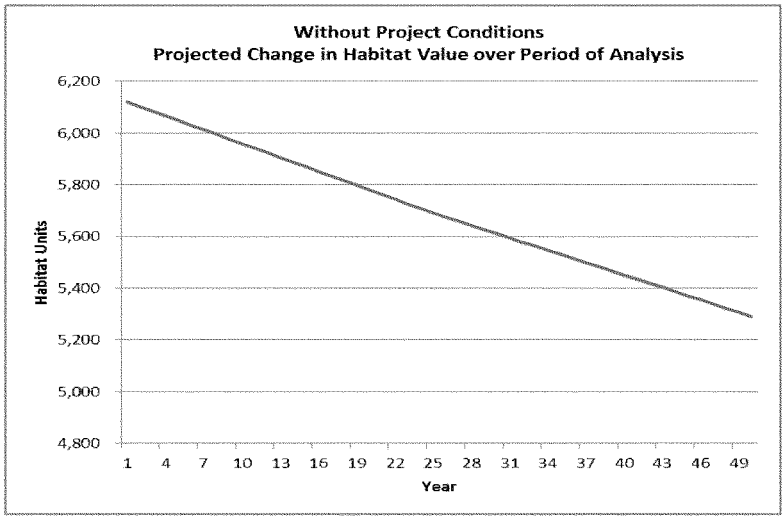

Figure 4-1 Baseline to Future HU Comparison

These total HUs for the preliminary alternatives were then annualized to inform the economic analysis and to generate the final array of cost effective and "best buy" plans as described in detail on the following pages. These results quantify the overall value of the restored habitat, based on species, habitat, and functions being provided by each alternative as compared to the future without project condition. Results show that riparian and riverine restoration has the potential to provide restored habitat function and value in the urban setting of Los Angeles. Maximizing acreage of these habitats would benefit ecosystem functioning and species diversity in the highly urbanized, degraded study area.

4.10 FLOODING RISK AND TUNNEL DEPENDENCIES

Consideration was given to the potential for alternatives and individual measures to increase flood risk. Several alternatives included removal of the concrete channel, or large portions of it. This would require diversion of flood flows around the study area to avoid damaging infrastructure and inducing flooding. To that end, the preliminary array of alternatives was reviewed, by reach, to determine if the features would require a diversion tunnel.

Diversion tunnel costs were developed as a separate measure. Reaches and alternatives dependent on the diversion tunnel are indicated in grey cells and with an X in Table 4-6 below. The costs and benefits of these alternatives were compared, although the high tunnel cost, $1.5 billion, was considered excessive and meant that they were not cost effective and they were not evaluated further.

Table 4-6 Tunnel Dependencies by Reach and Alternative

Preliminary Alternative	Reach							
	1	2	3	4	5	6	7	8
1	X	X	X	X	X		X	X
2			X	X	X		X	
3	X	X	X	X	X		X	
4	X	X	X	X	X		X	
5				X			X	
6	X	X	X	X	X		X	
7	X	X	X	X	X		X	
8	X	X	X	X	X		X	
9	X		X					
10	X	X	X	X			X	
11			X	X	X		X	
12	X	X		X				
13	X		X	X	X		X	
14	X			X			X	
15	X						X	
16								
17	X	X					X	
18								
19								

Note: Gray shaded cells indicate reaches dependent on a diversion tunnel that were dismissed from further consideration due to excessive cost. White cells indicated reaches that were not dependent on a diversion tunnel and were therefore carried forward for further analysis. Black cells indicate no reach plan was included in the relevant preliminary alternative.

4.10.1 Other Alternatives Considered

Two additional alternatives that were considered in concept were to: (1) limit the project area to the LACDA right-of-way, and (2) widen the entire river channel. Both of these were removed from further consideration due to the reasons described below.

Limiting Project Area to LACDA Right-of-Way

The LACDA alternative involved consideration of whether an alternative situated wholly within the existing LACDA boundary could meet objectives. The LACDA boundary includes the river channel bottom and sides with very limited right-of-way on either side, much of which is occupied by bicycle paths on the west/south side of the river. The team concluded that a LACDA-footprint-limited alternative would not meet objectives because it would fail Objective 2, restoring regional connectivity, and it would also likely fail Objective 1 because flow velocities would not be sufficiently reduced to support restored

habitat. Therefore, LACDA lands will be included in alternatives, but it was determined that they are not sufficient in themselves to support restoration objectives.

Channel Widening to accommodate natural riparian river system

The team considered an alternative that involved channel widening sufficient to accommodate a natural riparian river system within the channel. This would require increasing the channel's width by 3 to 5 times (900 feet to 1,500 feet) based on the volume and velocity of water flowing through the channel during high flow scenarios. A rough estimate of the potential real estate acquisition cost was done assuming $50 to $120 per square foot depending upon the development on the parcels. The estimated real estate acquisition cost would be at least $7.6 billion. This would not include utility, infrastructure, business and residential relocation costs, or first costs of construction, which would greatly increase costs. Due to this incredibly high and excessive cost and the unlikelihood of acquiring, assembling, and preparing the parcels necessary in the study timeframe, channel widening to this extent was eliminated. If best management practices are adopted throughout the entire watershed to increase permeability and accomplish substantial peak flow reduction, and if a floodplain buy-back program is instituted, this measure may become more viable in the future.

4.11 COST EFFECTIVENESS/INCREMENTAL COST ANALYSIS

USACE does not consider monetary benefits or the generation of benefit to cost ratios when evaluating restoration projects. Rather than putting a monetary value on habitat benefits, the focus of the final evaluation is on the relationship of habitat benefits to project costs to ensure cost-effective and justified plans are put forth for recommendation for implementation. This process is summarized below and described in more detail in Appendix B, Economics.

Cost-effectiveness and incremental cost analyses were performed using the certified IWR Planning Suite software version 1.0.11.0. The CE/ICA is an evaluation tool that considers and identifies the relationship between changes in cost and changes in quantified, but not monetized, habitat benefits. The evaluation is used to identify the most cost-effective alternative plans to reach various levels of restoration output and to provide information about whether increasing levels of restoration are worth the added cost.

Functionally, the CE/ICA provides a framework for combining individual measures and sub-measures (scales) into alternative plans. The software expedites this effort of testing each combination of measures and tabulating the resulting costs and environmental benefits.

4.11.1 Cost Effectiveness Analysis

The cost effectiveness analysis seeks to answer the question: given an adequately described objective, what is the least costly way of attaining the objective? A plan is considered cost effective if it provides a given level of output for the least cost. Cost effectiveness analysis shall be used to identify the least cost solution for each level of environmental output being considered.

The cost effectiveness analysis is the first step in the CE/ICA. It compares the Average Annual Habitat Units (AAHUs) potentially achieved by each alternative to the cost of each alternative to generate a cost per AAHU. This cost provides a means to compare the cost-effectiveness of each plan. The three criteria used for identifying non-cost-effective plans or combinations include: (1) the same level of output could be produced by another plan at less cost; (2) a larger output level could be produced at the same cost; or (3) a larger output level could be produced at the least cost. Cost-effectiveness is one of the criteria by which all plans are judged and plays a role in the selection of the NER plan. Non-cost-effective combinations of plans are dropped from further consideration.

4.11.2 Incremental Cost Analysis

Incremental cost analysis compares the additional costs to the additional outputs of an alternative. It is a tool that can assist in the plan formulation and evaluation process, rather than a dictum that drives that process. The analysis consists of examining increments of plans or project features to determine their incremental costs and benefits. Increments of plans continue to be added and evaluated as long as the incremental benefits exceed the incremental costs. When the incremental costs exceed the incremental benefits, no further increments are added. Incremental analysis helps to identify and display variations in costs among different restoration measures and alternative plans. Thus, it helps decision makers determine the most desirable level of output relative to costs and other decision criteria.

The incremental cost analysis portion of the CE/ICA compares the incremental costs for each additional unit of output from one cost effective plan to the next to identify "best buy" plans. The first step in developing best buy plans is to determine the incremental cost per unit. The plan with the lowest incremental cost per unit over the No Action Alternative is the first incremental best buy plan. Plans that have a higher incremental cost per unit for a lower level of output are eliminated. The next step is to recalculate the incremental cost per unit for the remaining plans. This process is reiterated until the lowest incremental cost per unit for the next level of output is determined. The intent of the incremental analysis is to identify the most efficient plans based upon incremental benefits relative to incremental costs.

4.11.3 Identification of the Final Array

The CE/ICA allows comparison of successive levels of output and their incremental costs between alternatives. Results of the CE/ICA then inform the selection of an alternative. The results do not provide the discrete decision; rather they are a tool to help inform a decision. The CE/ICA provides an array of alternatives that undergo a separate tradeoff analysis, which may result in alternatives being screened out or selected based on considerations external to the CE/ICA.

For ecosystem restoration, a plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective, is identified as the NER plan. The selected plan should be cost effective and justified in achieving the desired level of output. Thus, the NER plan is selected from the suite of cost effective plans identified in the CE/ICA. While the NER plan is not required to be a best buy plan, this is often the case.

Each sub-plan from the 19 preliminary alternatives was input as a measure into the CE/ICA software (IWR Plan) to compare with costs of implementing each combination of measures for each reach. The preliminary alternatives were also entered as a whole. The program then combined the sub-reach plans (geomorphic reach plans) into recombined plans for comparison and evaluation with the preliminary plans. This produced an array of 171 cost effective plans, which included 21 best buy plans. A best buy plan is one that is both cost effective combination and the most efficient plan for providing different levels of habitat value for the cost. Figure 4-2 shows how recombining the management measures produced much more cost effective and efficient plans than the preliminary alternatives originally formulated at the charrettes. Also note that the first best buy plan that includes all reaches is Alternative 10. The provision contiguous restoration throughout all of the study area reaches is important to achieving connectivity benefits and is one of the key restoration objectives (as noted in Section 4.2.1 Specific Planning Objectives, and Section 4.2.2 Objectives Performance Criteria). The Best Buy Plans (1-21) are not the same as the Preliminary Alternatives (1-19), but rather are recombinations of the reach-based plans that comprised the Preliminary Alternatives. The Preliminary Alternatives are depicted with the red circles on Figure 4-2.

The recombination of plans by reach provided a more cost effective combination of measures for the least overall cost. The annual cost and output of each of the cost effective plans is shown in Figure 4-2. The red dots show the original 19 alternatives, which were not cost effective as formulated. These do not account for tunnel costs. The sub-reach plan combinations that were cost effective are shown as green boxes and the best buy plans area shown as blue triangles when only some reaches are included and purple diamonds where all reaches are included.

The CE/ICA analysis outputs showed that cost effective, best buy alternatives should be grouped and considered for inclusion in the final array based on the incremental increases in costs and benefits. These groupings are Alternatives 1-5, Alternatives 6-9, Alternatives 10-13, and Alternatives 14-16. Alternatives 17-21 begin to show higher incremental jumps in cost with fewer added benefits until you reach Alternative 21 (Figure 4-3). Figure 4-3 shows that significant increases in benefits are gained with the addition of Reach 6 (added in Best Buy Plan 7) and Reach 8 (added in Best Buy Plan 8). The best buy alternatives are composed of sub-reach plans, with the average annual costs and benefits shown in Table 4-7. The Plan Components for the Best Buy Plans, as listed in Table 4-7, represent the reach-based plans from the Preliminary Alternatives. The list is a result of the screening process displayed in Table 4-6. The Plan Components (Reach/Alternative) column includes the reach number (R2 for example meaning Reach 2), and the Plan number (A11 meaning the reach-based plan found in Preliminary Alternative 11). The Plan Components (Name) column represents the theme of the plan, or, most cases, by which Charrette Team the reach plan was developed. Bold reach numbers in Table 4-7 display when a reach is added to the Best Buy plans.

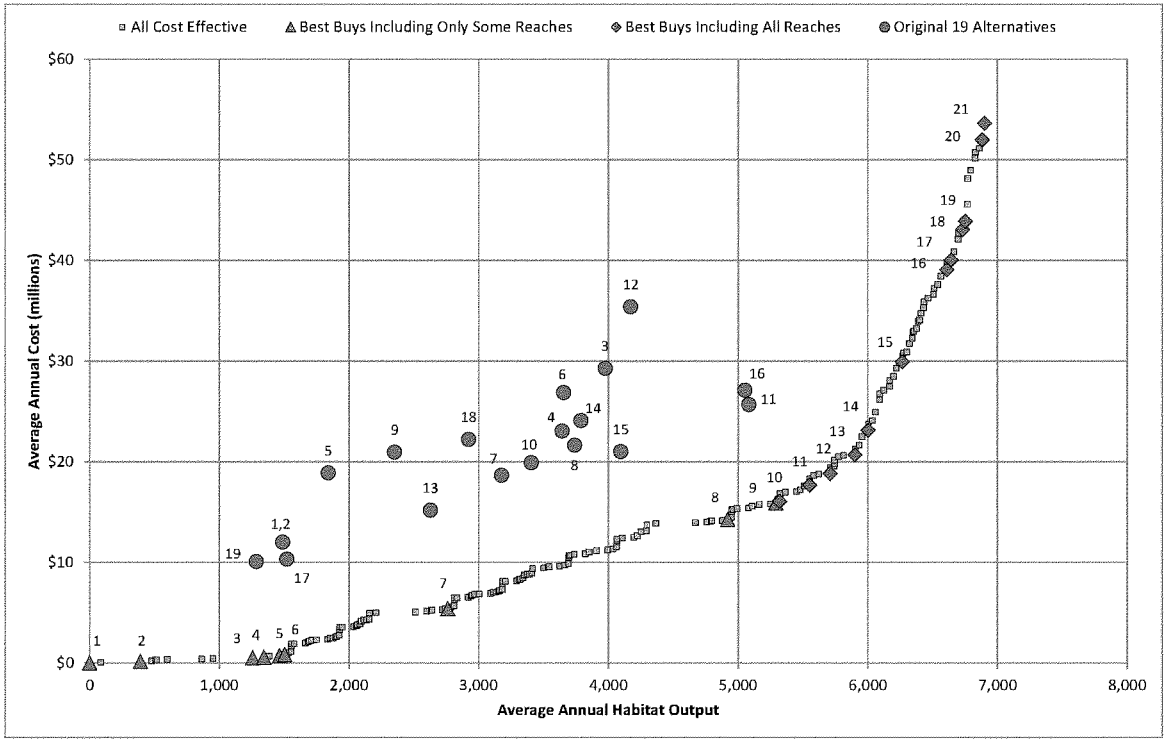

Figure 4-2 Best Buy Scatter Plot – Average Annual Habitat Output – All Plans AA Cost/AAHU Summary

(Preliminary Alternatives Shown os Red Dots Do Not include Tunnel Costs)

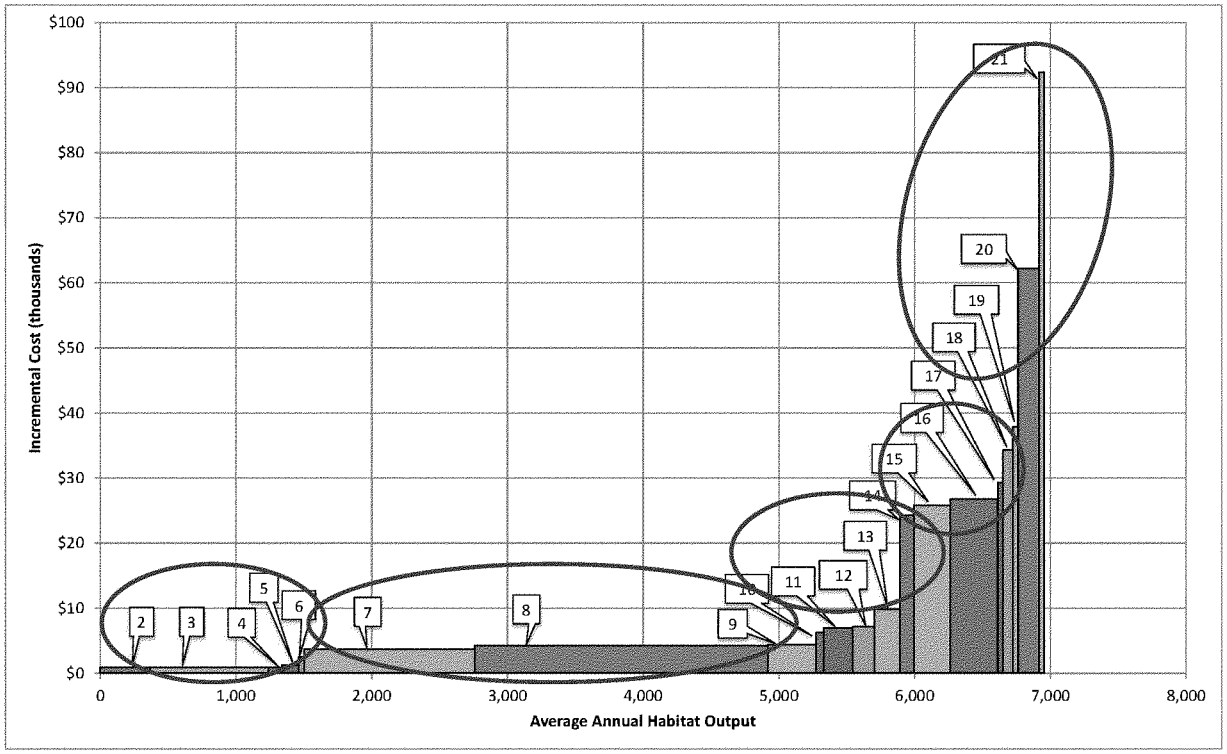

Figure 4-3 Box Plots of Annualized Costs vs. Benefits – All Best Buys

Table 4-7 Detailed Best Buy Plan Summary (Price Level April 2013, Interest Rate 3.75 Percent)

Best Buy Plan No.	Plan Components (Reach/Alternative)	Plan Components (Name)	Average Annual Cost	Average Annual Habitat Unit	Total Cost (No O&M)	Real Estate Percentage of Total Cost
1	No Action	No Action	$0	0	$0	0
2	R2 – A11	Reach 2 – Charette Team 4	$146,743	392	$2156,267	
3	**R1 – A11**	**Reach 1 – Charrette Team 4**	$523,358	1,258	$9,205,282	97
	R2 – A11	Reach 2 – Charrette Team 4				
4	R1 – A11	Reach 1 – Charrette Team 4	$583,950	1,345	$9,420,465	
	R2 – A11	Reach 2 – Charrette Team 4				
	R5 – A9 OR R5 – A16	Reach 5 – (Soft Bot. Ch. & Assoc. Banks) or (Side Channels Only)				
5	R1 – A11	Reach 1 – Charrette Team 4	$733,885	1,465	$11,460,534	74
	R2 – A11	Reach 2 – Charrette Team 4				
	R4 – A15	**Reach 4 – Charrette Team 2**				
	R5 – A9 OR R5 – A16	Reach 5 – (Soft Bot. Ch. & Assoc. Banks) or (Side Channels Only)				
6	R1 – A11	Reach 1 – Charrette Team 4	$839,159	1,505	$12,564,176	66
	R2 – A11	Reach 2 – Charrette Team 4				
	R3 – A17	**Reach 3 – Charrette Team 7**				
	R4 – A15	Reach 4 – Charrette Team 2				
	R5 – A9 OR R5 – A16	Reach 5 – (Soft Bot. Ch. & Assoc. Banks) or (Side Channels Only)				
7	R1 – A11	Reach 1 – Charrette Team 4	$5,396,226	2,761	$113,045,682	62
	R2 – A11	Reach 2 – Charrette Team 4				
	R3 – A17	Reach 3 – Charrette Team 7				
	R4 – A15	Reach 4 – Charrette Team 2				
	R5 – A9 OR R5 – A16	Reach 5 – (Soft Bot. Ch. & Assoc. Banks) or (Side Channels Only)				
	R6 – A14	**Reach 6 – Charrette Team 5**				
8	R1 – A11	Reach 1 – Charrette Team 4	$14,260,310	4,920	$130,404,666	84
	R2 – A11	Reach 2 – Charrette Team 4				
	R3 – A17	Reach 3 – Charrette Team 7				
	R4 – A15	Reach 4 – Charrette Team 2				
	R5 – A9 OR R5 – A16	Reach 5 – (Soft Bot. Ch. & Assoc. Banks) or (Side Channels Only)				
	R6 – A14	Reach 6 – Charrette Team 5				
	R8 – A15	**Reach 8 – Charrette Team 2**				
9	R1 – A11	Reach 1 – Charrette Team 4	$15,884,884	5,292	$344,492,270	85
	R2 – A11	Reach 2 – Charrette Team 4				
	R3 – A17	Reach 3 – Charrette Team 7				
	R4 – A16	**Reach 4 – Side Channels Only**				
	R5 – A9 OR R5 – A16	Reach 5 – (Soft Bot. Ch. & Assoc. Banks) or (Side Channels Only)				
	R6 – A14	Reach 6 – Charrette Team 5				
	R8 – A15	Reach 8 – Charrette Team 2				

Best Buy Plan No.	Plan Components (Reach/Alternative)	Plan Components (Name)	Average Annual Cost	Average Annual Habitat Unit	Total Cost (No O&M)	Real Estate Percentage of Total Cost
10	R1 – A11	Reach 1 – Charrette Team 4	$16,062,161	5,321	$347,280.353	85
	R2 – A11	Reach 2 – Charrette Team 4				
	R3 – A17	Reach 3 – Charrette Team 7				
	R4 – A16	Reach 4 – Side Channels Only				
	R5 – A9 OR R5 – A16	Reach 5 – (Soft Bot. Ch. & Assoc. Banks) or (Side Channels Only)				
	R6 – A14	Reach 6 – Charrette Team 5				
	R7 – A9	**Reach 7 – Soft Bot. Ch. & Assoc. Banks**				
	R8 – A15	Reach 8 – Charrette Team 2				
11	R1 – A11	Reach 1 – Charrette Team 4	$17,680,091	5,551	$383,175,827	77
	R2 – A11	Reach 2 – Charrette Team 4				
	R3 – A17	Reach 3 – Charrette Team 7				
	R4 – A16	Reach 4 – Side Channels Only				
	R5 – A9 OR R5 – A16	Reach 5 – (Soft Bot. Ch. & Assoc. Banks) or (Side Channels Only)				
	R6 – A14	Reach 6 – Charrette Team 5				
	R7 – A12	**Reach 7 – Charrette Team 3**				
	R8 – A15	Reach 8 – Charrette Team 2				
12	R1 – A11	Reach 1 – Charrette Team 4	$18,817,690	5,711	$405,921,076	73
	R2 – A11	Reach 2 – Charrette Team 4				
	R3 – A16	**Reach 3 – Side Channels Only**				
	R4 – A16	Reach 4 – Side Channels Only				
	R5 – A9 OR R5 – A16	Reach 5 – (Soft Bot. Ch. & Assoc. Banks) or (Side Channels Only)				
	R6 – A14	Reach 6 – Charrette Team 5				
	R7 – A12	Reach 7 – Charrette Team 3				
	R8 – A15	Reach 8 – Charrette Team 2				
13	R1 – A11	Reach 1 – Charrette Team 4	$20,673,266	5,902	$444,149,831	72
	R2 – A11	Reach 2 – Charrette Team 4				
	R3 – A16	Reach 3 – Side Channels Only				
	R4 – A16	Reach 4 – Side Channels Only				
	R5 – A9 OR R5 – A16	Reach 5 – (Soft Bot. Ch. & Assoc. Banks) or (Side Channels Only)				
	R6 – A13	**Reach 6 – Charrette Team 6**				
	R7 – A12	Reach 7 – Charrette Team 3				
	R8 – A15	Reach 8 – Charrette Team 2				
14	R1 – A11	Reach 1 – Charrette Team 4	$23,119,812	6,003	$494,777,190	65
	R2 – A11	Reach 2 – Charrette Team 4				
	R3 – A16	Reach 3 – Side Channels Only				
	R4 – A16	Reach 4 – Side Channels Only				
	R5 – A9 OR R5 – A16	Reach 5 – (Soft Bot. Ch. & Assoc. Banks) or (Side Channels Only)				
	R6 – A8	**Reach 6 – Charrette Team 1**				
	R7 – A12	Reach 7 – Charrette Team 3				
	R8 – A15	Reach 8 – Charrette Team 2				

Best Buy Plan No.	Plan Components (Reach/Alternative)	Plan Components (Name)	Average Annual Cost	Average Annual Habitat Unit	Total Cost (No O&M)	Real Estate Percentage of Total Cost
15	R1 – A11	Reach 1 – Charrette Team 4	$29,930,469	6,268	$636,484,639	50
	R2 – A11	Reach 2 – Charrette Team 4				
	R3 – A16	Reach 3 – Side Channels Only				
	R4 – A16	Reach 4 – Side Channels Only				
	R5 – A5	**Reach 5 – City: Los Feliz to Arroyo Seco**				
	R6 – A8	Reach 6 – Charrette Team 1				
	R7 – A12	Reach 7 – Charrette Team 3				
	R8 – A15	Reach 8 – Charrette Team 2				
16	R1 – A11	Reach 1 – Charrette Team 4	$39,069,505	6,610	$825,036,738	43
	R2 – A11	Reach 2 – Charrette Team 4				
	R3 – A16	Reach 3 – Side Channels Only				
	R4 – A16	Reach 4 – Side Channels Only				
	R5 – A5	Reach 5 – City: Los Feliz to Arroyo Seco				
	R6 – A8	Reach 6 – Charrette Team 1				
	R7 – A12	Reach 7 – Charrette Team 3				
	R8 – A3	**Reach 8 – Banks & Tribs Only**				
17	R1 – A11	Reach 1 – Charrette Team 4	$40,036,386	6,643	$845,245,201	42
	R2 – A9	**Reach 2 – Soft Bot. Ch. & Assoc. Banks**				
	R3 – A16	Reach 3 – Side Channels Only				
	R4 – A16	Reach 4 – Side Channels Only				
	R5 – A5	Reach 5 – City: Los Feliz to Arroyo Seco				
	R6 – A8	Reach 6 – Charrette Team 1				
	R7 – A12	Reach 7 – Charrette Team 3				
	R8 – A3	Reach 8 – Banks & Tribs Only				
18	R1 – A11	Reach 1 – Charrette Team 4	$43,055,891	6,731	$909,313,628	41
	R2 – A9	Reach 2 – Soft Bot. Ch. & Assoc. Banks				
	R3 – A16	Reach 3 – Side Channels Only				
	R4 – A16	Reach 4 – Side Channels Only				
	R5 – A5	Reach 5 – City: Los Feliz to Arroyo Seco				
	R6 – A8	Reach 6 – Charrette Team 1				
	R7 – A16	**Reach 7 – Side Channels Only**				
	R8 – A3	Reach 8 – Banks & Tribs Only				
19	R1 – A11	Reach 1 – Charrette Team 4	$43,887,027	6,753	$927,188,747	40
	R2 – A13	**Reach 2 – Charrette Team 6**				
	R3 – A16	Reach 3 – Side Channels Only				
	R4 – A16	Reach 4 – Side Channels Only				
	R5 – A5	Reach 5 – City: Los Feliz to Arroyo Seco				
	R6 – A8	Reach 6 – Charrette Team 1				
	R7 – A16	Reach 7 – Side Channels Only				
	R8 – A3	Reach 8 – Banks & Tribs Only				

Best Buy Plan No.	Plan Components (Reach/Alternative)	Plan Components (Name)	Average Annual Cost	Average Annual Habitat Unit	Total Cost (No O&M)	Real Estate Percentage of Total Cost
20	R1 – A11	Reach 1 – Charrette Team 4	$51,955,779	6,883	$1,108,341,724	43
	R2 – A13	Reach 2 – Charrette Team 6				
	R3 – A18	**Reach 3 – Comprehensive Pockets**				
	R4 – A16	Reach 4 – Side Channels Only				
	R5 – A5	Reach 5 – City: Los Feliz to Arroyo Seco				
	R6 – A8	Reach 6 – Charrette Team 1				
	R7 – A16	Reach 7 – Side Channels Only				
	R8 – A3	Reach 8 – Banks & Tribs Only				
21	**R1 – A16**	**Reach 1 – Side Channels Only**	$53,616,857	6,901	$1,142,415,672	42
	R2 – A13	Reach 2 – Charrette Team 6				
	R3 – A18	Reach 3 – Comprehensive Pockets				
	R4 – A16	Reach 4 – Side Channels Only				
	R5 – A5	Reach 5 – City: Los Feliz to Arroyo Seco				
	R6 – A8	Reach 6 – Charrette Team 1				
	R7 – A16	Reach 7 – Side Channels Only				
	R8 – A3	Reach 8 – Banks & Tribs Only				

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4.12 SELECTION OF THE FINAL ARRAY

This section describes how the final array was identified and the elements of each plan. A final array was selected from the best buy plans for further analysis. Selection of the final array was also based on the output from the CE/ICA analysis and the performance criteria for objectives. The final array provides a reasonable range of alternatives and at least minimally meets project objectives.

4.12.1 Objectives Performance Targets

The objective performance targets for ecosystem restoration were met, or not met, by the best buy alternatives as shown in Table 4-8 and Table 4-9 below.

Table 4-8 Targets Met by Best Buy Plans under Objective 1

OBJECTIVE 1: RESTORE VALLEY FOOTHILL RIPARIAN AND FRESHWATER MARSH HABITAT	
Target	**Alternatives Analysis**
Removal and management of invasives to less than 10 percent within 5 to 7 years post-construction of each feature. Includes both existing habitat in soft bottom reaches and proposed in channel habitat.	Each of the best buy Alternatives 2 to 21 would meet this part of the objective.
For Valley Foothill Riparian Habitat:	
Restore structurally diverse riparian habitat consisting of herbaceous (e.g., herbaceous vine cover), shrub (e.g., shrubby willow thicket), and tree (e.g., mature cottonwood-willow trees) layers in a minimum of five reaches resulting in 3 contiguous reaches. Restore riparian habitats with a varying number of structural layers (one, two, and three layers) to support survival and reproductive requirements for riparian obligate and transient wildlife species, including food, water, shelter, breeding, migration, and dispersal(Krueper, 1995).	This is accomplished beginning with Alternative 6, which restores overbanks in Reaches 1 and 2 and daylights streams in Reaches 3 to 5 (4 and 5 being soft bottom reaches). An additional reach and increasing area of restoration is added in Alternatives 7 to 21 to incrementally greater degrees.
Restore a minimum of 2 aquatic habitat nodes with a natural hydrologic connection to the river and riparian communities with a minimum distance of 150 meters from the water's edge to create areas capable of functioning as core habitat and refuge for native reptiles and amphibians (Semlitsch and Bodie 2003) and to minimize the risk of localized extinction due to natural disasters (IE flood, fire, drought) (Schippers et al. 1996; Dunning et al. 1995).	Habitat nodes are added in all alternatives in increasing degrees, but is not accomplished as described here for nodal core habitat and refuge until Reach 6 is added in Alternative 7 and is not accomplished in a second node until Alternative 8 adds Reach 8, with an additional large node added in Alternative 20.
Within 5-10 years of construction, restore and maintain dense, structurally diverse riparian habitat sufficient to maintain survival and reproductive needs of wildlife. Restore a minimum of one habitat node with a minimum width of 250 meters (820 feet) to support high frequencies of the Federally endangered least Bell's vireo (Kus 2002).	A riparian strand with a width greater than 250 meters can only be achieved at the LATC site, where these river adjacent parcels can support larger scale restoration and sustain enough riparian habitat to support high frequencies of least Bell's vireo. This is accomplished only by Alternatives 8 to 21 that include Reach 8 measures at LATC.

OBJECTIVE 1: RESTORE VALLEY FOOTHILL RIPARIAN AND FRESHWATER MARSH HABITAT	
Target	**Alternatives Analysis**
For Freshwater Marsh and Fish Habitat:	
Restore functioning freshwater marsh habitat consisting of emergent herbaceous vegetation (i.e., cattails, rushes, sedges) adapted to saturated soil conditions.	There is minimal restoration of freshwater marsh in Alternatives 2 to 12 through daylighted streams. There is a significant increase in freshwater marsh restoration added in Reach 6 in Alternatives 13 to 15. There is an incremental increase in marsh restoration in Alternatives 16 to 21, with restoration of marsh in the Los Angeles River State Historic Park in Reach 7 beginning in Alternatives 18 to 21 and at LATC beginning with Alternatives 16 to 21.
Restore aquatic habitat to support survival and reproductive requirements for fish and wildlife species, including food, water, shelter, breeding, migration, and dispersal.	Freshwater marsh adds refugia for fish and supports requirements for survival and reproduction for fish and other aquatic wildlife. There is some potential increase in freshwater marsh beginning with widening in Reach 6 in Alternative 7. There is a significant increase in freshwater marsh restoration added in Reach 6 in Alternatives 13 to 15, and an incremental increase in this restoration in Alternatives 16 to 21 that meets the needs for resting, nesting, and escape.
For a More Natural Hydrologic and Hydraulic Regime:	
Expansion of the River into at least one large, contiguous river adjacent area within the study area that promotes hydrologic connections to the floodplain and overbank areas.	This can only occur with inclusion of Taylor Yard or LATC. Taylor Yard is first added with expansion of the river in Alternatives 7 to 12 with an incremental increase in this reach in Alternative 13. LATC is first added in Alternatives 8 to 15 with diversion of flows and then greatly increased hydrologic/hydraulic connection is added in Alternatives 16 to 21.
Widen channel to accommodate meandering of the River in at least one reach	This can occur with inclusion of Taylor Yard or LATC. Taylor Yard is first added with expansion of the river in Alternatives 7 to 12 with an incremental increase in this reach in Alternative 13. LATC is first added in Alternatives 8 to 15 with diversion of flows and then greatly increased hydrologic/hydraulic connection is added in Alternatives 16 to 21. Further widening occurs in Alternatives 15 to 21 in Reach 5 with widening of the river from trap to vertical banks in Reach 5, and in Alternatives 17 to 21 with widening of the river from trap to vertical banks in Reach 2.
Connect river hydrologically (assisted or naturally) to overbank with at least one such connection per reach	The river is connected hydrologically to the overbank in each reach in Alternatives 10 to 21 through daylighting streams, using stormwater capture to sustain riparian vegetation on the overbank and then letting overbank flows enter the river, reconnection of the floodplain through widening, terracing and creating side channels. And by slowing any overbank flooding with riparian overbank habitat areas.
Within the main stem of the river, when increasing vegetation, target velocity should be less than 12 ft/s and ideally 8 ft/s	In channel vegetation is increased beginning with Alternative 7 when Reach 6 is added and with incremental increases at Alternatives 15, 16, and 17.
Restore seasonal overbank flooding to river adjacent areas for sustainability of habitat and natural ecological, hydrologic processes	This is accomplished by best buy Alternatives 7 to 21 in Reach 6 in Taylor Yard and 16 to 21 in Reach 8 in LATC. It is minimally accomplished with side channels in Reach 3 in 12 to 21 and in Reach 4 in 9 to 21.

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1 **Table 4-9 Targets Met by Best Buy Plans under Objective 2**

OBJECTIVE 2: INCREASE HABITAT CONNECTIVITY	
Target	**Alternatives Analysis**
Restoration of riparian and wetland aquatic wildlife habitat at tributary confluences to create connectivity to similar upstream habitats on the tributaries with ultimate nodal connection to the aquatic habitats in the San Gabriel and Verdugo Mountains (at least one major tributary connection should be restored.)	Reconnection hydrologically with at least one main tributary is first added in Alternative 11 with connection to the San Gabriels. Hydrologic reconnection with a second major tributary is added in Alternative 20 with added connection to the Verdugo Mountains.
Restore habitat corridors between large nodes in the ARBOR area to maximize connectivity for wildlife movement and dispersal on the local scale and minimize the risk of habitat sinks in an urban environment (Hilty et al. 2006, Hanski & Thomas 1994, Rudd 2002, Noss 1983), and to provide opportunities for regional wildlife movement	Large nodes that can be restored are at Taylor Yard, LATC and Verdugo Confluence. Existing habitat nodes adjacent to the river with connection to the Santa Monica Mountains are through Headworks in Reach 1 and Griffith Park in Reach 4. Reach 1 is first added t in alternative 3 with a connection through Headworks, Reach 6 is first added creating a large nodal connection to the river in Alternative 7, a second large nodal connection in Reach 8 is added in Alternative 8, Reach 4 with a side channel connection into Griffith Park is added in Alternative 9, a second connection to Griffith Park with a side channel in Ferraro Fields is added in Reach 3, Alternative 12, and a third large nodal connection is added in Verdugo Wash in Reach 3 in Alternative 20.
Restoration of wildlife habitat on channel banks	This is accomplished in Alternative 1 and is increased incrementally through Alternative 21. Restoration on the channel bank increases with inclusion of Taylor Yard in 7, and jumps again with inclusion of LATC in Alternative 7. Further reconnection is made with banks to Los Angeles River State Historic Park (Cornfields) in Reach 7 in Alternative 18.
Improved connectivity within the ARBOR area through restoration of habitat nodes with wetland and riparian habitat that are naturally hydrologically connected to the river corridor upstream and downstream of the Glendale Narrows.	The first natural hydrological connection to restored habitat nodes connected to the river corridor is added in Alternative 4 with a daylighted stream in Reach 5, and each larger alternative adds incrementally increased hydrologic connections with the most significant jumps in connections added with Alternatives 9, 11, 13, 16 and 20.
Lengthen the extent of contiguous vegetated pathways for reptile and small/medium mammal movement (currently limited to Reaches (4 to 6), to achieve upstream and/or downstream connections to at least one additional tributary or open space area that is currently isolated from the soft-bottom reach. This may be achieved by either in-channel or side-channel vegetated corridors.	Upstream riparian restoration connections in contiguous reaches begin with Alternative 2. However, downstream contiguous vegetated pathways are not wholly achieved. Downstream pathways are increased incrementally beginning with Alternative 10 and incrementally increase through Alternative 21. Alternatives 11 to 21 have the greatest amount of contiguous vegetated pathways.
Ideally, the alternatives will also achieve the following:	
Expansion of riparian and wetland wildlife habitat into large, contiguous river adjacent lands within the study area to support higher abundance of wildlife and more significant nodal connections to nearby ecological zones.	This occurs in alternatives that include Taylor Yard, LATC, or the Griffith Park or Ferraro Fields side channels. The Griffith Park side channel is first added in Alternative 9, Taylor Yard is first added in Alternative 8, LATC is first added in Alternative 8, and Ferraro Fields side channel is first added in Alternative 12.
Provide connectivity (via contiguous or near-contiguous vegetated movement pathways) between all of the reaches within the study area.	Upstream riparian restoration connections in contiguous reaches begin with Alternative 2. However, downstream contiguous vegetated pathways are not wholly achieved. Downstream pathways are increased incrementally beginning with Alternative 10 and incrementally increase through Alternative 21.
Include Reach 7 to provide nodal connections to San Gabriel Mountains via Arroyo Seco confluence and/or other smaller tributaries and to provide potential for future direct connections to the mountains via other projects upstream on Arroyo Seco	Reach 7 with restoration of the Arroyo Seco confluence is first added in Alternative 11. Smaller daylighted streams are added in Reach 5 in Alternative 4 with additional small streams added in Reach 4 in Alternative 5, Reach 3 in Alternative 6, Reach 6 in Alternative 7, Reach 8 in Alternative 8, and Reach 7 in Alternative 10. A second major tributary (Verdugo Wash) is connected in Alternative 20.

4.12.2 Comparisons

Using the results of the CE/ICA analysis, the design team and Sponsor closely examined the CE/ICA box plots, descriptions, and cost data. Costs are the preliminary costs for the Final Array Plans included in the Draft IFR. As explained in Chapter 6, following the public review period for the Draft IFR, USACE performed further analysis that included a more detailed cost analysis and made further cost updates. The updated costs based on the more detailed analysis, compared with the cost estimates included in the Draft IFR, are presented in section 6.6.3. Based on performance targets for objectives and CE/ICA analysis, best buy alternatives were screened or retained for inclusion in the final array as follows:

- All alternatives met targets for their included reaches for invasives removal and management.
- Alternatives 2 to 6 range in incremental benefits from 392 to 1,505 average annual habitat units (AAHUs) and a gradual increase in first costs from $2 million to $12 million. They were screened out because they did not significantly meet performance targets for restoration of freshwater marsh, a more natural hydrologic and hydraulic regime, or increase in habitat connectivity.
- Alternatives 7 to 9 range in first costs from $108 million to $330 million and incremental benefits increase from 2,761 to 5,292 AAHU's. Alternatives 8 and 9 meet performance targets for valley foothill riparian restoration, Alternatives 7-9 partially meet criteria for 3 out of 5 targets for restoring to a more natural hydrologic regime, and hydraulics meet 1 out of 2 criteria for restoration of freshwater marsh and fish habitat; and minimally meet criteria in 4 out of 8 targets for connectivity. Therefore, they were not carried forward.
- The extent of upstream to downstream habitat connectivity is important for restoration of wildlife movement within the study areas and in the region. The Glendale Narrows (Reaches 4, 5, and 6) currently support riparian vegetation with concrete slopes, but upstream and downstream areas (Reaches 1, 3, 7 and 8) have a fully concrete channel. Alternatives 2 to 9 do not significantly meet connectivity criteria for connections between upstream and downstream areas.
- Alternative 10 first costs are $345 million, adds the additional Reach (7) connecting the entire study area, and provides 5,321 AAHU's. This is the first alternative that includes restoration in all reaches. Alternative 10 meets targets for valley foothill riparian by restoring a structurally diverse habitat, in contiguous reaches, with varying structural layers, supports wildlife survival requirements, and includes riparian nodes of sufficient width to support wildlife requirements. It minimally meets targets for a more natural hydrologic and hydraulic regime by inclusion of Taylor Yard widening. Overbank connections are made with daylighted streams, stormwater capture, widening, terracing, and side channels. It restores seasonal and overbank flows in Reach 6 and increases naturalized areas in the river mainstem in Reach 6. It minimally meets all conditions for Objective 1 except it does not meet all criteria for hydrologic connections.
- Restoration of tributary confluences was included to begin to improve hydrologic and habitat connectivity in the watershed and improve wildlife corridors to other significant ecological areas such as the Verdugo and San Gabriel Mountains. Ultimately, other in-progress restoration efforts on the tributaries (beyond the study area boundaries) would provide further improvements to these connections. Measures that address these criteria were daylighting storm drains, adding side channels, and restoration work on tributaries to address Objective 2. Alternative 10 increases hydrologic and hydraulic connections by daylighting streams, reconnecting floodplains, and reconnecting wildlife habitat to overbanks. It connects not only to upstream but downstream through Reach 8 but does not restore connections to a major tributary. **Alternative 10 provides the lowest cost ($347 million) opportunity to meet objectives for connectivity and changes in hydrologic regime, and is therefore carried forward into the final array.**
- The group of Alternatives 10 to 13 range in total costs from $347 million to $444 million (Alternative 13). Habitat benefits increase from 5,321 units to 5,902 (Alternative 13). Within this grouping there are significant changes within Alternatives 10 to 13. Reaches 3, 6, and 7 are changed. Alternative 13 accomplishes all that Alternative 10 does, and adds freshwater marsh

habitat to better meet Objective 1. Connectivity is increased with additional contiguous pathways and restoration of the confluence at Arroyo Seco, the most significant tributary in the ARBOR reach with potential to connect to future restoration planning on that tributary. **Alternative 13 is the second alternative to be carried forward into the final array for further comparison, providing 5,902 AAHU's and costing $442 million.**

- The next incrementally grouped alternatives are 14 to 16. These alternatives range in benefits from 6,003 to 6,610 AAHU's with a total cost range from $495 million to $825 million. These all meet targets for perfonmance on Objective 1 with Alternative 16 showing an incremental jump in restoration of freshwater marsh, riffle-pool complexes, and conditions for native fish survival, greater hydrologic/hydraulic connections, and other related conditions. **Alternative 16 is the third alternative carried forward into the final array, providing benefits of 6,610 AAHUs and a cost of $774 million.**
- The remaining Alternatives 17 to 21 incrementally increase the habitat value from 6,643 to 6,901 AAHUs and have significantly increased total costs ranging from $845 million to $1.1 billion. In addition to the benefits and measures included in the other alternatives, these alternatives include widening and increased habitat in the river bed in Reach 2, and connection to the Los Angeles River State Historic Park (Cornfields) in Alternatives 18 to 21. Alternative 20 shows the greatest single increase in habitat value in this group with the addition of restoration of the confluence of a second major tributary (Verdugo Wash), increasing natural hydraulic conditions and regional connectivity. **This is the fourth alternative carried forward into the final array with benefits of 6,883 AAHUs and a cost of $1.04 billion.**

4.12.3 Final Array of Alternatives

The CE/ICA analysis yielded 21 Best Buy plans with a very wide range of both cost and output. The cost of the Best Buy Plans ranged from approximately $3 million to $1.2 billion. Output, measured by the CHAP analysis in terms of increased average annual habitat units (AAHUs), ranged from 392 AAHUs to 6,901 AAHUs. The wide range of plans represented a challenge in terms of identifying a subset of final array plans that best met planning objectives while also providing a distinct tradeoff between cost and output necessary for the ultimate identification of the National Ecosystem Restoration (NER) Plan. As described in the ER 1105-2-100 the NER Plan is the alternative and scale having the maximum excess of monetary and non-monetary beneficial effects over monetary and nonmonetary costs. This plan occurs where the incremental beneficial effects just equal the incremental costs, or alternatively stated where the extra environmental value is just worth the extra costs. The PGN also notes that in all but the most unusual cases, the NER Plan should be derived from the final set of Best Buy solutions.

Key considerations in the determination of the final array alternatives to carry forward included not only the results of efficiency, as measured by the CE/ICA, but the extent to which plans met key planning objectives, the significance of plan outputs, and plan acceptability, completeness and effectiveness. The table below summarizes cost and output data for the final array plans (Table 4-10) included in the Draft IFR. Costs presented in Table 4-10 are the preliminary costs for the Final Array Plans included in the Draft Report. Costs were subsequently refined and updated. Detailed, updated costs for both the NER Plan and Locally Preferred Plan are presented in Chapter 7.

Table 4-10 Final Array Costs and Outputs (Price Level April 2013)

Criteria	No Action	Alt 10 ART	Alt 13 ACE	Alt 16 AND	Alt 20 RIVER
NER Costs & Benefits					
Total First Cost	$0	$346 million	$442 million	$757 million	$1.04 billion
Total Investment Cost	$0	$347 million	$444 million	$774 million	$1.06 billion
Average Annual Project Cost	$0	$16.06 million	$20.67 million	$36.61 million	$49.76 million
Incremental Annual Cost	$0	$16.06 million	$4.61 million	$15.93 million	$13.15 million
Net Average Annual Habitat Output	0	5,321	5,902	6,509	6,782
% Increase versus No Action	0%	93%	104%	114%	119%
Incremental Output	0	5,321	581	607	273
Inc. Cost per Unit Output *	$0	$3,019	$7,936	$26,249	$48,186

* Costs presented in Table 4-10 are the preliminary costs for the Final Array Plans included in the Draft IFR. As explained in Chapter 6, following the public review period for the Draft IFR, USACE performed further analysis that included a more detailed cost analysis and made further cost updates. The updated costs based on the more detailed analysis, compared with the cost estimates included in the Draft IFR, are presented in section 6.6.3.

Alternative 10 was identified as the minimally acceptable plan to include in the final array as meeting objectives and the purpose and need. Although incremental output, based upon the AAHUs quantified by the CHAP analysis, for Alternative 10 was not significantly greater than Alternative 9, Alternative 10 is the first alternative that includes restoration in all 8 reaches, which is a key objective (Objective 2) to support restoration of nodal and regional connectivity for wildlife. This was one of the most important considerations in the assessment of plan effectiveness and acceptability. The importance of habitat connectivity is described in Section 2.2.4.

Alternatives 13, 16 and 20 represented key break points in the CE/ICA curve. As shown in Figure 4-4, incremental costs increase substantially for larger scale Best Buy plans. These are logical plans to carry forward for the final array, since they represent potential decision points for focusing the "Is it worth it?" questioning process. As shown in the table above, the final array plans vary substantially in terms of cost, output, and incremental costs per unit of output. Figure 4-4 depicts the CE/ICA graph, focusing exclusively on the final array plans.

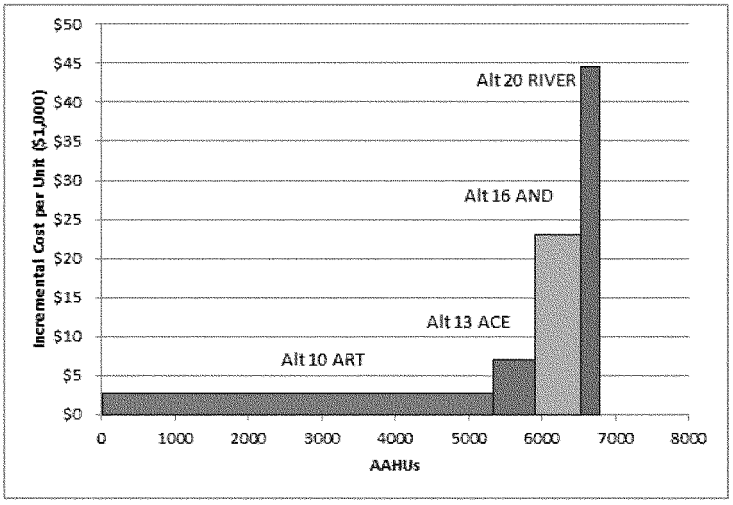


Figure 4-4 Incremental Cost Graph of the Final Array

Substitution – For the Final Array Plans to be carried forward for more detailed analysis, the Study Team modified the composition of Best Buy Plans 16 and 20 as identified through the CE/ICA analysis to substitute a smaller best buy alternative within Reach 6. Based upon the CE/ICA analysis, Best buy Alternative 13 included preliminary Alternative 13 in Reach 6, but Best Buy Plans 16 and 20 included Preliminary Alternative 8 instead. Preliminary Alternative 13 in Reach 6 includes freshwater marsh and widens the riverbed more than the reach sub-plan from Preliminary Alternative 8. Preliminary Alternative 13 also represents a cost savings of $51 million dollars versus Preliminary Alternative 8. Alternatives 16 and 20 remain cost effective and efficient plans with this substitution of including the smaller scale best buy alternative for Reach 6, since they are both comprised of best buy alternatives for all reaches. In particular, preliminary Alternative 13 for Reach 6 has a lower average cost per habitat unit than preliminary Alternative 8, while only having a minor reduction in AAHUs (1448 AAHUs vs. 1548 AAHUs). For these reasons, Reach 6 Alternative 13 was carried forward as a component of Final Array Plans 16 and 20.

4.13 NO ACTION ALTERNATIVE

The USACE is required to consider "No Action" as one of the alternatives to comply with the requirements of NEPA. The No Action Alternative is synonymous with the "without project condition" and is the basis against which all other alternative plans are measured. It assumes that no new project(s) will be implemented by the Federal government to achieve the planning objectives. Future development in the ARBOR reach would occur in accordance with currently adopted plans. This alternative has already been considered in the without project condition. For CEQA purposes, the City is required to consider the No Project Alternative. For purposes of this analysis, it is assumed that the No Action Alternative and No Project Alternative are the same.

Under the No Action Alternative, the identified problems would continue during the period of analysis. Continued human intervention and activities associated with urban development would further degrade

habitat in the study area, and possibly prevent any future restoration from being practical, feasible, or cost-effective. The habitat team assumed that there would be an increase in the presence of invasive plant species in riparian areas on the river and on the tributaries, urban influences from future planned developments, and a reduction in the number of species present within the study area overtime. A 25- and 50-year planning horizon was used to evaluate these assumed changes. These assumptions are described in further detail in Appendix G. Baseline habitat units were based on 842 acres. Baseline habitat value was 6,119 habitat units with a reduction in habitat value over the next 50 years to 5,291 habitat units. This represents a 14 percent reduction in habitat value in an already severely degraded habitat. Most of this reduction is expected to occur because of an increase in invasive vegetation with some increased effects of urbanization.

4.14 ACTION ALTERNATIVES

4.14.1 Summary

The Corps is required to consider a reasonable range of alternatives in the IFR. Where alternatives are considered but dismissed from further consideration, the reasons for their dismissal are briefly provided. The formulation strategy and dismissal of alternatives initially considered is discussed earlier in this chapter.

Four action alternatives composed the final array in the Draft IFR. The alternatives were named to assist the team, reviewers, and the public. The no action alternative is a part of the final array and provided a fifth alternative. In this Final IFR, a variation on Alternative 13, substituting the Reach 7 plan from Alternative 20, is also evaluated. This variation is within the spectrum of alternatives analyzed in the Draft IFR, as further discussed below.

The following alternatives were identified in the Draft IFR. These alternatives include construction of restoration features in and along the river in specific locations as well as removal of non-native vegetation throughout the channel bottom of the river and lower tributaries within the ARBOR reach, particularly in soft-bottom channel areas. The influence of restoration features extend beyond their immediate footprint to adjacent in-channel areas, increasing functions through additional shading, inputs of leaf litter and small woody debris, and foraging opportunities as discussed in Section 5.5. These elements, along with proposed improvements for wildlife access in certain areas, and new nodal connections provided by the active restoration features, make the entire river channel within the study area more conducive for wildlife movement. All alternatives described below include the channel bottom throughout the ARBOR reach in the restoration plan for that alternative.

Alternative 10

Alternative 10 is called the ART (for ARBOR Riparian Transitions) as it provides some restoration in all reaches and provides transitions or connections between existing riparian corridors and concrete lined river reaches. This basic restoration plan includes only minimal restoration at Taylor Yard and excludes restoration at both major confluence areas at the Arroyo Seco and Verdugo Wash. In Reach 1, it establishes riparian corridors along the overbanks of both sides of the River channel, improving potential wildlife connections from the river to the Headworks study site and the Santa Monica Mountains. It also restores riparian habitat at the Pollywog Park Area of Griffith Park and along the left overbank of the Burbank Western Channel. In Reach 2, the plan continues the establishment of the riparian corridor along the overbank on both sides of the River, with habitat connections to the Santa Monica Mountains. In Reach 3, it continues the riparian corridor on the right side of the River along Zoo Drive and daylights and restores riparian and freshwater marsh habitat at three streams currently encased in culverts, two on the east side of the River and one on the west side. In Reach 4, it establishes a riparian corridor on the left

overbank, creates a side channel at the edge of Griffith Park Golf Course with inlet and outlet to the River under I-5 on the right bank, lowers a portion of the Los Feliz Golf Course on the left bank of the River to allow seasonal flooding through existing culverts, and daylights eight streams. In Reach 5, this alternative continues the riparian corridor on the left overbank and includes a daylighted stream at the downstream end. In Reach 6, it widens the channel, approximately 80 feet along Taylor Yard, restores riparian habitat in the widened area and overbank, and creates a small terraced area in the Bowtie parcel. Restoration is continued in Reach 7 with three daylighted streams. In Reach 8, at the LATC site, it restores a historic wash and riparian habitat. This restoration would allow flows from the ephemeral wash to enter the River through existing culverts under the railroad lines. In addition to the specific features outlined above, this alternative removes invasive vegetation throughout the project footprint including river and tributary channel bottom areas. Alternative 10 addresses 528 acres, including approximately 105 acres of hard-bottom channel that benefits indirectly from the restoration measures, as described above. Alternative 10 minimally meets objectives, providing an increase in habitat of 93 percent over without-project conditions, and produces 5,321 habitat units (AAHUs). It increases habitat connectivity through restoration and creation of riparian corridors and increases hydrologic connectivity through daylighted streams.

Alternative 13

Alternative 13 is named ACE (for ARBOR Corridor Extension). Alternative 13 has the same restoration features as Alternative 10 in Reaches 1, 2, 4, 5, and 8 and provides additional restoration in Reaches 3, 6, and 7. In Reach 3, in addition to the measures identified in Alternative 10, this alternative would create a side channel entering upstream from the River behind Ferraro Fields and re-entering the River at the downstream end of the reach. In Reach 6, this alternative widens the river channel by over 300 feet into Taylor Yard with restoration of the floodplain and freshwater marsh in the widened channel. It also creates a backwater wetland at the Bowtie parcel, and it restructures the left bank upstream of the backwater wetland and downstream of Taylor Yard, as well as the entirety of the right bank, in this reach with implanted vegetation. In Reach 7, this alternative restores a portion of the Arroyo Seco tributary and makes nodal connections on the left side of the River to the Arroyo Seco watershed. This is accomplished through softening of the bed and banks with development of a riparian corridor in the tributary confluence and for one half mile upstream. The Arroyo Seco restoration supports connections through the River from the Santa Monica Mountains to the San Gabriel Mountains. Instead of the daylighted streams included in this reach in Alternative 10, this alternative lines the banks of the River downstream from the Arroyo Seco with overhanging vines and implanted vegetation. In addition to the specific features outlined above, this alternative removes invasive vegetation throughout the project footprint including river and tributary channel bottom areas. Alternative 13 addresses 588 acres, including approximately 105 acres of hard-bottom channel that benefits indirectly from the restoration measures, as described above. Alternative 13 increases restored habitat by 104 percent over without-project conditions and by 11 percent over Alternative 10. Alternative 13 delivers 581 more AAHUs than Alternative 10. Nodal connections for wildlife are increased by 309 percent over Alternative 10. Alternative 13 meets objectives in all reaches.

Alternative 16

Alternative 16 is called AND (for ARBOR Narrows to Downtown). This alternative includes the same features as Alternative 13 in Reaches 1-4 and 6-7 and includes greater restoration in Reaches 5 and 8. In Reach 5, this alternative widens the River channel by modifying the right bank from a trapezoidal bank to a vertical wall and modifies the left bank from trapezoidal to a terraced vegetated bank. At the downstream end of this reach, the River channel will also be widened by modifying the left bank. The daylighted stream in Alternatives 10 and 13 is also included in this reach. In Reach 8, the alternative includes additional restoration by terracing upstream of LATC on the right bank of the River, terracing downstream on the left bank, and removing the left bank and the concrete bed adjacent to LATC. The channel bed will be naturalized to support freshwater marsh in the River. This alternative widens the

River into the LATC site by 500 feet on a low terrace and another 1000 feet on a second terrace. The restoration features at the LATC site would also include the restoration of the historic wash, along with wetland habitat. In addition to the specific features outlined above, this alternative removes invasive vegetation throughout the project footprint, including river and tributary channel bottom areas. Alternative 16 addresses 659 acres, including approximately 91 acres of hard-bottom channel that benefits indirectly from the restoration measures, as described above. The features in Alternative 16 provide an increase in habitat of 114 percent over without project conditions and 10 percent over Alternative 13. This alternative provides 607 more AAHUs than Alternative 13. Nodal connections are increased above that provided in Alternative 13 by 85 percent. This alternative meets all objectives.

Alternative 20

Alternative 20 is called RIVER (for Riparian Integration via Varied Ecological Reintroduction) as it includes the same features as Alternative 16 in Reaches 1, 4, 5, 6, and 8 and includes greater restoration in Reaches 2, 3 and 7. In Reach 2, this alternative widens the River channel by modifying the right bank from a trapezoidal bank to a vertical wall. In Reach 3, the alternative restores the confluence with Verdugo Wash by softening the bed of the stream and significantly widening the mouth of the wash, thus providing riparian habitat and an additional connection to the San Gabriel Mountains through the Verdugo Hills. In Reach 7, this alternative includes the same Arroyo Seco restoration as Alternative 13, and in addition, reintroduces the daylighted streams included in Alternative 10 in lieu of the channel bank vegetation features that were in Alternatives 13 and 16. Also in Reach 7, this alternative restores freshwater marsh at the Los Angeles State Historic Park and creates a terraced bank connection to the River. In addition to the specific features outlined above, this alternative removes invasive vegetation throughout the project footprint, including river and tributary channel bottom areas. Alternative 20 most fully meets planning objectives, with inclusion of some degree of channel naturalization and restoration in nearly all reaches, restoration of two major confluences, and restoration of a connection between the River and the Los Angeles State Historic Park. Alternative 20 addresses 719 acres, including approximately 91 acres of hard-bottom channel that benefits indirectly from the restoration measures, as described above. Habitat is increased by 119 percent over without project conditions and 5 percent over Alternative 16. This alternative provides 273 more AAHUs than Alternative 16. Nodal habitat connectivity is increased over Alternative 16 by 120 percent.

Identified Variation on Alternative 13

As explained in the Draft IFR, the four alternatives that were presented for detailed consideration in the Draft IFR were composed of various reach plans. The four alternatives identified in the Draft IFR represent the spectrum of reasonable alternatives that substantially respond to the purpose and need statement. Agencies are obligated to evaluate a reasonable range of alternatives in enough detail so that a reader can compare and contrast the environmental effects of the various alternatives. The EIS portion of the IFR evaluates the impacts associated with each alternative and discloses the impacts by reach or major feature where appropriate.

As described in the Draft IFR, comments received could indicate that a reasonable alternative should be modified somewhat. If the modification is reasonable, the Corps should discuss it in the final IFR. If a comment indicates a variation on an alternative that was not considered by the agency, the Corps will also consider whether that variation is reasonable and if it is reasonable, will consider it in the final IFR. If the Corps does not view the modification or variation to be reasonable, the Corps will explain why it does not warrant further response. If it is qualitatively within the spectrum of alternatives that were discussed in the draft, a supplemental draft will not be needed. (Memorandum to Agencies: Forty Most Asked Questions Concerning Council on Environmental Quality's NEPA Regulations, 46 Fed. Reg. 18026 (1981)) If a reasonable variation is suggested by a comment that is qualitatively beyond the spectrum of alternatives already discussed, then a supplemental draft would be needed to consider and solicit

comment on that new and substantially different plan. The alternatives considered in detail provide a range of restoration efforts, with Alternative 10 including the lowest level of restoration and Alternative 20 the most intensive and largest footprint of restoration. Therefore, identification of variations or alternatives within this spectrum generally does not require a supplemental IFR.

Ultimately, this process is intended to result in an informed recommendation of a project for authorization. As described in the Draft IFR, the recommended project could be any of the four action alternatives and one no-action alternative analyzed in the Draft IFR, or a plan that modifies one of the four action alternatives to add features present in another alternative, substitutes one or more reach plans from a larger alternative, or is any other plan within the spectrum analyzed in the final IFR. The Draft IFR notified agencies, stakeholders, and the public that the plan ultimately selected may be an alternative within the spectrum of the final array alternatives fully analyzed in this draft IFR.

Following the public review period for the Draft IFR, the Corps performed further analysis that included a more detailed cost analysis, real estate cost updates, and further modified contingencies based upon a full cost risk summary analysis. This analysis identified a more cost effective variation on Alternative 13 that is identical to Alternative 13 except for Reach 7, where it includes the reach plan included in Alternative 20. This variation is within the spectrum of reasouable alternatives identified in the Draft IFR, and the reach plans composing it were analyzed in detail. The Reach 7 substitution provides greater benefits than Alternative 13 at lower cost. This variation was thus identified for inclusion in this Final IFR.

Alternative 13v (for variation) includes all the features of Alternative 13 with the exception of Reach 7, in which the Reach 7 plan from Alternative 20 is used. Like the other alternatives, this alternative includes invasives vegetation removal throughout the project footprint, including river and tributary channel bottom areas. Alternative 13v addresses 598 acres, including approximately 105 acres of hard-bottom channel that benefits indirectly from the restoration measures, as described above. Alternative 13v delivers 89 more AAHUs than Alternative 13, increases habitat by 106% over without project conditions, and increases nodal connectivity over Alternative 13 by 33%. It meets objectives in all reaches.

Summary of Restoration Differences Among Alternatives

While Alternative 10 includes restoration measures in each reach, the subsequent alternatives provide a greater extent of restoration. Alternative 13 adds major tributary restoration with inclusion of one half mile of the Arroyo Seco, while Alternative 20 adds another major tributary with restoration of the Verdugo Wash confluence. Alternative 10 has some channel widening in Reach 6, but the increased widening of Reach 6 in Alternative 13 is much more significant. Alternatives 16 and 20 include increasingly more extensive restoration that includes removal of concrete with naturalization of the channel bed and removal of the channel wall barrier in Reach 8, channel widening in Reaches 5 and 8 in Alternatives 16 and 20 with added widening in Reach 2 in Alternative 20. Alternative 13v provides the benefits of Alternative 13 in Reaches 1-6 and 8, and the Reach 7 benefits of Alternative 20.

Table 4-11 includes a matrix of the measures, in addition to invasives removal in each alternative in the final array. These measures are described in more detail in each alternative description. As described earlier the final array alternatives were formulated by recombining reaches from the original 19 alternatives to identify the most cost effective plans that met the planning objectives. This formulation process resulted in alternatives having some reach plans in common. Detailed plates showing the placement of measures can be found in Appendix A, Design.

Table 4-11 Final Alternatives Measure Matrix

Reach	Submeasure	Alternative				
		10	13	13v	16	20
1. Pollywog Park area of Griffith Park	Riparian habitat corridors	x	x	x	x	x
2. Bette Davis Park area of Griffith Park	Restructure top of bank to support vines					x
	Riparian habitat corridors	x	x	x	x	x
	Modify trap channel to vertical banks					x
3. Ferraro Fields area of Griffith Park	Create pool & riffle system and plant for freshwater marsh		x	x	x	x
	Daylight streams plant with riparian fringe and freshwater marsh	x	x	x	x	X
	Divert flow into side channels with riparian fringe and return to the river		x	x	x	x
	Riparian habitat corridors		x	x	x	x
	Open water habitat	x				
	Widen mainstem					x
	Widen tributaries					x
4. Griffith Park	Create pool & riffle system and plant for freshwater marsh	x	x	x	x	x
	Daylight streams plant with riparian fringe and freshwater marsh	x	x	x	x	x
	Divert flow into side channels with riparian fringe and return to the river	x	x	x	x	x
	Riparian habitat corridors	x	x	x	x	x
5. Riverside Drive	Create pool & riffle system and plant for freshwater marsh				x	x
	Daylight streams plant with riparian fringe and freshwater marsh	x	x	x	x	x
	Wildlife access from river to bank (in daylighted streams)				x	x
	Restructure channel walls to support vines				x	x
	Riparian habitat corridors	x	x	x	x	x
	Terrace banks				x	x
	Modify trap channel to vertical banks				x	x
6. Taylor Yard	Create pool & riffle system and plant for freshwater marsh		x	x	x	X
	Restructure channel walls to support vegetation		x	x	x	x

Reach	Submeasure	Alternative				
		10	13	13v	16	20
	Riparian habitat corridors	x	x	x	x	x
	Restructure top of bank to support vines and other vegetation		x	x	x	x
	Widen channel mainstem	x	x	x	x	x
	Widen channel sloping or terracing back to overbank levels	x	x	x	x	x
7. Arroyo Seco/ Los Angeles State Historic Park	Create pool & riffle system and plant for freshwater marsh			x		x
	Daylight streams plant with riparian fringe and freshwater marsh	x		x		x
	Divert flow into side channels with riparian fringe and return to the river			x		x
	Riparian habitat corridors		x	x	x	x
	Restructure channel walls to support vegetation, plantings		x		x	
	Widen channel (Arroyo Seco) sloping or terracing back to overbank levels		x	x	x	x
8. LATC	Create pool & riffle system and plant for freshwater marsh				x	x
	Restore historic wash with riparian habitat	x	x	x	x	x
	Divert flow into side channels with riparian fringe and return to the river				x	x
	Wildlife access from river to bank	x	x	x	x	x
	Riparian habitat corridors	x	x	x	x	x
	Widen channel				x	x
	Terrace banks				x	x

4.14.2 Alternative 10 (ART) Description by Reach

In the ARBOR Riparian Transitions or ART plan, reaches would be restored to increase connections between upstream and downstream riparian areas and restore lost riparian strands on the overbank. This alternative restores/benefits a total of 528 acres, and each reach is described below. Figure 4-5 through Figure 4-8 at the end of this section display mapping of this alternative. In addition to removal of invasives species throughout the project footprint, this alternative includes the following specific restoration features.

Reach 1 Pollywog Park Area of Griffith Park

Reach 1 sub-plan for all alternatives in the final array would implement a habitat corridor with riparian planting on the overbanks of both sides of the River and other nearby locations. Overbanks are those areas

adjacent to the river where overland flow in flood events could occur in a natural river environment. Areas of restoration include the left overbank across the River from the Headworks Study Site, the Pollywog Park area of Griffith Park, the open area directly downstream of Headworks on the right overbank, and the left overbank of Burbank Western Channel (tributary from the north/west).

Riparian corridor restoration would involve planting a riparian community of cottonwood/willow, sycamore, mugwort, mulefat, and scarlet monkeyflower with a buffer of sagebrush, buckwheat, and native herbaceous plants. It would include irrigation for establishment and water harvesting features to sustain plants, including micro-grading and/or swales to capture and infiltrate water. Water sources could include reclaimed water, harvesting of stormwater and street runoff (with small wetland features at the end of adjacent streets), and/or highway runoff. Where stormwater or street runoff is excessive during storm events, a connection to the River would allow it to overflow into the channel. Establishment and drought management for this vegetation would utilize irrigation, either through flood irrigation (simulating a natural riparian regime) or drip irrigation, dependent upon the availability of water. In Pollywog Park, the water from an existing storm drain will spread/meander into the park, and during big storms may then flow back into the river at the downstream end through an existing culvert. There would be no substantial channel modifications within this reach. While there is a levee at the downstream end of this reach, any planting in that area would comply with all levee regulations. The set of measures in this reach sub plan was the most incrementally cost effective and with the most benefits for all alternatives in the final array. Figure 4-21 includes a rendering of Pollywog Park with restoration.

Reach 2 Bette Davis Park Area of Griffith Park

This reach sub-plan continues establishment of habitat corridors/riparian planting along the overbanks of both sides of the River. This includes restoration of riparian habitat in the Bette Davis Park area of Griffith Park on the left bank and the area between Zoo Drive and SR-134, with connections under the highway to a restored linear riparian planting along the River extending into Reach 3. There would be no channel modifications within this reach. Modifications to levees would comply with levee regulations. This reach sub-plan was the most incrementally cost effective with the most benefits for Alternatives 10, 13, 13v and 16.

Reach 3 Ferraro Fields/Verdugo Wash Area of Griffith Park

This reach sub-plan continues establishment of the riparian corridor along Zoo Drive on the right side of the River. It also daylights a stream currently confined in a large culvert just downstream of Ferraro Fields on the right bank in the Zoo Drive area and daylights two smaller streams on the left bank. Depending upon the length of the daylighted stream, it would be planted with riparian vegetation and end at the confluence with the River in a small freshwater marsh. If it is not possible to design an efficient confluence, the connection to the River would remain gated. Freshwater marsh vegetation would include clustered field sedge, fragrant flatsedge, Parish's spikerush and common rush, scarlet monkey flower, California bulrush, narrow leaved cattail, and common cattail. There would be no modifications to the channel itself. Levee protection would remain. This reach sub-plan was the most incrementally cost effective with the most benefits for Alternative 10.

Reach 4 Griffith Park

This reach sub-plan would restore riparian and wetland habitat by establishing a riparian corridor on the left bank of the River, daylighting eight streams, creating a side channel diverting river flows through the Griffith Park (Harding) Golf Course on the right bank, and lowering the Los Feliz Golf Course on the left bank to allow seasonal flooding through existing culverts.

The riparian corridor on the left overbank would be implemented as continuously as possible within the requirements of levee regulations. There would be no channel modifications within this reach. The side stream through Griffith Park would enter the park from the River under the I-5 Freeway (or farther upstream if necessary) and exit the park to reenter the River downstream under the I-5 as well. A riparian fringe of trees and marsh vegetation would line the new side channel. The Los Feliz Golf Course would be lowered, rebuilt, and allowed to seasonally flood (with no changes to the River channel walls) in order to establish a riparian habitat interspersed with the golf course greens. Figure 4-25 is a rendering of restoration at Los Feliz.

There are eight streams currently encased in culverts that would be opened and naturalized as tributaries as far upstream as possible (at a minimum opening up the stream within the River right-of-way). Depending upon the length of the daylighted stream, it would be planted with riparian vegetation and end at the confluence with the river in a small freshwater marsh. If it is not possible to design an efficient confluence, the connection to the River would remain gated.

This reach sub-plan was the most incrementally cost effective with the most benefits for all alternatives in the final array.

Reach 5 Riverside Drive

This reach sub-plan would continue implementation of the habitat corridor restoration in a narrow strip along the left overbank to avoid interference with the existing levee system (in compliance with current USACE guidance for vegetation on levees), and would daylight and restore one stream currently encased in a culvert with a riparian fringe and freshwater marsh. The stream would be opened and naturalized as far upstream as possible (at a minimum, this would open up a confluence within the River right-of-way). Depending upon the length of the daylighted stream, it would be planted with riparian vegetation and end at the confluence with the River in a small freshwater marsh of approximately 1 acre. If it is not possible to design an efficient confluence due to the levee, the connection to the river would remain gated. Examples can be found in Los Angeles at North Atwater Park.

This reach sub-plan was the most incrementally cost effective with the most benefits for Alternatives 10, 13 and 13v.

Reach 6 Taylor Yard

Restoration measures in this reach sub-plan include increasing riparian habitat within the Bowtie site and at Taylor Yard. This would include widening the channel bed on the left side of the river by a minimum of 80 feet and connecting this new channel bed to the existing level of the overbank with a sloped bank vegetated with riparian plants. The length of this widening would extend through the beginning of the bend in the Bowtie site downstream for 700 feet through the G-2 Taylor Yard parcel and beyond, for a maximum of about 1,000 feet. Widening would include removal of concrete and excavation followed by reconstruction of the channel structure to stabilize the bank using grade control, rock walls with toe-ins (an extension of the wall below the bed), and/or geotextiles, and would provide for a gradual, undulating four-to-one (4:1) slope up to current grade. There is limited terracing at the downstream end of the Bowtie site as it transitions into the widened Taylor Yard. In the widened area, the riparian area on the overbank would be similar to that described for Reach 1 and the bank would be vegetated with plants that would survive seasonal inundation and would lay down in flood events.

At the upstream end of the Bowtie site, the channel banks would be lowered in an approximate 100-foot-wide by 600-foot-long riparian area by creating a setback in the channel wall with a terrace planted with riparian and marsh habitat. The terrace would be 10 feet above the channel invert transitioning from upstream and downstream ends. The left overbank along the Bowtie site would be planted with a riparian

corridor, irrigated for establishment, and water harvested from stormwater drainages. This reach sub-plan was the most incrementally cost effective with the most benefits for Alternative 10.

Reach 7 Arroyo Seco/Los Angeles State Historic Park

This reach sub-plan would daylight three streams currently confined in storm drains/culverts. One is just upstream of Arroyo Seco on the opposite bank (right bank), and the others are downstream of Arroyo Seco. The second is on the right bank upstream of Los Angeles State Historic Park, and the third is on the left bank. Both streams on the right bank connect to the hills in Elysian Park. A freshwater marsh would be located in the daylighted area outside of the mainstem of the River channel. The streams would be opened and naturalized as tributaries as far upstream as possible (at a minimum opening up the stream within the River right-of-way). Depending on the length of the daylighted stream, it would be planted with riparian vegetation and end at the confluence with the River in a small freshwater marsh. If it is not possible to design an efficient confluence, the connection to the River would remain gated. There would be no modifications to the channel itself. This reach sub-plan was the most incrementally cost effective with the most benefits for Alternative 10.

Reach 8 LATC

In this Reach 8 sub-plan, the LATC site would be restored with riparian habitat. Micro-grading would slope the site to restore the historical wash that once ran through this area. The restored historical wash would meander through the property and would be connected to the existing River channel through a wide culvert or designed confluence, if possible. The wash location would be determined by the USACE's hydrology and hydraulic analysis and would be located in the most appropriate place. This reach sub-plan also establishes riparian habitat within the site.

There would be no channel modifications within this reach as water entering the River from the historical wash would be routed through existing storm drains in the channel wall. This reach sub-plan was the most incrementally cost effective with the most benefits for Alternatives 10, 13 and 13v.

4.14.3 Alternative 13 (ACE) Description by Reach

ARBOR Corridor Extension (ACE) Alternative 13 restores/benefits a total of 588 acres. In addition to removal of invasives species throughout the project footprint, this alternative includes the following specific restoration features. Restoration features are shown in Figure 4-9 through Figure 4-12 at the end of this section.

Reach 1 Pollywog Park Area of Griffith Park

This reach sub-plan is the same as described for Alternative 10. This Reach 1 sub-plan was the most incrementally cost effective with the most benefits for all alternatives in the final array.

Reach 2 Bette Davis Park Area of Griffith Park

This reach sub-plan is the same as described for Alternative 10. This Reach 2 sub-plan was the most incrementally cost effective with the most benefits for Alternatives 10, 13, and 16.

Reach 3 Ferraro Fields/Verdugo Wash area of Griffith Park

This reach sub-plan includes the three daylighted streams from the reach sub-plan for Alternative 10. In addition, using water diverted from the River, it creates a side channel that would flow along the west side of Ferraro Fields and reenter the River through the daylighted stream on the right bank. The side channel is depicted in Figure 4-23. The side channel would support a riparian fringe, and open water and freshwater marsh would be located in the daylighted area outside of the mainstem of the River channel.

This reach sub-plan continues and expands the riparian corridor from the reach plan for Alternative 10. Riparian areas would be located on the right overbank along Zoo Drive, along the River's edge at Ferraro Fields, and between the daylighted streams on the left overbank. There would be no modifications to the channel itself. Levee protection would remain and levee vegetation policy would be followed. This reach sub-plan was the most incrementally cost effective with the most benefits for Alternatives 13, 13v, and 16.

Reach 4 Griffith Park

This reach sub-plan is the same as described for Alternative 10. This reach sub-plan was the most incrementally cost effective with the most benefits for all alternatives in the final array.

Reach 5 Riverside Drive

This reach sub-plan is the same as described for Alternative 10. It was the most incrementally cost effective with the most benefits for Alternatives 10, 13, and 13v.

Reach 6 Taylor Yard

The Reach 6 sub-plan in Alternative 13 restores riparian corridors and widens the soft bottom bed of the River by over 300 feet with additional slope back to the overbank elevation along the reach for a length of approximately 1,000 feet. At the upstream end of the reach, a back water wetland would be developed at river level, and there would be a small terraced area at the downstream end of the Bowtie parcel to facilitate the transition into the widened area at Taylor Yard. Aquatic riverine habitats including freshwater marsh would dominate the new river bed. The banks of the River, upstream of the Bowtie backwater wetland and downstream of Taylor Yard on the left bank and the entirety of the right bank, would be restructured to support overhanging vines and other vegetation. This reach sub-plan was the most incrementally cost effective with the most benefits for Alternative 13, 13v, 16, and 20. Restoration at Taylor Yard is depicted in Figure 4-27 at the end of this section.

Reach 7 Arroyo Seco/Los Angeles River State Historic Park

In this Reach 7 sub-plan, the Arroyo Seco tributary would be restored with riparian habitat. This stream would have its banks and bed softened by removing concrete for approximately one-half mile upstream and planning riparian vegetation on its banks. It would be stabilized with erosion control elements to maintain the existing protection. At the confluence on the upstream edge of the River, a backwater riparian wetland would be established. Within the River channel itself, the banks would be restructured to support vegetation on the banks. This reach subplan was the most incrementally cost effective with the most benefits for Alternatives 13 and 16 in the Draft IFR. However, after more detailed cost analysis, it was concluded that this reach sub-plan was not cost effective compared to the sub-plan in Alternatives 13v and 20. Figure 4-28 is a rendering of a restored Arroyo Seco.

Reach 8 LATC

This reach sub-plan is the same as for Alternative 10. It was the most incrementally cost effective with the most benefits for Alternatives 10, 13, and 13v.

4.14.4 Alternative 13v Description by Reach

Alternative 13v restores/benefits a total of 598 acres and is a variation of Alternative 13. In addition to removal of invasives species throughout the project footprint, this alternative includes the following specific restoration features. It includes the same reach sub-plans as Alternative 13 except in Reach 7, where it includes the sub-plan from Alternative 20.

Reach 1 Pollywog Park Area of Griffith Park

Alternative 13v restores/benefits a total of 598 acres and is a variation of Alternative 13. It includes the same reach sub-plans as Alternative 13 except in Reach 7, where it includes the sub-plan from Alternative 20.

Reach 2 Bette Davis Park Area of Griffith Park

This reach sub-plan is the same as described for Alternative 10. This reach sub-plan was the most incrementally cost effective with the most benefits for Alternatives 10, 13, 13v, and 16.

Reach 3 Ferraro Fields/Verdugo Wash area of Griffith Park

This reach sub-plan is the same as described for Alternative 13. This reach sub-plan was the most incrementally cost effective with the most benefits for Alternatives 13, 13v, and 16.

Reach 4 Griffith Park

This reach sub-plan is the same as described for Alternative 10. It was the most incrementally cost effective with most benefits for all alternatives in the final array.

Reach 5 Riverside Drive

This reach sub-plan is the same as described for Alternative 10. It was the most incrementally cost effective with the most benefits for Alternatives 10, 13, and 13v.

Reach 6 Taylor Yard

This reach sub-plan is the same as described for Alternative 13. It was the most incrementally cost effective with the most benefits for Alternatives 13, 13v, 16 and 20.

Reach 7 Arroyo Seco/Los Angeles River State Historic Park

This reach sub-plan is the same as described for Alternative 20. It was the most incrementally cost effective with the most benefits for Alternatives 13v and 20.

Reach 8 LATC

This reach sub-plan is the same as for Alternative 10. It was the most incrementally cost effective with the most benefits for Alternatives 10, 13, and 13v.

4.14.5 Alternative 16 (AND) Description by Reach

ARBOR Narrows to Downtown Alternative 16 (AND), would restore/benefit a total of 659 acres. In addition to removal of invasives species throughout the project footprint, this alternative includes the following specific restoration features. Specific restoration features are shown in Figure 4-13 through Figure 4-16 at the end of this section.

Reach 1 Pollywog Park Area of Griffith Park

This reach sub-plan is the same as described for Alternative 10. This Reach 1 sub-plan was the most incrementally cost effective with the most benefits for all alternatives in the final array.

Reach 2 Bette Davis Park Area of Griffith Park

This reach sub-plan is the same as described for Alternative 10. This Reach 2 sub-plan was the most incrementally cost effective with the most benefits for Alternatives 10, 13, 13v, and 16.

Reach 3 Ferraro Fields/Verdugo Wash Area of Griffith Park

This reach sub-plan is the same as described for Alternative 13. It was the most incrementally cost effective with the most benefits for Alternatives 13, 13v, and 16.

Reach 4 Griffith Park

This reach sub-plan is the same as described for Alternative 10. It was the most incrementally cost effective with the most benefits for all alternatives in the final array.

Reach 5 Riverside Drive

In Reach 5, the right bank would be modified from a trapezoidal bank to a vertical bank. This would increase the width of the soft bottom bed of the River by over 100 feet. The top of the bank would be notched and planted with overhanging vines. The left bank would be modified from trapezoidal to terraced and planted with riparian herbaceous vegetation and would include any necessary erosion measures, which would consist of concrete-lined beds. The land side of the bank would be planted with riparian herbaceous vegetation. At the downstream end of this reach, the River will also be widened on the left bank with appropriate erosion control measures in place. This would further increase the natural river bottom area. The daylighted stream in the sub-plan for Alternatives 10 and 13 is also included in this reach sub-plan. All of these measures would comply with levee vegetation regulations. This reach sub-plan was the most incrementally cost effective with the most benefits for Alternatives 16 and 20.

Reach 6 Taylor Yard

This reach sub-plan is the same as for Alternative 13. It was the most incrementally cost effective with the most benefits for Alternative 13 and 13v, and substituted by the team for Alternatives 16 and 20.

Reach 7 Arroyo Seco/Los Angeles River State Historic Park

This reach sub-plan is the same as for Alternative 13. It was the most incrementally cost effective with the most benefits for Alternatives 13 and 16 in the Draft IFR. However, after more detailed cost analysis, it was concluded that this reach sub-plan was not cost effective compared to the sub-plan in Alternatives 13v and 20.

Reach 8 LATC

In this sub-plan, Reach 8 would be modified with terracing on the right bank upstream of LATC and on the left bank downstream of LATC. This terracing would be planted with riparian vegetation. The channel would be modified from concrete to soft bottom to support aquatic habitat including freshwater marsh, and the reach would be widened. The marsh would extend into the LATC site 500 feet, with riparian area extending another 1,000 feet into the LATC site, gradually sloping up to existing bank elevations. The historic wash would be restored through the property with a riparian fringe as well as other side channels, and river flows would be diverted out of the River into the LATC site creating a large wetland area. A railroad trestle would be included with this alternative to allow the connection of the River channel and the adjacent restored areas. This reach sub-plan was the most incrementally cost effective with the most benefits for Alternatives 16 and 20. This is displayed on Figure 4-30 at the end of this section.

4.14.6 Alternative 20 (RIVER) Description by Reach

Riparian Integration via Varied Ecological Reintroduction (RIVER) Alternative 20 would restore/benefit a total of 719 acres. In addition to removal of invasives species throughout the project footprint, this alternative includes the following specific restoration features. Restoration features are shown in

Figure 4-17 through Figure 4-20 at the end of this section.

Reach 1 Pollywog Park Area of Griffith Park

This reach sub-plan is the same as deseribed for Alternative 10. This Reach 1 sub-plan was the most incrementally cost effective with the most benefits for all alternatives in the final array.

Reach 2 Bette Davis Park Area of Griffith Park

The reach sub-plan for this alternative includes the habitat corridors/riparian planting included in the reach sub-plan for Alternative 10. In addition, this alternative modifies the right bank of the channel from trapezoidal to a vertical bank with overhanging vines, creating 80 feet of additional soft bottom width in the channel. This reach sub-plan was the most incrementally cost effective with the most benefits for Alternative 20. Figure 4-22 at the end of this section includes a rendering of modified River banks in this reach.

Reach 3 Ferraro Fields/Verdugo Wash area of Griffith Park

This reach sub-plan would include the riparian corridor along the right bank, the side channel and one of the daylighted streams included in the reach sub-plan for Alternative 13, and it would also restore the Verdugo Wash confluence. The side channel would be established on the west side (right bank) at Ferraro Fields with water diverted from the River. The stream currently confined in a large culvert just downstream of Ferraro Fields in the Zoo Drive area would be daylighted. The side channel would support a riparian fringe. The daylighted stream would include a riparian fringe with freshwater marsh at the confluence. Riparian areas are located on the right bank along Zoo Drive and on the River's edge at Ferraro Fields. These features would not modify the channel. In the Verdugo Wash confluence, the channel mouth will be widened, and the left bank of the wash would be sloped back to the existing overbank elevation, as depicted in Figure 4-24 at the end of this section. One potential design would use riparian vegetation to stabilize the south bank and a combined riparian and marsh community in the widened channel. Riparian habitat will be planted along the overbank of the widened Verdugo Wash. Levee protection would be tied in to the bank, and other levee protection will remain. Levee vegetation policy will be followed. Details for the confluence area will be determined during the detailed design phase. This reach sub-plan was the most incrementally cost effect with the most benefits for Alternative 20.

Reach 4 Griffith Park

This reach sub-plan is the same as described for Alternative 10, 13, 13v, and 16. It was the most incrementally cost effective with most benefits across for all alternatives in the final array.

Reach 5 Riverside Drive

This reach sub-plan is the same as described for Alternative 16. It was the most incrementally cost effective with the most benefits for Alternatives 16 and 20.

Reach 6 Taylor Yard

This reach sub-plan is the same as described for Alternative 13, 13v, and16. It was the most incrementally cost effective with the most benefits for Alternative 13, and substituted by the team for Alternatives 16 and 20.

Reach 7 Arroyo Seco/Los Angeles State Historic Park

This Reach 7 sub-plan includes the three daylighted streams restored in the Alternative 10 sub-plan and the restoration of the Arroyo Seco tributary included in the Alternative 13 sub-plan. In addition, this Reach 7 sub-plan restores freshwater marsh at the Los Angeles State Historic Park and terraces the adjacent right River bank to include riparian vegetation and connect the marsh area to the river. To facilitate the terracing, the existing rail road track would be trestled at grade as shown in Figure 4-29. It was the most incrementally cost effective with the most benefits for Alternatives 13v and 20.

Reach 8 LATC

This reach sub-plan is the same as for Alternative 16. It was the most incrementally cost effective with the most benefits for Alternatives 16 and 20.

4.14.7 Water Budget

As described in Section 3.4.5, a water budget was calculated. It quantified the amount of available water in the study area at approximately 211,000 af/year. In addition to the estimated inputs the potential consumptive use of that water was estimated in Appendix E for each of Alternatives 10, 13, 16, and 20. This includes estimates of infiltration, evaporation, and evapotranspiration. The total water demand for these alternatives is between 65,000 and 69,000 af/year. Alternative 13v would have a similar demand to Alternative 13. That is compared to the annual sources of approrximately 211,000 af/year.

4.15 OPERATION, MAINTENANCE, REPAIR, REPLACEMENT, AND REHABILITATION

Operation, maintenance, repair, replacement, and rehabilitation activities (OMRRR) would occur after the project is constructed in order to keep project features functioning as designed. Activities would be similar among the alternatives and vary in scale consistent with each alternative. This will include annual inspections and maintenance, periodic repair and/or replacement of project features, management of invasives throughout the constructed restoration features and channel bottom areas within the restoration footprint, and provision of irrigation to constructed features during drought. Costs are based on a percentage of the initial construction cost of items anticipated to require maintenance over the life of the project, as well as estimates for inspection and maintenance and invasives management and are listed in Appendix C Cost. A detailed OMRRR Plan will be developed during implementation and will be coordinated with the current OMRRR Plan for the existing LACDA flood risk management project.

USACE has identified that a modification to the LACDA OMRRR plan would be needed to avoid contradictory maintenance requirements for the areas of restoration features. The LACDA OMRRR plan would thus be modified to accommodate the restoration, with maintenance for restoration a City responsibility under the restoration OMRRR plan.

At the same time, the USACE would modify the LACDA OMRRR plan for the rest of the ARBOR reach to preserve flood risk management function while complementing the restoration project. These modifications would allow some native vegetation to remain in the rest of the reach to the extent that design conveyance capacities would be met or would experience only minimal changes from the design conditions. Such OMRRR would remain contingent on funding and would be anticipated to be phased in over time. These OMRRR modifications would be refined during design of the restoration project.

4.16 RECREATION PLAN

As described above one of the study objectives is to increase passive recreation that is compatible with the restored environment. To that end, USACE and the non-Federal sponsor cooperatively formulated recreation plans with features integrated into the ecosystem restoration plan; however, these features are

evaluated as separable components of the plan. The features of the recreation plan are designed to capitalize on the areas where substantial ecosystem restoration is proposed. As such, it is assumed that the ecosystem restoration will have taken place when considering the effects of the recreation plan features. Recreation development at ecosystem restoration projects is intended to be compatible with, but also enhance the visitation experience by taking advantage of natural values. The recreation experience is intended to build upon ecosystem restoration and take advantage of restored values and not detract from them as described by EP 1162-2-502 (USACE, 1999). The formulation of recreation plans were informed by that guiding principle and designed with the intent to be operated in a manner consistent with the primary project purpose or ecosystem restoration.

The formulation for recreation is conducted ancillary to ecosystem restoration at an appropriate scope and scale compatible with the restoration features. As a function of our formulation process, a corresponding recreation plan is formulated after identification of the final array and in the case of this study, after the identification of the NER Plan and Tentatively Selected Plan. The recreation plan developed for the NER and TSP was commensurate with the scope and scale of the proposed restoration in a manner that do not impair the restoration outputs. While plans are not specifically formulated for plans other than the NER and LPP, recreational features for other plans are assumed to be similar in features and proportionate in scope and scale. Although no specific recreation plan was formulated to correspond to Alternative 10 or 16, if one of these restoration alternatives were to be selected for implementation, associated recreation facilities compatible with the restoration features would be anticipated to be implemented at similar but slightly reduced scale to those described for the NER and the LPP, respectively. Proposed recreation features described in the following sections would be included at the appropriate scale in all plans.

More detailed description of the recreation analysis can be found in Appendix B, Economics and Chapter 6, with potential impacts included in Chapter 5.

4.16.1 Proposed Recreation Features

Two recreation plans were formulated, both containing the same components but to a different extent. One recreation plan was developed to be consistent with and take full advantage of the restoration features found within the (Alternative 13. The recreation plan option corresponding to Alternative 13v, the NER Plan, includes all the features in the plan for Alternative 13 and is essentially identical. A larger plan variation consistent with the most extensive of the Final Array of Alternatives (Alternative 20) was also developed, consistent with public desire for additional recreation and open space access opportunities. Both recreation plans include the modification, upgrade, or creation of multi-use trails and related basic amenities (access points, wildlife viewpoints, parking lots, restrooms, and signage). The plan also includes non-motorized multi-use bridges across the River and smaller pedestrian bridges across tributaries or within large restored areas. At the current level of design, trails are assumed to be multiple-use, 12 feet wide, with a decomposed granite surface. Safety ramps will be a part of project design and will be multi-use for maintenance, safety exits, and potential access by kayakers and canoeists.

Specifically, the plans call for:

The recreation plan option corresponding to ecosystem restoration Alternative 13 and 13 v includes the following specific features:

- 5.89 miles of new unpaved non-motorized multi-use trail *(to include decomposed granite surface and trail signage)*
- 0.3 miles of new paved multi-use trail *(short extension of current southern end of LA River Bike Path)*
- 1 small bridge/crossing within Taylor Yard

- 1 medium bridge within LATC
- 2 paved parking lots, one at Taylor Yard and one at LATC *(each about 15,000 square feet)*
- 4 restrooms, one at Bette Davis Park, two at Taylor Yard, and one at LATC
- 1 pedestrian underpass at the south end of Taylor Yard
- 24 trail access points throughout the study area *(access points would include grading and planting, signage, stairs, benches, gating, and trash receptacles to provide quality trail access)*
- 6 wildlife viewing points throughout the study area *(viewpoints would include an elevated wood deck with railing, benches, interpretive signage, and trash receptacles to allow users to enjoy high quality viewsheds within the restored ARBOR reach)*
- 4 pedestrian underpasses under bridges along the river to support trail connectivity

The recreation plan option corresponding to ecosystem restoration Alternative 20 includes the following specific features:

- 7.98 miles of new unpaved non-motorized multi-use trail *(to include decomposed granite surface and trail signage)*
- 1.26 miles of new paved multi-use trail *(extension of current southern end of LA River Bike Path)*
- 2 bridges spanning the River
- 1 smaller bridge/crossing within Taylor Yard
- 4 small/medium bridges within LATC
- 2 paved parking lots, one at Taylor Yard and one at LATC *(each about 15,000 square feet)*
- 4 restrooms, one at Bette Davis Park, two at Taylor Yard, and one at LATC
- 1 pedestrian underpass at the south end of Taylor Yard
- 28 trail access points throughout the study area *(access points would include grading and planting, signage, stairs, benches, gating, and trash receptacles to provide quality trail access)*
- 11 wildlife viewing points throughout the study area *(viewpoints would include an elevated wood deck with railing, benches, interpretive signage, and trash receptacles to allow users to enjoy high quality viewsheds within the restored ARBOR reach)*
- 6 pedestrian underpasses along the river to support trail connectivity

4.16.2 Benefits of the Recreation Plan

The proposed recreation features would provide both direct and indirect benefits to recreation participants as well as the communities surrounding the ARBOR reach. Direct benefits of the recreation plan would include:

- Improved quality and quantity of trails for multiple user groups along the river
- Increased connectivity of each side of the river's recreation resources
- Increased public safety through better signage and trail development along the river
- Improved viewing and lines of sight along the river, especially in areas of substantial restoration via the ecosystem restoration plan
- Opportunity for interpretive signage and environmental education
- Improved public health by providing opportunities for exercise and psychological respite

In addition to these direct benefits, communities along the ARBOR reach will receive benefits in the form of increased quantity and quality of neighborhood parks. The addition of trails and amenities in the restored LATC will benefit the surrounding historically underserved communities along the downstream end of the ARBOR reach, providing substantial open space in highly developed neighborhoods, which are currently considered park-deficient. The recreation plan will also help support the projected RED benefits related to redevelopment in the study area.

4.16.3 Expected Recreation Benefits

Visitation estimates generated utilizing a unit day value method described in the Economic Appendix generated recreation values for the without and with project conditions were calculated. Taking the difference between the with-project and the without project, net recreation benefits were estimated. Table 4-12 summarizes expected recreation benefits. Amortization over the period of analysis uses the FY2015 Federal discount rate of 3.375 percent over a 50-year period of analysis. The analysis estimates amortized annual benefits of $2,479,128 for the Alternative 13 and 13v recreation plan option and $3,509,832 for the Alternative 20 recreation plan option. Recreation benefits are shown at 2015 price levels, in accordance with Economic Guidance Memorandum 15-03.

Table 4-12 Summary of Recreation Value Calculation (Price Level FY 2015)

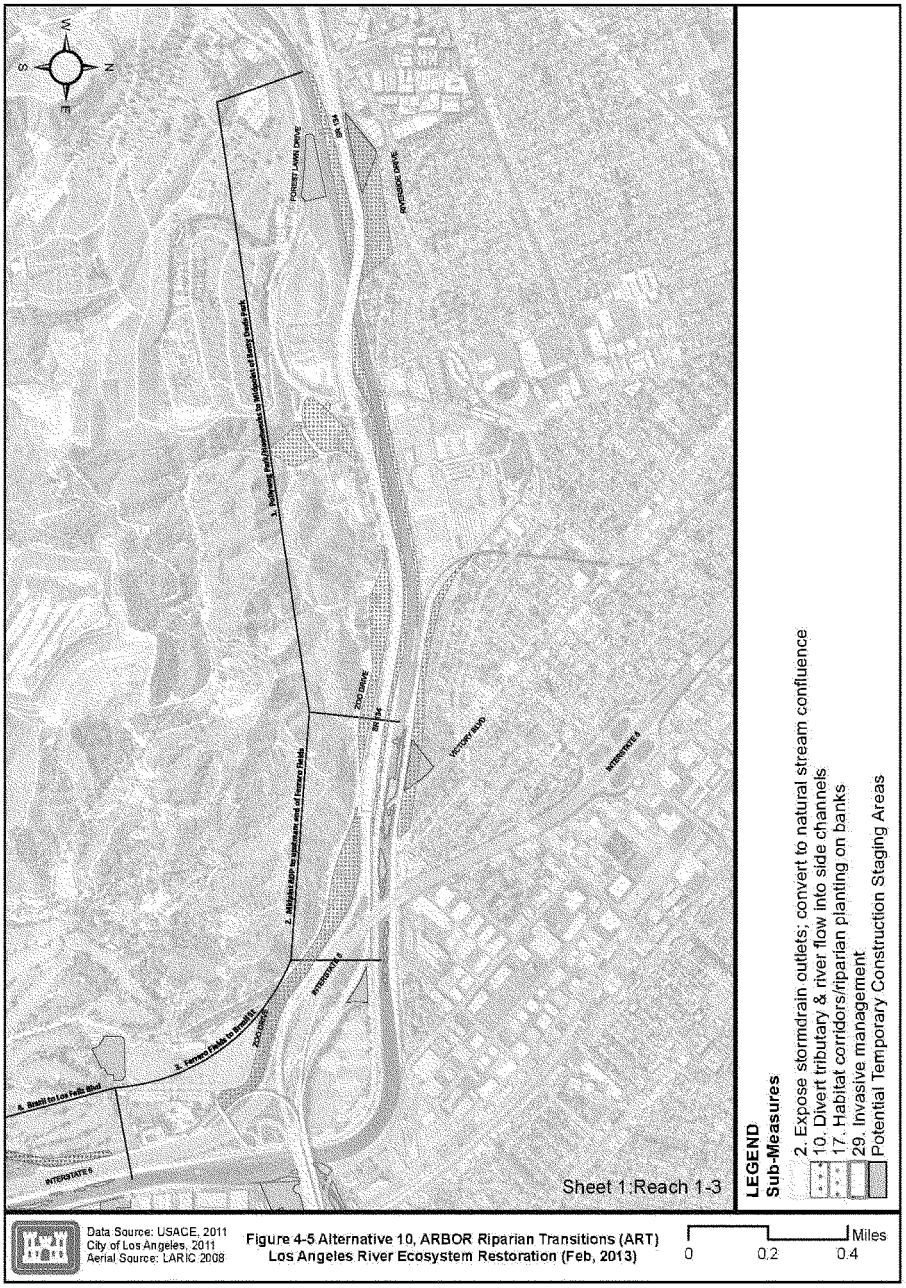
	Without Project	With Alt 13 and 13v	With Alt 20
Average Annual Visitation	437,879	662,106	730,701
Value per Visit	$6.44	$8.01	$8.67
Average Annual Recreation Value	$2,82,1692	$5,300,821	$6,331,524
Recreation value based upon UDV EGM 15-03			

4.16.4 Benefit Cost Analysis

Construction costs were developed for the proposed recreation features. Costs and benefits of the two recreation plans are described in more detail in Appendix B as well as Chapter 6. The construction cost of the Alternative 13 and 13v recreation option is estimated as $10,353,000, and Alternative 20 option as $18,054,000. Based on this analysis the benefits of both alternative recreation plans exceed their costs. (Table 4-13). Values in the table are the most current results and based upon October 2015 price levels.

Table 4-13 Benefit-to-Cost Ratio by Alternative (Price Level October 2015, Interest Rate FY15-3.375 Percent)

Alternative	Annual Benefits ($)	Annual Costs ($)	Net Benefits	BCR
No Action	$0	$0	0.00	0.00
Alternative 13 Recreation Plan Option	$2,479,000	$606,000	$1,873,000	4.09
Alternative 20 Recreation Plan Option	$3,510,000	$978,000	$2,532,000	3.59


Sheet 1:Reach 1-3
LEGEND
Sub-Measures
2. Expose stormdrain outlets; convert to natural stream confluence
10. Divert tributary & river flow into side channels
17. Habitat corridors/riparian planting on banks
29. Invasive management
Potential Temporary Construction Staging Areas
Data Source: USACE, 2011
City of Los Angeles, 2011
Aerial Source: LARIC 2008
Figure 4-5 Alternative 10, ARBOR Riparian Transitions (ART)
Los Angeles River Ecosystem Restoration (Feb, 2013)
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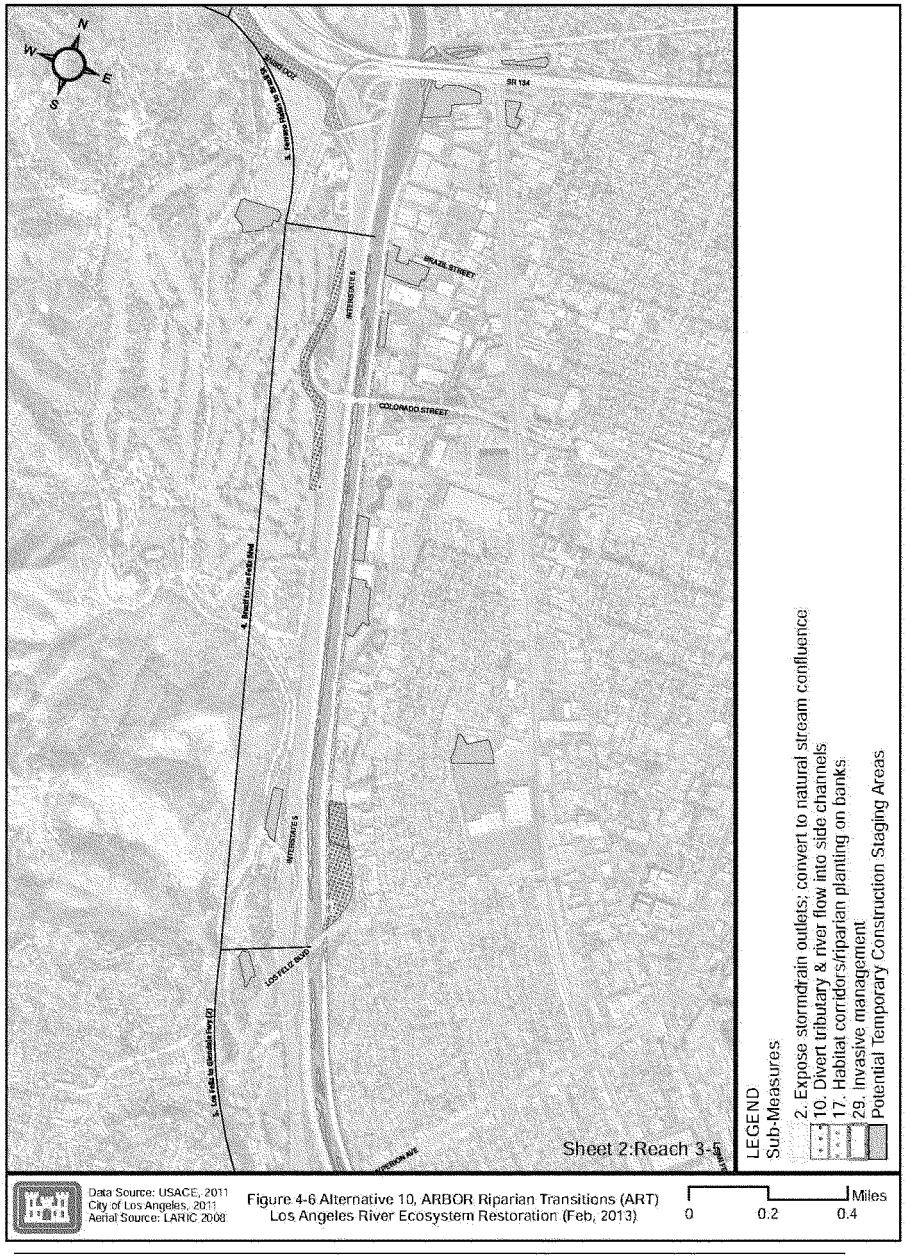
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SR 134
BRAZIL STREET
COLORADO STREET
LOS FELIZ BLVD
INTERSTATE 5
Sheet 2:Reach 3-5
LEGEND
Sub-Measures
2. Expose stormdrain outlets; convert to natural stream confluence
10. Divert tributary & river flow into side channels
17. Habitat corridors/riparian planting on banks
29. Invasive management
Potential Temporary Construction Staging Areas
Data Source: USACE, 2011
City of Los Angeles, 2011
Aerial Source: LARIC 2008
Figure 4-6 Alternative 10, ARBOR Riparian Transitions (ART)
Los Angeles River Ecosystem Restoration (Feb, 2013)
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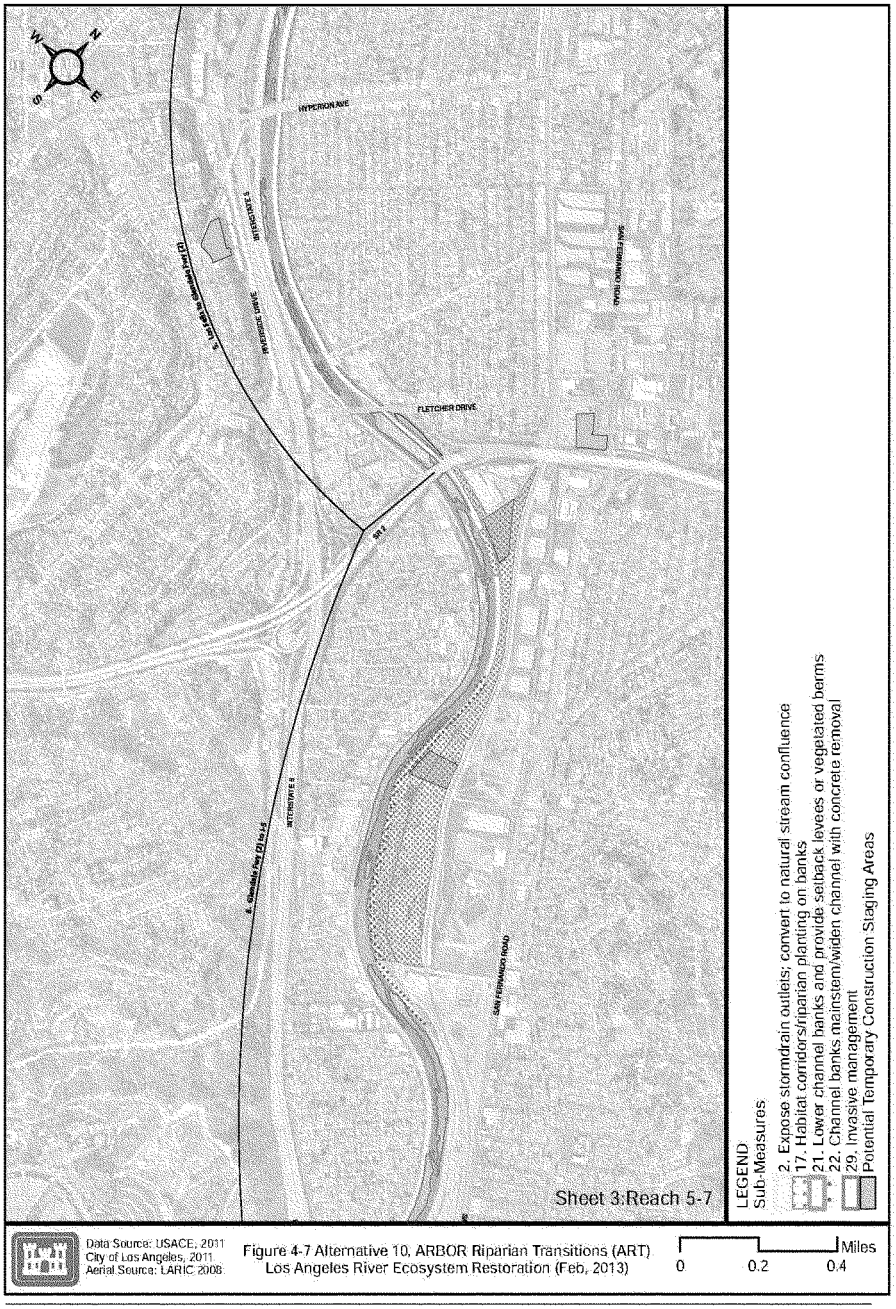
HYPERION AVE
FLETCHER DRIVE
SAN FERNANDO ROAD
JETSTREAM E
JETSTREAM S
Sheet 3:Reach 5-7
LEGEND
Sub-Measures
2. Expose stormdrain outlets; convert to natural stream confluence
17. Habitat corridors/riparian planting on banks
21. Lower channel banks and provide setback levees or vegetated berms
22. Channel banks, mainstem/widen channel with concrete removal
29. Invasive management
Potential Temporary Construction Staging Areas
Data Source: USACE, 2011
City of Los Angeles, 2011
Aerial Source: LARIC 2008
Figure 4-7 Alternative 10, ARBOR Riparian Transitions (ART)
Los Angeles River Ecosystem Restoration (Feb, 2013)
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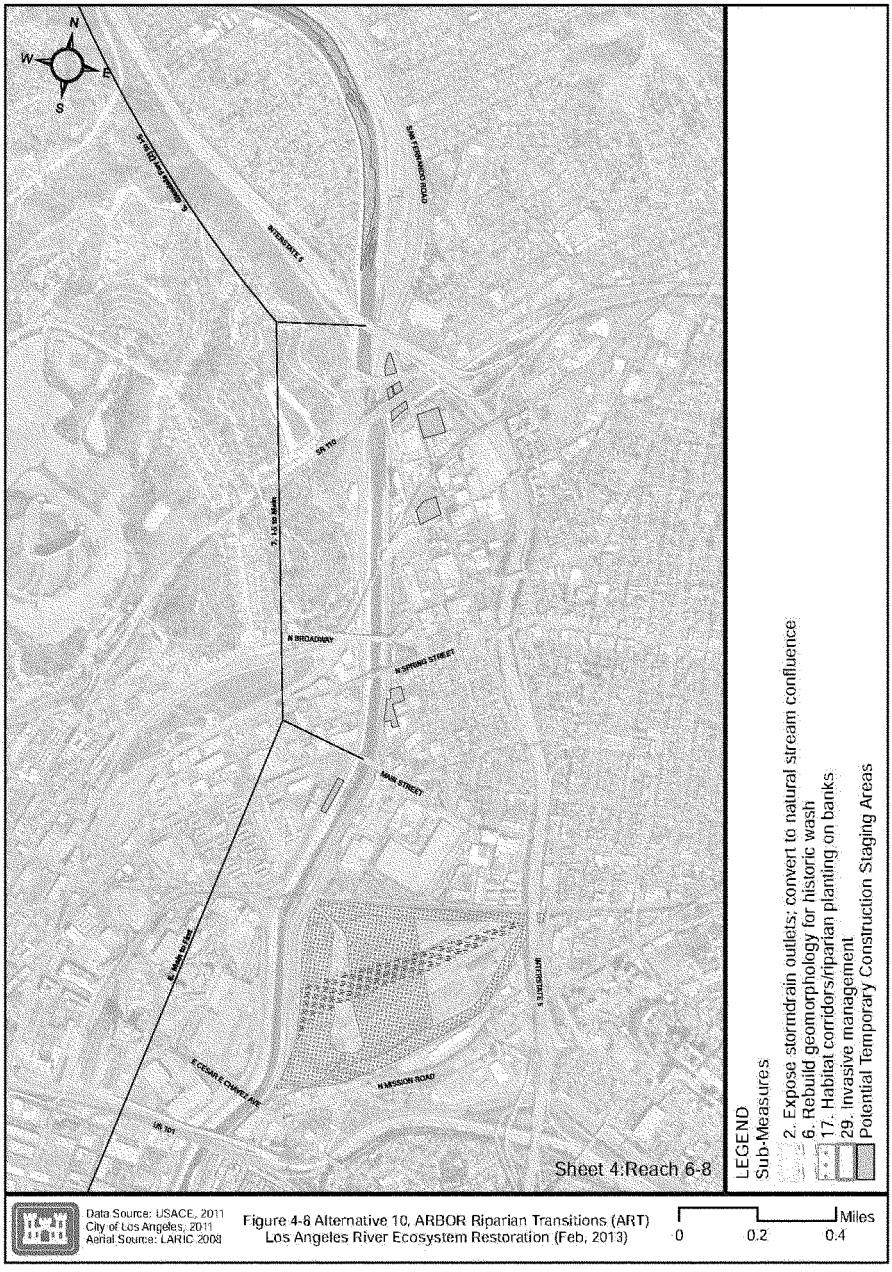
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SAN FERNANDO RD
INTERSTATE 5
SR 110
N BROADWAY
N SPRING STREET
MAIN STREET
E CESAR E CHAVEZ AVE
N MISSION ROAD
US 101
Sheet 4:Reach 6-8
LEGEND
Sub-Measures
2. Expose stormdrain outlets; convert to natural stream confluence
6. Rebuild geomorphology for historic wash
17. Habitat corridors/riparian planting on banks
29. Invasive management
Potential Temporary Construction Staging Areas
Data Source: USACE, 2011
City of Los Angeles, 2011
Aerial Source: LARIC 2008
Figure 4-8 Alternative 10, ARBOR Riparian Transitions (ART)
Los Angeles River Ecosystem Restoration (Feb, 2013)
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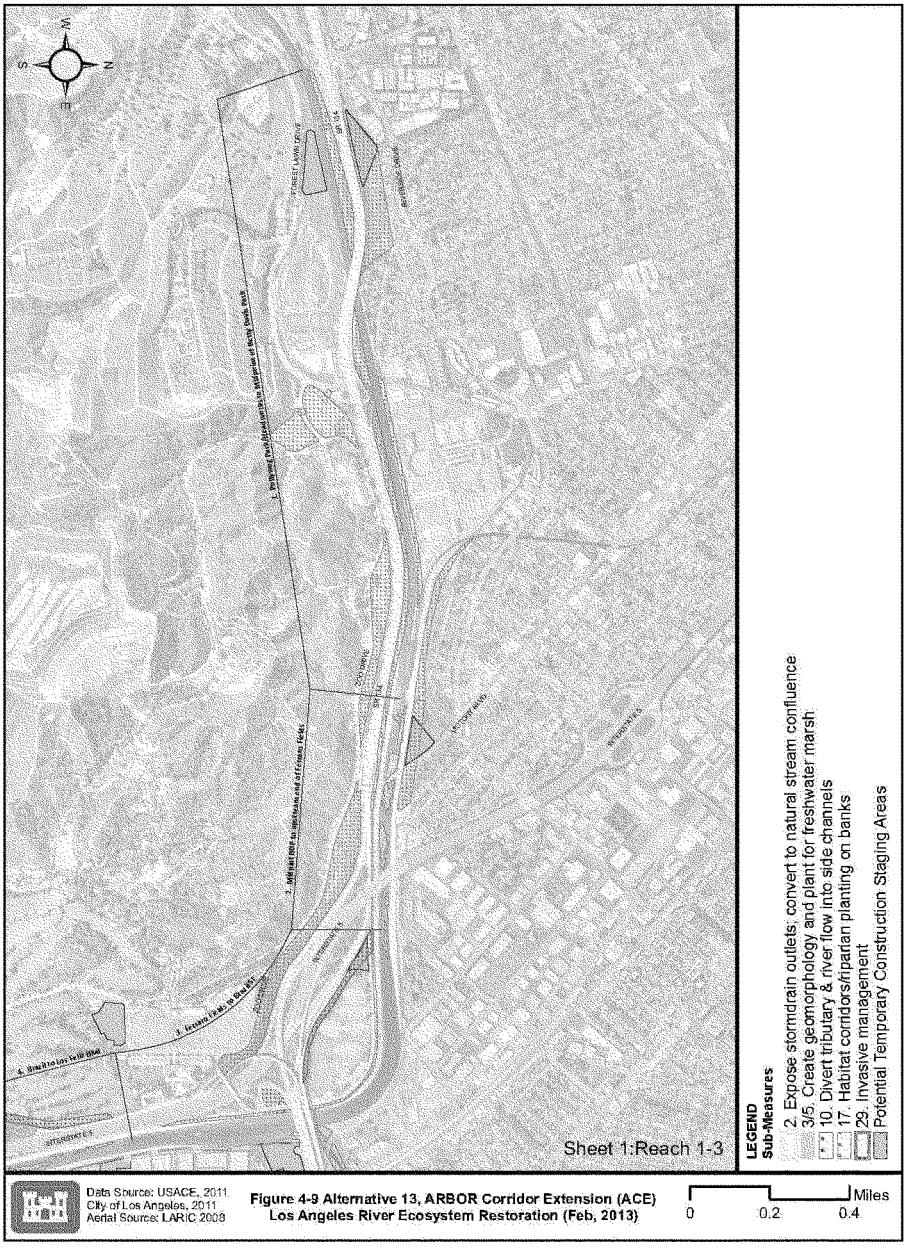
Sheet 1:Reach 1-3
LEGEND
Sub-Measures
2. Expose stormdrain outlets; convert to natural stream confluence
3/5. Create geomorphology and plant for freshwater marsh
10. Divert tributary & river flow into side channels
17. Habitat corridors/riparian planting on banks
29. Invasive management
Potential Temporary Construction Staging Areas
Data Source: USACE, 2011
City of Los Angeles, 2011
Aerial Source: LARIC 2008
Figure 4-9 Alternative 13, ARBOR Corridor Extension (ACE)
Los Angeles River Ecosystem Restoration (Feb, 2013)
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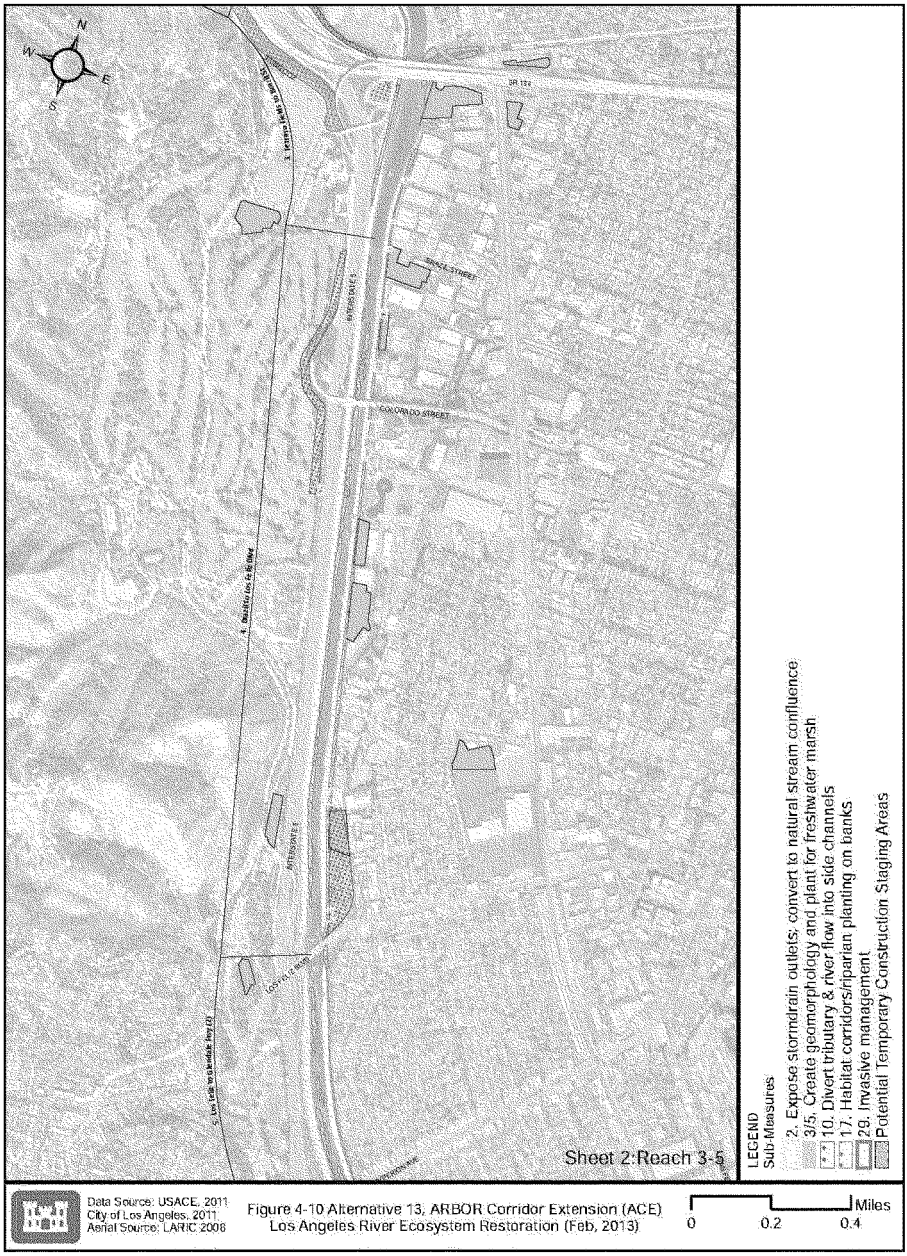
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Sheet 2:Reach 3-5
LEGEND
Sub-Measures
2. Expose stormdrain outlets; convert to natural stream confluence
3/5. Create geomorphology and plant for freshwater marsh
10. Divert tributary & river flow into side channels
17. Habitat corridors/riparian planting on banks
29. Invasive management
Potential Temporary Construction Staging Areas
Data Source: USACE, 2011
City of Los Angeles, 2011
Aerial Source: LARIC 2006
Figure 4-10 Alternative 13; ARBOR Corridor Extension (ACE)
Los Angeles River Ecosystem Restoration (Feb, 2013)
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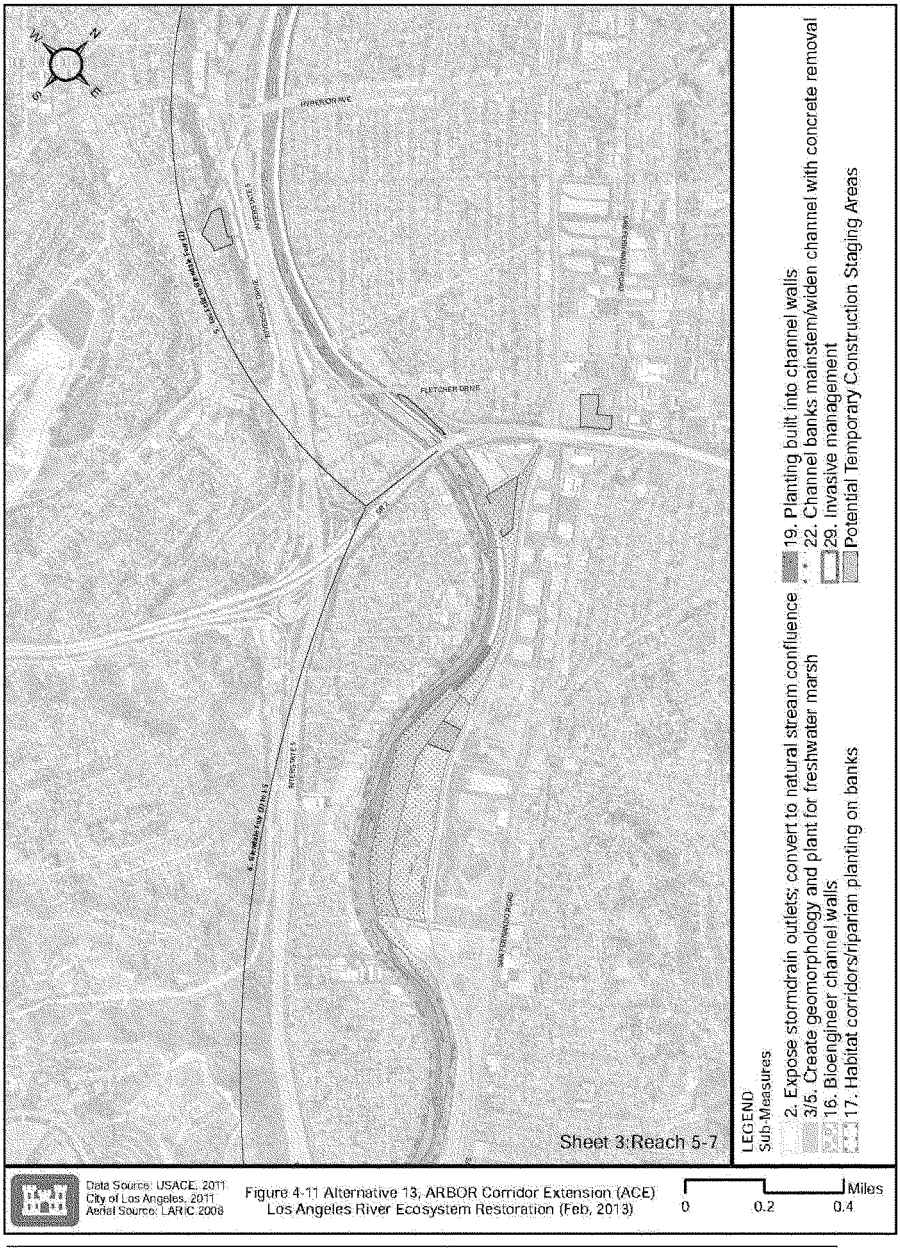
RIVERSIDE DRIVE
FLETCHER DRIVE
GOODWIN AVE
ARBOR VITAE ST
Sheet 3:Reach 5-7
LEGEND
Sub-Measures
2. Expose stormdrain outlets; convert to natural stream confluence
3/5. Create geomorphology and plant for freshwater marsh
16. Bioengineer channel walls
17. Habitat corridors/riparian planting on banks
19. Planting built into channel walls
22. Channel banks mainstem/widen channel with concrete removal
29. Invasive management
Potential Temporary Construction Staging Areas
Data Source: USACE, 2011
City of Los Angeles, 2011
Aerial Source: LARIC 2008
Figure 4-11 Alternative 13, ARBOR Corridor Extension (ACE)
Los Angeles River Ecosystem Restoration (Feb, 2013)
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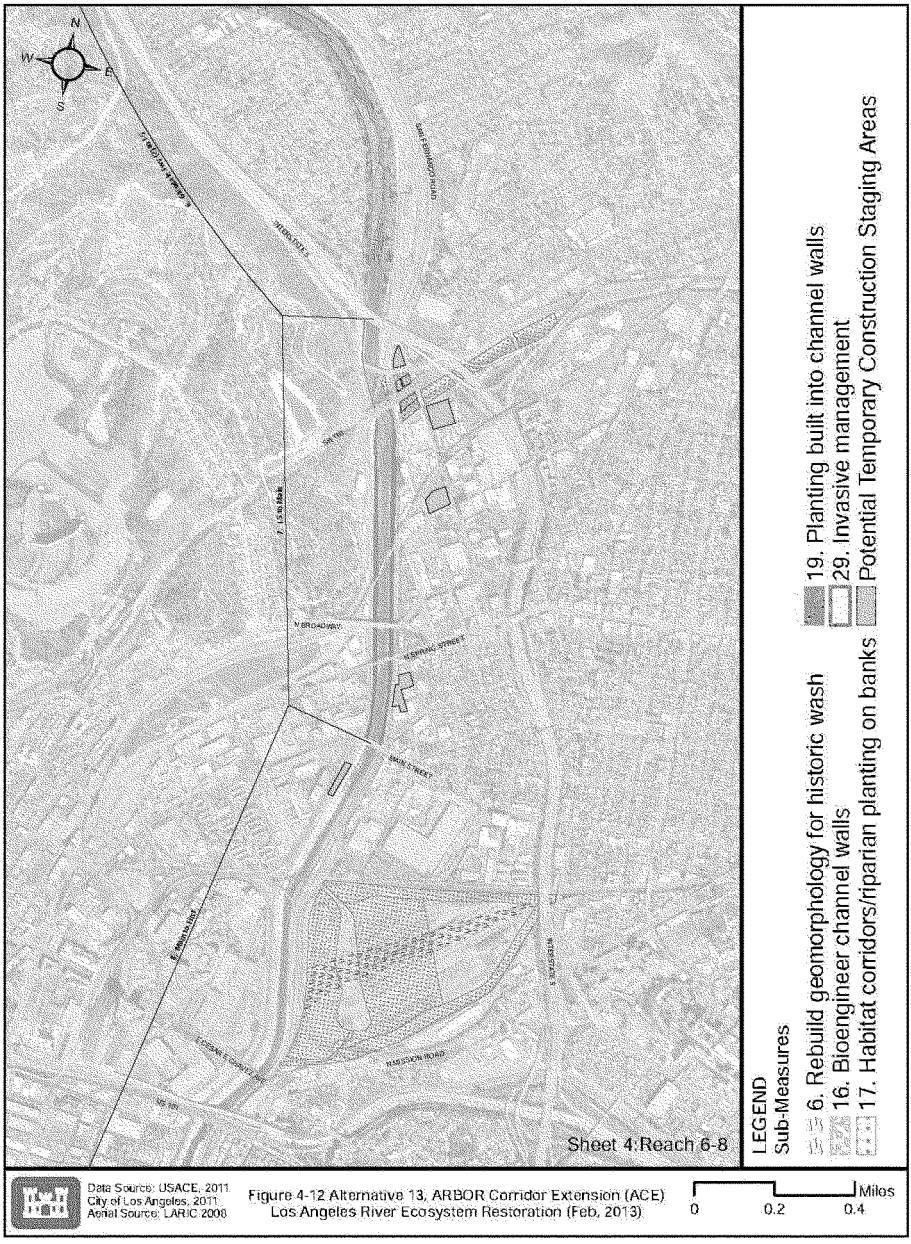
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Sheet 4:Reach 6-8
LEGEND
Sub-Measures
6. Rebuild geomorphology for historic wash
16. Bioengineer channel walls
17. Habitat corridors/riparian planting on banks
19. Planting built into channel walls
29. Invasive management
Potential Temporary Construction Staging Areas
Data Source: USACE, 2011
City of Los Angeles, 2011
Aerial Source: LARIC 2008
Figure 4-12 Alternative 13, ARBOR Corridor Extension (ACE)
Los Angeles River Ecosystem Restoration (Feb, 2013)
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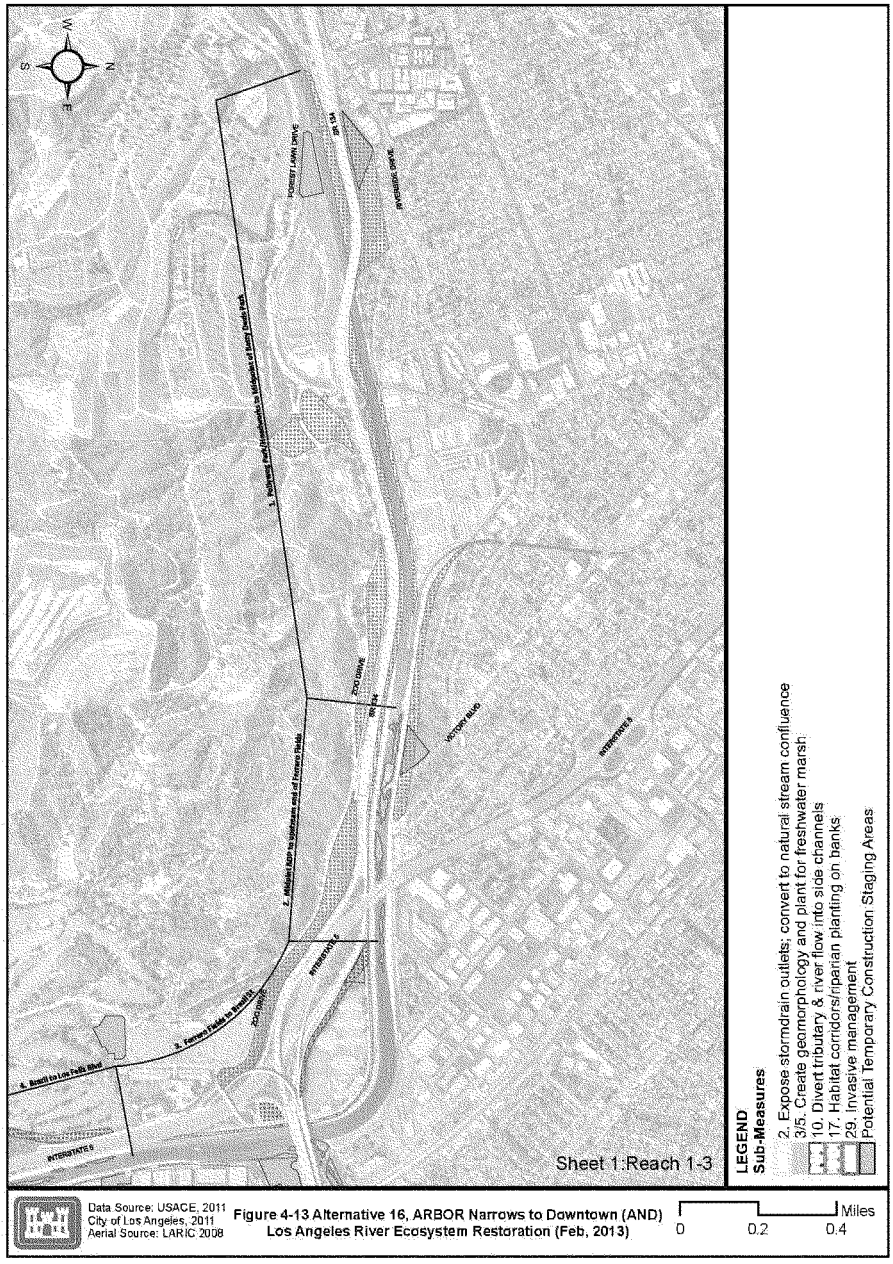
Sheet 1:Reach 1-3
LEGEND
Sub-Measures
2. Expose stormdrain outlets; convert to natural stream confluence
3/5. Create geomorphology and plant for freshwater marsh
10. Divert tributary & river flow into side channels
17. Habitat corridors/riparian planting on banks
29. Invasive management
Potential Temporary Construction Staging Areas
Data Source: USACE, 2011
City of Los Angeles, 2011
Aerial Source: LARIC 2008
Figure 4-13 Alternative 16, ARBOR Narrows to Downtown (AND)
Los Angeles River Ecosystem Restoration (Feb, 2013)
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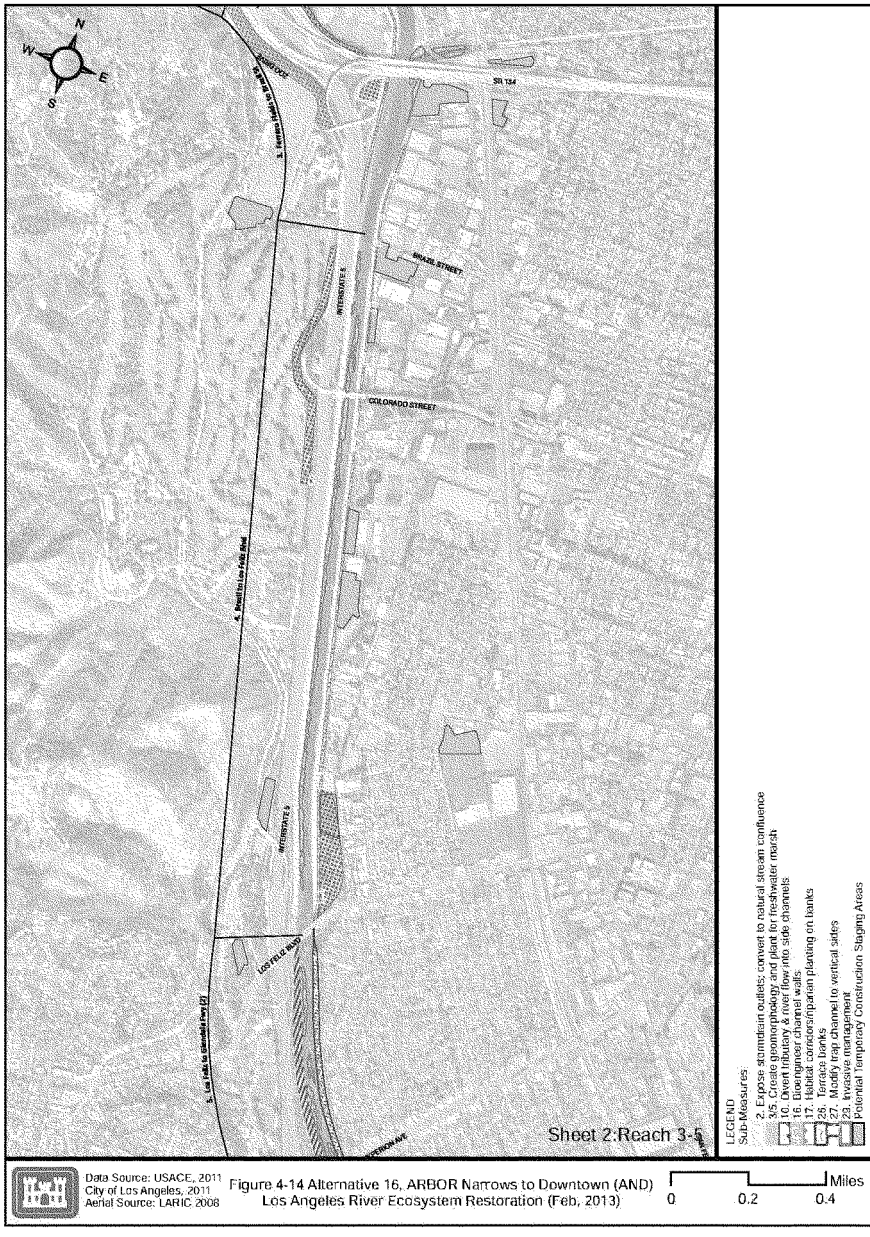
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BRAZIL STREET
INTERSTATE 5
COLORADO STREET
4. Pacific Coast Hwy
INTERSTATE 5
LOS FELIZ BLVD
5. Los Feliz to Glendale Fwy (2)
VERNON AVE
Sheet 2:Reach 3-5
LEGEND
Sub-Measures:
2. Expose stormdrain outlets; convert to natural stream confluence
15. Create grading/topology and plant for freshwater marsh
16. Divert flow to & from Rio de Los Angeles into side channels
16. Downgrade channel walls
17. Habitat corridors/riparian planting on banks
26. Terrace banks
27. Modify trap channel to vertical sides
23. Invasive management
Potential Temporary Construction Staging Areas
Data Source: USACE, 2011
City of Los Angeles, 2011
Aerial Source: LARIC 2008
Figure 4-14 Alternative 16, ARBOR Narrows to Downtown (AND)
Los Angeles River Ecosystem Restoration (Feb, 2013)
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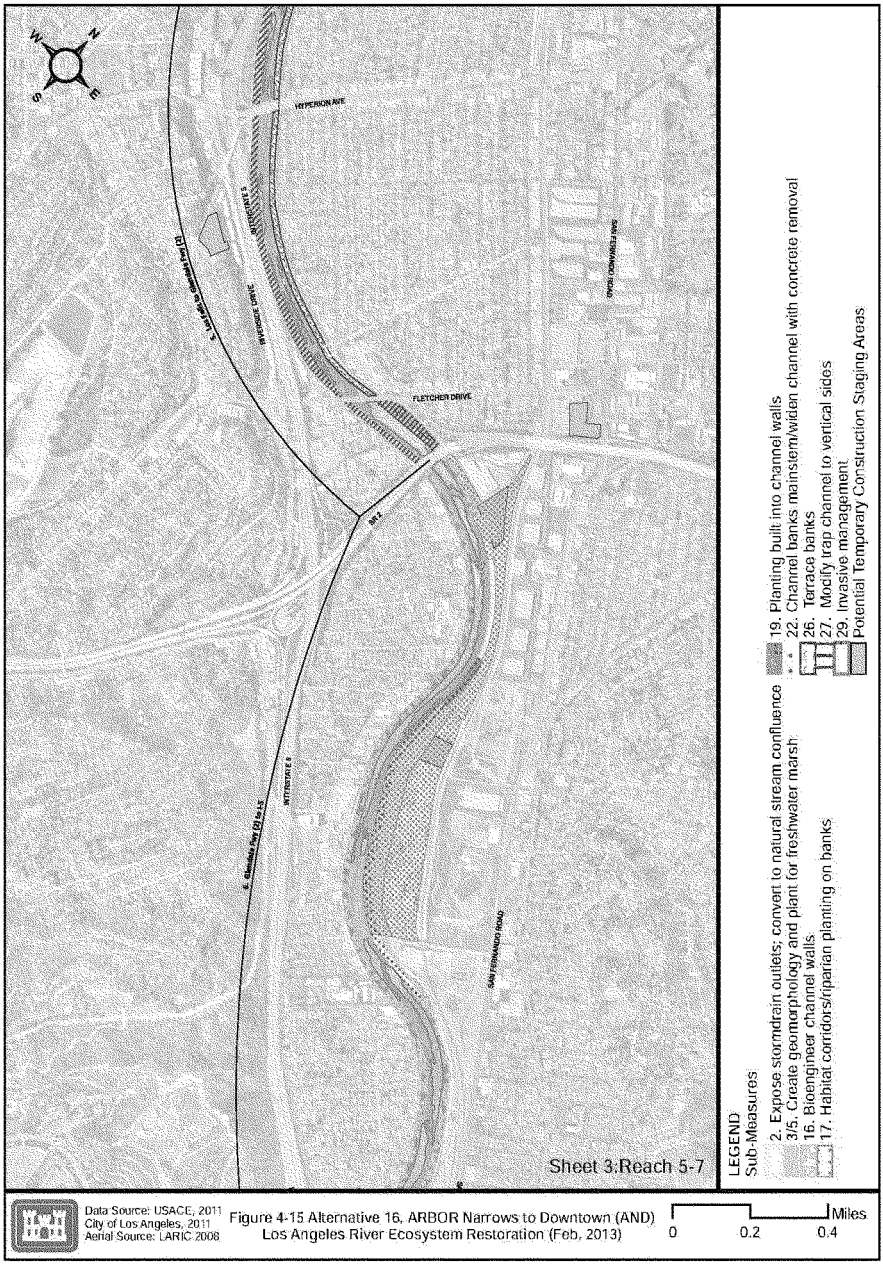
HYPERION AVE
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SAN FERNANDO ROAD
SAN FERNANDO ROAD
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I-5 SAN DIEGO FWY
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RTE 2
RTE 5
RTE 5
Sheet 3:Reach 5-7
LEGEND
Sub-Measures
2. Expose stormdrain outlets; convert to natural stream confluence
3/5. Create geomorphology and plant for freshwater marsh
16. Bioengineer channel walls
17. Habitat corridors/riparian planting on banks
19. Planting built into channel walls
22. Channel banks mainstem/widen channel with concrete removal
26. Terrace banks
27. Modify trap channel to vertical sides
29. Invasive management
Potential Temporary Construction Staging Areas
Data Source: USACE, 2011
City of Los Angeles, 2011
Aerial Source: LARIC 2008
Figure 4-15 Alternative 16, ARBOR Narrows to Downtown (AND)
Los Angeles River Ecosystem Restoration (Feb, 2013)
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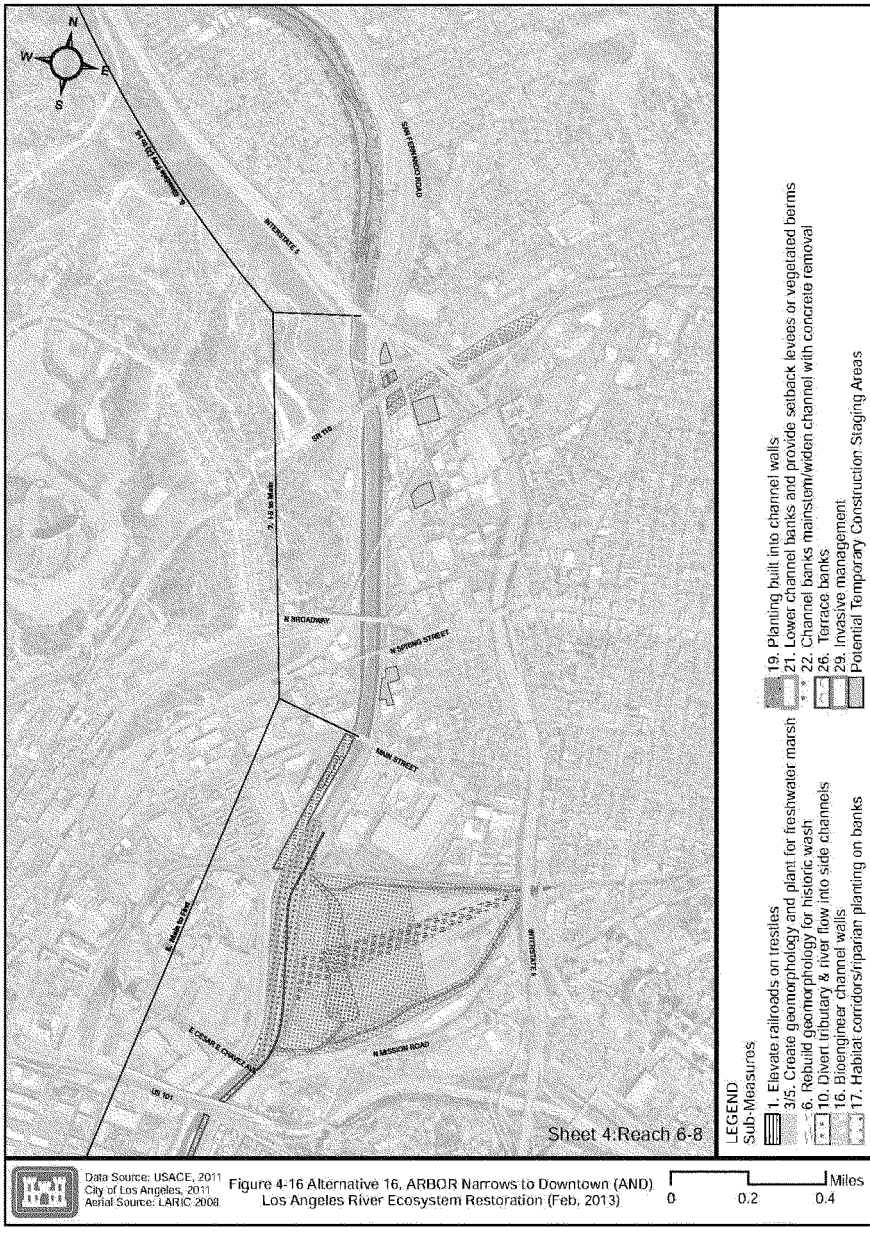
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US 101
Sheet 4:Reach 6-8
LEGEND
Sub-Measures
1. Elevate railroads on trestles
3/5. Create geomorphology and plant for freshwater marsh
6. Rebuild geomorphology for historic wash
10. Divert tributary & river flow into side channels
16. Bioengineer channel walls
17. Habitat corridors/riparian planting on banks
19. Planting built into channel walls
21. Lower channel banks and provide setback levees or vegetated berms
22. Channel banks mainstem/widen channel with concrete removal
26. Terrace banks
29. Invasive management
Potential Temporary Construction Staging Areas
Data Source: USACE, 2011
City of Los Angeles, 2011
Aerial Source: LARIC 2008
Figure 4-16 Alternative 16, ARBOR Narrows to Downtown (AND)
Los Angeles River Ecosystem Restoration (Feb, 2013)
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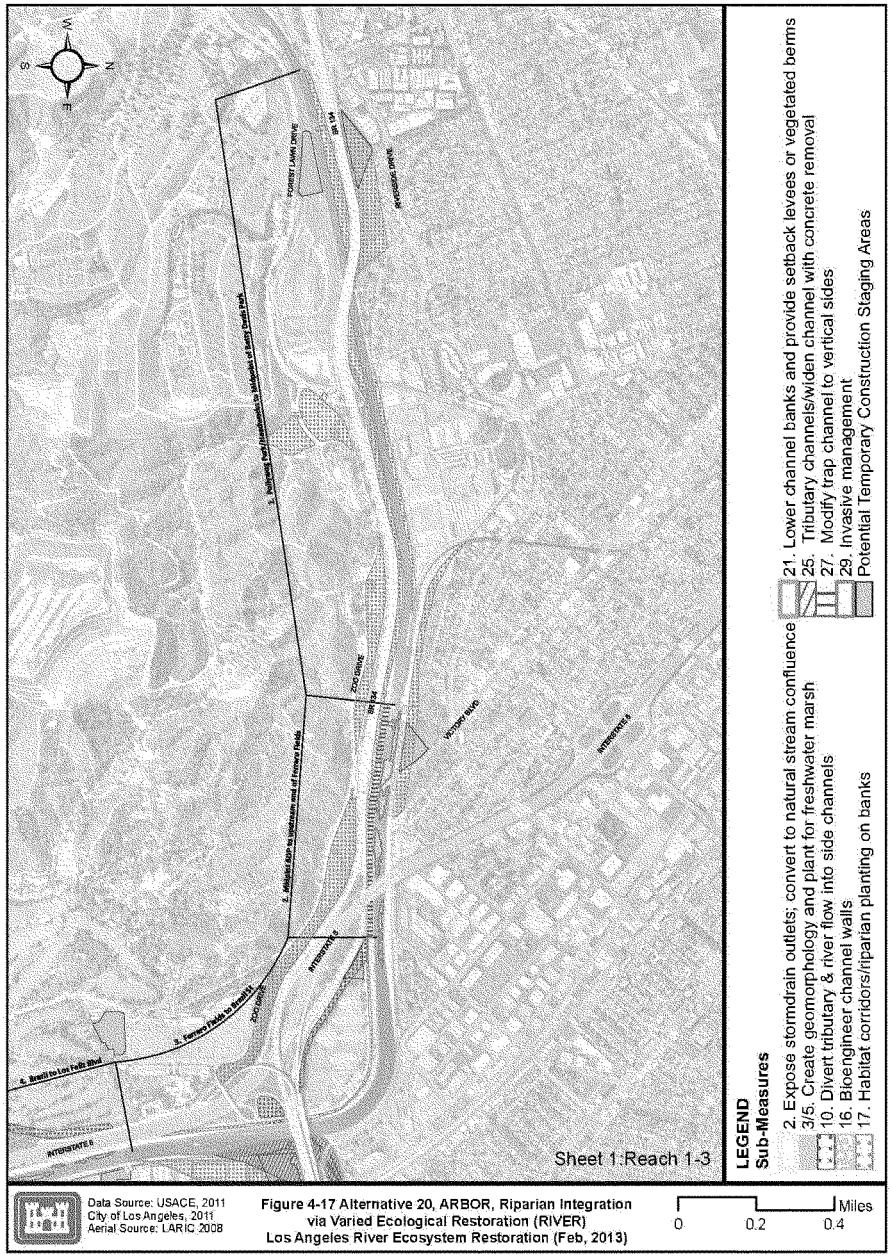
Sheet 1:Reach 1-3
LEGEND
Sub-Measures
2. Expose stormdrain outlets; convert to natural stream confluence
3/5. Create geomorphology and plant for freshwater marsh
10. Divert tributary & river flow into side channels
16. Bioengineer channel walls
17. Habitat corridors/riparian planting on banks
21. Lower channel banks and provide setback levees or vegetated berms
25. Tributary channels/widen channel with concrete removal
27. Modify trap channel to vertical sides
29. Invasive management
Potential Temporary Construction Staging Areas
Data Source: USACE, 2011
City of Los Angeles, 2011
Aerial Source: LARIC 2008
Figure 4-17 Alternative 20, ARBOR, Riparian Integration via Varied Ecological Restoration (RIVER)
Los Angeles River Ecosystem Restoration (Feb, 2013)
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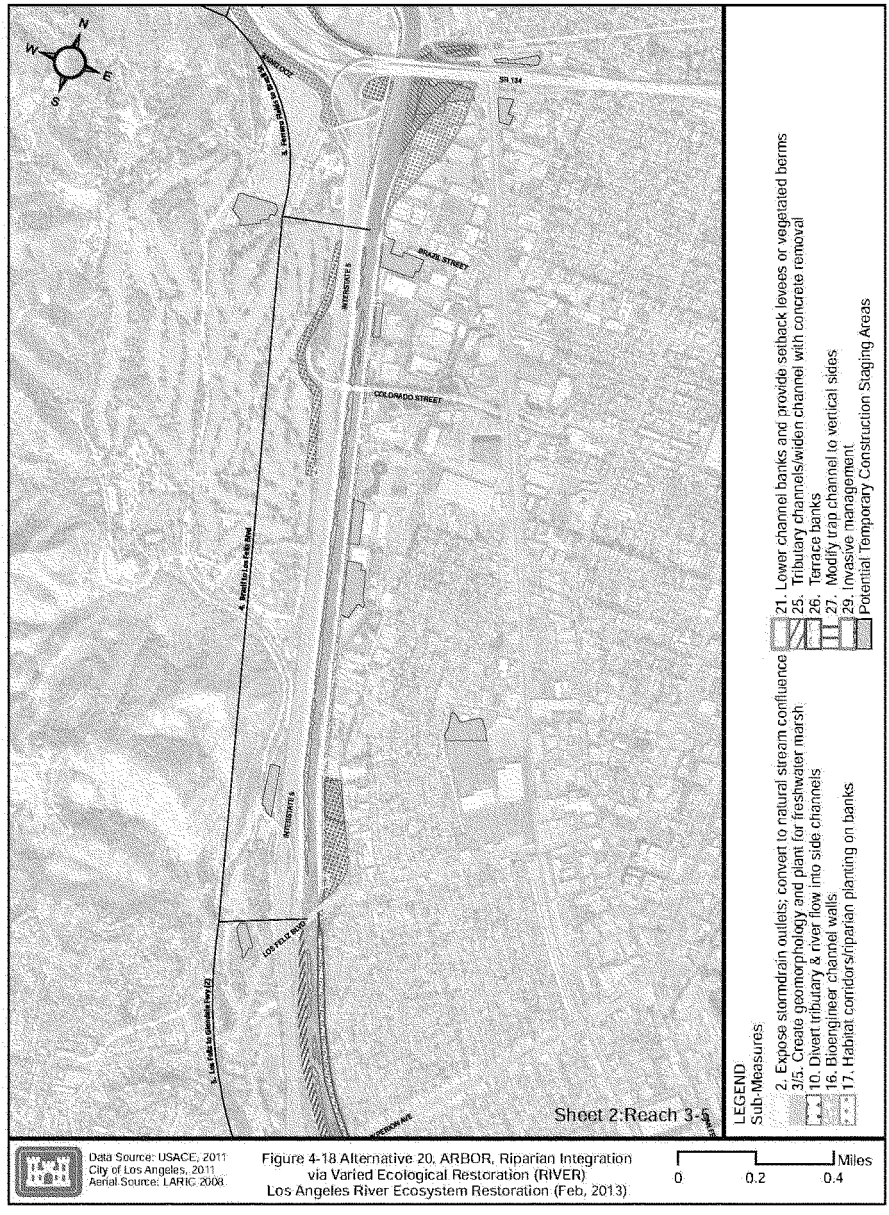

Figure 4-18 Alternative 20, ARBOR, Riparian Integration via Varied Ecological Restoration (RIVER) Los Angeles River Ecosystem Restoration (Feb, 2013)

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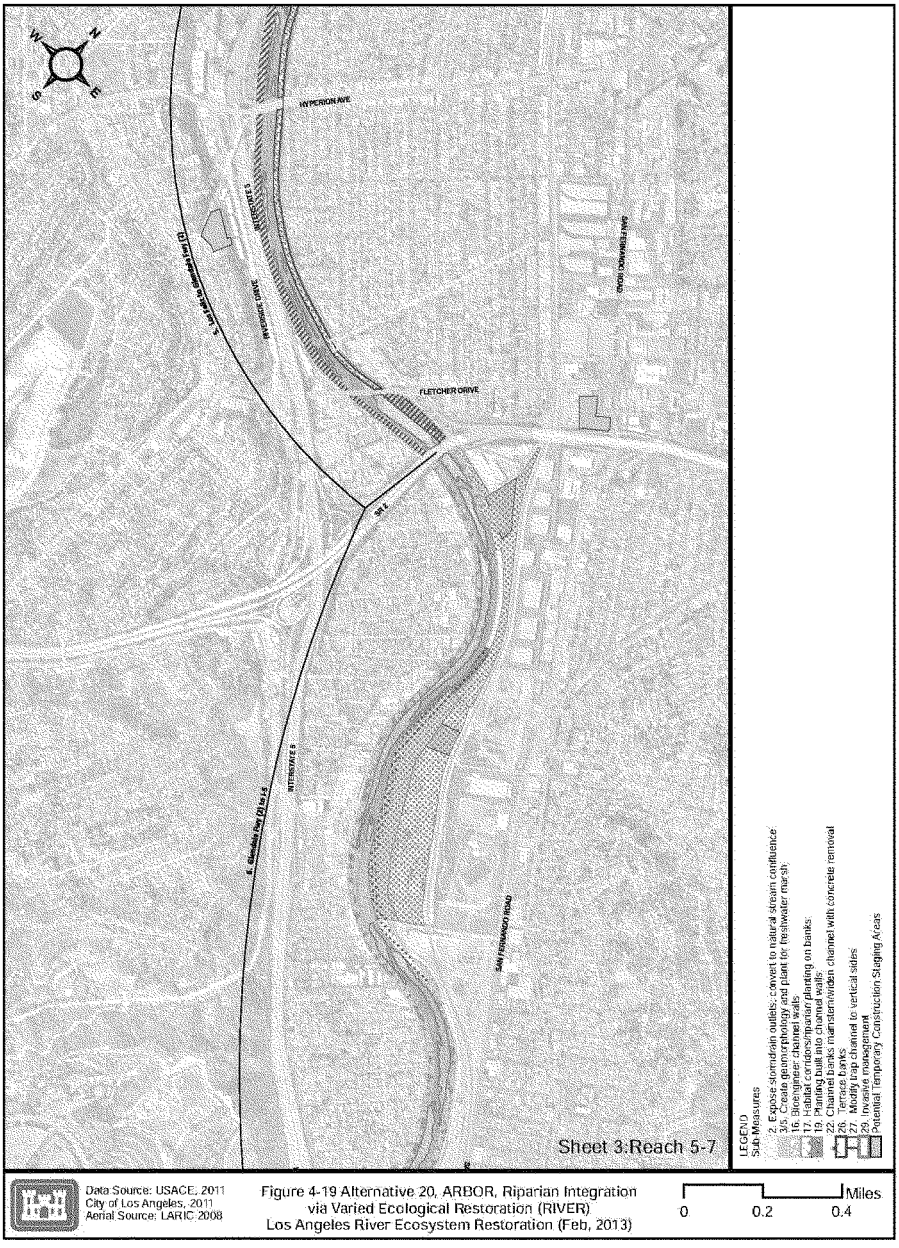
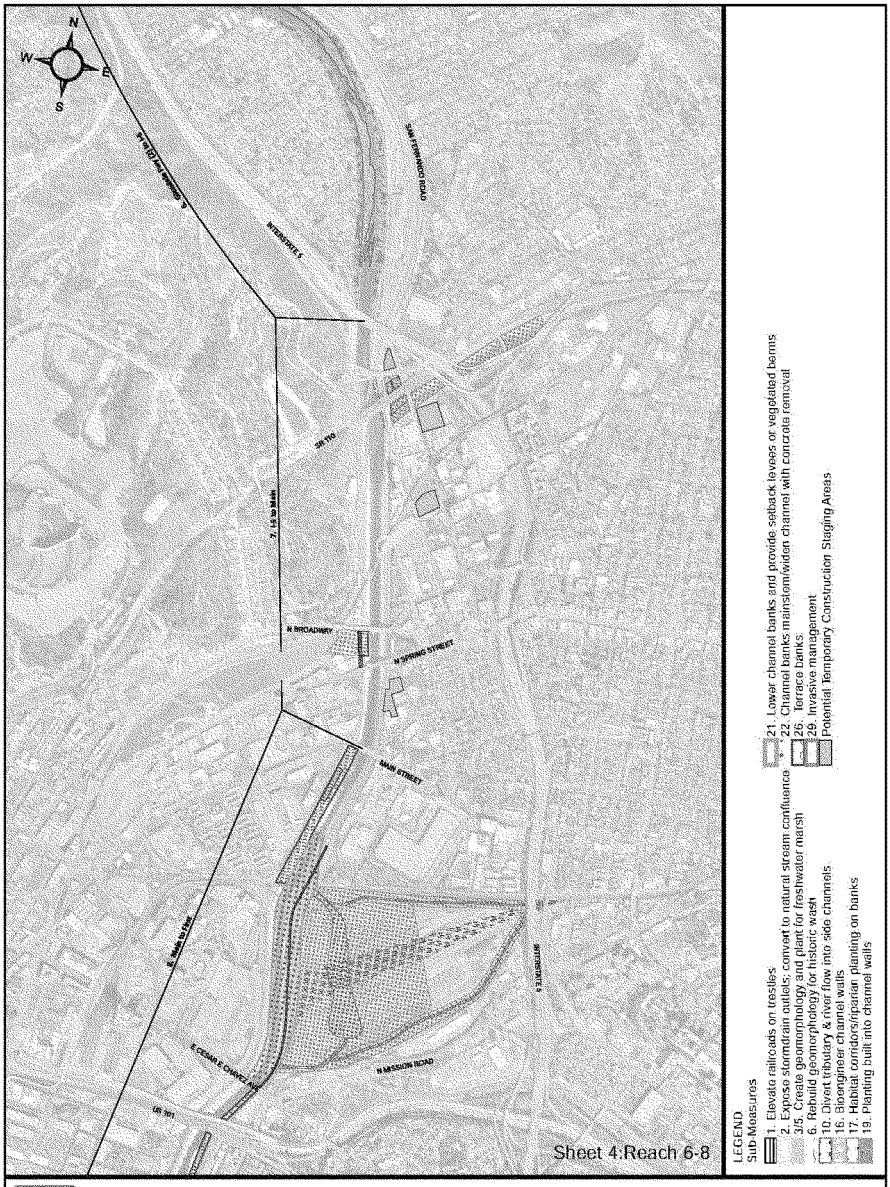


Figure 4-19 Alternative 20, ARBOR, Riparian Integration via Varied Ecological Restoration (RIVER) Los Angeles River Ecosystem Restoration (Feb, 2013)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SAN FERNANDO ROAD
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SR 170
N BROADWAY
N SPRING STREET
MAIN STREET
N MISSION ROAD
SR 101
Sheet 4:Reach 6-8
LEGEND
Sub Measures
1. Elevate railroads on trestles
2. Expose stormdrain outlets; convert to natural stream confluence
3/5. Create geomorphology and plant for freshwater marsh
6. Rebuild geomorphology for historic wash
10. Divert tributary & river flow into side channels
16. Bioengineer channel walls
17. Habitat corridors/riparian planting on banks
19. Planting built into channel walls
21. Lower channel banks and provide setback levees or vegetated berms
22. Channel banks mainstem/widen channel with concrete removal
26. Terrace banks
29. Invasive management
Potential Temporary Construction Staging Areas
Data Source: USACE, 2011
City of Los Angeles, 2011
Aerial Source: LARIC 2008
Figure 4-20 Alternative 20, ARBOR, Riparian Integration via Varied Ecological Restoration (RIVER)
Los Angeles River Ecosystem Restoration (Feb, 2013)
0
0.2
0.4
Miles

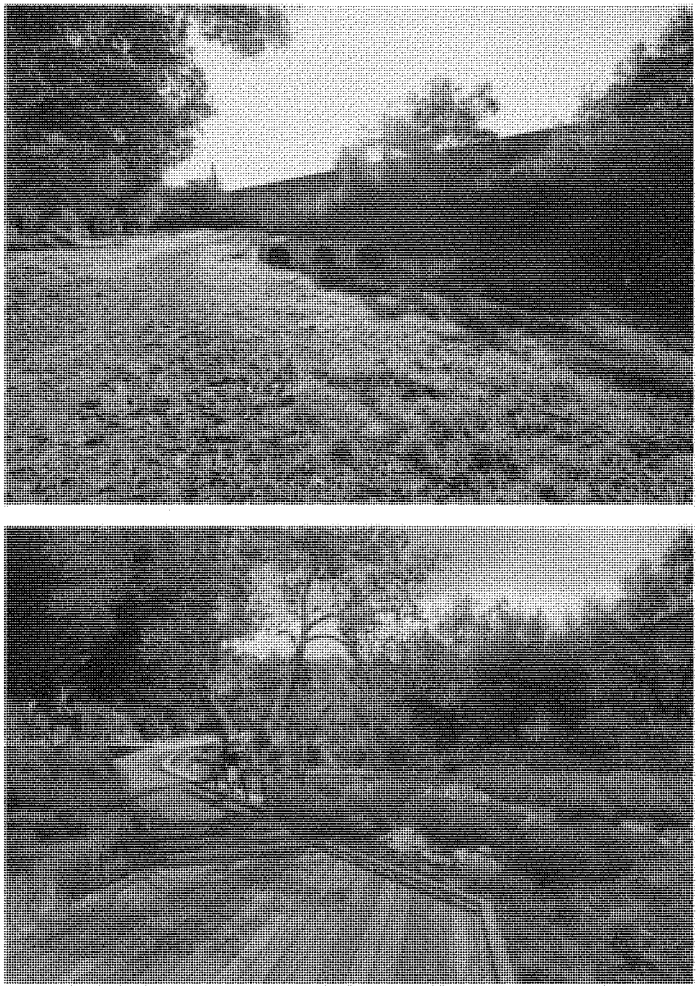

Figure 4-21 Reach 1. Pollywog Park, looking Southeast (Existing and Rendering of Proposed Restoration and Recreation Features)[7]

[7] Associated with all alternatives

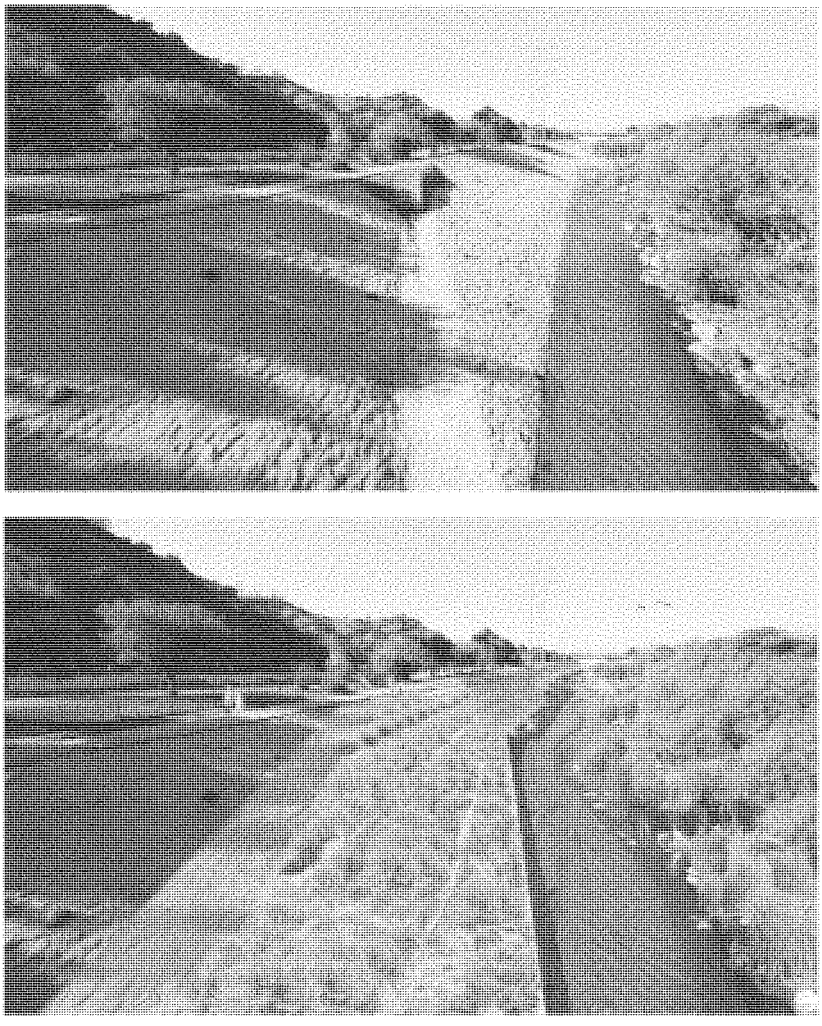

Figure 4-22 Reach 2. Looking Upstream from Riverside Drive Bridge (Existing Channel and Rendering of Proposed Terraced Banks/Vegetated Channel Walls) [8]

[8] Associated with Alternative 20

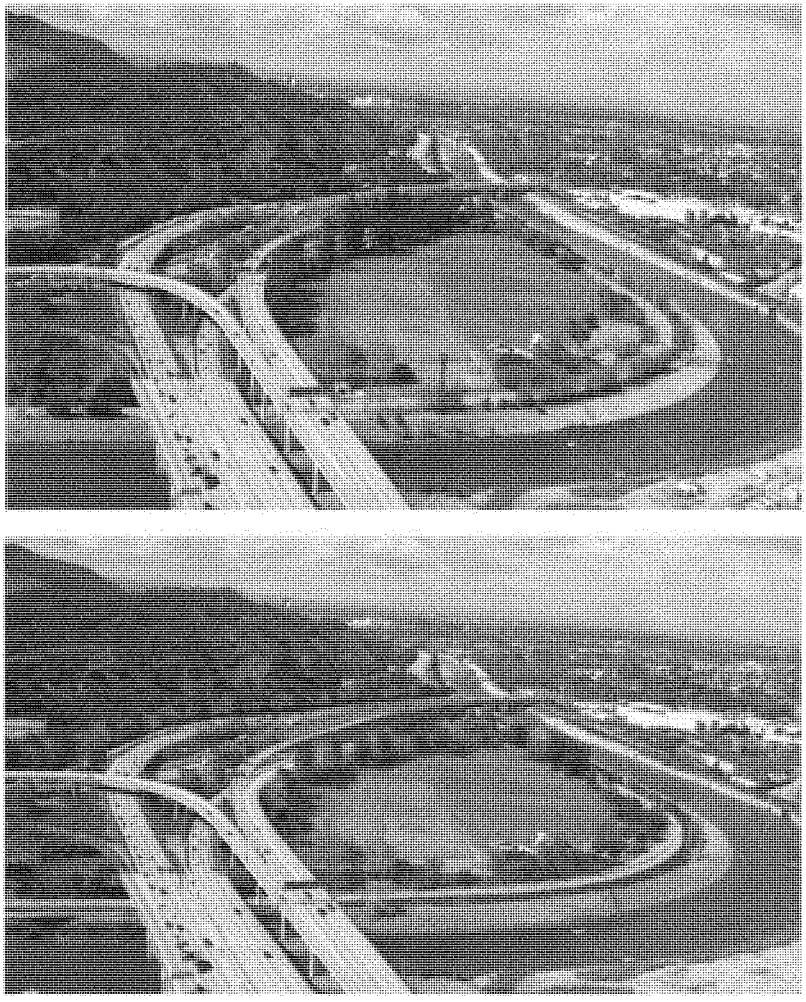

Figure 4-23 Reach 3. Ferraro Fields. Looking Westward/Upstream (Existing and Rendering of Proposed Side Channel with Daylighted Stream)[9]

[9] Associated with Alt. 13,13v,16, and 20

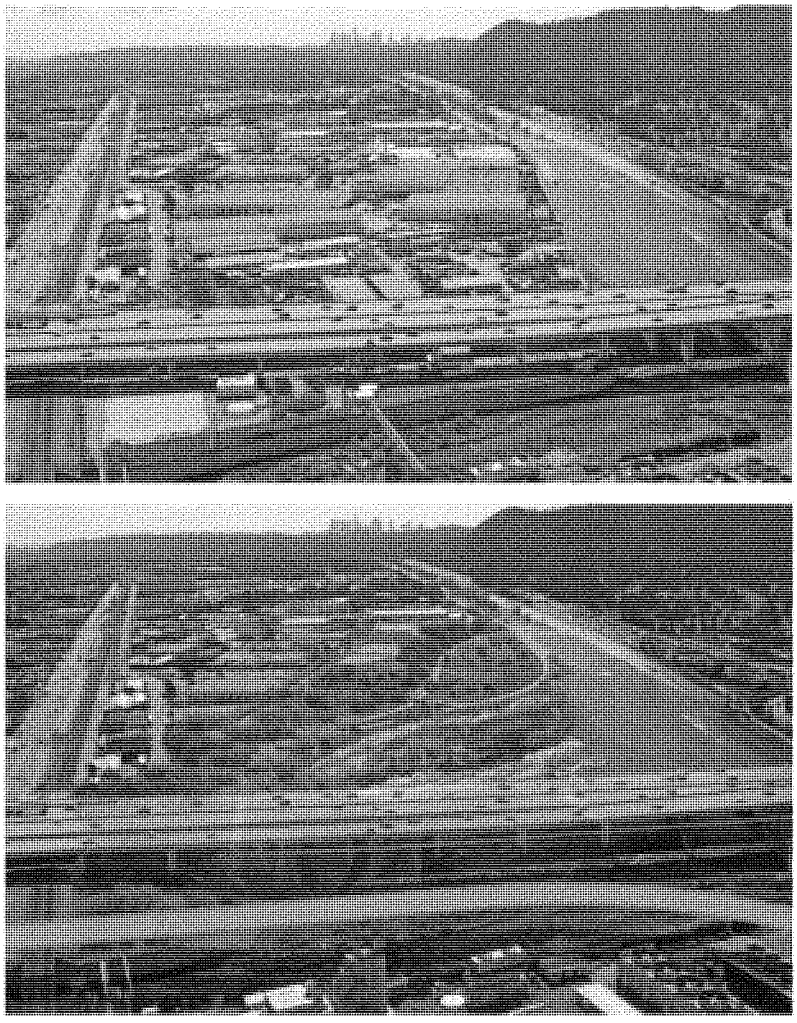

Figure 4-24 Reach 3. Verdugo Wash. Looking Downstream (Existing and Rendering of Proposed Restoration Measures)[10]

[10] Associated with Alt. 20

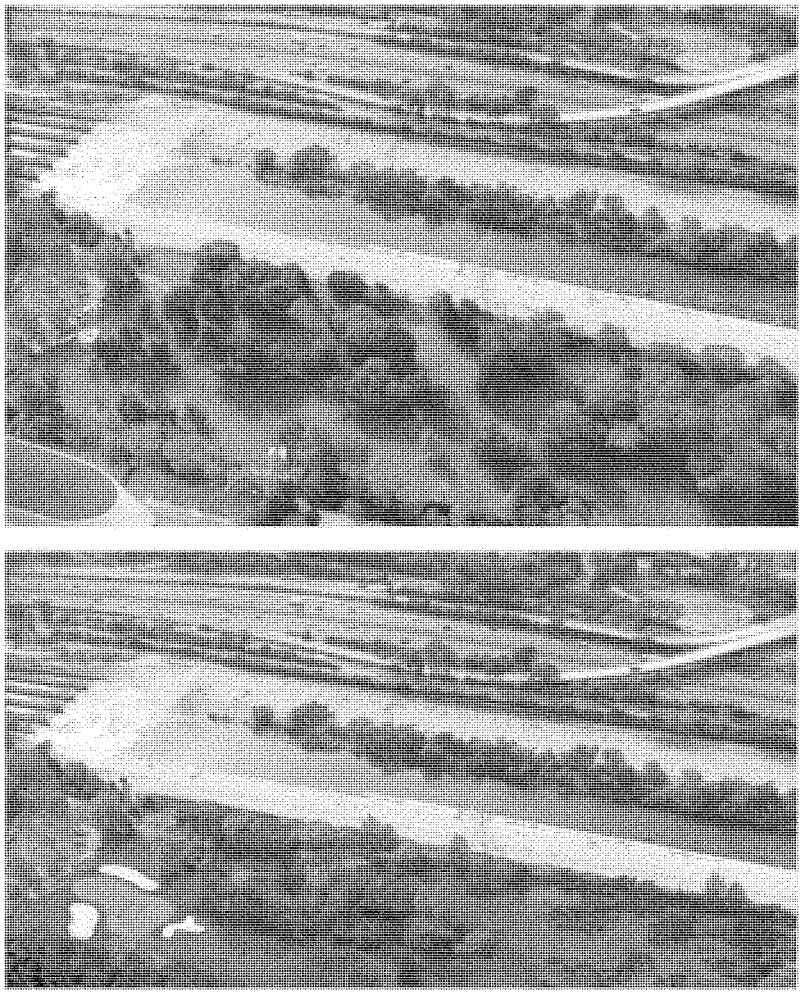

Figure 4-25 Reach 4. Los Feliz Golf Course. Looking Westward (Existing and Rendering of Proposed Restoration Measures)[11]

[11] Associated with All Alternatives

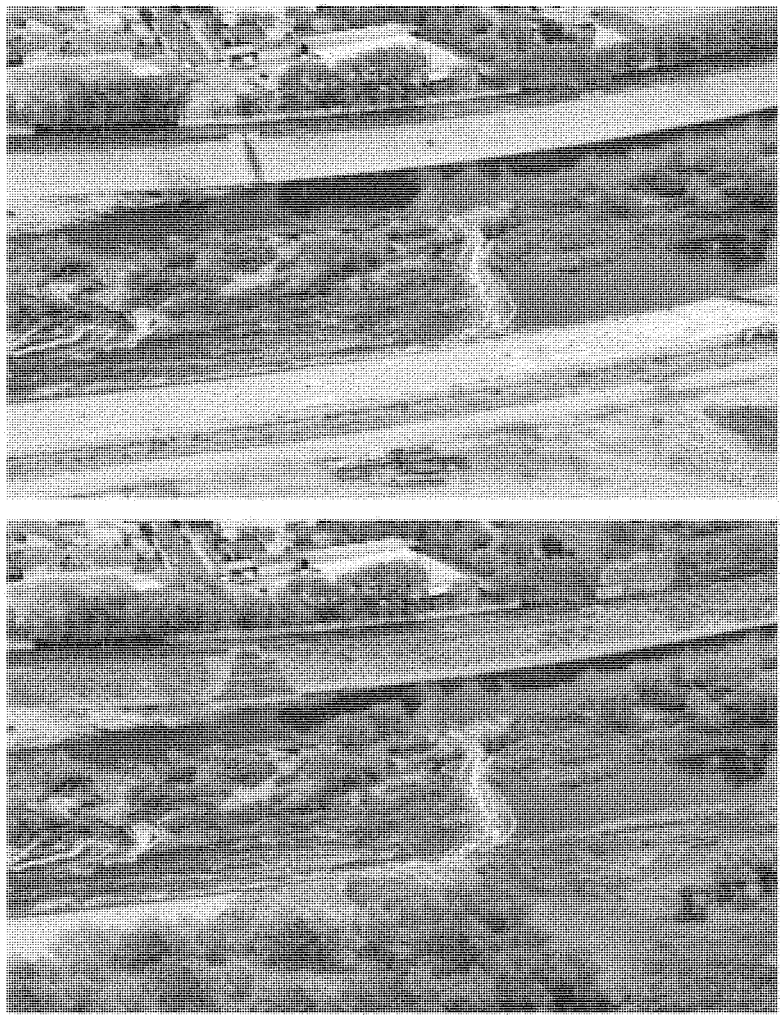

Figure 4-26 Reach 6. Looking West, with the Bowtie Parcel in the Foreground and Marsh Park in the Background (Existing Chanuel and Rendering of Proposed Daylighted Stream and Vegetated Walls)[12]

[12] Daylighted Streams and Vegetated walls associated with all Alternatives

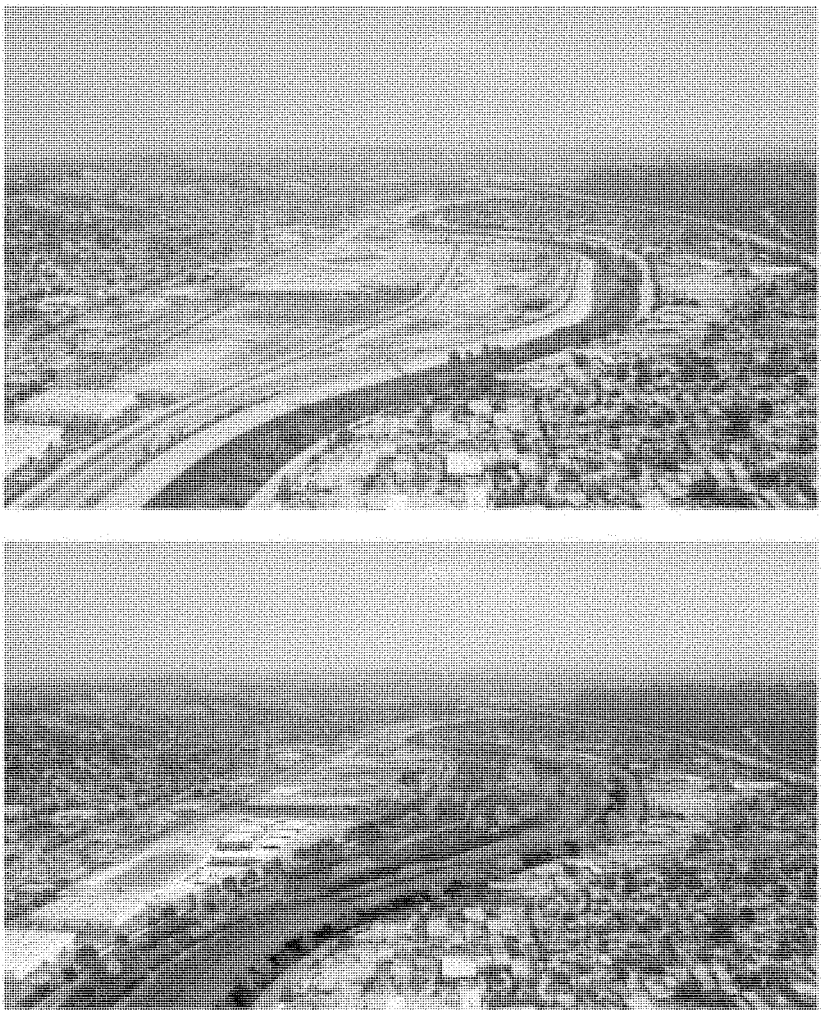

Figure 4-27 Reach 6. Taylor Yard, Looking Downstream (Existing and Rendering of Proposed Restored Reach)[13]

[13] Associated with All Alternatives

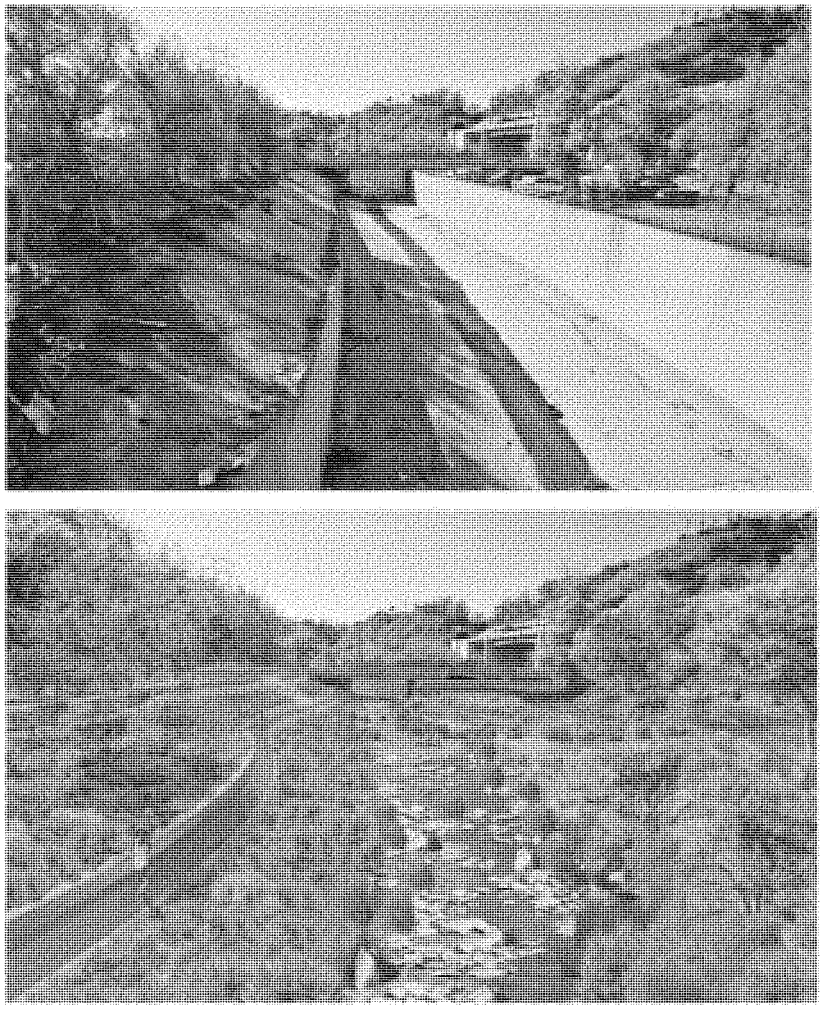

Figure 4-28 Reach 7. Arroyo Seco Channel, Looking Westward (Existing and Rendering of Proposed Restored Arroyo Seco Tributary)[14]

[14] Associated with all Alternatives

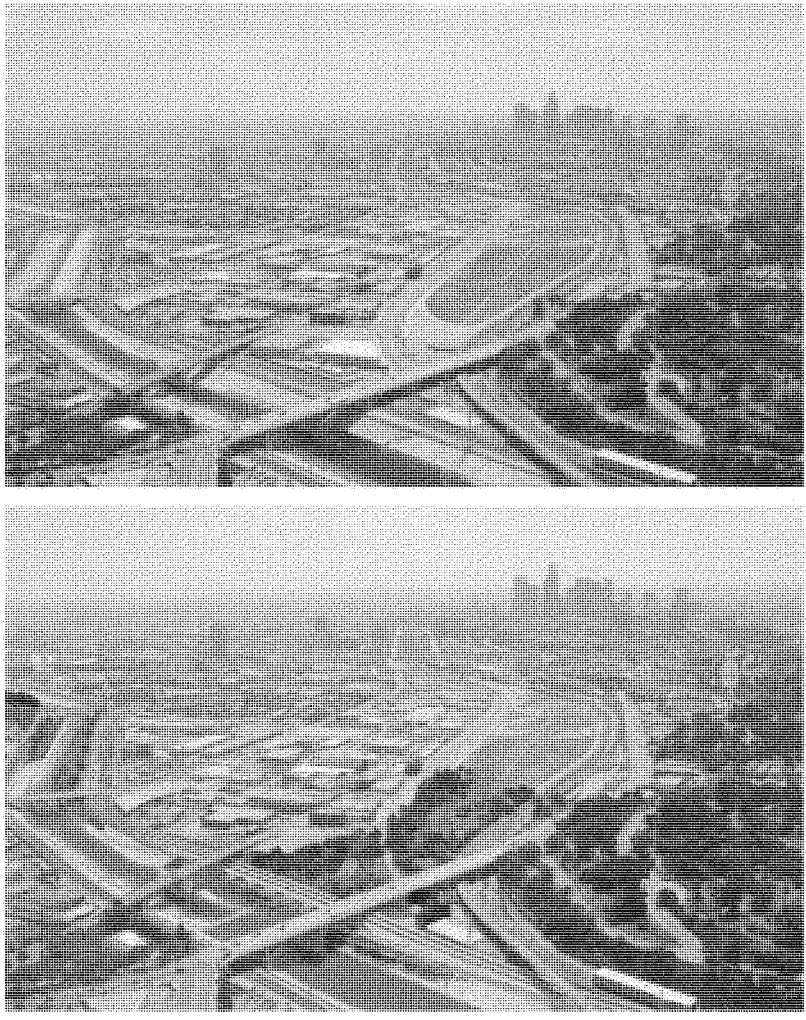

Figure 4-29 Reach 7. Cornfields, Looking Downstream (Existing and Rendering of Proposed Restoration: Measures at the River Channel and the Los Angeles State Historic Park) [15]

[15] Associated with Alt 13v & 20

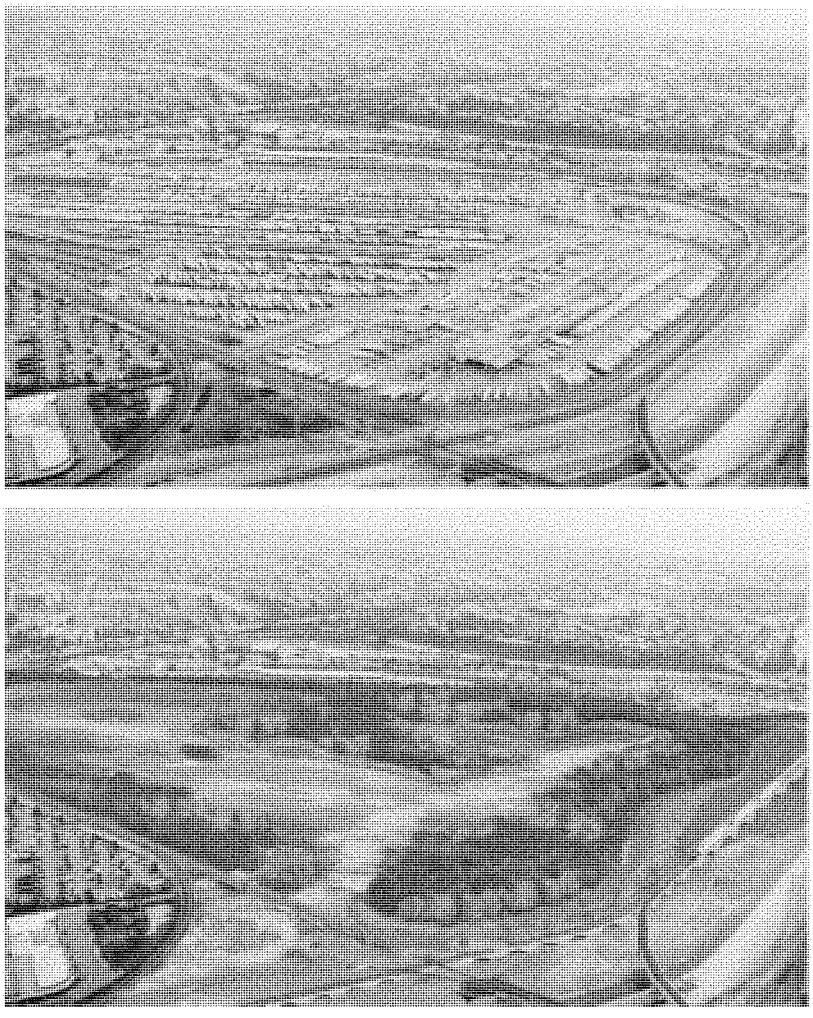

Figure 4-30 Reach 8. LATC, Looking Southeastward (Existing and Rendering of Proposed Restoration Measures)[16]

[16] Associated with Alt. 20

5 EVALUATION OF ALTERNATIVE PLANS AND ENVIRONMENTAL CONSEQUENCES

This section evaluates the environmental impacts of the no action alternative and the action alternatives. The environmental conditions for each resource are compared with future conditions for each alternative plan. Both beneficial and adverse effects are considered, including direct effects during construction and operation and indirect effects of restoration under each of the proposed alternatives along with related actions. A short description of relevant regulations is given for each resource area; additional information on specific regulations that may require permits or consultation is given in Section 10 of this report.

The basis of significance for each resource is used to evaluate the significance of any adverse effects, and measures are proposed to avoid, minimize, or mitigate any significant adverse effects for each resource. The USACE has integrated NEPA requirements into its regulations, policies, and guidance. Engineering Regulation (ER) 1105-2-100, "Planning Guidance Notebook," April 2000, provides the following for identifying significant effects:

- Significance based on institutional recognition means that the importance of the effect is acknowledged in the laws, adopted plans, and other policy statements of public agencies and private groups. Institutional recognition is often in the form of specific criteria.
- Significance based on public recognition means that some segment of the general public recognized the importance of the effect. Public recognition may take the form of controversy, support, conflict, or opposition expressed formally or informally.
- Significance based on technical recognition means that the importance of an effect is based on the technical or scientific criteria related to critical resource characteristics.

For this EIS/EIR, the NEPA analysis typically adopts the CEQA thresholds of significance stated for each resource to address significance. However, for some resources, the NEPA analysis identifies significance thresholds in addition to the CEQA thresholds. In the case of the air quality and greenhouse gas analysis, the NEPA analysis does not adopt the CEQA thresholds and instead applies separate significance criteria in accordance with the Clean Air Act. In the case of environmental justice, the NEPA analysis adopts significance criteria aligned with the Executive Order on environmental justice. In the case of cultural resources, the NEPA and CEQA analyses identify different significance criteria.

The following alternatives were analyzed in detail in the Draft IFR:

- No Action Alternative.
- Alternative 10 or ART (for ARBOR Riparian Transitions) provides restoration in all reaches and provides transitions or connections between existing riparian corridors and concrete lined river reaches.
- Alternative 13 or ACE (for ARBOR Corridor Extension) adds additional restoration in the soft bottom reaches of the Glendale Narrows, increased widening in Taylor Yard, and restoration at the Arroyo Seco confluence.
- Alternative 16 or AND (for ARBOR Narrows to Downtown) widens and adds terracing in Reach 5, and adds terracing, widening, softening of the bed and restored wetlands in LATC.
- Alternative 20 or RIVER (for Riparian Integration via Varied Ecological Reintroduction) widens Reach 2, restores the confluence with Verdugo Wash in Reach 3, and restores wetlands at the Los Angeles State Historic Park with a terraced connection to the mainstem in Reach 7.

As discussed in Chapter 4, the Draft IFR identified that alternatives within the spectrum of the final array of alternatives fully analyzed in the Draft IFR could be considered in the Final IFR. Following public review, further analysis was performed that included a more detailed cost analysis using Mii software,

real estate cost updates, and further modified contingencies based upon a full cost risk summary analysis. This analysis identified a more cost effective variation on Alternative 13 (referred to in this IFR as "Alternative 13v") that is identical to Alternative 13 except for Reach 7, where it includes the reach plan included in Alternative 20. In that Reach 7 plan, in addition to the Arroyo Seco restoration included in Alternative 13, this Alternative includes the three daylighted streams included in the reach plan for Alternative 10 and it also restores freshwater marsh at the Los Angeles State Historic Park and terraces the existing channel bank adjacent to the Los Angeles State Historic Park, where the railroad line along the overbank would be trestled at grade to facilitate the terracing. It excludes the restructuring of channel banks in the Alternative 13 plan for Reach 7.

Because the impacts analysis in the Draft IFR included all of the components of Alt 13v, no separate or additional impacts analysis is necessary. For the impacts of Alternative 13v for Reaches 1-6 and 8, see the Alternative 13 narrative analysis by resource area below. For the impacts of Alternative 13v for Reach 7, see the Alternative 20 narrative analysis by resource area below. For the analysis of air quality in Section 5.2 below, Alternative 13v is displayed separately for clarity. As discussed in Chapter 4, the recreation plan associated with 13v is the same as the recreation plan associated with 13 described in Chapter 4 and Chapter 5.9.3.

Where appropriate, descriptions of potential impacts for each alternative have been identified by geomorphic reach grouping (Reaches 1-3, 4-6, and 7-8). For other resources, impacts have been provided for individual reaches or by study area as appropriate. A summary of potential effects by alternative is shown in Table 5-1. The table has been updated to include the Alternative 13v variation. All impacts identified in the table apply to both CEQA and NEPA unless otherwise stated.

Table 5-1 Comparison of Potential Impacts

Resource	No Action Alternative	Alternative 10 (ART)	Alternative 13 (ACE)	Alternative 13v	Alternative 16 (AND)	Alternative 20 (RIVER)
GEOLOGY, SEISMOLOGY, SOILS, AND MINERALS	***Construction Impacts*** None. ***Operation Impacts*** None.	***Construction Impacts*** Soil erosion resulting from heavy equipment would be controlled through BMPs and would be temporary. Impacts would be **less than significant**. ***Operation Impacts*** Soil erosion resulting from heavy equipment necessary for operation and maintenance will be controlled through BMPs. Impacts would be **less than significant**. Beneficial impacts to operations would include the vegetation and stabilization of project area soils.	***Construction Impacts*** Potential impacted area increases from Alt 10 as do type of demolition and construction. Protection of soils would occur through BMPs and construction impacts would be temporary. Impacts would be **less than significant**. ***Operation Impacts*** Operation impacts are **less than significant**. Beneficial impacts would increase where additional riparian vegetation is established and non-native plants are removed.	***Construction Impacts*** *Impacts similar to Alt. 13 except that* potential impacted area increases from Alt 13 as does type of demolition and construction in Reach 7. Protection of soils would occur through BMPs and construction impacts would be temporary. Impacts would be **less than significant**. ***Operation Impacts*** Operation impacts are **less than significant**. Beneficial impacts would increase where additional riparian vegetation is established and **non-native** plants are removed.	***Construction Impacts*** Alt 16 construction is larger in scale and duration than Alt 10 and 13, yet employs the same methods. Protection of soils would occur through BMPs and construction impacts would be temporary. Impacts would be **less than significant**. ***Operation Impacts*** Operation impacts are **less than significant**. Beneficial impacts would increase where additional riparian vegetation is established and non-native plants are removed.	***Construction Impacts*** Alt 20 construction is larger in scale and duration than other alternatives, yet employs the same methods. Protection of soils would occur through BMPs and construction impacts would be temporary. Impacts would be **less than significant**. ***Operation Impacts*** Operation impacts are **less than significant**. Beneficial impacts would increase where additional riparian vegetation is established and non-native plants are removed.
AIR QUALITY AND GREENHOUSE GASES	***Construction Impacts*** None. ***Operation Impacts*** Emissions associated with existing operational practices and daily visitations to the project area would remain largely unchanged.	***Construction Impacts***: Estimated construction emissions would not exceed General Conformity de Minimis Thresholds (NEPA) or Regional Significance Thresholds (NEPA & CEQA). Emissions for NOx would exceed Localized Significance Thresholds (CEQA) during construction in 2018 and 2019. Emissions of greenhouse gasses would not exceed the CEQA significance thresholds. **Impacts would be less than siguificant under NEPA. Due to exceedance of Localized Significance Thresholds (CEQA), impacts under CEQA would be significant and unavoidable.** ***Operation Impacts***: Estimated operation impacts including maintenance and increased daily visitations would not exceed General Conformity de Minimis Thresholds (NEPA), Regional Significance Thresholds (NEPA & CEQA), or Localized Significance Thresholds (CEQA). Emissions of greenhouse gasses would not exceed the CEQA significance thresholds. **Impacts would be less than significant under NEPA and CEQA.**	***Construction Impacts***: Estimated construction emissions would not exceed General Conformity de Minimis Thresholds (NEPA) or Regional Significance Thresholds (NEPA & CEQA). Emissions for NOx would exceed Localized Significance Thresholds (CEQA) during construction in 2018 and 2019. Emissions of greenhouse gasses would not exceed the CEQA significance thresholds. **Impacts would be less than significant under NEPA. Due to exceedauce of Localized Significance Thresholds (CEQA), impacts under CEQA would be significant and unavoidable.** ***Operation Impacts***: Same as Alternative 10.	***Construction Impacts***: Estimated construction emissions would not exceed General Conformity de Minimis Thresholds (NEPA), Regional Significance Thresholds (NEPA & CEQA), or Localized Significance Thresholds (CEQA). **Impacts would be less than significant under NEPA & CEQA.** ***Operation Impacts***: Same as Alternative 10.	***Construction Impacts***: Estimated construction emissions would not exceed General Conformity de Minimis Thresholds (NEPA) or Regional Significance Thresholds (NEPA & CEQA). Emissions for NOx would exceed Localized Significance Thresholds (CEQA) during construction in 2020, 2022, and 2023. Emissions of greenhouse gasses would not exceed the CEQA significance thresholds. **Impacts would be less than significant under NEPA. Due to exceedance of Localized Significance Thresholds (CEQA), impacts under CEQA would be significant and unavoidable.** ***Operation Impacts***: Same as Alternative 10.	***Construction Impacts***: Estimated construction emissions would not exceed General Conformity de Minimis Thresholds (NEPA) or Regional Significance Thresholds (NEPA & CEQA). Emissions for NOx would exceed Localized Significance Thresholds (CEQA) during construction in 2022, 2023, and 2024. Emissions of greenhouse gasses would not exceed the CEQA significance thresholds. **Impacts would be less than significant under NEPA. Due to exceedance of Localized Significance Thresholds (CEQA), impacts under CEQA would be significant and unavoidable.** ***Operation Impacts***: Same as Alternative 10.
LAND USE	***Construction Impacts*** None. ***Operation Impacts*** There would be no change in operations or operational impacts. Improved land use conditions adjacent to the river would not	***Construction Impacts*** Restoration in Reach 8 would conflict with the Industrial and Light Industrial land use designation, as well as specific goals and policies concerning industrial land uses in local plans. **This would result in a significant adverse impact under NEPA and and a significant and unavoidable impact under CEQA.** ***Operation Impacts*** Significant impacts associated with changes in land use would be permanent and will continue during operation.	***Construction Impacts*** Same as Alt 10. **This would result in a significant adverse impact under NEPA and a significant and unavoidable impact under CEQA.** ***Operation Impacts*** Significant impacts associated with changes in land use would be permanent and will continue during operation.	***Construction Impacts*** Same as Alt 10. **This would result in a significant adverse impact under NEPA and a significant and unavoidable impact under CEQA** ***Operation Impacts*** Significant impacts associated with changes in land use would be permanent and will continue during operation.	***Construction Impacts*** Same as Alt 10. In addition Reach 3 conflicts with industrial land use designation **would result in a significant adverse impact under NEPA and a significant and uuavoidable impact under CEQA** ***Operation Impacts*** Significant impacts associated with changes in land use would be permanent and will continue during operation.	***Construction Impacts*** Same as Alt 10. In addition, Reach 3 and Reach 7 conflict with industrial land nse designations which **would result in a significant adverse impact under NEPA and a significant and unavoidable impact under CEQA** ***Operation Impacts*** Significant impacts associated with changes in land use would be permanent and will continue during operation.

Table 5-1 Comparison of Potential Impacts

Resource	No Action Alternative	Alternative 10 (ART)	Alternative 13 (ACE)	Alternative 13v	Alternative 16 (AND)	Alternative 20 (RIVER)
	occur.					
WATER RESOURCES	*Construction Impacts* None. *Operation Impacts* No adverse impacts. Benefits to water quality and quantity would not occur.	***Construction Impacts*** Potential temporary impacts to surface water quality could include contamination by erosion, release of grease or oils, and resuspension of sediment. BMPs would be implemented and construction would be temporary. Impacts would be **less than significant**. Restoration measures are designed to not impair flood risk management functions. Base flows supportive of beneficial uses, which protect aquatic life and human uses, may be temporarily affected in the immediate construction zone, but would not be affected upstream or downstream of the study area. ***Operation Impacts*** No adverse impacts from operation/maintenance measures. **Beneficial impacts** would result from increased pervious surfaces for infiltration, attenuation of flood waters from side channels, and decreased flows resulting from increased use in habitat functions. Incidental benefits would occur from removal of impervious surfaces and through physical and biological pollutant removal mechanisms when riverine habitat is established.	***Construction Impacts*** Same as Alternative 10, though covering a greater footprint. BMPs would be implemented and construction would be temporary. Impacts would be **less than significant**. ***Operation Impacts*** Under Alternative 13 operation impacts to hydrologic features, water quality, and groundwater resources would be **beneficial** and would be similar to those found under Alternative 10, but over a larger area.	***Construction Impacts*** Same as Alternative 13, although the footprint in Reach 7 is slightly smaller in the channel and includes 10 acres of wetland restoration at the State Park, temporary impacts to Waters would be slightly increased over Alt 13. BMPs would be implemented and construction would be temporary. Impacts would be **less than significant**. ***Operation Impacts*** Under Alternative 13 operation impacts to hydrologic features, water quality, and groundwater resources would be **beneficial** and would be similar to those found under Alternative 13.	***Construction Impacts*** Same as Alternative 13, though covering a greater footprint. BMPs would be implemented and construction would be temporary. Impacts would be **less than significant**. ***Operation Impacts*** Operation impacts to hydrologic features, water quality, and groundwater resources would be **beneficial** and would be similar to those found under Alternative 10 and 13, but over a larger area than 13.	***Construction Impacts*** Same as Alternative 16, though covering a greater footprint. BMPs would be implemented and construction would be temporary. Impacts would be **less than significant**. ***Operation Impacts*** Operation impacts to hydrologic features, water quality, and groundwater resources would be **beneficial** and would be similar to those found under Alternative 10, 13, and 16, but over a larger area than any other alternative.
BIOLOGICAL RESOURCES	*Construction Impacts* None. *Operation Impacts* No adverse impacts. No new riparian, marsh, side channel or other habitat would be created and no *benefits* would be realized for fish and wildlife assemblages in the study area.	***Construction Impacts*** The effects of constructing riparian habitat corridors could include temporary air and noise pollution, which could disturb nesting, breeding, or fledging populations of wildlife; temporary sediment runoff into the River, which could impair habitat quality for fish and other aquatic creatures; and temporary increased potential for infestation of invasive plant species. Temporary construction, ability of species to move into other areas, revegetation of disturbed areas, and the already degraded biological conditions result in **less than significant impacts**. ***Operation Impacts*** Operation and maintenance activities will be managed to ensure impacts would be **less than significant; and that beneficial impacts will occur**. Following completion of restoration, the improved size and quality of habitat will be a significant beneficial impact to biological resources. Increased native riparian, wetland, and in channel habitats will benefit fish and wildlife. Greater connectivity of habitats and wildlife corridors will allow increased wildlife movement through the study area and into adjacent habitat areas.	***Construction Impacts*** Same as Alt 10, though covering a larger footprint. All construction impacts would be temporary and would ultimately result in improved aquatic and terrestrial conditions, making certain any potential adverse impacts would be **less than significant**. ***Operation Impacts*** Same as Alt 10 though larger areas would be subject to operation and maintenance activities. This alternative would have **greater beneficial impacts** over the life of its operation than Alternative 10, since additional habitat would be restored.	***Construction Impacts*** Same as Alt 13 though covering a larger footprint in Reach 7. All construction impacts would be temporary and would ultimately result in improved aquatic and terrestrial conditions, making certain any potential adverse impacts would be **less than significant**. ***Operation Impacts*** Same as Alt 10 though larger areas would be subject to operation and maintenance activities. This alternative would have **greater beneficial impacts** over the life of its operation than Alternative 13, since additional habitat would be restored in Reach 7.	***Construction Impacts*** Despite the increasing footprint, impacts will remain **less than significant** for the same reasons detailed for Alt 10. ***Operation Impacts*** Same as Alt 10 though larger areas would be subject to operation and maintenance activities. **Benefits to biological resources would incrementally increase from Alt 13** due to the larger restoration footprint.	***Construction Impacts*** Construction impacts for this alternative would be the similar to those described for Alternatives10, 13, and 16 (**less than significant**), although the area involved and amount of earthwork needed would increase. ***Operation Impacts*** Same as Alt 10 though larger areas would be subject to operation and maintenance activities. **Benefits to biological resources would incrementally increase from Alt 16** due to the larger restoration footprint.
CULTURAL RESOURCES	*Construction Impacts* No adverse impacts. Beneficial impacts associated with the locating, cataloguing, and protecting of	***Construction Impacts*** Impacts to cultural resources include likely adverse effects and or adverse changes to the river control structures along the Los Angeles River; potential adverse effects and/or adverse changes to archaeological resources through ground disturbance; and the possibility of adverse effects to currently unknown historic pproperties/historic resources that may be identified by future cultural resource investigations conducted early in PED. By completing the process outlined in the PA to avoid, minimize,	***Construction Impacts*** Same as Alt 10. ***Operation Impacts*** Same as Alt 10.	***Construction Impacts*** Same as Alt 10. ***Operation Impacts*** Same as Alt 10.	***Construction Impacts*** Impacts under this alternative would be the same as Alternative 10; however, additional acreage at the Los Angeles State Historic Park may increase the likelihood of adverse effects/adverse changes. By completing the process outlined in the PA to avoid, minimize, and	***Construction Impacts*** Impacts under this alternative would be the same as Alternative 10; however, additional acreage *at* Verdugo Wash and the Los Angeles State Historic Park may increase the likelihood of adverse effects/adverse changes. By completing the process outlined in the PA to avoid, minimize, and

Table 5-1 Comparison of Potential Impacts

Resource	No Action Alternative	Alternative 10 (ART)	Alternative 13 (ACE)	Alternative 13v	Alternative 16 (AND)	Alternative 20 (RIVER)
	cultural resources would not occur. *Operation Impacts* No adverse impacts.	and mitigate any adverse effects and by implementing the BMPs, it is anticipated that the adverse effects/adverse changes will be **less than significant.** *Operation Impacts* Operation and maintenance activities typically do not involve extensive ground disturbance, though further protection would be afforded if it were necessary under Section 106 and proper protocols. We anticipate less than significant impacts.			mitigate any adverse effects and by implementing the BMPs, it is anticipated that the adverse effects/adverse changes will be **less than significant** *Operation Impacts* Same as Alt 10.	mitigate any adverse effects and by implementing the BMPs, it is anticipated that the adverse effects/adverse changes will be **less than significant.** *Operation Impacts* Same as Alt 10.
TRAFFIC AND CIRCULATION	*Construction Impacts* None. *Operation Impacts* No adverse impacts. Benefits to pedestrian, bicycle, and equestrian traffic through the study area would not occur.	***Construction Impacts*** Construction activities would occur over a period of 9 years. For all alternatives, a construction traffic management plan would be prepared and submitted to LADOT for review and approval prior to project implementation to ensure impacts to railroads, bike lanes, and roadways are minimized. A traffic management plan, traffic control plan, and appropriate BMPs would be implemented. Closures and diversions would be temporary. LATC capacity would be removed but replaced elsewhere in the Los Angeles Basin. Impacts would be **less than significant**. ***Operation Impacts*** The project would not alter the existing roadway network, introduce new hazards, change the roadway capacity or negatively impact emergency access. The project would indirectly result in vehicle trips to area roads because it would make portions of the River a recreational destination, but these trips would be unlikely affect the performance of the roadway network. Impacts will be **less than significant**. Improved appearance and access would provide benefits to non-motorized trail users.	***Construction Impacts*** Construction activities would occur over a period of 10 years, but for the same reasons noted in Alt 10. Impacts would be **less than significant.** ***Operation Impacts*** Operational impacts on traffic and transportation would be similar to those described for Alternative 10.	***Construction Impacts*** Construction activities would occur over a period of 10 years, with slightly more worker commute trips than Alt 13 for construction in Reach 7. Rail line in Reach 7 would be trestle at grade. Impacts would be **less than significant.** ***Operation Impacts*** Operational impacts on traffic and transportation would be similar to those described for Alternative 13.	***Construction Impacts*** Construction activities would occur over a period of 15 years and the number of daily worker commute trips would be approximately three times as many as for Alt 13. Rail line in Reach 8 would be trestle at grade. Impacts would be **less than significant**. ***Operation Impacts*** Operational impacts on traffic and transportation would be similar to those described for Alternative 10 and 13.	***Construction Impacts*** Construction activities would occur over a period of 15 years and the number of daily worker commute trips would be higher than for all other alternatives. Rail lines in Reach 7 and 8 would be trestle at grade. Impacts would be **less than significant**. ***Operation Impacts*** Operational impacts on traffic and transportation would be similar to those described for Alternative 10, 13 and 16.
NOISE	*Construction Impacts* None. *Operation Impacts* None.	**Construction Impacts** Construction at Reaches 5 and 6 would temporarily increase noise levels near residential structures. Impacts would be **less than significant** with incorporation of best management practices and avoidance measures. Construction at Reaches 1-4 and Reaches 7-8 would not result in significant noise impacts. ***Operation Impacts*** Occasional use of heavy trucks and machinery may be necessary during routine operations and maintenance activities. Noise impacts would be periodic and temporary. Best management practices would be implemented. Impacts would be less than significant.	***Construction Impacts*** Overall duration of construction would be longer than Alt 10. Impacts in Reaches 5-6 would be similar to Alt 10. Impacts would be **less than significant** with incorporation of best management practices and avoidance measures. Construction at Reaches 1-4 and Reaches 7-8 would not result in significant noise impacts. ***Operation Impacts*** Same as Alt 10.	***Construction Impacts*** Overall duration of construction would be longer than Alt 13. Construction at Reaches 5 and 6 would temporarily increase noise levels near residential structures. Impacts would be **less than significant** with incorporation of best management practices and avoidance measures. Construction at Reaches 1-4 and Reaches 7-8 would not result in significant noise impacts. ***Operation Impacts*** Same as Alt 13	***Construction Impacts*** Overall duration of construction would be longer than Alt 13. Construction at Reaches 5 and 6 would temporarily increase noise levels near residential structures. Impacts would be **less than significant** with incorporation of best management practices and avoidance measures. Construction at Reaches 1-4 and Reaches 7-8 would not result in significant noise impacts. ***Operation Impacts*** Same as Alt 10.	***Construction Impacts*** Overall duration of construction would be longer than Alt 16. Construction at Reaches 5 and 6 would temporarily increase noise levels near residential structures. Impacts would be **less than significant** with incorporation of best management practices and avoidance measures. Construction at Reaches 1-4 and Reaches 7-8 would not result in significant noise impacts. ***Operation Impacts*** Same as Alt 10.
RECREATION	*Construction Impacts* None. *Operation Impacts* No adverse impacts. Benefits to recreation access would not	***Construction Impacts*** During construction, potential adverse impacts will result from temporary or partial closure or relocation of trail systems, access points, bridges, or crossings along the River and golf courses. Temporary increases in noise and air pollution in the vicinity of construction may degrade the recreation experience at adjacent facilities. These effects may temporarily impact activities such as walking/jogging, cycling, equestrian, and bird watching. Impacts would be minor and temporary. Impacts are	***Construction Impacts*** **Less than significant,** temporary adverse effects would be similar to Alternative 10 with the addition of potential access impacts for playing fields at Ferraro Fields. ***Operation Impacts*** Additional beneficial effects to recreational	***Construction Impacts*** **Less than significant,** temporary adverse effects would be similar to Alternative 13 with the addition of temporary impacts to access to construction area at Los Angeles State Historic Park. ***Operation Impacts*** Additional	***Construction Impacts*** **Less than significant,** temporary adverse recreation and public access effects during the construction period would be similar to those described for Alternative 13. ***Operation Impacts*** Potential benefits to recreation may be	***Construction Impacts*** **Less than significant**, temporary adverse recreation and public access effects during the construction period would be similar to those described for Alternative 16 with the potential temporary full or partial closure of Los Angeles State Historic Park for construction of marsh/wetland

Table 5-1 Comparison of Potential Impacts

Resource	No Action Alternative	Alternative 10 (ART)	Alternative 13 (ACE)	Alternative 13v	Alternative 16 (AND)	Alternative 20 (RIVER)
	occur.	considered to be **less than significant**. ***Operation Impacts*** Alternative 10 would have **no significant impacts** on recreation and public access resources in the study area. Beneficial effects would include improved aesthetic quality of the River, and increased quality, quantity, and diversity of recreation resources along the River. Habitat quality improvements may have larger beneficial effects on specific recreation activities which are heavily dependent on the health of the river, such as bird watching.	facilities, uses, access, opportunities and experiences would be expected for Alternative 13 due to the increased level of restoration.	beneficial effects to recreational facilities, uses, access, opportunities and experiences would be expected for Alternative 13v due to the increased level of restoration and connection to Los Angeles State Historic Park.	slightly higher than for Alternative 13 due to the increased level of restoration under Alternative 16.	restoration features. ***Operation Impacts*** Potential benefits to recreation may be slightly higher than for Alternative 16 due to the increased level of restoration under Alternative 20.
AESTHETICS	***Construction Impacts*** None. ***Operation Impacts*** No adverse impacts. Benefits to aesthetic value would not be realized through plantings, creation of new habitats, and greening of channel.	***Construction Impacts*** Components of this alternative would result in temporary, **less than significant** impacts to aesthetic condition during construction. However, many of these areas are already in industrial use and therefore visually degraded. In areas regularly utilized for recreation, where aesthetic appeal is particularly desirable, construction efforts would be streamlined to occur quickly, to avoid interfering with recreational opportunities, and to affect as small an area as possible in order to minimize impacts. ***Operation Impacts*** Aesthetics will be greatly improved as a result of the restoration through riparian plantings along daylighted culverts, side channels, and overbank areas. As vegetation matures and flourishes, it will also serve to green and soften the channel. Operation activities that require the presence of trucks will not significantly interfere with visual appeal.	***Construction Impacts*** Though proposed measures are anticipated to take longer to implement due to the expanded area covered by this alternative, impacts are the same as Alt 10 (**less than significant**). ***Operation Impacts*** Aesthetics along the River would be greatly improved as a result of the restoration. Operation and maintenance activities would not interfere with visual appeal.	***Construction Impacts*** Though proposed measures are anticipated to take longer to implement due to the expanded area covered by this alternative, impacts are the same as Alt 10 (**less than significant**). ***Operation Impacts*** Aesthetics along the River would be greatly improved as a result of the restoration. Operation and maintenance activities would not interfere with visual appeal.	***Construction Impacts*** Though proposed measures are anticipated to take longer to implement due to the expanded area covered by this alternative, impacts are the same as Alt 10 (**less than significant**). ***Operation Impacts*** Aesthetics along the River would be greatly improved as a result of the restoration. Operation and maintenance activities would not interfere with visual appeal.	***Construction Impacts*** Though proposed measures are anticipated to take longer to implement due to the expanded area covered by this alternative, impacts are the same as Alt 10 (**less than significant**). ***Operation Impacts*** Aesthetics along the River would be greatly improved as a result of the restoration. Operation and maintenance activities would not interfere with visual appeal.
PUBLIC HEALTH AND SAFETY/ HTRW	***Construction Impacts*** None. ***Operation Impacts*** No adverse impacts. Benefits to well-being of local residents through biological, recreational, and aesthetic improvements would not be realized.	***Construction Impacts*** OSHA and USACE safety standards, and BMPs addressing each of these risks during construction will be implemented, and construction will be in compliance with all applicable laws, regulations, and ordinances. The sponsor would remediate or ensure remediation of HTRW contaminated soils on project lands prior to construction at those sites. The sponsor also would be responsible for addressing any HTRW contaminated groundwater during dewatering activities necessary for construction. Potential impacts would be **less than significant.** ***Operation Impacts*** Improved access could increase water-related injuries and bring people in proximity to HTRW areas. River channel designs would maximize safety, however, and vector control agencies will be coordinated with to ensure that related issues are addressed. Impacts are anticipated to be **less than significant**.	***Construction Impacts*** Impacts would be the same as Alternative 10, and the same BMPs would be implemented. The larger project footprint for this alternative is not anticipated to result in significant adverse impacts during construction. Impacts would be **less than significant**. ***Operation Impacts*** Impacts would be the same as Alternative 10.	***Construction Impacts*** Impacts would be the same as Alternative 13, and the same BMPs would be implemented. The larger project footprint for this alternative is not anticipated to result in significant adverse impacts during construction. Impacts would be **less than significant**. ***Operation Impacts*** Impacts would be the same as Alternative 13.	***Construction Impacts*** Impacts would be the same as Alternatives 10 and 13, and the same BMPs would be implemented. The larger project footprint for this alternative is not anticipated to result in significant adverse impacts during construction. Impacts would be **less than significant**. ***Operation Impacts*** Impacts would be the same as Alternatives 10 and 13.	***Construction Impacts*** Impacts would be the same as Alternatives 10, 13 and 16, and the same BMPs would be implemented. The larger project footprint for this alternative is not anticipated to result in significant adverse impacts during construction. As with the other alternatives, Impacts would be **less than significant.** ***Operation Impacts*** Impacts would be the same as Alternatives 10, 13 and 16.
UTILITIES AND PUBLIC SERVICES	***Construction Impacts*** None. ***Operation Impacts*** None.	***Construction Impacts*** Utility and stormwater management plans would be prepared prior to the start of construction. The amount of debris generated would not exceed landfill capacity. No additional public services are anticipated to be needed during construction. Utility relocations would occur in Reaches 6 and 7. Impacts would be **less than significant**.	***Construction Impacts*** Though construction activities would occur over a longer time period than for Alt 10, impacts would remain **less than significant**. Utility relocations would be the same as Alt 10. Debris generated would not exceed landfill	***Construction Impacts*** Though construction activities would occur over a longer time period than for Alt 10, impacts would remain **less than significant**. Utility relocations would be the same as Alt 13. Debris generated would not exceed landfill	***Construction Impacts*** Though construction activities would occur over a longer time period than for Alt 13, impacts would remain **less than significant**. Utility relocations would be the same as Alt 13 except in Reach 8, where more utilities	***Construction Impacts*** Though construction activities would occur over a longer time period than for Alt 13, impacts would remain **less than significant**. Utility relocations would be the same as Alt 16. Debris generated would not exceed landfill

Table 5-1 Comparison of Potential Impacts

Resource	No Action Alternative	Alternative 10 (ART)	Alternative 13 (ACE)	Alternative 13v	Alternative 16 (AND)	Alternative 20 (RIVER)
		Operation Impacts Maintenance of plantings may result in a long-term increased demand for water and electricity. Impacts would be **less than significant**. Beneficial impacts to outdoor education would arise in the form of interpretive opportunities for local schools.	capacity. ***Operation Impacts*** Impacts to public services and utilities would be the same as those described for Alternative 10 and would be **less than significant**.	capacity. ***Operation Impacts*** Impacts to public services and utilities would be the same as those described for Alternative 10 and would be **less than significant**.	would be relocated. Debris generated would not exceed landfill capacity. ***Operation Impacts*** Impacts to public services and utilities would be the same as those described for Alternatives 10 and 13 and would be **less than significant.**	capacity. ***Operation Impacts*** Impacts to public services and utilities would be the same as those described for Alternatives 10, 13, and 16 and would be **less than significant**.
SOCIOECONOMICS AND ENVIRONMENTAL JUSTICE	***Construction Impacts*** None. ***Operation Impacts*** No adverse impacts. Benefits to populations of minorities and those living at the poverty level would not be realized through the improvement of existing recreation access, aesthetic improvement, and biological restoration.	***Construction Impacts*** Closures or reduced access to recreational facilities would be temporary and coordinated with appropriate entities. LATC site functions would be relocated. Impacts would be **less than significant**. The infusion of construction funds into the regional economy will generate economic benefits. The alternative would not have disproportionately high and adverse human health or environmental effects on EJ populations. ***Operation Impacts*** Operation would result in **less than significant** impacts to socioeconomics. Improved aesthetic quality, habitat value, quality and quantity of recreation resources, and improved accessibility would provide beneficial effects.	***Construction Impacts*** Generally the same as Alt 10 (**less than significant**), or slightly amplified. ***Operation Impacts*** Generally the same as Alt 10 (**less than significant**).	***Construction Impacts*** Generally the same as Alt 13 (but slightly amplified). In addition, requires temporary partial closure of Los Angeles State Historic Park. Closure would be temporary and substitute recreation areas in the vicinity would be available. Impacts would be **less than significant**. . ***Operation Impacts*** Generally the same as Alt 13 (**less than significant**).	***Construction Impacts*** Generally the same as Alt 13, or slightly amplified (**less than significant**). ***Operation Impacts*** Generally the same as Alt 13 (**less than significant**).	***Construction Impacts*** Generally the same as Alt 16, but slightly amplified. In addition, requires temporary partial closure of Los Angeles State Historic Park. Closure would be temporary and substitute recreation areas in the vicinity would be available. Impacts would be **less than significant**. ***Operation Impacts*** Similar to Alt 16 **less than significant**.
CUMULATIVE IMPACTS	None.	**Significant adverse long-term cumulative impacts** have been identified for Land Use. **Significant adverse short-term cumulative impacts under CEQA** have been identified for Air Quality. **Substantial beneficial long-term cumulative impacts** have been identified for Biological Resources. Beneficial cumulative impacts have been identified for Water Resources, Recreation, and Aesthetics.	Cumulative Impacts would be similar to those described for Alternative 10, although this alternative would result in greater benefits to biological and water resources, recreation and aesthetics.	Cumulative Impacts would be similar to those described for Alternatives 10 and 13, except that short-term adverse air quality impacts would not be significant under CEQA, and this alternative would result in greater benefits to biological and water resources, recreation and aesthetics.	Cumulative Impacts would be similar to those described for Alternative 10, 13 and 13v (except that short-term adverse air quality impacts would be less under 13v). This alternative would result in greater benefits to biological and water resources, recreation and aesthetics.	Cumulative Impacts would be would be similar to those described for Alternative 10, 13, 13v and 16, with the following exceptions. Short-term adverse air quality impacts would be less under 13v. Also, land use impacts would be greatest with Alternative 20 because of the additional acquisition of industrial properties at the Verdugo Wash and Cornfields sites. This alternative would result in greater benefits to biological and water resources, recreation and aesthetics.

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5.1 GEOLOGY, SEISMOLOGY, SOILS, AND MINERALS

5.1.1 Regulatory Framework

Numerous environmental laws and regulations govern the geologic and seismic resources in the study area. An overview of some of the more pertinent regulations and responsible agencies is presented below.

The United States Geologic Survey (USGS) of the U.S. Department of the Interior provides reliable scientific information to describe and understand the earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life. The USGS does not have regulatory authority/jurisdiction, but rather it provide scientific information that can be used to help mitigate impacts from natural disasters such as earthquakes, landslides, and volcanoes.

California has promulgated a number of regulations regarding geology and soils. The International Building Code regulates construction practices including sections pertinent to design and construction to avoid geotechnical hazards. The codes include design standards and general design parameters for seismic design. The State Building Standards Commission is responsible for administering California's building codes, including adopting, approving, publishing, and implementing codes and standards.

The Alquist-Priolo Earthquake Fault Zoning Act was passed in 1972 to address the hazards of surface faulting to buildings. This state law was a direct result of the 1971 San Fernando Earthquake. The purpose of the Alquist-Priolo Earthquake Fault Zoning Act is to prevent the construction of buildings used for human occupancy on the surface trace of active faults. This act only addresses the hazard of surface fault rupture. Other earthquake hazards are addressed by the Seismic Hazards Mapping Act passed in 1990, which addresses non-surface fault rupture earthquake hazards, including liquefaction and seismically induced landslides.

The Seismic Hazards Mapping Act requires the mapping of seismic hazard zones to mitigate hazards to help protect public health and safety. Included are shaking hazards, liquefaction, and landslides. Amplified shaking hazard zones are areas where historic occurrence of amplified ground shaking or local geological and geotechnical conditions indicate a potential for ground shaking to be amplified to such a level that mitigation would be required. Liquefaction hazard zones are areas where historic occurrences of liquefaction, or local geological, geotechnical, and groundwater conditions, indicate a potential for permanent ground displacement. Earthquake-induced landslide hazard zones are areas where Holocene occurrence of landslide movement, or local slope of terrain, and geological, geotechnical and ground moisture conditions indicate a potential for permanent ground displacements.

A number of local building permits and programs regulate development and construction of facilities in the City and Los Angeles County. The Los Angeles Building Code provides requirements for construction, grading, excavation, use of fill, and foundation work including types of materials and design, so as to minimize the likelihood and severity of consequences from geologic hazards. The Los Angeles Department of Building and Safety regulates construction and development in hillside areas.

5.1.2 Significance Criteria

Significance criteria for this resource are based primarily on the environmental checklist in the California Environmental Quality Act (2005) and City of Los Angeles CEQA Guidelines (City of Los Angeles 2006). Restoration measures would be considered to have a significant impact to geologic and soil resources or topography if any of the following were to occur:

- They increased exposure of people or structures to risk of loss, injury, or death resulting from earthquakes, liquefaction, or landslides.
- They resulted in substantial soil erosion loss or loss of topsoil.
- They were constructed within a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landside, lateral spreading, subsidence, liquefaction, or collapse.
- They were constructed on expansive soil, as defined in the Uniform Building Code (1994), creating substantial risks to life or property.
- They would result in loss of a known valuable mineral resource or in the loss of availability of a locally important mineral resource identified in an approved land use plan.
- One or more distinct and prominent geologic or topographic features were destroyed, permanently covered, or materially and adversely modified. Such features may include, but are not limited to, hilltops, ridges, hillslopes, canyons, ravines, rock outcrops, waterbodies, streambeds, and wetlands.

5.1.3 Environmental Impacts

No Action Alternative

Construction Impacts

Under the No Action Alternative, topography and geology, soils, and seismic hazards would not be significantly affected by construction activities, since no construction would occur under this alternative. Topographic and geologic features, which include, but are not limited to, mountain range shifting, crustal spreading, subsidence, seismic ocean floor uplift, and basin sediment in-fill and subsequent aggradation would persist indefinitely, subject to weathering and possibly by other effects.

Soils would continue to be eroded and deposited from fluvial processes. Soil erosion in the headwaters of the watershed would continue to result in the transport and deposition of sediment along the soft bed channel sections of the study area.

Seismicity in Southern California is highly active and would continue to cause damages to people and structures in the study area and surrounding area, dependent upon the frequency and magnitude of seismic events. Threats to property and life where soils, topography, and climate are favorable for landslides along the foothills and slopes of the Santa Monica Mountains and the Repetto and Elysian Hills would continue. Areas identified as potential locations for liquefaction along the base of the Santa Monica Mountains, the Elysian and Repetto Hills, and along the Los Angeles River would remain hazards.

Operation Impacts

Under the No Action Alternative restoration measures would not be constructed; and operation and maintenance would continue under the current LACDA operation manual, subject to funding availability. Operation impacts would not have a significant effect on topography and geology, soils, and seismic hazards.

Alternative 10 (ART)

Construction Impacts

Implementation of Alternative 10 would not have a significant impact on study area topography and geology, soils, or seismic hazards in the study area. Construction would be designed to code, as applicable for structural stability during earthquakes.

Alternative 10 would not have a significant impact on study area topography or underlying geology. Restoration measures under this alternative do not propose to alter or modify distinct topographic or geologic landforms in the study area. Terracing of channel banks would result in slight changes in topography, but these changes are within the already modified topography of the River channel.

Ground-disturbing activities during construction could result in soil erosion, or loss of top soil in areas both within the channel itself and on upland areas above the channel. Under Alternative 10, ground-disturbing activities that may occur include:

- Demolition and excavation of concrete and earthen material for the construction of side channels,
- Demolition of channel walls and excavation of overbank areas at storm drain outlets for daylighting and wetland habitat creation,
- Demolition of concrete paved and or grouted rock channel bed and side slope protection,
- Widening of channel bed and top of banks via excavation and grading of earthen material,
- Excavation of channel bed and side slopes for riprap structures and terraced and in-channel planters,
- Use of heavy equipment for hauling away of concrete debris and excavated material, and
- Excavation for topsoil fill and vegetation establishment on side slopes of maintenance roads and channel.

Disturbances to soil in all areas would be controlled through a suite of erosion control measures designed for construction activities. The extent of ground disturbance would be minimized prior to construction by identifying the minimum required area for staging and access routes. Staging areas and access routes would consider existing conditions, and would be located where soils are not already exposed or where disturbance has already occurred. Industrial districts, parking lots, and undeveloped ruderal areas would provide the best locations. Some lands intended for ecosystem restoration would also be used for staging areas prior to construction of features on those sites. Areas that have aesthetic, recreational, open space or habitat value would be avoided to the extent possible.

During construction, areas that would be disturbed within the project footprint, at staging locations, and along hauling routes would be evaluated to determine where erosion control measures would be necessary. These controls would include BMPs such as (1) the placement of straw bales or other filters that prevent soils from moving off-site during precipitation events, (2) placement of mulch or chemical stabilizers, and/or use of watering trucks where dry conditions could result in creation of fugitive dust, (3) identification of suitable locations for deposit of excavation spoils, and (4) minimization of number of truck trips or hauling distances, among others. Following construction efforts, disturbed ground would be restored with native plantings to stabilize exposed areas and return the site to aesthetically suitable conditions.

Other than the relocation and reconstruction of existing channel walls to widen the channel in Reach 6, the proposed measures are limited to habitat restoration; no major structures that could incur damages or pose a threat to the safety of persons in the event of failure would be built under the proposed alternative. Implementation of measures under this alternative would not cause or increase the risk of exposure of any person or structure to an active fault in the study area, and therefore would result in a less than significant impact.

The California Department of Conservation's Seismic Hazards and Zonation Program has classified all reaches of the study area as susceptible to liquefaction (CADC 2012b). Measures proposed under this alternative include the removal of channel concrete in Reach 6, widening of the channel banks in Reach 6, vegetation of channel side slopes in Reach 6, and the naturalization of overbank areas in Reach 1, 2, 4, 5,

6, and 8. These measures would not be significant alterations in comparison to the existing channel's original construction nearly 70 years ago; as a conservative estimate and worst case scenario, it is assumed that measures would only slightly increase the chance of liquefaction due to minimal disturbance of the underlying soils and geology. This would not increase the hazard for liquefaction enough to be considered significant.

The California Department of Conservation's Seismic Hazards and Zonation Program has classified and mapped areas susceptible to landslides. These areas include the foothills and mountainous slopes of the Santa Monica Mountains and the Elysian and Repetto Hills (CADC 2012b). These areas do not overlap with the study area and the proposed restoration measures. As a result, proposed measures would not cause or increase the risk of landslides in the study area.

Operation Impacts

Operation impacts to topography, geology, soils, and seismicity post-construction are expected to be minimal and non-significant. Operation impacts would be similar in nature to the channel's current operation and maintenance activities. During the establishment of riparian and in-channel vegetation, topsoil erosion could occur due to high flows and may need to be replaced and/or replanted. Maintenance of restoration features would need to either follow existing, or develop new, channel maintenance BMP guidelines to prevent impacts to restoration measures and the project area during maintenance activities. Beneficial impacts from operations would include increased maintenance of substrate for vegetation establishment and stabilization of project area soils.

Indirect Effects of and Related Actions to Construction and Operation

Indirect effects of Alternative 10 on topography, geology, soils and seismicity are not anticipated to be significant. Following completion of restoration measures, areas planted with native species would incur beneficial impacts. Restored riparian zones would provide native plant cover to reduce erosion, while removal of impervious surfaces and daylighting of enclosed tributaries and storm drains would allow for increased nutrient exchange and groundwater percolation.

Like the other action alternatives, construction would require that the existing use at the LATC site be discontinued because a portion of the site would be converted to riparian habitat. The existing site functions are anticipated to be relocated at a new site or through expansion of an existing rail yard. The relocation of LATC site functions could result in minor and temporary impacts to geology, seismology, soils and minerals at the new site. The site functions would be anticipated to be located within the Los Angeles Basin in an area that was already zoned for industrial use, having the existing condition of typically industrialized lands. Construction of a new site or expansion of an already existing site may have temporary impacts on soils. The use of heavy equipment, trucks, and excavation of the site could potentially result in loss of topsoils, changes to existing soil composition, and erosion. However, lands within industrial zones typically already have altered soils and impacts to soils would be temporary during the construction of the new facility. Once construction is completed, the operation of the new facility is not expected to impact soils, geology, or mineral resources. These effects are the same for all action alternatives. Prior to site selection, the CEQA lead agency will conduct a detailed CEQA analysis of the relocation of LATC site functions, including effects on geologic resources. Should any additional NEPA documentation be required, it would be undertaken by the NEPA lead agency.

These impacts are expected to be the same for each of the action alternatives.

Alternative 13 (ACE)

Construction Impacts

Restoration measures in this alternative would include the measures in Alternative 10 in Reaches 1, 2, 4, 5, and 8 and provides additional restoration in Reaches 3, 6, and 7. In Reach 3, in addition to the measures identified in Alternative 10, this alternative would create a side channel at Ferraro Fields. In Reach 6, this alternative creates a backwater wetland at the Bowtie parcel and restructures the left bank upstream of the backwater wetland and downstream of Taylor Yard, as well as the entirety of the right bank, with implanted vegetation, and widens the River more than in Alternative 10. In Reach 7, this alternative restores a portion of the Arroyo Seco tributary through softening of the bed and banks with development of a riparian corridor in the tributary confluence and for one half mile upstream. Instead of the daylighted streams included in this reach in Alternative 10, this alternative lines the banks of the River downstream from the Arroyo Seco with overhanging vines and implanted vegetation. While this alternative would include more construction work for implementation of the additional features, the nature and type of impacts are similar to those in Alternative 10, and erosion control procedures and post-construction restoration of disturbed sites are anticipated to occur in all project areas, as described under Alternative 10. As a result, implementation of Alternative 13 is not expected to result in significant adverse impacts to topography and geology, soils, and seismic hazards in the study area, nor would it increase the potential for liquefaction or landslides.

Operation Impacts

Operation impacts would be similar to Alternative 10, but may be slightly more extensive due to the larger area of restoration.

Indirect Effects of and Related Actions to Construction and Operation

In addition to the impacts identified for Alternative 10, beneficial impacts to soils in the long term would occur over a larger area due to the greater extent of riparian restoration.

Alternative 16 (AND)

Construction Impacts

Alternative 16 proposes restoration measures that would cover a larger portion of the study area in comparison to Alternative 10. In comparison to Alternatives 10 and 13, measures under Alternative 16 would also include the relocation of existing railroad tracks to trestles, construction of planting built into channel walls, and channel bed deepening. Construction impacts would be similar to those occurring under Alternative 10 and 13, but would include larger footprints of disturbance at the LATC site in Reach 8, and the following additional impacts:

- Demolition and excavation of channel walls to construct vegetated plantings,
- Demolition and excavation to deepen channel bed, and
- Demolition and excavation of old railroad features and construction of trestles at grade in Reach 8 to allow restoration of the river and historic floodplain below the rail lines.

As summarized in Alternative 10 and 13, all project area ground disturbances under Alternative 16 would be similarly treated for erosion control, and post-construction restoration would return disturbed areas to their original, or better, condition. As a result, implementation of Alternative 16 is not expected to have significant adverse impacts on topography and geology, soils, and seismic hazards in the study area, nor would it increase the potential for liquefaction or landslides. Instead, this alternative would provide benefits to soils in restored riparian zones that cover 19 additional acres compared to Alternative 10.

Operation Impacts

Operation impacts would not be significant and would be similar to Alternative 10 and 13, but with the potential for additional maintenance of topsoil and vegetation in proposed channel plantings and the more extensive footprint of restored riparian zones. Benefits to the stabilization of project area soils would be seen over an area 19 acres larger than under Alternative 10 due to more extensive restoration and revegetation efforts.

Indirect Effects of and Related Actions to Construction and Operation

In addition to the impacts identified for Alternative 13, beneficial impacts would increase to soils in the long term due to the larger restoration footprint.

Alternative 20 (RIVER)

Construction Impacts

In comparisou to Alternatives 10, 13, and 16, Alternative 20 proposes the most extensive restoration measures over the largest area, including 37 more acres of restored riparian habitat than the next largest alternative (16) spread amongst all reaches. Restoration measures uuder Alternative 20 are comparable to Alternative 16, but additionally include the widening of Verdugo Wash confluence and more extensive channel reshaping activities. In Reach 7, this Alternative includes the three daylighted streams included in the reach plan for Alternative 10 and the Arroyo Seco restoration included in Alternative 13 and 16, with ground disturbance as discussed in those alternatives. Instead of the restructuring of channel banks included in Alternatives 13 and 16, it restores freshwater marsh at the Los Angeles State Historic Park and terraces the existing channel bank adjacent to the Los Angeles State Historic Park, and the railroad line along the overbank would be trestled at grade to facilitate the terracing. Construction impacts would be similar to Alternative 16, with the following additional effects:

- Demolition, excavation, and reshaping of existing channel walls to widen channel invert in Reach 2, and
- Demolition and excavation at the confluence area of Verdugo Wash.
- Terracing of channel walls in Reach 7, and installation of railroad trestle at grade.

As discussed in Alternatives 10, 13, and 16, construction activities resulting in project area ground disturbances in Alternative 20 would be similarly treated for erosion control, and post-construction restoration would return disturbed areas to their original, or better, condition. As a result, implementation of Alternative 20 is not expected to have significant adverse impacts on topography and geology, soils, and seismic hazards in the study area, nor would it increase the potential for liquefaction or landslides. Implemented restoration measures would benefit existing soil conditions in restored riparian areas by stabilizing them.

Operation Impacts

Operation impacts under Alternative 20 would not be significant and would be similar to Alternative 16, but would not include the needed maintenance of implanted vegetation topsoil and vegetation.

Indirect Effects of and Related Actions to Construction and Operation

In addition to the impacts identified for Alternative 16, beneficial impacts to soils in the long term would increase due to the larger restoration footprint.

5.1.4 Best Management Practices and Impact Avoidance Measures

For all action alternatives, BMPs would include, but not be limited to, the following:

- Minimizing the extent of areas to be cleared, graded, or recontoured,
- Erecting construction fencing in all areas that require clearing, grading, revegetation, or recontouring,
- Conducting all construction work in accordance with site-specific construction plans that minimize the potential for sediment to enter the stream,
- Applying mulch or chemical stabilizers to disturbed areas as needed, and/or using a water truck to reduce fugitive dust,
- Stabilizing and reseeding disturbed areas with native grasses after construction is complete,
- Installing silt fences to prevent silt and sediment from entering the River channel,
- Grading spoil sites to minimize surface erosion and prevent sediment from entering water courses or the stream channel to the maximum extent feasible,
- Designing and implementing a dewatering plan to avoid operating equipment in flowing water by using temporary cofferdams or some other suitable diversion to divert channel flow around the channel and bank construction area, and
- Limiting certain aspects of in-channel construction to the low-flow period between April 15 and October 31 (non-flood season) to minimize soil erosion.
- Soils and all materials used for backfilling or stabilization must be certified to be free of contaminants.
- In-channel work would be isolated from existing flows by the use of dewatering structures such as cofferdams constructed from k-rails and other suitable materials.

    - Cofferdam construction will be adequate to prevent seepage into or from the work area.

    - Cofferdams may be constructed from sand bags, concrete k-rails, sheet piles or other appropriate materials that would not leach contaminants into the water column or increase downstream turbidity.

    - Ensure that dewatering structures and coffer dams are in place and functional prior to in-water work.

    - Visually inspect all cofferdam components on a regular basis.

    - Check for water seepage under the dam and general integrity of the dam.

    - Fix all leaks immediately.

    - If turbid water is discharged from the work area despite the cofferdam, place wattles, filter fabric, silt fencing across the flow stream downstream of the work area as appropriate.

    - All cofferdams and associated structures will be removed upon completion of work.

- Prepare a storm water pollution prevention plan (SWPPP) consistent with Regional Water Quality Control Board policy and guidelines. At a minimum, the SWPPP would include the following elements:

- Work areas, staging areas, or stockpile areas that could be subject to erosion during storm events would be stabilized with erosion control measures as appropriate. These measures could typically include silt fencing, straw bales, sand bags, filter fabric, coir rolls or wattles.

- Erosion control methods used to prevent siltation would be monitored weekly and maintained as needed.

- Stabilize and reseed disturbed upland areas with native grasses, shrubs, and trees upon completion of construction.

- Stationary equipment such as motors, pumps, generators and welders located within or adjacent to the channel or basin will be positioned over drip pans.

- Any equipment or vehicles driven and/or operated within or adjacent to the channel or basin should be checked and maintained daily, to prevent leaks. All maintenance will occur in a designated offsite area. The designated area will include a drain pan or drop cloth and absorbent material to clean up spills.

- Fueling and equipment maintenance will be done in a designated area removed from the area of the channel or basin such that no petroleum products or other pollutants from the equipment may enter these areas via rainfall or runoff. The designated area will include a drain pan or drop cloth and absorbent materials to clean up spills.

- Materials for the containment of spills (i.e., absorbent materials, silt fencing, filter fabric, coir rolls) will be identified and be available onsite prior to commencement of construction or maintenance activities.

- Any accidental spill of hydrocarbons or coolant that may occur within the work area will be cleaned immediately. Absorbent materials will be maintained within the work area for this purpose.

- No wet concrete product will come into contact with any flowing or standing water at any time. Areas where raw cement or grout are applied or where concrete curing or finishing operations are conducted will be separated from any ponded or diverted water flows by a cofferdam or silt-free, exclusionary fencing. All equipment involved with the concrete or grouting operations will be located within a contained area while using any slurry or concrete product. A protective berm or other structure will be in place prior to maintenance and/or repair activities.

- Any spill of the grout, concrete, concrete curing or wash water adjacent to or within the work area will be removed immediately.

5.2 AIR QUALITY AND GREENHOUSE GASES

5.2.1 Regulatory Framework

Sources of air emissions in the SCAB are regulated by the USEPA, CARB, and SCAQMD. In addition, regional and local jurisdictions play a role in air quality management. The role of each regulatory agency is discussed below.

Federal Regulations

The Federal Clean Air Act (CAA) of 1963 and its subsequent amendments form the basis for the nation's air pollution control effort. The USEPA is responsible for implementing most aspects of the CAA. Basic elements of the act include the NAAQS for major air pollutants, hazardous air pollutant standards, attainment plans, motor vehicle emission standards, stationary source emission standards and permits, acid rain control measures, stratospheric ozone protection, and enforcement provisions.

The CAA delegates the enforcement of the Federal standards to the states. In California, the CARB is responsible for enforcing air pollution regulations. In the SCAB, the SCAQMD has this responsibility.

General Conformity Rule

Section 176(c) of the CAA states that a Federal agency cannot issue a permit for, or support an activity within, a nonattainment or maintenance area unless the agency determines it will conform to the most recent USEPA-approved State Implementation Plan (SIP). This means that projects using Federal funds or requiring Federal approval must not: (1) cause or contribute to any new violation of a NAAQS; (2) increase the frequency or severity of any existing violation; or (3) delay the timely attainment of any standard, interim emission reduction, or other milestone.

A conformity determination is required for each criteria pollutant or precursor where the total of direct and indirect emissions of the criteria pollutant or precursor in a nonattainment or maintenance area caused by the Federal action would equal or exceed rates specified in 40 C.F.R. 93.153. See Table 5-2, below. The SCAB, as noted in Table 3-2, is currently in extreme nonattainment for ozone (precursors: VOC or NOx); nonattainment for PM2.5; maintenance for PM10; maintenance for NO2; and maintenance for CO; and nonattainment for lead. Based on the present attainment designation for the SCAB, a Federal action would conform to the SIP if annual emissions are below 100 tons of CO, PM2.5,PM10, or N02, 10 tons of NOx or VOC, or 25 tons of lead.

State Implementation Plan

For areas that do not attain the NAAQS, the CAA requires the preparation of a SIP, detailing how the State will attain the NAAQS within mandated timeframes. In response to this requirement, the SCAQMD and Southern California Association of Governments (SCAG) developed the 2003 Air Quality Management Plan (2003 AQMP) (SCAQMD 2003a). The focus of the 2003 AQMP was to demonstrate attainment of the Federal PM10 standard by 2006 and the Federal one-hour O3 standard by 2010, while making expeditious progress toward attainment of State standards. The 2003 AQMP also includes a NO2 maintenance plan.

The SCAQMD and SCAG, in cooperation with the CARB and the USEPA, have developed the 2007 AQMP for the primary purposes of demonstrating compliance with the new PM2.5 and 8-hour O3 NAAQS. This plan also provides additional measures beyond the 2003 AQMP for the attainment of the PM10 standard that was not attained by 2006, the one-hour O3 NAAQS (the standard was revoked by the USEPA, but the SCAQMD is still tracking progress towards attainment of this standard), and other planning requirements. The SCAQMD Governing Board adopted the Final 2007 AQMP on June 1, 2007

(SCAQMD 2007). Since it will be more difficult to achieve the 8-hour O3 NAAQS compared to the 1-hour O3 NAAQS, the 2007 AQMP contains substantially more emission reduction measures compared to the 2003 AQMP. The 2003 AQMP is still the latest approved Attainment Plan for PM10; however, the SCAQMD submitted a PM10 Redesignation Request and Attainment Plan for the SCAB to USEPA in 2010 that is currently pending USEPA action.

USEPA approved the 2007 8-hour O3 plan in March 2012, and approved nearly all elements of the 2007 PM2.5 plan in September 2012. However, in August 2012 USEPA proposed to withdraw approval of parts of the approved ozone planning requirements (VMT emissions offset demonstration), and proposed to find that the 1 hour O3 plan is inadequate for meeting the standard, which would require a new attainment plan be submitted as part of a revised SIP within 12 months of approval of this proposed inadequacy finding. The SCAQMD is currently in the process of preparing the 2012 AQMP and published the Draft 2012 AQMP in July 2012, a revised Draft 2012 AQMP in September 2012, and a Draft Final 2012 AQMP in November 2012.

On June 11, 2007, the USEPA re-designated the SCAB from nonattainment to attainment for the CO one-hour and eight-hour NAAQS. The USEPA also approved a SIP revision for the SCAB nonattainment area in California as meeting the CAA requirements for maintenance plans for CO. The USEPA made an adequacy finding and approved motor vehicle emission budgets, which are included in the maintenance plan. The USEPA also approved the California motor vehicle inspection and maintenance (I/M) program as meeting the low enhanced I/M requirements for CO in the South Coast region (USEPA 2007).

Non-Road Diesel Fuel Rule

In May 2004, the USEPA set sulfur limits for non-road diesel fuel. Under this rule, starting January 1, 2012 (USEPA 2004), diesel fuel used by all non-road equipment (not including marine and aircraft fuel) would be limited to 15 ppm sulfur, which would be equivalent to the sulfur content restrictions of the California Diesel Fuel Regulations.

Emission Standards for On-Road Trucks

To reduce emissions from on-road, heavy-duty diesel trucks, the USEPA established a series of cleaner emission standards for new engines, starting in 1988. These emission standards regulations have been revised over time and the latest effective regulation, the 2007 Heavy-Duty Highway Rule, provides for reductions in PM, NOx, and non-methane hydrocarbon emissions that were phased in during the model years 2007 through 2010 (USEPA 2000).

Environmental Protection Agency Diesel Fuel Rule

This EPA rule limited the sulfur content in on-road diesel fuel to 15 ppm starting June 1, 2006 (EPA 2006a).

Off-Road Diesel Engine Rule

To reduce emissions from off-road diesel equipment, the EPA established a series of increasingly strict emission standards for new engines. Locomotives and marine vessels are exempt from this rule. Manufacturers of off-road diesel engines would be required to produce engines with certain emission standards under the following compliance schedule:

- Tier 1 standards were phased in from 1996 to 2000 (year of manufacture), depending on the engine horsepower category.
- Tier 2 standards were phased in from 2001 to 2006.
- Tier 3 standards were phased in from 2006 to 2008.

- Tier 4 standards, which likely will require add-on emissions control equipment to attain them, will be phased in from 2008 to 2015.

Greenhouse Gases

Under the provisions of the CAA, the USEPA has the authority to regulate GHGs should a finding be made that GHGs have the potential to create adverse impacts. In April 2007, the U.S. Supreme Court held that GHG emissions are pollutants within the meaning of the CAA. In reaching its decision, the Court also acknowledged that climate change results, in part, from anthropomorphic causes (Massachusetts et al. v. Environmental Protection Agency 549 U.S. 497, 2007). The Supreme Court's ruling paved the way for the regulation of GHG emissions by USEPA under the CAA. In response to this Supreme Court decision, on December 7, 2009 the USEPA Administrator signed two distinct findings regarding GHGs under Section 202(a) of the CAA:

- Endangerment Finding: That the current and projected concentrations of the GHGs in the atmosphere threaten the public health and welfare of current and future generations; and,
- Cause or Contribute Finding: That the combined emissions of GHGs from new motor vehicles and new motor vehicle engines contribute to the GHG pollution which threatens public health and welfare.

USEPA has enacted a number of GHG regulations and other environmental regulations that will impact GHG emissions, including:

- Mandatory GHG Reporting
- GHG Tailoring Rule for PSD Permits
- GHG Vehicle Emissions Standards
- Corporate Average Fuel Economy Standards
- Renewables Fuel Standard

On December 18, 2014, the Council for Environmental Quality (CEQ) released its "Revised Draft Guidance for Greenhouse Gas Emissions and Climate Change Impacts." The guidance sets 25,000 metric tons of annual carbon dioxide equivalent emissions as a reference point below which a quantitative analysis of greenhouse gas is not recommended unless it is easily accomplished based on available tools and data. The reference level is for purposes of disclosure and not a substitute for an agency's determination of significance under NEPA.

State Regulations

California Clean Air Act

In California, the CARB is designated as the responsible agency for all air quality regulations. The CARB, which became part of the California Environmental Protection Agency (Cal/EPA) in 1991, is responsible for implementing the requirements of the Federal CAA, regulating emissions from motor vehicles and consumer products, and implementing the California Clean Air Act of 1988 (CCAA). The CCAA outlines a program to attain the CAAQS for O3, NO2, SO2, and CO by the earliest practical date. Since the CAAQS are often more stringent than the NAAQS, attainment of these more stringent CAAQS will require more emission reductions than what will be required to show attainment of the NAAQS. Similar to the Federal system, the State requirements and compliance dates are based on the severity of the ambient air quality standard violation within a region.

Assembly Bill (AB) 1807 – Air Toxics Program

AB 1807 established California's Air Toxics Program in 1983. The Air Toxics Program is a two-phased program for the identification and control of air toxics. During the first phase (identification), the CARB and the Office of Environmental Health Hazard Assessment (OEHHA) prepare draft reports on exposure assessment and health assessment. The draft reports are distributed for public review and comment. Comments can be made in writing or at public workshops. The report is then submitted to the independent scientific review panel (SRP), which reviews the reports for scientific accuracy and submits its findings to the CARB. The SRP is a nine-member group of professionals with backgrounds in disciplines such as medicine, atmospheric science, statistics, and toxicology. The SRP members are appointed by the Governor or the State legislature. At a public hearing, the Board decides whether to list the substance as a TAC.

Once the CARB identifies a substance as a TAC, it begins the second phase (control) of California's TAC program. In this phase, an assessment is conducted to determine the need for, and degree of, further controls. As in the identification phase, public outreach is an essential element in the development of a control plan and any control measures. The CARB works with districts and holds numerous public workshops and individual meetings with stakeholders in an open public process. If appropriate, each air toxic control measure is then adopted by the CARB at a public hearing.

AB 2588 – Air Toxics "Hot Spots" Information and Assessment Act

AB 2588, enacted in 1987, is designed to provide information to State and local agencies and to the general public on the extent of airborne emissions from stationary sources and the potential public health impact of those emissions. The "Hot Spots" Act requires that OEHHA develop risk assessment guidelines for the "Hot Spots" Program (Health and Safety Code Section 44360[b][2]). In addition, the "Hot Spots" Act specifically requires OEHHA to develop a "likelihood of risks" approach to health risk assessment. The "Hot Spots" Act requires stationary sources of TACs to prepare facility-wide health risk assessments in accordance with OEHHA guidelines, and to notify the public in the event of a potential health risk. The "Hot Spots" Act also establishes criteria for requiring implementation of risk reduction measures for high-risk facilities.

Heavy Duty Diesel Truck Idling Regulation

This CARB rule became effective February 1, 2005 and prohibits heavy-duty diesel trucks from idling for longer than five minutes at a time, unless they are queuing, provided the queue is located beyond 100 feet from any homes or schools (CARB 2006a).

CARB Drayage Truck Regulation

This CARB rule became effective December 3, 2009. The regulation requires trucks to meet engine emission requirements by a certain date. Under Phase 1, by December 31, 2012, all trucks must reduce PM emissions by 85 percent and must meet 2007 engine emission standards. The Drayage Truck Regulation also requires trucks to be registered in the Drayage Truck Registry.

California Diesel Fuel Regulations

In 2004, the CARB set limits on the sulfur content of diesel fuel sold in California for use in on-road and off-road motor vehicles (CARB 2004). Under this rule, diesel fuel used in motor vehicles except harbor craft and intrastate locomotives has been limited to 500 ppm sulfur since 1993. The sulfur limit was reduced to 15 ppm beginning on September 1, 2006. Diesel fuel used in harbor craft in the SCAB also was limited to 500 ppm sulfur starting January 1, 2006 and was lowered to 15 ppm sulfur on September 1, 2006.

Statewide Portable Equipment Registration Program (PERP)

The PERP establishes a uniform program to regulate portable engines and portable engine–driven equipment units (CARB 2005b). Once registered in the PERP, engines and equipment units may operate throughout California without the need to obtain individual permits from local air districts, as long as the equipment is located at a single location for no more than 12 months. There may be construction equipment that would be required to be PERP registered, but there are no known operating emissions sources that would be subject to this regulation.

Heavy-Duty Diesel Truck Idling Regulation

This CARB rule affected heavy-duty diesel trucks in California beginning in 2008. The rule requires that heavy-duty trucks be equipped with a non-programmable engine system that shuts down the engine after 5 minutes to prevent long idling times or, as an alternative, meet a stringent NO_X idling emission standard.

On-Road Heavy-Duty Diesel Vehicles (In Use) Regulation

On December 12, 2008, CARB approved the on-road heavy-duty diesel vehicle (in use) regulation to significantly reduce PM and NO_X emissions from existing diesel vehicles operating in California. The regulation applies to nearly all diesel-fueled trucks and buses with a gross vehicle weight rating (GVWR) greater than 14,000 pounds that are privately or Federally owned and for privately and publicly owned school buses.

Starting January 1, 2012, the regulation would phase-in requirements for heavier trucks to reduce PM emissions with exhaust retrofit filters that capture pollutants before they are emitted to the air or by replacing vehicles with newer vehicles that are originally equipped with PM filters. Starting on January 1, 2015, lighter trucks with a GVWR of 14,001 to 26,000 pounds with engines that are 20 years or older would need to be replaced with newer trucks. Starting January 1, 2020, all remaining trucks and buses would need to be replaced so that they would all have 2010 model year engines or equivalent emissions by 2023.

Greenhouse Gas Emissions

Responding to growing scientific and political concern regarding global climate change, California has recently adopted a series of laws to reduce the level of GHGs in the atmosphere and emissions of GHGs from commercial and private activities within the state. Assembly Bill (AB) 1493 requires the development and adoption of regulations to achieve "the maximum feasible reduction of greenhouse gases" emitted by noncommercial passenger vehicles, light-duty trucks, and other vehicles used primarily for personal transportation. It also requires CARB to design and implement emission limits, regulations, and other measures to reduce GHG emissions to 1990 levels by 2020.

Local Regulations and Agreements

The SCAQMD is primarily responsible for planning, implementing, and enforcing Federal and State ambient standards within this portion of the SCAB. As part of its planning responsibilities SCAQMD prepares Air Quality Management Plans and Attainment Plans as necessary based on the attainment status of the air basins within its jurisdiction. The SCAQMD is also responsible for permitting and controlling stationary source criteria and air toxic pollutants as delegated by the USEPA.

Through the attainment planning process, the SCAQMD develops the SCAQMD Rules and Regulations to regulate sources of air pollution in the SCAB (SCAQMD 2012b). The applicable SCAQMD rules to the Project are listed below.

SCAQMD Rule 401 – Visible Emissions

This rule prohibits discharge of air contaminants or other material, which are as dark or darker in shade as that designated No. 1 on the Ringelmann Chart or obscure an observer's view.

SCAQMD Rule 402 – Nuisance

This rule prohibits discharge of air contaminants or other material that cause injury, detriment, nuisance, or annoyanee to any considerable number of persons or to the public; or that endanger the comfort, repose, health, or safety of any such persons or the public; or that cause, or have a natural tendency to cause, injury or damage to business or property.

SCAQMD Rule 403 – Fugitive Dust

The purpose of this rule is to control the amount of PM entrained in the atmosphere from man-made sources of fugitive dust. Under Rule 403, no person shall conduct active operations without utilizing the applicable best available control measures to minimize fugitive dust emissions. Construction and operation fugitive dust emission sources are subject to this rule, which covers all fugitive dust emissions sources, such as unpaved and paved roads, storage piles, and earthmoving operations.

Additional requirements apply to operations on a property with 50 or more acres of disturbed surface area, or for any earth-moving operation with a daily earth-moving or throughput volume of 5,000 cy or more three times during the most recent 365-day period. These requirements include submittal of a dust control plan, maintaining dust control records, and designating a SCAQMD-certified dust control supervisor.

SCAQMD Rule 1113 – Architectural Coatings

This rule requires manufacturers, distributors, and end-users of architectural and industrial maintenance coatings to reduce VOC emissions from the use of these coatings, primarily by placing limits on the VOC content of various coating categories.

SCAQMD Rule 1901 – Adoption of General Conformity Rule

This rule adopts the guidelines for the General Conformity Rule within SCAQMD.

SCAQMD Regulation XI – Source Specific Standards

This regulation is composed of several dozen individual rules, most of which are not applicable to the project.

SCAQMD Regulation XIII – New Source Review

This regulation requires the permitting of new stationary sources and requires the use of BACT to control criteria pollutant emissions and requires offsetting emissions, other than CO, if they are over four tons per year.

5.2.2 Assessment Methodology

Air pollutant emissions associated with each alternative were estimated using CalEEMod Version 13.2.2, an air emissions modeling software developed by the SCAQMD in collaboration with other air districts in California, to estimate criteria air pollutant and greenhouse gas emissions from various land use development projects. The emission modeling software is used by air districts within California.

For construction emissions an equipment inventory was developed for specific tasks required to implement management measures listed in Section 4.4.5. Equipment information included off-road and

on-road equipment types, quantity of equipment, hours of off-road equipment operation, and on-road transportation distances. For Alternatives 13, 13v and 20, a general multi-year construction schedule and detailed construction phasing for each management measure were entered into CalEEMod. Each measure entered into CalEEMod was correlated with information from the equipment inventory. Detailed construction schedules for Alternative 16 and 10 were not developed. However, Alternative 16 is a truncated variation of Alternative 20. Likewise, Alternative 10 is a truncated variation of Alternative 13. As a result, appropriate construction phases entered into CalEEMod for Alternative 20 were deleted to estimate emissions for Alternative 16. Likewise, appropriate construction phases entered into CalEEMod for Alternative 13 were deleted to estimate emissions for Alternative 10. See the Air Quality Technical Appendix (Appendix F) for additional information on deleted construction phases.

Maximum daily and annual emissions were estimated for each construction year for all alternatives. Results were compared to applicable regulatory thresholds to determine significant impacts.

Operational emissions would include maintenance activities and as well as increased visitation by the public to the project area. Maintenance activities would likely entail annual vegetation maintenance activities over a 30 day period. Required equipment would include approximately five medium duty pickup trucks, two backhoes, two loaders, one excavator, two chippers, and two dump trucks. An increase of approximately 572 average daily visitors is projected with implementation of any action alternatives (See Recreational Analysis Appendix, Tables 3 and 4). In so far as all alternatives share many common restoration features, the scope, nature, and duration of maintenance activities are not expected to be notably different. Furthermore, the increase in visitation is projected with implementation of any action alternatives. Operational emissions are not expected to substantially change from year to year. As a result, maximum daily and annual emissions estimates were limited to one year.

Maintenance related emissions were estimated using CalEEMod. Emissions associated with increased visitations were estimated in Microsoft Excel using SCAQMD emissions factors for passenger vehicles (model years 1982-2026). Daily and annual CO2e emissions were calculated using U.S. Environmental Protection Agency's CO2e calculator at http://www.epa.gov/cleanenergy/energy-resources/calculator.html#results.

Estimates of lead emissions were not calculated for construction and operational phases. Lead emissions from mobile sources in California have significantly decreased due to the near elimination of lead in fuels. Thus, CalEEMod, the South Coast Air Quality Management District-approved emission modeling software, does not provide estimated emissions for lead. Little to no quantifiable and foreseeable lead emissions would be generated by the alternatives.

Greenhouse gas (GHG) emissions were estimated by amortizing the sum of construction-related GHG emissions for all construction years over a 30 year period. The resulting figure was added to annual estimates of operational GHG emissions. Operational emissions include emissions from maintenance and increased visitations. Unlike construction emissions, operational GHG emissions were assumed to remain the same from year to year. GHG emissions are reported as CO2 equivalents (CO2e).

The Air Quality Technical Appendix (Appendix F) presents more detailed analyses, including emissions calculation methodologies, assumption, input data and model run files.

5.2.3 Air Quality Significance Thresholds

Disclosure of environmental impacts under NEPA and CEQA typically include defining or selecting a level of significance for each potential impact. Once these significance thresholds have been established,

the estimated impacts can be compared to the thresholds to determine whether those impacts would be significant. The following thresholds were used to determine significance under NEPA, CEQA, or both.

In general, significance impact thresholds were based on current CEQA Guidelines, specifically the guidelines established by the SCAQMD for assessing air quality impacts. Air emissions would be significant if implementation of a proposed project or its alternatives would result in any of the following:

AQ-1 General Conformity Applicability Rates (NEPA): Conflicts with or obstructs implementation of the applicable air quality plan (NEPA).

AQ-2 (CEQA & NEPA): Violates any air quality standard or contributes substantially to an existing or projected air quality violation.

AQ-3 (CEQA & NEPA): Results in a cumulatively considerable net increase of any criteria pollutant for which the project region is in non-attainment under an applicable Federal or state ambient air quality standard (including releasing emissions that exceed quantitative threshold for ozone precursors).

AQ-4 (CEQA): Exposes sensitive receptors to substantial pollutant concentrations.

AQ-5 (CEQA & NEPA): Creates objectionable odors affecting a substantial number of people.

AQ-6 (CEQA): Results in greater than 10,000 MT per year of greenhouse gas emissions from the construction and operation of the alternative.

AQ-1: General Conformity Applicability Rates (NEPA)

The General Conformity applicability rates are typically applied to the preferred alternative for the purpose of assessing General Conformity determinations under the Clean Air Act. However, under AQ-1, the General Conformity applicability rates are utilized for the purpose of comparison and disclosure of all alternatives under NEPA. Table 5-2 summarizes these thresholds.

Table 5-2 General Conformity Applicability Rules

Pollutant	Federal Attainment Designation	Rates (Tons/Year)
Ozone (precursors: VOC or NO_x)[b]	Serious nonattainment	50
	Severe nonattainment	25
	Extreme nonattainment	10
	Other areas outside of an ozone transport region	100
CO, SO_2, and NO_2	All nonattainment and maintenance areas	100
PM_{10}	Serious nonattainment	70
	Moderate nonattainment and maintenance	100
$PM_{2.5}$	All nonattainment and maintenance areas	100
Pb (Lead)	All nonattainment and maintenance	25

(a) Source: 40 CFR 93.153
(b) Ozone precursors (NOx and VOCs): Gasoline and diesel engines do not directly emit ozone. Ozone is a product of NOx and VOCs reacting in the presence of sunlight. Since engines directly emit NOx and VOCs, their values function as surrogates for ozone emissions.

Appendix F contains the Clean Air Act Applicability Analysis for Alternative 13v, the NER Plan, and Alternative 20, the Locally Preferred Plan and Recommended Plan. Maintenance activities are considered exempt under 40 CFR 93.153(c)(2)(iv), and were not included in the total of direct and indirect emissions evaluated in the applicability analysis in Appendix F. Emissions from increased visitation by the public as a result of construction of the project cannot be practically controlled by the Corps and were therefore not

considered indirect emissions caused by the Federal action in the applicability analysis. However, operational emissions are evaluated under AQ-1 for purposes of NEPA.

Because all alternatives would convert the existing LATC site to restored habitat, a functionally equivalent facility is anticipated to be constructed elsewhere in the Los Angeles Basin. Emissions from relocation of site functions elsewhere in the basin cannot be practically controlled by the Corps, and the Corps does not have continuing program responsibility; therefore, such emissions are not considered indirect emissions caused by the Federal action in the applicability analysis. Construction of relocated site functions would result in temporary increases in emissions. Operation of relocated site functions may increase localized emissions in and around the relocation site. However, the relocation of the site functions within the Los Angeles Air Basin would not transfer the operational impacts of the site functions to a different air basin. Prior to site selection CEQA lead agency will conduct a detailed CEQA analysis in analyzing the relocation of LATC site functions, including air emissions. Should any additional NEPA documentation be required, it would be undertaken by the NEPA lead agency. These effects are anticipated to be the same for all action alternatives.

AQ-2: Regional Significance Thresholds (CEQA and NEPA)

AQ-2 was assessed using SCAQMD-developed Regional Significance Thresholds (RSTs) for mass daily emission rates of criteria pollutants for both construction and operational sources. RSTs represent the maximum emissions from a project that are not expected to cause or contribute to an exceedance of the most stringent applicable Federal or state ambient air quality standard in the SCAB. RSTs are presented in pounds per day. Thresholds for construction impacts are based on the maximum or peak daily emissions during the construction period, which provides a "worst-case" analysis of the construction emissions. Similarly, significance determinations for operational emissions are based on the maximum or peak daily allowable emissions during the operational phase. Table 5-3 summarizes the RSTs.

Table 5-3 Regional Air Quality Significance Thresholds

Mass Daily Thresholds [a]		
Pollutant	**Construction**	**Operation**
Nitrogen Oxide (NOx)	100 lbs/day	55 lbs/day
Volatile Organic Compounds (VOC)[b]	75 lbs/day	55 lbs/day
Particle Pollution (PM_{10})	150 lbs/day	150 lbs/day
Particle Pollution ($PM_{2.5}$)	55 lbs/day	55 lbs/day
Sulfur Oxides (SOx)	150 lbs/day	150 lbs/day
Carbon Monoxide (CO)	550 lbs/day	550 lbs/day
Lead	3 lbs/day	3 lbs/day

(a) Source: SCAQMD CEQA Handbook (SCAQMD, 1993)
(b) SCAQMD uses Reactive Organic Gasses (ROG) instead of VOC. The terms are interchangeable.

AQ-3: Cumulative Impacts (CEQA and NEPA)

AQ-3 was assessed using RSTs. The SCAQMD typically considers projects that exceed the RSTs to be cumulatively significant. Conversely, projects that do not exceed the thresholds are generally not considered to be cumulatively significant. This approach will be applied to impacts under CEQA and NEPA.

AQ-4: Localized Significance Thresholds (CEQA)

AQ-4 was assessed using SCAQMD-developed localized significant thresholds (LSTs) that identify daily emissions levels at a project construction site that could cause or contribute to adverse localized air quality impacts to the nearest sensitive receptors. For purposes of a CEQA analysis, the SCAQMD considers a sensitive receptor to be a receptor such as a residence, hospital, prison, and convalescent facility where it is possible that an individual could remain for 24 hours. Schools are also considered sensitive receptors. Commercial and industrial facilities are not considered sensitive receptors because employees do not typically remain on site for a full 24 hours. The applicable LSTs for the study area are shown in Table 5-4.

Table 5-4 Localized Air Quality Significance Thresholds

Localized Significance Thresholds	
Pollutant	**Construction (lbs/day)**
Nitrogen Oxide (NOx)	46
Particle Pollution (PM_{10})	4
Particle Pollution ($PM_{2.5}$)	3
Carbon Monoxide (CO)	231

AQ-5: Odors (CEQA and NEPA)

To assess AQ-5, the SCAQMD CEQA Air Quality Handbook indicates that land uses likely to result in odor nuisance complaints include: agriculture, wastewater treatment plants, food processing plants, chemical plants, composting, refineries, landfills, dairies, and fiberglass molding. Since the project would not result in construction of the facilities listed above, it is assumed that odor impacts would be less than significant under both CEQA and NEPA. Brief, qualitative discussions of control orders associated with the alternative are included in Section 5.2.3.

AQ-6: Greenhouse Gas (CEQA)

The SCAQMD adopted a quantitative significance threshold of 10,000 metric tons (MT) per year for industrial (stationary source) projects. In the absence of applicable GHG thresholds for ecosystem restoration projects, the 10,000 metric ton threshold for GHG is adopted for use in this analysis. The SCAQMD recommends that the total construction emissions be amortized over the lifetime of the project and then added to annual operational emissions. If the lifetime of a project is not known, then a 30-year lifetime is assumed. AQ-6 is assessed pursuant to this method.

NEPA Greenhouse Gas Statement

There are currently no Federal GHG emission thresholds. Therefore, the USACE will not utilize the SCAQMD quantitative CEQA significance threshold for industrial projects, propose a new GHG threshold, or make a NEPA significance impact determination for GHG emissions anticipated to result from any of the alternatives. Rather, in compliance with NEPA implementing regulations, the anticipated emissions will be disclosed for each alternative without expressing a judgment as to their significance.

5.2.4 Environmental Impacts

No Action Alternative

Construction Impacts

There would be no construction related air emissions under the No Action Alternative since no construction would occur.

Operational Impacts

There would be no operational related air emissions under the No Action Alternative since no construction would occur.

Alternative 10

Alternative 10 would be constructed over a 10 year period starting in 2017 and ending in 2026. Table 5-5 and Table 5-6 show the annual and daily emission estimates, respectively.

Emissions estimates for Alternative 10 were not based on detailed construction schedules as was done for Alternatives 13, 13v, and 20. However, Alternative 10 is a truncated variation of Alternative 13. As a result, appropriate construction phases entered into CalEEMod for Alternative 13 were deleted to estimate emissions for Alternative 10. See the Air Quality Technical Appendix (Appendix F) for additional information on deleted construction phases.

Construction Impacts

- *AQ-1: General Conformity Applicability Rates (NEPA)*
  As shown in Table 5-5, estimated annual emissions would not exceed the General Conformity Applicability Rates. As a result, construction activities associated with this alternative would result in less than significant impacts.

- *AQ-2: Regional Significance Thresholds (CEQA and NEPA)*
  As shown in Table 5-6, estimated daily construction emissions would not exceed any RST. As a result, construction activities associated with this alternative would result in less than significant impacts.

- *AQ-3: Cumulative Impacts (CEQA and NEPA)*
  The population in Los Angeles County is expected to increase in the future. Increases in population and housing could increase traffic, utility demands, and construction projects, which would all result in increased air pollution. Additionally, air pollutant emissions associated with past and present development and activities have contributed to local and regional air pollution. Several development projects in Los Angeles County could occur in the vicinity of the proposed project and alternatives during the same period and would contribute to cumulative effects. The estimated daily construction and operational emissions would not exceed any RSTs. Therefore, impacts to cumulative impacts would be less than significant.

- *AQ-4: Localized Significance Thresholds (CEQA)*
  As shown in Table 5-6, estimated daily construction emissions for NOx would exceed LST during construction in 2018 and 2019. Estimated emissions for CO, PM10, and PM2.5 would remain below LSTs for all construction years. Since, construction would

take place within an urbanized setting including sensitive receptors, exceedence of NOx LST in 2018 and 2019 would result in significant impacts.

- *AQ-5: Odors (CEQA and NEPA)*
  Potential sources that may emit odors during construction activities would include diesel emissions from on- and off-road equipment. However, construction would be limited to relatively small footprints interspersed throughout the project area, and the number of diesel powered equipment would be limited to those indicated in Appendix F. Furthermore, not all diesel equipment are expected to be operating simultaneously. Therefore, construction emissions would be transient and would result in less than significant impact to odors.

- *AQ-6: Greenhouse Gas Thresholds (CEQA)*
  As shown in Table 5-9, estimated GHG emissions would not exceed the 10,000 MT annual CO2e threshold for both raw values and the 30-year amortized values. Thus, the alternative would result in less than significant impacts.

Table 5-5 Alternative 10 Estimated Annual Emissions (Constructiou)

Pollutants	General Conformity Thresholds (tons/yr)	2017 Estimated Emissions (tons/year)	2018 Estimated Emissions (tons/year)	2019 Estimated Emissions (tons/year)	2020 Estimated Emissions (tons/year)	2021 Estimated Emissions (tons/year)	2022 Estimated Emissions (tons/year)	2023 Estimated Emissions (tons/year)	2024 Estimated Emissions (tons/year)	2025 Estimated Emissions (tons/year)	2026 Estimated Emissions (tons/year)
Ozone (VOC)	10	0.12	0.12	0.06	0.11	0.05	0.07	0.07	0.00	0.06	0.06
Ozone (NOX)	10	1.38	1.21	0.62	1.20	0.49	0.66	0.64	0.00	0.50	0.51
NO2	100	1.38	1.21	0.62	1.20	0.49	0.66	0.64	0.00	0.50	0.51
CO	100	0.81	0.80	0.41	0.77	0.36	0.62	0.63	0.00	0.60	0.57
PM10	100	0.07	0.07	0.03	0.06	0.03	0.04	0.03	0.00	0.03	0.03
PM2.5	100	0.06	0.06	0.03	0.05	0.02	0.03	0.03	0.00	0.02	0.02

Table 5-6 Alternative 10 Estimated Daily Emissions (Construction)

Pollutants	Regional Significant Thresholds (lbs/day)	Local Significant Thresholds (lbs/day)	2017 Estimated Emissions (lbs/day)	2018 Estimated Emissions (lbs/day)	2019 Estimated Emissions (lbs/day)	2020 Estimated Emissions (lbs/day)	2021 Estimated Emissions (lbs/day)	2022 Estimated Emissions (lbs/day)	2023 Estimated Emissions (lbs/day)	2024 Estimated Emissions (lbs/day)	2025 Estimated Emissions (lbs/day)	2026 Estimated Emissions (lbs/day)
VOC	75	n/a	2.90	5.97	5.69	2.53	4.14	2.50	1.74	0.00	1.72	1.87
NOX	100	46	32.47	63.55	58.21	26.89	41.99	23.89	16.69	0.00	14.95	16.90
CO	550	231	18.95	40.57	38.50	18.09	31.16	23.16	16.23	0.00	16.40	17.60
SO2	150	n/a	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.00	<0.005	<0.005
PM10	150	4	1.67	3.53	3.07	1.46	2.19	1.26	0.88	0.00	0.81	0.93
PM2.5	55	3	1.46	3.05	2.65	1.25	1.89	1.05	0.75	0.00	0.66	0.76
CO2e	n/a	n/a	3474	5909	5807	2844	4835	4153	3867	0.00	2995	3217

Operational Impacts

Operational emissions would include maintenance activities and as well as increased visits to the project area. Impacts are expected to remain similar from year to year. Maintenance activities would likely entail annual vegetation maintenance activities over a 30 day period. Required equipment would include approximately five medium duty pickup trucks, two backhoes, two loaders, one excavator, and two dump trucks. Maintenance would likely occur after September 15 of any year subsequent to the conclusion of bird nesting season. An increase of approximately 572 average daily visitors is projected with implementation of any build alternative (See Recreational Analysis Appendix, Tables 3 and 4). Maintenance activities are considered exempt under 40 CFR 93.153(c)(2)(iv), and were not included in the total of direct and indirect emissions evaluated in the applicability analysis in Appendix F. Emissions from increased visitation by the public as a result of construction of the project cannot be practically controlled by the Corps and were therefore not considered indirect emissions caused by the Federal action in the applicability analysis. However, these emissions were evaluated under AQ-1 for purposes of NEPA.

- ***AQ-1: General Conformity Applicability Rates (NEPA)***
  As shown in Table 5-7, estimated annual operational emissions would not exceed the General Conformity Applicability Rates. As a result, operation activities associated with this alternative would result in less than significant impacts.

- ***AQ-2: Regional Significance Thresholds (CEQA and NEPA)***
  As shown in Table 5-8, estimated daily operational emissions would not exceed any RST. As a result, construction activities associated with this alternative would result in less than significant impacts.

- ***AQ-3: Cumulative Impacts (CEQA and NEPA)***
  The population in Los Angeles County is expected to increase in the future. Increases in population and housing could increase traffic, utility demands, and construction projects, which would all result in increased air pollution. Additionally, air pollutant emissions associated with past and present development and activities have contributed to local and regional air pollution. Several development projects in Los Angeles County could occur

in the vicinity of the proposed project and alternatives during the same period and would contribute to cumulative effects. The estimated daily construction and operational emissions would not exceed any RSTs. Therefore, impacts to cumulative impacts would be less than significant.

- ***AQ-4: Localized Significance Thresholds (CEQA)***
  As shown in Table 5-8, estimated daily operational emissions would not exceed any LST. As a result, operational emissions associated with this alternative would result in less than significant impacts.

- ***AQ-5: Odors (CEQA and NEPA)***
  Potential sources that may emit odors during maintenance activities would include diesel emissions from on- and off-road equipment. However, the scope of maintenance would be limited to relatively small footprints interspersed throughout the project area, and the number of diesel powered equipment would be limited to those indicated in Appendix F. Furthermore, not all diesel equipment are expected to be operating simultaneously. Emissions associated with maintenance activities would be transient. Emissions from increased daily visits would be associated with light passenger vehicles which have relatively less odors than diesel emissions. Based on the above, operational emissions associated with this alternative would result in less than significant impacts.

- ***AQ-6: Greenhouse Gas Thresholds (CEQA)***
  As shown in Table 5-9, estimated GHG emissions would not exceed the 10,000 MT annual CO2e threshold. Thus, the alternative would result in less than significant impacts.

Table 5-7 Alternative 10 Estimated Annual Emissions (Operation)

Pollutants	General Conformity Rates (tons/yr)	Estimated Emissions (tons/year)	Estimated Emissions (tons/year)
		Maintenance	Visitations
Ozone (VOC)	10	0.03	6.14
Ozone (NOX)	10	0.40	0.51
NO2	100	0.40	0.51
CO	100	0.28	0.78
PM10	100	0.02	0.18
PM2.5	100	0.02	0.11

Table 5-8 Alternative 10 Estimated Daily Emissions (Operation)

Pollutants	Regional Significant Rates (lbs/day)	Local Significant Rates (lbs/day)	Estimated Emissions (lbs/day)	Estimated Emissions (lbs/day)
			Maintenance	Visitations
VOC	55.00	n/a	2.40	4.80
NOX	55.00	46.00	26.60	3.10
CO	550.00	231.00	18.90	37.60
SO2	150.00	n/a	0.03	0.12
PM10	150.00	4.00	1.35	1.10
PM2.5	55.00	3.00	1.19	0.73
CO2e	n/a	n/a	3563.00	12720.00

Table 5-9 Alternative 10 Annual GHG Emissions (Construction and Operations)

Annual CO2e Emissions Sources	SCAQMD GHG Rates (MT/yr)	Annual Estimated Emissions (MT/year)
Construction	n/a	29
Maintenance	n/a	48
Visitations	n/a	2079
Total CO2e	10,000	2156

Alternative 13

Alternative 13 would be constructed over a 10 year period starting in 2017 and ending in 2026. Table 5-10 and Table 5-11 show the annual and daily emission estimates, respectively.

Construction Impacts

- ***AQ-1: General Conformity Applicability Rates (NEPA)***
  As shown in Table 5-10, estimated annual emissions would not exceed the General Conformity Applicability Rates. As a result, construction activities associated with this alternative would result in less than significant impacts.

- ***AQ-2: Regional Significance Thresholds (CEQA and NEPA)***
  As shown in Table 5-11, estimated daily construction emissions would not exceed any RST. As a result, construction activities associated with this alternative would result in less than significant impacts.

- ***AQ-3: Cumulative Impacts (CEQA and NEPA)***
  The population in Los Angeles County is expected to increase in the future. Increases in population and housing could increase traffic, utility demands, and construction projects, which would all result in increased air pollution. Additionally, air pollutant emissions associated with past and present development and activities have contributed to local and regional air pollution. Several development projects in Los Angeles County could occur in the vicinity of the proposed project and alternatives during the same period and would contribute to cumulative effects. The estimated daily construction and operational emissions would not exceed any RSTs. Therefore, impacts to cumulative impacts would be less than significant.

- ***AQ-4: Localized Significance Thresholds (CEQA)***
  As shown in Table 5-11, estimated daily construction emissions for NOx would exceed LST during construction in 2018 and 2019. Estimated emissions for CO, PM10, and PM2.5 would remain below LSTs for all construction years. Since, construction would take place within an urbanized setting including sensitive receptors, exceedence of NOx LST in 2018 and 2019 would result in significant impacts.

- ***AQ-5: Odors (CEQA and NEPA)***
  Potential sources that may emit odors during construction activities would include diesel emissions from on- and off-road equipment. However, construction would be limited to relatively small footprints interspersed throughout the project area, and the number of diesel powered equipment would be limited to those indicated in Appendix F. Furthermore, not all diesel equipment are expected to be operating simultaneously. Therefore, construction emissions would be transient and would result in less than significant impact to odors.

- ***AQ-6: Greenhouse Gas Thresholds (CEQA)***
  As shown in Table 5-12, estimated GHG emissions would not exceed the 10,000 MT annual CO2e threshold for both raw values and the 30-year amortized values. Thus, the alternative would result in less than significant impacts.

Operational Impacts

Operational emissions would be similar to those characterized under Alternative 10. Impacts to all air quality significance thresholds would be less than significant.

Table 5-10 Alternative 13 Estimated Annual Emissions (Construction)

Pollutants	General Conformity Thresholds (tons/yr)	2017 Estimated Emissions (tons/year)	2018 Estimated Emissions (tons/year)	2019 Estimated Emissions (tons/year)	2020 Estimated Emissions (tons/year)	2021 Estimated Emissions (tons/year)	2022 Estimated Emissions (tons/year)	2023 Estimated Emissions (tons/year)	2024 Estimated Emissions (tons/year)	2025 Estimated Emissions (tons/year)	2026 Estimated Emissions (tons/year)
Ozone (VOC)	10	0	0.22	0.16	0.11	0.10	0.07	0.07	0.09	0.06	0.06
Ozone (NOX)	10	1	2.28	1.69	1.20	1.02	0.66	0.64	0.87	0.50	0.51
NO2	100	1	2.28	1.69	1.20	1.02	0.66	0.64	0.87	0.50	0.51
CO	100	1	1.45	1.09	0.77	0.75	0.62	0.63	0.85	0.60	0.57
PM10	100	0	0.12	0.08	0.06	0.06	0.04	0.03	0.04	0.03	0.03
PM2.5	100	0	0.11	0.07	0.05	0.05	0.03	0.03	0.03	0.02	0.02

Table 5-11 Alternative 13 Estimated Daily Emissions (Construction)

Pollutants	Regional Significance Thresholds (lbs/day)	Local Significant Thresholds (lbs/day)	2017 Estimated Emissions (lbs/day)	2018 Estimated Emissions (lbs/day)	2019 Estimated Emissions (lbs/day)	2020 Estimated Emissions (lbs/day)	2021 Estimated Emissions (lbs/day)	2022 Estimated Emissions (lbs/day)	2023 Estimated Emissions (lbs/day)	2024 Estimated Emissions (lbs/day)	2025 Estimated Emissions (lbs/day)	2026 Estimated Emissions (lbs/day)
VOC	75	n/a	2.90	7.45	5.68	2.53	4.57	2.50	1.74	3.31	1.72	1.87
NOX	100	46	32.47	77.96	58.18	26.89	45.97	23.89	16.69	30.75	14.95	16.90
CO	550	231	18.95	46.59	38.35	18.09	35.52	23.16	16.23	28.81	16.40	17.60
SO2	150	n/a	0.03	0.08	0.06	0.03	0.06	0.04	0.04	0.07	0.03	0.03
PM10	150	4	1.67	4.28	3.04	1.46	2.49	1.26	0.88	1.48	0.81	0.93
PM2.5	55	3	1.46	3.74	2.64	1.25	2.14	1.05	0.75	1.20	0.66	0.76
CO2e	n/a	n/a	3474	8142	5772	2844	5420	4153	3867	6841	2995	3217

Table 5-12 Alternative 13 Annual GHG Emissions (Construction and Operations)

Annual CO2e Emissions Sources	SCAQMD GHG Rates (MT/yr)	Annual Estimated Emissions (MT/year)
Construction	n/a	46
Maintenance	n/a	48
Visitations	n/a	2079
Total CO2e	10,000	2173

Alternative 13v

Alternative 13v would be constructed over a 10 year period starting in late 2017 and ending in mid 2027. Table 5-13 and Table 5-14 show the annual and daily emission estimates, respectively.

Construction Impacts

- ***AQ-1: General Conformity Applicability Rates (NEPA)***
  As shown in Table 5-13, estimated annual emissions would not exceed the General Conformity Applicability Rates. As a result, construction activities associated with this alternative would result in less than significant impacts.

  Alternative 13v is the NER. Per the Clean Air Act Applicability Analysis in Appendix F, a General Conformity Determination would not be required for the implementation of this alternative.

- ***AQ-2: Regional Significance Thresholds (CEQA and NEPA)***
  As shown in Table 5-14, estimated daily construction emissions would not exceed any RST. As a result, construction activities associated with this alternative would result in less than significant impacts.

- ***AQ-3: Cumulative Impacts (CEQA and NEPA)***
  The population in Los Angeles County is expected to increase in the future. Increases in population and housing could increase traffic, utility demands, and construction projects, which would all result in increased air pollution. Additionally, air pollutant emissions associated with past and present development and activities have contributed to local and regional air pollution. Several development projects in Los Angeles County could occur in the vicinity of the proposed project and alternatives during the same period and would contribute to cumulative effects. The estimated daily construction and operational emissions would not exceed any RSTs. Therefore, impacts to cumulative impacts would be less than significant.

- ***AQ-4: Localized Significance Thresholds (CEQA)***
  As shown in Table 5-14, estimated daily construction emissions would remain below LSTs for all construction years. Thus, impacts would be less than significant.

- ***AQ-5: Odors (CEQA and NEPA)***
  Potential sources that may emit odors during construction activities would include diesel emissions from on- and off-road equipment. However, construction would be limited to relatively small footprints interspersed throughout the project area, and the number of diesel powered equipment would be limited to those indicated in Appendix F. Furthermore, not all diesel equipment are expected to be operating simultaneously. Therefore, construction emissions would be transient and would result in less than significant impact to odors.

- ***AQ-6: Greenhouse Gas Thresholds (CEQA)***
  As shown in Table 5-15, estimated GHG emissions would not exceed the 10,000 MT annual CO2e threshold for both raw values and the 30-year amortized values. Thus, the alternative would result in less than significant impacts.

Operational Impacts

Operational emissions would be similar to those characterized under Alternative 10. Impacts to all air quality significance thresholds would be less than significant.

Table 5-13 Alternative 13v Estimated Annual Emissions (Construction)

Pollutants	General Conformity Thresholds (tons/yr)	2017 Estimated Emissions (tons/year)	2018 Estimated Emissions (tons/year)	2019 Estimated Emissions (tons/year)	2020 Estimated Emissions (tons/year)	2021 Estimated Emissions (tons/year)	2022 Estimated Emissions (tons/year)	2023 Estimated Emissions (tons/year)	2024 Estimated Emissions (tons/year)	2025 Estimated Emissions (tons/year)	2026 Estimated Emissions (tons/year)	2027 Estimated Emissions (tons/year)
Ozone (VOC)	10	0.007	0.11	0.07	0.10	0.11	0.09	0.04	0.08	0.06	0.09	0.05
Ozone (NOX)	10	0.08	1.32	0.78	1.09	1.18	0.98	0.44	0.80	0.08	0.21	0.14
NO2	100	0.08	1.32	0.78	1.09	1.18	0.98	0.44	0.80	0.08	0.21	0.14
CO	100	0.03	0.75	0.50	0.78	0.91	0.78	0.45	0.78	0.54	0.83	0.48
PM10	100	0.005	0.06	0.04	0.05	0.06	0.04	0.02	0.04	0.02	0.05	0.03
PM2.5	100	<0.005	0.05	0.03	0.04	0.05	0.03	0.01	0.03	0.02	0.04	0.02

Table 5-14 Alternative 13v Estimated Annual Emissions (Construction)

Pollutants	Regional Significance Thresholds (lbs/day)	Local Significant Thresholds (lbs/day)	2017 Estimated Emissions (lbs/day)	2018 Estimated Emissions (lbs/day)	2019 Estimated Emissions (lbs/day)	2020 Estimated Emissions (lbs/day)	2021 Estimated Emissions (lbs/day)	2022 Estimated Emissions (lbs/day)	2023 Estimated Emissions (lbs/day)	2024 Estimated Emissions (lbs/day)	2025 Estimated Emissions (lbs/day)	2026 Estimated Emissions (lbs/day)	2027 Estimated Emissions (lbs/day)
VOC	75	n/a	0.67	1.56	1.04	2.27	2.26	1.58	1.47	3.80	0.09	2.34	1.44
NOX	100	46	7.75	19.22	11.15	23.56	22.88	16.21	14.65	36.33	8.15	20.93	12.76
CO	550	231	3.10	10.60	8.70	16.36	17.93	11.77	11.35	34.00	6.95	20.09	13.09
SO2	150	n/a	0.01	0.02	0.01	0.02	0.02	0.02	0.02	0.05	0.02	0.04	0.02
PM10	150	4	0.44	0.89	0.55	1.22	1.23	0.74	0.67	1.90	0.36	1.05	0.68
PM2.5	55	3	0.34	0.77	0.48	1.06	1.05	0.64	0.58	1.60	0.30	0.80	0.56
CO2e	n/a	n/a	1296	2187	1168	2449	2744	2312	2312	5141	2115	4529	2399

Table 5-15 Alternative 13v Annual GHG Emissions (Construction and Operations)

Annual CO2e Emissions Sources	SCAQMD GHG Rates (MT/yr)	Annual Estimated Emissions (MT/year)
Construction	n/a	41
Maintenance	n/a	48
Visitations	n/a	2079
Total CO2e	10,000	2168

Alternative 16

Alternative 16 would be constructed over a 15 year period starting in 2018 and ending in 2032. Table 5-16 and Table 5-17 show the annual and daily emission estimates, respectively.

Emissions estimates for Alternative 16 were not based on detailed construction schedules as was done for Alternatives 13, 13v, and 20. However, Alternative 16 is a truncated variation of Alternative 20. As a result, appropriate construction phases entered into CalEEMod for Alternative 20 were deleted to estimate emissions for Alternative 16. See the Air Quality Technical Appendix (Appendix F) for additional information on deleted construction phases.

Construction Impacts

- ***AQ-1: General Conformity Applicability Rates (NEPA)***
  As shown in Table 5-16, estimated annual emissions would not exceed the General Conformity Applicability Rates. As a result, construction activities associated with this alternative would result in less than significant impacts.

- ***AQ-2: Regional Significance Thresholds (CEQA and NEPA)***
  As shown in Table 5-17, estimated daily construction emissions would not exceed any RST. As a result, construction activities associated with this alternative would result in less than significant impacts.

- ***AQ-3: Cumulative Impacts (CEQA and NEPA)***
  The population in Los Angeles County is expected to increase in the future. Increases in population and housing could increase traffic, utility demands, and construction projects, which would all result in increased air pollution. Additionally, air pollutant emissions associated with past and present development and activities have contributed to local and regional air pollution. Several development projects in Los Angeles County could occur in the vicinity of the proposed project and alternatives during the same period and would contribute to cumulative effects. The estimated daily construction and operational emissions would not exceed any RSTs. Therefore, impacts to cumulative impacts would be less than significant.

- ***AQ-4: Localized Significance Thresholds (CEQA)***
  As shown in Table 5-17, estimated daily construction emissions for NOx would exceed LST during construction in 2020, 2022, and 2023. Estimated emissions for CO, PM10, and PM2.5 would remain below LSTs for all construction years. Since, construction would take place within an urbanized setting including sensitive receptors, exceedence of NOx LST in 2020, 2022, and 2023 would result in significant impacts.

- ***AQ-5: Odors (CEQA and NEPA)***
  Potential sources that may emit odors during construction activities would include diesel emissions from on- and off-road equipment. However, construction would be limited to relatively small footprints interspersed throughout the project area, and the number of diesel powered equipment would be limited to those indicated in Appendix F. Furthermore, not all diesel equipment are expected to be operating simultaneously. Therefore, construction emissions would be transient and would result in less than significant impact to odors.

- *AQ-6: Greenhouse Gas Thresholds (CEQA)*
  As shown in Table 5-18, estimated GHG emissions would not exceed the 10,000 MT annual CO2e threshold for both raw values and the 30-year amortized values. Thus, the alternative would result in less than significant impacts.

Operational Impacts

Operational emissions would be similar to those characterized under Alternative 10. Impacts to all air quality significance thresholds would be less than significant.

Table 5-16 Alternative 16 Estimated Annual Emissions (Construction)

Pollutants	General Conformity Thresholds (tons/yr)	2018 Estimated Emissions (tons/year)	2019 Estimated Emissions (tons/year)	2020 Estimated Emissions (tons/year)	2021 Estimated Emissions (tons/year)	2022 Estimated Emissions (tons/year)	2023 Estimated Emissions (tons/year)	2024 Estimated Emissions (tons/year)	2025 Estimated Emissions (tons/year)	2026 Estimated Emissions (tons/year)	2027 Estimated Emissions (tons/year)	2028 Estimated Emissions (tons/year)	2029 Estimated Emissions (tons/year)	2030 Estimated Emissions (tons/year)	2031 Estimated Emissions (tons/year)	2032 Estimated Emissions (tons/year)
Ozone (VOC)	10	<0.005	0.13	0.01	0.01	0.22	0.21	0.10	0.10	0.06	0.06	0.05	0.10	0.07	0.08	0.14
Ozone (NOX)	10	<0.005	1.38	1.17	1.14	2.14	1.92	0.92	0.83	0.50	0.51	0.46	0.88	0.27	0.32	0.56
NO2	100	<0.005	1.38	1.17	1.14	2.14	1.92	0.92	0.83	0.50	0.51	0.46	0.88	0.27	0.32	0.56
CO	100	<0.005	0.85	0.80	0.84	1.77	1.82	0.90	0.92	0.66	0.64	0.50	0.96	0.64	0.54	0.87
PM10	100	<0.005	0.07	0.07	0.06	0.11	0.10	0.05	0.04	0.03	0.03	0.03	0.05	0.02	0.02	0.03
PM2.5	100	<0.005	0.06	0.06	0.05	0.09	0.08	0.04	0.03	0.02	0.02	0.02	0.04	0.01	0.01	0.02

Table 5-17 Alternative 16 Estimated Daily Emissions (Construction)

Pollutants	Regional Significant Thresholds (lbs/day)	Local Significant Thresholds (lbs/day)	2018 Estimated Emissions (lbs/day)	2019 Estimated Emissions (lbs/day)	2020 Estimated Emissions (lbs/day)	2021 Estimated Emissions (lbs/day)	2022 Estimated Emissions (lbs/day)	2023 Estimated Emissions (lbs/day)	2024 Estimated Emissions (lbs/day)	2025 Estimated Emissions (lbs/day)	2026 Estimated Emissions (lbs/day)	2027 Estimated Emissions (lbs/day)	2028 Estimated Emissions (lbs/day)	2029 Estimated Emissions (lbs/day)	2030 Estimated Emissions (lbs/day)	2031 Estimated Emissions (lbs/day)	2032 Estimated Emissions (lbs/day)
VOC	75	n/a	0.01	3.83	8.21	3.59	5.00	5.05	3.25	2.98	2.53	4.36	3.67	2.91	1.70	2.07	4.22
NOX	100	46	0.04	38.52	83.67	36.56	47.71	48.36	30.24	25.50	19.95	38.54	32.95	25.72	7.81	8.86	17.39
CO	550	231	0.17	25.37	59.37	29.02	41.55	45.42	28.35	27.16	26.24	39.56	35.77	26.40	14.73	18.47	31.22
SO2	150	n/a	<0.005	0.04	0.09	0.07	0.10	0.11	0.05	0.07	0.06	0.08	0.06	0.05	0.04	0.05	0.10
PM10	150	4	0.04	2.13	4.61	1.76	2.31	2.51	1.60	1.27	1.05	2.08	1.87	1.38	0.35	0.46	0.97
PM2.5	55	3	0.01	1.82	3.99	1.44	1.88	2.15	1.35	1.01	0.82	1.72	1.54	1.15	0.25	0.36	0.74
CO2e	n/a	n/a	40	3970	9043	6545	9775	10471	4824	6837	5752	7224	6132	5167	3897	4706	9631

Table 5-18 Alternative 16 Annual GHG Emissions (Construction and Operations)

Annual CO2e Emissions Sources	SCAQMD GHG Rates (MT/yr)	Annual Estimated Emissions (MT/year)
Construction	n/a	88
Maintenance	n/a	48
Visitations	n/a	2079
Total CO2e	10,000	2215

Alternative 20

Alternative 20 would be constructed over a 15 year period starting in 2018 and ending in 2032. Table 5-19 and Table 5-20 show the annual and daily emission estimates, respectively.

Construction Impacts

- ***AQ-1: General Conformity Applicability Rates (NEPA)***
  As shown in Table 5-19, estimated annual emissions would not exceed the General Conformity Applicability Rates. As a result, construction activities associated with this alternative would result in less than significant impacts.

  Alternative 20 is the Recommended Plan and the Locally Preferred Plan. Per the Clean Air Act Applicability Analysis in Appendix F, a General Conformity Determination would not be required for the implementation of this alternative.

- ***AQ-2: Regional Significance Thresholds (CEQA and NEPA)***
  As shown in Table 5-20, estimated daily construction emissions would not exceed any RST. As a result, construction activities associated with this alternative would result in less than significant impacts.

- ***AQ-3: Cumulative Impacts (CEQA and NEPA)***
  The population in Los Angeles County is expected to increase in the future. Increases in population and housing could increase traffic, utility demands, and construction projects, which would all result in increased air pollution. Additionally, air pollutant emissions associated with past and present development and activities have contributed to local and regional air pollution. Several development projects in Los Angeles County could occur in the vicinity of the proposed project and alternatives during the same period and would contribute to cumulative effects. The estimated daily construction and operational emissions would not exceed any RSTs. Therefore, impacts to cumulative impacts would be less than significant.

- ***AQ-4: Localized Significance Thresholds (CEQA)***
  As shown in Table 5-20, estimated daily construction emissions for NOx would exceed LST during construction in 2022, 2023, and 2024. Estimated emissions for CO, PM10, and PM2.5 would remain below LSTs for all construction years. Since, construction would take place within an urbanized setting including sensitive receptors, exceedence of NOx LST in 2022, 2023, and 2024 would result in significant impacts.

- ***AQ-5: Odors (CEQA and NEPA)***
  Potential sources that may emit odors during construction activities would include diesel emissions from on- and off-road equipment. However, construction would be limited to relatively small footprints interspersed throughout the project area, and the number of diesel powered equipment would be limited to those indicated in Appendix F. Furthermore, not all diesel equipment are expected to be operating simultaneously. Therefore, construction emissions would be transient and would result in less than significant impact to odors.

- ***AQ-6: Greenhouse Gas Thresholds (CEQA)***
  As shown in Table 5-21, estimated GHG emissions would not exceed the 10,000 MT annual CO2e threshold for both raw values and the 30-year amortized values. Thus, the alternative would result in less than significant impacts.

Operational Impacts

Operational emissions would be similar to those characterized under Alternative 10. Impacts to all air quality significance thresholds would be less than significant.

Table 5-19 Alternative 20 Estimated Annual Emissions (Construction)

Pollutants	General Conformity Thresholds (tons/yr)	2018 Estimated Emissions (tons/year)	2019 Estimated Emissions (tons/year)	2020 Estimated Emissions (tons/year)	2021 Estimated Emissions (tons/year)	2022 Estimated Emissions (tons/year)	2023 Estimated Emissions (tons/year)	2024 Estimated Emissions (tons/year)	2025 Estimated Emissions (tons/year)	2026 Estimated Emissions (tons/year)	2027 Estimated Emissions (tons/year)	2028 Estimated Emissions (tons/year)	2029 Estimated Emissions (tons/year)	2030 Estimated Emissions (tons/year)	2031 Estimated Emissions (tons/year)	2032 Estimated Emissions (tons/year)
Ozone (VOC)	10	<0.005	0.13	0.01	0.01	0.22	0.21	0.24	0.10	0.06	0.06	0.08	0.13	0.07	0.08	0.14
Ozone (NOX)	10	<0.005	1.38	1.17	1.14	2.14	1.92	2.16	0.83	0.50	0.51	0.71	1.14	0.27	0.32	0.56
NO2	100	<0.005	1.38	1.17	1.14	2.14	1.92	2.16	0.83	0.50	0.51	0.71	1.14	0.27	0.32	0.56
CO	100	<0.005	0.85	0.80	0.84	1.77	1.82	2.12	0.92	0.66	0.64	0.82	1.21	0.64	0.54	0.87
PM10	100	<0.005	0.07	0.07	0.06	0.11	0.10	0.12	0.04	0.03	0.03	0.04	0.06	0.02	0.02	0.03
PM2.5	100	<0.005	0.06	0.06	0.05	0.09	0.08	0.09	0.03	0.02	0.02	0.03	0.05	0.01	0.01	0.02

Table 5-20 Alternative 20 Estimated Daily Emissions (Construction)

Pollutants	Regional Significant Thresholds (lbs/day)	Local Significant Thresholds (lbs/day)	2018 Estimated Emissions (lbs/day)	2019 Estimated Emissions (lbs/day)	2020 Estimated Emissions (lbs/day)	2021 Estimated Emissions (lbs/day)	2022 Estimated Emissions (lbs/day)	2023 Estimated Emissions (lbs/day)	2024 Estimated Emissions (lbs/day)	2025 Estimated Emissions (lbs/day)	2026 Estimated Emissions (lbs/day)	2027 Estimated Emissions (lbs/day)	2028 Estimated Emissions (lbs/day)	2029 Estimated Emissions (lbs/day)	2030 Estimated Emissions (lbs/day)	2031 Estimated Emissions (lbs/day)	2032 Estimated Emissions (lbs/day)
VOC	75	n/a	0.01	3.83	8.21	3.59	5.00	5.05	6.77	2.98	2.53	4.36	1.99	3.80	1.70	2.07	4.22
NOX	100	46	0.04	38.52	83.67	36.56	47.71	48.36	59.25	25.50	19.95	38.54	18.02	32.50	7.81	8.86	17.39
CO	550	231	0.17	25.37	59.37	29.02	41.55	45.42	62.11	27.16	26.24	39.56	18.91	34.54	14.73	18.47	31.22
SO2	150	n/a	<0.005	0.04	0.09	0.07	0.10	0.11	0.14	0.07	0.06	0.08	0.04	0.08	0.04	0.05	0.10
PM10	150	4	0.04	2.13	4.61	1.76	2.31	2.51	3.19	1.27	1.05	2.08	1.00	1.78	0.35	0.46	0.97
PM2.5	55	3	0.01	1.82	3.99	1.44	1.88	2.15	2.53	1.01	0.82	1.72	0.80	1.41	0.25	0.36	0.74
CO2e	n/a	n/a	40	3970	9043	6545	9775	10471	13602	6837	5752	7224	3941	7928	3897	4706	9631

Table 5-21 Alternative 20 Annual GHG Emissions (Construction and Operations)

Annual CO2e Emissions Sources	SCAQMD GHG Rates (MT/yr)	Annual Estimated Emissions (MT/year)
Construction	n/a	100
Maintenance	n/a	48
Visitations	n/a	2079
Total CO2e	10,000	2227

Best Management Practices and Impact Avoidance Measures

In a letter dated November 18, 2013, the SCAQMD provided a number of recommendations to attenuate air quality impacts. The recommendations, modified as appropriate, would be implemented.

- Tier 4 equipment and haul trucks no older than 2010 would be utilized to the extent practicable during construction years when emissions are expected to exceed Local Significance Thresholds.

- Mobile Emission Attenuating Measures:
  - Provide temporary traffic controls such as a flag person, during all phases of construction to maintain smooth traffic flow.
  - Provide dedicated turn lanes for movement of construction trucks and equipment on-and off-site.
  - Reroute construction trucks away from congested streets or sensitive receptor areas.
  - Utilize electricity from power poles rather than temporary diesel or gasoline power generators to the extent practicable.

- Fugitive Dust Attenuating Measures:
  - Appoint a construction relations officer to act as a community liaison concerning on-site construction activity including resolution of issues related to PM10 generation.
  - Suspend all excavating and grading operations when wind speeds (as instantaneous gusts) exceed 25 miles per hour.
  - Require frequent street sweeping surrounding the project site to minimize fugitive dust emissions from track-out. All street sweeping shall use alternatively fueled sweepers that are equivalent to those specified in SCAQMD Rules 1186 and 1186.1.
  - Install wheel washers where vehicles enter and exit the construction site onto paved roads or wash off trucks and any equipment leaving the site each trip.
  - Apply water three times daily, or non-toxic soil stabilizers according to manufacturer's specifications, to all unpaved parking or staging areas or unpaved road surfaces.
  - Replace ground cover in disturbed areas as quickly as possible.
  - Apply non-toxic soil stabilizers according to manufacturers' specifications to all inactive construction areas (previously graded areas inactive for ten days or more).

5.3 LAND USE

5.3.1 Regulatory Framework

Land use in the study area is managed according to Federal, state, regional, and local policies. Because these policies create land use patterns in the study area, they are described in detail in the Affected Environment section (Section 3.3).

The Cities of Los Angeles and Glendale adopted the State of California CEQA Guidelines (Title 14, California Code of Regulations, Sec. 15000 et seq.) as the CEQA Guidelines for their cities in 2002, and 2003, respectively (City of Los Angeles 2002, City of Glendale 2003). The significance criteria provide the thresholds to identify the impacts of land use actions, land use consistency, and land use compatibility. These criteria are identified in the environmental checklist from the CEQA Guidelines. Although the City of Burbank has not formally adopted the state CEQA Guidelines, it has used the significance criteria from the state in recent CEQA analyses, including the EIR for the updated General Plan 2035 (City of Burbank 2013c). These criteria are applicable when determining the potential impacts of implementing any of the proposed project alternatives.

5.3.2 Significance Criteria

A significant adverse impact would be considered to occur if the following resulted per the CEQA guidelines:

- Permanent inconsistencies with the adopted land use/density designation in the General Plan, Community Plan, LA-RIO district, redevelopment plan, specific plan for the site, or adopted habitat conservation plan or natural community conservation plan, or

- The introduction of permanent features that would physically divide an existing neighborhood or community.

5.3.3 Environmental Impacts

No Action Alternative

Construction Impacts

Under the No Action Alternative, no construction efforts would be undertaken and there would be no impacts to land use. Future land use would be controlled through existing regulatory, community, and master planning efforts. Per the City's General Plan (City of Los Angeles 2009), the study area is essentially built out, and future development would involve recycling of land. Furthermore, annual growth in population for the study area is projected to decline to less than 0.3% over the next 25 years (LAEDC 2012). No large-scale changes to land use patterns are anticipated under the No Action Alternative.

Operation Impacts

Under the No Action Alternative, land use would continue to be regulated and guided via Federal, state, regional, and local guidance, general plans, master planning, ordinances, and land use zoning plans. Land use zoning is expected to remain the same without implementation of restoration. Industrial, commercial, and residential areas would continue to occupy their current extent, or changes in zoning would be

controlled via jurisdictional guidance. Continued deterioration of land use conditions could occur if parcels not utilized for restoration, such as abandoned buildings, vacant lots, and undeveloped parcels along the River, are not rehabilitated or restored independently.

Land uses within the study area under future without-project conditions would be similar to existing conditions in areas where the land uses in the vicinity of the River are primarily zoned for single-family residential, parks and open space, and specific planned commercial uses; these include large areas of Reaches 1-3 in Los Angeles and Burbank, and areas of Reaches 4-6 within and adjacent to Griffith and Elysian Parks.

The Hollywood Community Plan was updated in June 2012, but no significant land use changes were proposed within the study area; therefore, land uses would remain relatively stable. The City of Burbank's new general plan, referred to as the Burbank2035 General Plan was adopted in 2013 (City of Burbank 2013b) but does not include significant changes in land uses within the study area compared to the previous general plan. The City of Glendale is continuing several master planning efforts within the study area; these include the Bicycle Transportation Plan that contains areas within Reaches 1-3. These improvements, designed to address non-motorized transportation, are applicable to the entire city as well as the study area; these planning efforts would occur with or without the proposed project.

The City of Los Angeles has adopted new land use plans and use districts within the study area, such as the Cornfield Arroyo Seco Specific Plan, Northeast Los Angeles Riverfront District, and LA-RIO District, as described in Section 3.3, which may reasonably be anticipated to lead to land use, landscaping, and design standard transitions within the study area in the absence of any Federal action.

The Boyle Heights Community Plan is currently being updated, and the community has dual goals of preserving industrial uses and jobs while increasing parks, recreation and open space options in the community. The Boyle Heights Community Plan is the effective Land Use Element for Boyle Heights in the City of Los Angeles General Plan.

Open space, parks, and recreation would continue to be limited in the study area. Non-Federal actions to introduce parks or conduct small scale restoration would incrementally increase recreational land use value to the area, but would occur slowly, incurring only minimal benefits to land use.

Alternative 10

Construction and Operational Impacts

General plans, and community and specific plans, may include policies concerning the short term impacts of noise, traffic, air quality, and other resource areas that result from construction and related temporary project implementation activities. However, land use objectives, goals, and policies typically concern the permanent use of the land; the general plans and applicable community plans within Reaches 1-8 do not address land use impacts from construction activities. Establishment of staging sites for construction may alter land uses within the reaches temporarily, but these impacts would be short term, and any adverse land use impacts related to construction activities would be less than significant.

Implementation of any of the measures in Alternative 10 would result in changes to the environment and would convert lands to restoration area.

None of the measures would construct permanent features that would divide an existing community. Specific land use impacts of construction of restoration features and operation of the resulting restoration are considered together by reach, below.

Reaches 1-3

The Hollywood Community Plan is the largest community plan of those that encompass the River channel. This plan contains Open Space and Public Facilities land use designations within Reaches 1-3, and was updated in June 2012. The Open Space designation allows for park and recreational uses, and includes Griffith Park and lands adjacent to and within the river channel. The Public Facilities designation reflects the public ownership, access and operation of infrastructure and primarily includes existing freeway right-of-way areas but also includes lands adjoining the channel that are subject to riparian and channel restoration and improvement measures. The measures implemented within Reaches 1-3 in this Alternative would be consistent with these land use designations. In addition, they would be consistent with policies in the Hollywood Community Plan for public improvements, including Public Improvements Policy 2 supporting the creation of a Los Angeles River Greenbelt to be integrated with existing and proposed parks, trails, and scenic routes. Therefore, no land use impacts from implementation of the measures within Reaches 1-3 would occur (City of Los Angeles 2012).

The City of Glendale borders portions of Reaches 2 and 3. Restoration measures in this Alternative would not extend into the City of Glendale; therefore no impacts to City of Glendale land use designations, including Single Family Residential and Industrial, would occur along these reaches. In addition, no impacts would occur to the goals and objectives in the Bicycle Transportation Plan since the proposed Class I bicycle trail would occur on the opposite side of the River channel from the restoration measures (City of Glendale 2012).

Operation of the measures in Reaches 1-3 would occur adjacent to or in the immediate vicinity of existing recreational and open space land uses, such as the Ferraro Sports Complex and the Los Angeles Zoo; however, the measures would not result in conflicts with these land uses nor affect their viability.

Reaches 4-6

Restoration measures would be consistent with the Open Space and Public Facilities land use designations in the Northeast Los Angeles and Silver Lake-Echo Park-Elysian Valley Community Plans where they would occur, and no land use impacts would result.

Measures in Reach 4 would include a side channel along the edge of the Harding Golf Course and a river diversion into the Los Feliz Golf Course as well as eight daylighted streams. The land area to be affected by implementation of these measures is designated for Open Space and Public Facilities. Implemented measures would be consistent with these uses; therefore potential adverse impacts to land use would be less than significant.

Restoration in Reach 5 would consist of a riparian corridor along the east bank and a daylighted stream. These measures would be implemented on lands designated as Open Space and Public Facilities in the Northeast Los Angeles Community Plan, and would not conflict with these uses. Therefore, potential adverse land use impacts would be less than significant.

Restoration measures in Reach 6 would include increasing riparian habitat by at least 80 acres in the channel, at the Bowtie site and through widening of the river at the Taylor Yard parcel. Although much of the Taylor Yard site has been converted into the Rio de Los Angeles State Park, a narrow band of industrial land remains between the western boundary of the park and the River channel. Although the land has been traditionally used for industrial purposes, it currently has a land use designation of Open Space and Public Facilities in the Northeast Los Angeles Community Plan. Use of this land for channel improvements and riparian restoration measures would be consistent with the Open Space and Public Facilities land use designations. In addition, the Northeast Los Angeles Community Plan includes specific

goals and policies, including Open Space Policy 4-2.1 and Recreation and Park Facilities Policy 5-2.1, to promote open space and recreation uses and increase public access along the River. Further, implementation of the measures would still allow for the operation of the active rail operations located between Reach 6 and the state park. On the western side of the River channel in Reach 6, within the Silver Lake-Echo Park-Elysian Valley Community Plan Area, restoration measures would not extend beyond the river channel. Therefore, land use impacts would be less than significant (City of Los Angeles 2007).Existing land uses within Reaches 4-6, including the rail operations adjacent to Taylor Yard, would also not be adversely impacted by operation of the measures in a manner that would render them obsolete. Therefore, land use impacts would be less than significant.

Reaches 7 -8

In Reach 7, three streams currently encased in culverts/stormdrains would be daylighted. Two of these, located on the west side of the River, would occur in areas designated as Open Space and Public Facilities, and would be consistent with these land use designation. The third is located on the east side of the River in an area designated as Hybrid Industrial. Permitted uses in Hybrid Industrial zones include conservation and environmental uses. The proposed daylighted storm drain would be consistent with this land use designation. Land use impacts in Reach 7 would be less than significant.

Within Reach 8, a portion of the LATC site would be converted to riparian habitat. This site is located within the Boyle Heights Community Plan Area. According to this Plan, the land use designation within the site is Industrial, reflecting the current use of the site as a container transfer facility and rail yard. Conversion of the site to riparian habitat would conflict with the Industrial land use designation, as well as specific goals and policies concerning industrial land uses in the Plan. These include Industrial Objectives 1 and 2, which aim to preserve industrial lands for industrial uses to preserve employment and tax-base revenue, and Policy 4 which calls for industrial areas north of the I-10 and west of I-5 to be maintained and improved as a means of providing revenue for the City and employment opportunities for its residents (City of Los Angeles 2007). Because the conversion of the site would conflict with the Industrial land use designation, implementation of restoration measures within Reach 8 would result in a significant adverse impact to land use. In addition to impacts at the LATC site, an area zoned as Light Industrial would be affected by conversion to riparian habitat. This land is located adjacent to and north of LATC, and is currently occupied by four small businesses. Conversion of this land to riparian habitat would be inconsistent with this land use designation and would constitute a significant adverse impact to land use. Significant impacts associated with changes in land use would be permanent and will continue during operation.

Indirect Effects of and Related Actions to Construction and Operation

Under each of the action alternatives, the LATC site functions are anticipated to be relocated within the Los Angeles Basin. Siting is anticipated to occur where land is already zoned industrial and thus would not result in a change to land use; therefore, impacts to land use due to relocation of site functions are anticipated to be less than significant. The LATC site functions may be relocated at an existing facility that will be expanded, or at a new site, but in either case would be anticipated to be relocated within an industrial zone with reasonable access to UPRR rail lines. All applicable general plans and land use regulations would be considered for any future site prior to site selection. Any conflicts with surrounding land uses would be identified during project-specific CEQA analysis that would be performed to determine potential impacts resulting from relocation of the site functions. Should any additional NEPA documentation be required, it would be undertaken by the NEPA lead agency. These effects are anticipated to be the same for all action alternatives.

Because the conversion to riparian habitat of a portion of the existing LATC site would likely preclude the railroad from continuing its current use on the remainder of the parcel not required for the project, the remainder would be anticipated to be utilized for other purposes by the City or sold for private use as industrial, commercial, or residential. Use by the City for public purposes or by others for commercial or residential use would result in conversion of land use on that portion of the site in addition to the portion required for the project, with that conversion constituting a significant impact. However, the site would have to be rezoned before such conversion could take place. These impacts are anticipated to be the same for all action alternatives.

Alternative 13

Construction and Operational Impacts

Land use impacts from construction and operation would be similar to those under Alternative 10, with a larger footprint.

In Reaches 1, 2, 4, 5, and 8, the measures and impacts would be the same as under Alternative 10. Impacts in Reach 8 would be significant due to the conflict with the Industrial land use designation.

Under this alternative in Reach 3, measures in addition to the 3 daylighted streams in Alternative 10 would include side channel creation with riparian habitat at Ferraro Fields and a freshwater marsh at the confluence of the side channel with the river. These measures would occur in lands designated as Open Space and Public Facilities in the Hollywood Community Plan. Measures would be consistent with these uses; therefore implementing these measures would not constitute a significant adverse land use impact in Reach 3. Restoration measures in Reach 3 in Alternative 13 would not extend into the City of Glendale, therefore no impacts to City of Glendale land use designations, including Single Family Residential and Industrial, would occur.

In Reach 6, relative to Alternative 10, this alternative would add reconfiguration and widening of the channel into the westernmost portion of Taylor Yard, with the channel widened 300 feet instead of 80 feet. However, similar to Alternative 10, potential land use impacts would be less than significant since these lands are designated for Open Space and Public Facilities uses and would not disrupt the railroad operations between the Taylor Yard and the Rio de Los Angeles State Park.

Restoration measures within Reach 7 would be different than under Alternative 10, and would consist of restructuring Los Angeles River channel walls to support vines and other vegetation, and softening the bed and banks of the Arroyo Seco tributary for one-half mile upstream and restoring a backwater wetland at the confluence with the River. Restoration at the Arroyo Seco confluence and on the main channel banks would occur in areas designated as Open Space and Public Facilities in the Cornfield Arroyo Seco Specific Plan. The proposed restoration at these locations would be consistent with these land use designations. Implementing these restoration measures would not constitute a significant adverse land use impact in Reach 7.

Alternative 16

Construction and Operational Impacts

Restoration measures in Reaches 1-4, 6 and 7 would be the same as Alternative 13; therefore, impacts in these reaches would be the same.

Measures in Reach 5 would include additional channel widening and terracing. These measures would not affect land uses differently than Alternatives 10 and 13, and would be consistent with the respective

community plans applicable to those reaches, because widening of Reach 5 occurs within the existing channel right of way, with only channel geometry changed. Therefore, potential adverse land use impacts would be less than significant.

In Reach 8, the measures would be more extensive than Alternatives 10 and 13, and would include the reconfiguration and widening of the main channel, including increasing the channel invert width up to 500 feet and construction of a 1,000-foot wide bench into the LATC, as well as modifications to the left bank downstream of LATC and the right bank upstream of LATC. Within the channel itself, the concrete would be removed and the bed would be naturalized. The additional channel wall modifications and in-channel work in Reach 8 would occur in areas designated as Open Space and would be consistent with that use, and would not constitute a significant impact. In Reach 8, existing rail lines along the LATC parcel would require trestling to facilitate project construction and operation. Existing rail lines are anticipated to be trestled at grade and would not result in a change in land use. As in Alternatives 10 and 13 conversion of the LATC site and adjacent lands from Industrial and Light Industrial uses to open space is inconsistent with community plans and constitutes a significant adverse impact on land use. Significant impacts associated with changes in land use would be permanent and will continue during operation.

Alternative 20

Construction and Operational Impacts

Restoration measures in Reaches 1-2 and 5-6 would be the same as Alternative 16; therefore, land use impacts in these reaches would be less than significant. Restoration measures in Reach 8 would be the same as Alternative 16; therefore, land use impacts in this reach would be significant and adverse. Significant impacts associated with changes in land use would be permanent and will continue during operation.

Reach 3

Restoration measures on the left bank of the River along the lower part of Reach 3 would be more extensive than those in Alternatives 10, 13, and 16, and would impact lands designated as Industrial in the Verdugo Wash area of the Northeast Los Angeles Community Plan and in the City of Glendale. Active industrial uses currently in operation within the proposed restoration area would not be able to continue to exist at the site with the restoration measures included in this alternative. Approximately 11 businesses in Reach 3 would be displaced by the project. Restoration measures in Reach 3 in this alternative would result in the permanent conversion of land designated as Industrial to a non-industrial use. This would conflict with the designated Industrial use definition for those lands, resulting in a significant adverse impact to land use.

Reaches 7

Measures in Reach 7 under Alternative 20 would include all measures in Alternative 10 (daylighted streams) and some of the measures in Alternative 13 (restoring the Arroyo Seco confluence) but would exclude the measures in Alternative 13 for restructuring of the channel walls to include overhanging vines. As discussed for those alternatives, the measures from Alternative 10 and 13 that are included in Alternative 20 would not result in significant adverse impacts, as the measures would be consistent with the land use designation. In addition, Alternative 20 would include restoration measures at and adjacent to the Los Angeles State Historic Park (Cornfields) site that would occur on lands designated as Open Space and Hybrid Industrial in the Cornfield Arroyo Seco Specific Plan. Approximately two businesses in Reach 7 would be displaced by construction; however, the restoration use would be consistent with the land use designation. Permitted uses in Hybrid Industrial zones include conservation and environmental uses. The proposed restoration activities would be consistent with this land use designation in the

Cornfield Arroyo Specific Plan. Reach 7 construction, similar to Reach 8 construction, also requires alteration of existing rail lines (trestling at grade) by the sponsor along the LA State Historic Park but would not discontinue the current rail use. Land use impacts in Reach 7 would therefore be less than significant. The effects of land use conversion will continue for the life of the project. There will be beneficial effects to lands designated as open space as the areas become restored.

5.3.4 Best Management Practices and Impact Avoidance Measures

BMPs for protection of land use may be provided through the application of community plans. Local communities will have the opportunity to evaluate land uses and this may assist in identifying the best measures for avoiding impacts to land use.

In Reach 3 under Alternative 20, the conversion of lands in the Verdugo Wash area for River restoration measures could displace existing industrial operations on land designated for industrial purposes, per the Northeast Los Angeles Community Plan. The Northeast Los Angeles Community Plan is the effective Land Use Element for the Northeast CPA. The City of Los Angeles, as part of its efforts to address changing land uses in the area, may conduct an analysis of the Industrial land designations adjacent to, and in the vicinity of, the River. The City of Los Angeles is developing a Vision Plan and Economic Development Strategy for the Northeast Los Angeles Riverfront District. The boundaries of this district contain the Verdugo Wash at the northernmost point and the Los Angeles State Historic Park at the southernmost point. The Vision document aims to highlight the northeast Los Angeles River landscape by creating a continuous, linear, recreational experience. This analysis would examine the continued viability of industrial land uses near the River corridor, and suggest modifications of land use designations, goals, and policies, in the Northeast Los Angeles Community Plan where appropriate. This analysis would include potential impacts on current industrial land uses and suggest modifications of land use policies to ensure that these uses can continue as River restoration measures are implemented.

In Reach 8 under all the alternatives, the proposed River restoration measures occurring at LATC would displace the existing industrial container rail operations, thus potentially reducing the viability of other industrial uses within the Boyle Heights and Lincoln Heights communities. The Boyle Heights Community Plan is currently being updated, and the community has dual goals of preserving industrial uses and jobs while increasing parks, recreation and open space options in the community. The Boyle Heights Community Plan is the effective Land Use Element for Boyle Heights in the City of Los Angeles General Plan.

5.4 WATER RESOURCES

5.4.1 Regulatory Framework

Clean Water Act

The Clean Water Act (CWA) governs discharge of dredge or fill materials into the waters of the United States and it governs pollution control and water quality of waterways throughout the U.S. Its intent, in part, is to restore and maintain the biological integrity of the nation's waters (33 U.S.C. 1251 et seq). It provides standards and enforcement, a number of regulatory programs with permits and licenses, grants, and revolving funds, as well as general provisions and provisions for research and related programs. Relevant sections are Sections 401, 402, and 404.

Section 401(a)(1) of the CWA, 33 U.S.C. § 1341(a)(1), provides that "[a]ny applicant for a Federal license or permit to conduct any activity including, but not limited to, the construction or operation of

facilities, which may result in any discharge into the navigable waters, shall provide the licensing or permitting agency a certification from the State in which the discharge originates or will originate…that any such discharge will comply with the applicable provisions of sections 1311, 1312, 1313, 1316, and 1317 of this title." The State of California has authority to give such a certification, which it has delegated to the Regional Water Quality Control Boards. A Section 401 water quality certification will be required for the restoration measures. An application for a Section 401 water quality certification has been submitted to the Los Angeles Regional Water Quality Control Board.

Section 402 establishes the National Pollutant Discharge Elimination System (NPDES). Pursuant to Section 402 and the state General Construction Storm Water Permit, a NPDES permit would be required for any project construction activities that would result in the disturbance of one or more acres. Generally, the construction contractor would be required to prepare a Storm Water Pollution Prevention Plan (SWPPP) which would be filed along with a Notice of Intent (NOI) and other compliance related documents with the State Water Resources Control Board (State Water Board). The SWPPP must be prepared by a Qualified SWPPP Developer (QSD) before construction commences. The SWPPP would contain a visual monitoring program, and a water quality monitoring program for non-visible pollutants to determine construction site BMP effectiveness. The SWPPP would list all BMPs to be implemented during construction activities.

Section 404 addresses discharges of dredged or fill material to waters of the United States. Waters of the U.S., defined at 33 Code of Federal Regulations (C.F.R.) Part 328, include coastal and inland waters, lakes, rivers, and streams, including adjacent wetlands and tributaries. The U.S. Environmental Protection Agency's Section 404(b)(1) Guidelines (40 C.F.R. Part 230) are the substantive environmental criteria used by the Corps to evaluate project impacts to waters of the U.S. The Corps does not issue itself permits for Corps Civil Works projects but must comply with the 404(b)(1) guidelines. Unless exempt under section 404(r) of the Clean Water Act, the 404(b)(1) guidelines prohibit the Corps from undertaking a project unless it is the LEDPA. The LEDPA is the practicable alternative that is least damaging to the aquatic ecosystem. The term "practicable" is defined in 40 CFR 230.10(a)(2) as: "[a]n alternative … available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes." An analysis of impacts on waters of the United States is included at Appendix M of this IFR.

National Flood Insurance Act

This act established the Federal flood insurance program, prior to which, affordable private flood insurance was generally not available. Under the National Flood Insurance Program, Federally subsidized flood insurance is made available to owners of flood-prone property in participating communities. Administered by the Federal Insurance Administration of the Federal Emergency Management Agency (FEMA), participating communities are required to adopt certain minimum floodplain management standards, including restrictions on development in designated floodways, a requirement that new structures in the 100-year flood zone be elevated to or above the 100-year flood level (known as base flood elevation), and a requirement that subdivisions are designed to minimize exposure to flood hazards (NOAA 2006). Any work that may affect the flood elevations would be coordinated with FEMA.

Executive Orders

EO 11988, Floodplain Management, was issued on May 24, 1977, to avoid to the extent possible the long- and short-term adverse impacts of occupying and modifying floodplains and to avoid direct or indirect support of floodplain development wherever there is a practicable alternative. An analysis documenting compliance with EO 11988 is included in Chapter 10 of this IFR.

EO 11990, Protection of Wetlands, issued on May 24, 1977, helps avoid the long-term and short-term adverse impacts associated with destroying or modifying wetlands and avoiding direct or indirect support of new construction in wetlands when there is a practicable alternative.

Porter-Cologne Water Quality Control Act

The Porter-Cologne Water Quality Control Act established the State Water Board, which has the ultimate authority over state water rights and water quality policy. It also established nine regional boards to oversee water quality on a day-to-day basis at the local or regional level. The regional boards develop and update their respective basin plans, which are used to address beneficial uses, water quality standards for both surface water and groundwater, and measures necessary to control point and nonpoint sources. The regional boards regulate all pollutant or nuisance discharges that may affect either surface water or groundwater. The Porter-Cologne Act also applies to nonpoint as well as point source discharges. It establishes an administrative permitting authority, in the form of waste discharge requirements, waiver of these requirements, or basin plan prohibitions, to be used to control nonpoint source discharges (California Regional Water Quality Control Board 2004). Within the study area, stormwater management plans and authorizations are coordinated with the Los Angeles Regional Water Quality Control Board, along with the City and Los Angeles County.

California Fish and Wildlife Code, Sections 1600-1607

Sections 1600 through 1607 regulate work that would substantially divert, obstruct, or change the natural flow of a river, stream, or lake; that would substantially change the bed, channel, or bank of a river, stream, or lake; or that would use material from a streambed.

Local Regulations

In December 2012, the Los Angeles Regional Water Quality Control Board reissued a Municipal Separate Storm Sewer System (MS4) NPDES Permit (No. R4-2012-0175). The update of the previous NPDES permit, which was issued in 2001, focuses on permit governance structure, core stormwater management program requirements, and incorporation of TMDLs. It includes a program for developing Watershed Management Plans and Enhanced Watershed Management Plans, which will allow permittees to develop customized strategies, control measures, and BMPs to address watershed priorities, which include complying with receiving water limitations, TMDL provisions, prohibitions on non-storm water discharges, and minimum control measures.

5.4.2 Significance Criteria

The following thresholds of significance are based on CEQA guidelines. A project would be considered to have a significant impact if it would cause the following to occur:

- WQ Significance Criterion 1: Violation of any water quality standard or waste discharge requirements.
- WQ Significance Criterion 2: Substantial depletion of groundwater supplies or substantial interference with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted).
- WQ Significance Criterion 3: Substantial change to the existing drainage pattern of the study area, including the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site.

- WQ Significance Criterion 4: Creation or contribution to runoff that exceeded the capacity of existing or planned stormwater drainage systems or introduced substantial additional sources of polluted runoff.
- WQ Significance Criterion 5: Located housing within a 100-year flood hazard area as mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map.
- WQ Significance Criterion 6: Located structures where they would impede or redirect flood flows.
- WQ Significance Criterion 7: Resulted in greater exposure of people or structures to a significant risk of loss, injury or death involving flooding including flooding as a result of the failure of a levee or dam.
- WQ Significance Criterion 8: Increased the risk of inundation of the study area by seiche, tsunami or mudflow,
- WQ Significance Criterion 9: Increase in the water surface elevation of peak flows in the River.
- WQ Significance Criterion 10: Substantial changes to the amount of surface water in the River, including both diminished or increased flow.
- WQ Significance Criterion 11: Resulted in a permanent, adverse change to the movement of surface water sufficient to produce a substantial change in the current or direction of water flow.
- WQ Significance Criterion 12: Created pollution, contamination, or nuisance, as defined in Section 13050 of the California Water Code.
- WQ Significance Criterion 13: Caused regulatory standards to be exceeded, as defined in the applicable NPDES permit or water quality standards in the Los Angeles Regional Water Quality Control Board's Basin Plan.
- WQ Significance Criterion 14: Change potable water levels sufficiently to reduce the ability of a water utility to use the groundwater basin for public water supplies, conjunctive use purposes, imported water storage, summer/winter peaking, or to respond to emergencies and drought.
- WQ Significance Criterion 15: Reduction in yields of adjacent wells or well fields (public or private).
- WQ Significance Criterion 16: Adversely altered the rate or direction of flow of groundwater.
- WQ Significance Criterion 17: Resulted in demonstrable and sustained reduction of groundwater recharge capacity.

5.4.3 Environmental Impacts

No Action Alternative

Construction Impacts

No impacts to water resources would occur from construction under this alternative because construction would not occur.

Operational Impacts

Hydrologic, water quality, and groundwater conditions within the study area will continue changing based on population pressures, new and continuing regulations, and future climate conditions. The hydrologic regime in the study area will continue to be characteristic of urban environments with high peak flows and short durations, with resultant peaks in pollutants that quickly dissipate to normal levels. Although increased population density and impervious areas within the watershed, upstream of and on tributaries within the study area, could potentially increase these conditions, measures within the Los Angeles County MS4 Permit are designed to curtail this potential. New regulations that serve to implement development and redevelopment requirements for hydro-modification/low-impact development practices,

which are designed to capture on-site runoff primarily through infiltration and diversions, could decrease future impacts due to urbanization. Current climate change studies have indicated a likely increase in the frequency of extreme weather conditions in the future. These extreme weather events could compound and increase watershed peak flows.

Water quality impairments within the watershed are primarily being addressed through the TMDL process. TMDL implementation plans, which serve to identify best management practices (BMPs) to reduce water quality impairments and meet watershed beneficial uses have been developed and incorporated into the renewed Los Angeles County MS4 permit (Los Angeles County 2012a) for several reaches of the study area. Watershed water quality conditions have undergone extensive scrutiny and analysis in the past few decades due to public awareness and the participation of watershed stakeholder groups. Though increased urbanization within the watershed has been correlated with degraded water quality conditions, watershed stakeholders have helped to develop current regulations to improve these conditions. Newly required hydro-modification and low-impact development regulations are also contributing to the reduction of watershed contaminants through the containment and treatment of urban runoff.

Groundwater conditions within the watershed are impaired due to historic land use contaminants that have persisted in the water table. Treatment facilities have been established to treat groundwater contamination, which will improve conditions over time. Like surface water quality, public awareness and watershed stakeholder groups have helped develop regulations to protect groundwater from further degradation. If improperly managed, population growth within the study area has the potential to create higher demands for water use in the region and further degrade the basin's ability to naturally recharge water. In recognition of the potential for higher water demand in the future the State Water Resources Control Board adopted a Recycled Water Policy (2009) promoting the increased use of recycled water from local municipal wastewater sources as well as the increased capture and use of storm water. The policy also requires that management measures be developed to protect groundwater basin water quality, which may be impacted by the increase in recycled water use.

Surface water quality pollution in the River channel and tributaries would be expected to continue to improve due to ongoing efforts to meet required regulatory pollutant reductions. Groundwater areas contaminated by persistent contaminants from historic land use activities would also continue to slowly improve over time due to implemented groundwater treatment BMPs. The majority of groundwater supply in the study area would continue to come from the Upper Los Angeles River Area groundwater basin. Groundwater basins would continue to be recharged and managed to support future water resource uses. Surface and groundwater water quality improvements due to management activities would continue to improve to the extent feasible under the No Action Alternative, or as water quality program funding permits. However, the Los Angeles River is a highly urbanized and degraded system. Due to pollution impacts traced to highly urbanized and industrial land use activities located in the watershed, water quality problems will likely persist at measurable levels.

Under the No Action Alternative, restoration measures would not be constructed; therefore, the potential for operation impacts would be non-existent.

Alternative 10 (ART)

Impacts to water resources may occur from construction efforts or from the operation of the completed project. Construction of Alternative 10 would consist of daylighting streams currently encased in culverts, restoring riparian corridors along River and tributary overbank areas, widening of the river channel in Reach 6 at Taylor Yard, and restoration of a historic wash and riparian habitat within the LATC site, along with removal of invasive vegetation throughout the project footprint.

Overall, temporary impacts incurred during the construction phase could be adverse although not significant, while greater beneficial impacts are anticipated once the project is complete. Potential impacts are described below for construction and operation of the project.

Clean Water Act Section 401 water quality certification and enrollment in the State of California's General NPDES Permit for Discharges of Storm Water Associated with Construction Activity would be required for this alternative. Before land disturbance of one acre or greater occurs or less than one acre but part of a larger common plan of development, the construction contractor would need to complete and submit a NOI to the State Water Board to obtain coverage under the permit. The SWPPP would be required to be prepared by a QSD before construction commences. The SWPPP would contain a visual monitoring program, and a water quality monitoring program for non-visible pollutants to determine construction site BMP effectiveness. The SWPPP would list all BMPs to be implemented during construction activities.

Construction Impacts

WQ Significance Criterion 1: Violation of any water quality standard or waste discharge requirements.

As discussed under WQ Significance Criterion 12 and WQ Significance Criterion 13, construction would not violate any water quality standard or waste discharge requirements. Impacts would be less than significant.

WQ Significance Criterion 2: Substantial depletion of groundwater supplies or substantial interference with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted).

The alternative would discharge permanent fill material into existing waters of the U.S. However, the fill material would not result in an increase of impermeable surfaces. Excavated concrete would be replaced with either soil backfill or rocks. Furthermore, the alternative would create new, soft bottom waters of the U.S., resulting in an increase of permeable surface areas to enhance groundwater recharge functions. Furthermore, the alternative would not require installation of wells to pump groundwater. As a result there would be no substantial depletion of groundwater supplies or interference with groundwater recharge. Impacts would be less than significant.

WQ Significance Criterion 3: Substantial change to the existing drainage pattern of the study area, including the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site.

The alternative would not result in changes in the number, size or capacity of drainages discharging into the River. The existing drainage area would remain unchanged. Thus, there would be no increase in base flow that could result in substantial erosion or siltation. Portions of the River would be widened. However, the modifications would not alter the course of the River since the majority of the River is fixed in place due to channelization. There would be no substantial change to the existing drainage pattern. Impacts would be less than significant.

WQ Significance Criterion 4: Creation or contribution to runoff that exceeded the capacity of existing or planned stormwater drainage systems or introduced substantial additional sources of polluted runoff. The study area is located within a fully developed urban area which drains into the River. The alternative would not entail construction on previously undeveloped areas that would increase the drainage area.

Furthermore, conversion of existing industrial areas to riparian areas would decrease additional sources of polluted runoff. Impacts would be less than significant.

WQ Significance Criterion 5: Located housing within a 100-year flood hazard area as mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map. This alternative entails construction of ecosystem restoration features in the River and adjacent areas. No housing developments would be constructed. There would be no impact.

WQ Significance Criterion 6: Located structures where they would impede or redirect flood flows.

The alternative would not result in placement of structures that would impede or redirect flood flows.

As discussed in WQ Significance Criterion 7, hydrologic features would not be significantly affected by measures proposed under Alternative 10. Modifications to the channel will not increase the maximum water surface elevation. Modifications to the channel are not expected to result in substantial changes to water velocity and circulation. Impacts would be less than significant.

WQ Significance Criterion 7: Resulted in greater exposure of people or structures to a significant risk of loss, injury or death involving flooding including flooding as a result of the failure of a levee or dam.

During construction, hydrologic features would not be adversely affected. It is assumed that instream construction and modification of the project reaches would be conducted primarily in dry weather months (April 15 – October 31) to avoid wet weather storm flows, or that work areas would be adequately protected and not affect flood conveyance. In areas where instream construction would occur, diversions would be implemented to bypass dry weather flows downstream. Some areas would require dewatering during construction. Base flows supportive of beneficial uses, which protect aquatic life and human uses, may be temporarily affected in the immediate construction zone, but would not be affected upstream or downstream of the study area (SWRCB 1994).

Under all alternatives, modifications to the channel will not increase the maximum water surface elevation. Under all alternatives, modifications to the channel are not expected to result in substantial changes to water velocity and circulation. During the next detailed design phase, restoration measures will be further designed to not impair flood risk management functions in any portion of the study area or areas downstream. While initial assessment identified that an increase in water surface elevation could occur at transition areas (areas where the channel has geometric changes (transitioning from trapezoidal to rectangular or from a widened section to a narrow section) or changes in construction material (transitioning between soft-bottom and concrete)) if no design refinements were made, the detailed design will ensure the maximum water surface elevations will not increase when compared to the existing conditions. Any change in water surface in the transition areas will be avoided through design refinements to the project modifications to channel geometry and/or avoidance of introduction of vegetation and enforcing existing operations and maintenance requirements limiting vegetation growth in those areas. The number of transition areas increases from Alternative 10 through Alternative 20. Additional hydraulic analysis will be conducted and design modifications will be implemented during the design phase to provide more detail on the channel hydraulics with the recommended plan in place. Under all the alternatives and with implementation of such design refinements, there will be no increase in flood damages through the study area as compared to existing conditions. Impacts would be less than significant.

Under all action alternatives, invasive species would be removed throughout the project area, including the River channel and tributary bottom, during construction. Removal of invasive vegetation from in-channel areas would facilitate conveyance of flows and would not increase flood risks.

WQ Significance Criterion 8: Increased the risk of inundation of the study area by seiche, tsunami or mudflow.

There would be no construction within low-lying coastal areas or hillsides. The study area is located within a fully developed urban area. Construction would occur within and adjacent to the River. As a result, there would be no risk of inundation by seiche, tsunami, or mudflow. There would be no impacts.

WQ Significance Criterion 9: Increase in the water surface elevation of peak flows in the River.

As discussed under WQ Significance Criterion 3, WQ Significance Criterion 4, and WQ Significance Criterion 7, the alternative would not result in an increase in water surface elevation of peak flows in the River. Impacts would be less than significant.

WQ Significance Criterion 10: Substantial changes to the amount of surface water in the River, including both diminished or increased flow.

As discussed under WQ Significance Criterion 3, WQ Significance Criterion 4, and WQ Significance Criterion 7, the alternative would not change the amount of surface water in the River. Impacts would be less than significant.

WQ Significance Criterion 11: Resulted in a permanent, adverse change to the movement of surface water sufficient to produce a substantial change in the current or direction of water flow.

As discussed under WQ Significance Criterion 3, WQ Significance Criterion 4, and WQ Significance Criterion 7, the alternative would not change the movement of surface water sufficient to produce a substantial change in the current or direction of water flow. Impacts would be less than significant.

WQ Significance Criterion 12: Created pollution, contamination, or nuisance, as defined in Section 13050 of the California Water Code.

Section 13050 of the California Water Code defines pollution as alterations of the quality of the waters of the State by waste to a degree which unreasonably affects either the designated beneficial uses or facilities that serve these uses.

The Los Angeles Regional Water Quality Control Board has designated four Beneficial Uses for the project area:

- Warm Freshwater Habitat: Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

  The project area supports nonnative fish species such as mosquito fish, catfish, and green sunfish, and carp throughout the study reach. Invertebrates are also present. Native fish species are not present. In-channel activities during construction will require dewatering. However, dewatering would only occur with phased construction designed to isolate areas for short periods of time. Impacts would be temporary. There would be no permanent adverse impacts. Upon completion of construction, additional vegetated waters of the U.S. would be available for use by aquatic organisms. This indirectly benefits the rest of the fish and wildlife assemblage in the area by creating more foraging habitat and refuge.

- Wetland Habitat: Uses of water that support wetland ecosystems, including, but not limited to, preservation or enhancement of wetland habitats, vegetation, fish, shellfish, or wildlife, and other unique wetland functions which enhance water quality, such as providing flood and erosion control, stream bank stabilization, and filtration and purification of naturally occurring contaminants.

  Wetlands likely occur in the soft bottom areas in Reach 2 and Reaches 4-6. In-channel construction may require work in areas with wetlands or riffle and pool complexes, resulting in temporary adverse impacts to these resources. Prior to initiation of construction, the study area would be surveyed for these features. Construction would avoid and minimize impacts to these features to the maximum extent practicable. Impacts to wetlands during construction would be temporary. Due to the existing seed bank and perennial flow, affected wetland vegetation is expected to recover soon after completion of construction. Subsequent to construction, the additional soft bottom areas created by the project would facilitate growth of additional vegetation. A portion of these new waters are expected to exhibit wetland characteristics soon after completion of construction. The project would augment existing wetland functions and services.

- Wildlife Habitat: Uses of water that support terrestrial ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g.. mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.

  Vegetation is present within the project area especially in Reach 2 and Reaches 4-6. The assemblage is a mixture of native and non-native vegetation. Native vegetation includes mature willows and shrubs. Non-native vegetation is primarily present in the shrub layer with giant reed (Arundo donax) as the dominant species. Wildlife utilize the vegetation, although the existing degraded condition does not support resident or breeding populations of threatened or endangered species.

  In general, species present in the study area are those that are opportunistic and/or habituated to human presence. These species are able to move to alternative locations if they are disturbed by construction activities and, therefore, are not anticipated to be impacted adversely. During construction activities, noise and presence of visual forms associated with an active construction site may discourage establishment of nests or foraging within the vicinity of the work area. However, construction would not occur simultaneously within the entire project area. The construction footprint would migrate from one location to another over a number of years through the project area. As a result, avian and wildlife species within the active construction zone should be able to relocate to and utilize unaffected areas. Upon completion of construction, additional riparian habitat would be available for wildlife utilization. The project would also restore regional habitat connectivity to the Santa Monica Mountains.

- Ground Water Recharge: Uses of water for natural or artificial recharge of ground water for purposes of future extraction, maintenance of water quality, or halting of saltwater intrusion into freshwater aquifers.

  The project would discharge permanent fill within existing waters of the U.S. However, the fill would not result in an increase of impermeable surfaces. Therefore, there would be no loss of existing waters of the U.S. Furthermore, the project would create additional acres of new, soft bottom waters of the U.S. As a result, the project would augment existing groundwater recharge capacity upon completion of construction. See Appendix M for additional discussion on

discharges of fill material into waters of the U.S. Similarly, no permanent loss of waters of the State is anticipated.

Based on the above, construction activities under Alternative 10 would not result in alterations of the quality that would not be compatible with designated beneficial uses. Impacts would be less than significant.

WQ Significance Criterion 13: Caused regulatory standards to be exceeded, as defined in the applicable NPDES permit or water quality standards in the Los Angeles Regional Water Quality Control Board's Basin Plan.

The alternative would require ground-disturbing work and use of construction equipment within the River. There would be temporary impacts to water quality during construction. However, there would be no long-term impairments of water quality.

During construction, k-rails would be temporarily discharged in the River on a periodic basis. Sandbags or plastic sheeting required to seal the work area from surrounding flows would also be temporarily discharged. The k-rails and associated materials would be removed from waters of U.S. upon completion of construction of each phase. Movement of vehicles across earthen substrate during the placement and removal of dewatering structures would temporarily elevate turbidity in the water column. When fully isolated from surrounding flows, work within the River would result in minimal or no increases in turbidity. During construction, permanent fill would be discharged into waters of the U.S. Upon completion of each phase, waters flowing across newly constructed areas would result in temporary increases in turbidity as flows mobilize unconsolidated soils and other loose particles. Turbidity would return to baseline levels in short order upon establishment of dynamic equilibrium within the water column. Use of construction vehicles increases the potential for accidental release of fuels, solvents, or other petroleum-based contaminants.

Discharge of fill materials are not expected to result in long-term introduction of contaminants into the water column. All temporary fill would be chemically inert and would consist of either concrete k-rails or sandbags comprised of clean sand obtained from a source that is certified in providing contaminant-free materials. Much of the permanent fill material would also be chemically inert, and would consist of materials such as concrete and rock from a certified source, none of which would leach contaminants into the water column. Topsoil would be acquired from a certified contaminant-free source, and would be free of most weed seeds; hazardous toxic, and radioactive wastes, or other contaminants.

The increase in soft bottom waters of the U.S. would likely increase the potential for turbidity beyond existing baseline levels. However, most of the newly created/restored soft bottom areas would be vegetated. The vegetation would attenuate turbidity levels. Furthermore, because most of the surfaces upstream and downstream the project area are hardened, channel modifications are not expected to result in water quality impacts due to excessive erosion, scour, and headcuts.

Under all alternatives, invasive vegetation within the River and tributary channel bottoms within the project footprint would be removed. Vegetation would typically be removed by hand tools. Thus, the activity would not result in discharges of fill material in most instances. In cases where limited earthmoving may be required, there would be discharges of earthen fill. However, impacts would be temporary.

Discharges within waters of the U.S. are subject to Section 401 of the Clean Water Act. An application for a Section 401 water quality certification has been submitted to the Los Angeles Regional Water

Quality Control Board. Based on the above and with the implementation of terms and conditions of the certification, the alternative would not exceed regulatory standards and would be in compliance with the Los Angeles Regional Water Quality Control Board's Basin Plan. Impacts would be less than significant.

WQ Significance Criterion 14: Change potable water levels sufficiently to reduce the ability of a water utility to use the groundwater basin for public water supplies, conjunctive use purposes, imported water storage, summer/winter peaking, or to respond to emergencies and drought.

As discussed under WQ Significance Criterion 2, the alternative would not result in substantial depletion of groundwater supplies or interference with groundwater recharge. Thus, the ability to utilize the groundwater basin for public water supplies would not be affected. Impacts would be less than significant.

WQ Significance Criterion 15: Reduction in yields of adjacent wells or well fields (public or private).

As discussed under WQ Significance Criterion 2, the alternative would result in substantial depletion of groundwater supplies or interference with groundwater recharge. Thus, there would be no reduction in yields of public and private wells. Impacts would be less than significant.

WQ Significance Criterion 16: Adversely altered the rate or direction of flow of groundwater.

As discussed under WQ Significance Criterion 2, the alternative would not require permanent installation of wells to pump groundwater. Due to the high water table, groundwater may need to be dewatered within work areas during construction. The scale of dewatering operations would not alter the rate or direction of flow of groundwater. Furthermore, any impacts would be temporary since there would be no dewatering activities upon completion of construction. Thus, the rate and direction of flow of groundwater would be unaltered. Impacts would be less than significant.

WQ Significance Criterion 17: Resulted in demonstrable and sustained reduction of groundwater recharge capacity.

As discussed under WQ Significance Criterion 2, the alternative would not result in substantial depletion of groundwater supplies or interference with groundwater recharge. Impacts would be less than significant.

Operational Impacts

Maintenance of ecosystem restoration features would be conducted under this alternative by the City. Maintenance in general would include removal of invasive species throughout the project footprint, including the River and tributary channel bottom; repair and replacement of irrigation pipes and sprinklers; maintenance of constructed trails, terraces, and viewing areas; trimming of native vegetation; removal of trash and accumulated sediment; graffiti abatement; vector management; and like-for-like structural repair.

The Corps would continue to be responsible for maintaining all other aspects of the portion of the LACDA project that overlaps with the restoration project footprint. Within the channel areas outside the constructed restoration features, the operation and maintenance of the LACDA project would also be modified to allow native vegetation to remain in the channel to the extent it does not have more than minimal effect on conveyance. Detailed hydrologic and hydraulic analysis will be used during the design phase to further determine how much vegetation may be supported in the channel without affecting the

flood risk management function. Riparian areas planted through restoration will be preserved on overbank areas, where they will not inhibit flood conveyance.

Movement of vehicles within the channel and discharges of fill material within waters of U.S. associated with small-scale, routine maintenance activities would temporarily increase turbidity within the immediate work area. Dewatering structures such as coffer dams would be utilized for lengthy or complex maintenance activities. When fully isolated from surrounding flows, work within waters of the U.S. would result in minimal or no increases in turbidity. All temporary fill would be chemically inert and would consist of either concrete k-rails or sandbags comprised of clean sand. Much of the permanent fill would also be chemically inert, and would consist of materials such as concrete and rock. The fill will not leach contaminants into the water column. Since the discharges of permanent fill material would be associated with like-for-like repairs, there would be no increase in impermeable surfaces. As a result, groundwater recharge functions would remain unaffected. Temporary or permanent discharges of fill material would not change the design elevations or contours. Flood risks would not be increased.

Invasive species in the River and tributary channel bottom within the project area would typically be removed by hand tools. Thus, the activity would not result in discharges of fill material in most instances. In cases where limited earthmoving may be required, there would be discharges of earthen fill material. However, impacts would be temporary and there would be no loss of waters of the U.S. Removal of invasive vegetation from the project footprint would facilitate conveyance of flows and would not increase flood risks.

Indirect Effects of and Related Actions to Construction and Operation

Fill material used in construction would consist of materials such as concrete, rock from a certified source, or pre-seeded turf reinforcement matting, none of which would leach contaminants into the water column. Topsoil would be acquired from a certified contaminant-free source, and would be free of most weed seeds, and free of HTRW, or other contaminants. Thus, potential for long-term leaching of contaminants into the water column would be minimal. Although the increase in soft bottom waters of the US would likely increase the potential for turbidity beyond existing baseline levels, the restored areas would be vegetated. The vegetation would attenuate turbidity levels. Concrete, rocks, and soils discharged in waters of the US would not be substantially different from the existing concrete, rocks, and soils at the site, with minimal indirect effects on substrate.

Incidental benefits to water quality would occur in all reaches of the study area; these benefits would be realized in the short term due to the removal of impervious surfaces in the River and riparian overbank areas, but would not be fully realized until riverine habitat was established.

Water quality pollutant removal mechanisms incidental to the implementation of restoration measures include physical and biological components. Physical removal includes the removal of pollutants through adsorption, absorption, filtration, and ultraviolet disinfection. Adsorption allows for a pollutant to bind to another substance through adhesion and thereby be removed from the environment (ammonia, copper, cyanide, indicator bacteria, lead, nutrients, oil, and selenium). Absorption allows for uptake of a pollutant, when it is incorporated into vegetation (nutrients). Filtration is the removal of a pollutant by mechanical or physical means (trash). Ultraviolet disinfection occurs when ultraviolet rays are used to kill microorganisms (indicator bacteria).

Biological removal includes phytoremediation and bioremediation. Phytoremediation is the process of using plants to remove, transfer, stabilize, and destroy environmental contaminants (ammonia, copper, cyanide, indicator bacteria, lead, nutrients, oil, and selenium). Bioremediation is the process of using

organisms to remove, transfer, stabilize, and destroy environmental contaminants (ammonia, copper, cyanide, indicator bacteria, lead, nutrients, oil, and selenium).

The restored habitat could provide benefits by helping to provide biological and chemical removal of constituents that contribute to the River's 303(d) listing, including ammonia, copper, cyanide, indicator bacteria, lead, nutrients (algae), oil, selenium, and trash (SWRCB 2010).

After construction is complete, new acres of riparian and wetland habitat would be present within the expanded River. Daylighting upland culverts will create riparian corridors which will provide additional filtration of stormwater entering the system. Riparian and wetland vegetation, along with bioengineered wall vegetation, will combine to increase shading of the river, which may reduce microclimate temperatures

Groundwater benefits from construction would include increased groundwater infiltration and recharge for future water uses, though these benefits would likely not be significant.

Because this alternative would replace the existing LATC site functions with riparian habitat, the existing functions of the LATC site would be relocated to another site within the Los Angeles Basin. Both construction and operation have the potential to impact water resources at the future site, if present. However, it is expected that the future site would be selected based on its functional equivalence to the existing site, in an area that is already used for industrial activities. The future LATC site would be within an existing Los Angeles Basin industrial zone, ensuring continued regulation by the Regional Water Quality Control Board and minimal potential for impacts to water resources. Similarly, operation of the new site will include comparable functions to the existing site, including required stormwater runoff protections. Prior to site selection, the CEQA lead agency would conduct a detailed CEQA analysis of the effects of the relocation, including effects to water resources. Should any additional NEPA documentation be required, it would be undertaken by the NEPA lead agency. These effects are anticipated to be the same for all action alternatives.

Alternative 13 (ACE)

Construction Impacts

Impacts to water resources under Alternative 13 would be similar to those discussed in detail under Alternative 10. Construction under Alternative 13 would encompass a larger portion of the study area to include the Arroyo Seco confluence and restructuring of the channel banks in Reach 7 and increased widening at Taylor Yard in Reach 6, as well as an additional side channel in Reach 3. It would not include the three daylighted streams in Reach 7 of Alternative 10. Hydrologic features, water quality, and groundwater resources would not be significantly affected by restoration measures under Alternative 13. In comparison to Alternative 10, Alternative 13 would be implemented over a larger area, increasing the potential for construction impacts.

Similar to Alternative 10, there would be no permanent loss of waters of the U.S. Waters of the U.S. would be temporarily impacted by the construction of restoration features. New waters of the U.S. would be created by construction of this alternative. This alternative would require the Corps obtain water quality certification. Temporary and permanent impacts to waters of the U.S. are analyzed in Appendix M of this IFR. Similarly, no permanent loss of waters of the state regulated by the CDFW is anticipated.

Beneficial impacts under Alternative 13 would also be similar to Alternative 10, but would increase because of the slightly larger area of implementation. Beneficial impacts include increased riverine and riparian habitat, increased interaction between surface to groundwater by softening the channel bottom,

and increased natural "polishing" and removal of pollutants from surface water. In addition to the regional habitat connectivity restored under Alternative 10, this alternative would also restore regional habitat connectivity to the San Gabriel Mountains.

Operational Impacts

Operation impacts under Alternative 13 would not significantly affect hydrologic features, water quality, and groundwater resources. Impacts would be the same to those found under Alternative 10, but over a slightly larger area to include the additional constructed features.

Alternative 16 (AND)

Construction Impacts

Impacts to water resources under Alternative 16 would be similar to those discussed in detail under Alternative 10. In comparison to Alternative 10 and 13, Alternative 16 proposes additional substantial restoration measures over a larger area of implementation within the project area, with a larger footprint of disturbance at LATC. The additional measures include:

- Demolition and excavation of channel walls to restore the historic floodplain connection to the river channel, and removal of concrete bed of the river, in Reach 8, and
- Demolition and excavation to widen channel bed and create terraced banks in Reach 5

Hydrologic features, water quality, and groundwater resources would not be significantly affected by restoration measures under Alternative 16. In comparison to Alternatives 10 and 13, Alternative 16 would be implemented over a larger area, increasing the potential for construction impacts.

Beneficial impacts would be similar to those found under Alternative 10 and 13, but would also include increased riverine and riparian habitat, increased interaction between surface to groundwater by softening the channel bottom, and increased natural "polishing" and removal of pollutants from surface water.

Similar to Alternative 10, there would be no permanent loss of waters of the U.S. Waters of the U.S. would be temporarily impacted by the construction of restoration features. New waters of the U.S. would be created by construction of this alternative. Temporary and permanent impacts to waters of the U.S. are further analyzed in Appendix M of this IFR. Similarly, no permanent loss of waters of the state regulated by the CDFW is anticipated.

Operational Impacts

Operation impacts under Alternative 16 would not significantly affect hydrologic features, water quality, and groundwater resources and would be the same to those found under Alternative 13, but over a slightly larger area.

Alternative 20 (RIVER)

Construction Impacts

Restoration measures and associated construction and beneficial impacts to water resources within the project area under Alternative 20 would be similar in scope to those discussed in detail under Alternative 10, but would be implemented over a larger portion of the study area. Likewise, impacts to water quality and water resources under Alternative 20 would be similar to those discussed in detail under Alternative 10. Impacts would encompass a larger area due to the greater extent of restoration features.

In comparison to Alternatives 10, 13, and 16, Alternative 20 proposes restoration measures over the largest area. Restoration measures under Alternative 20 would be similar to Alternative 16, but would also include the widening of Verdugo Wash in Reach 3, and channel reshaping/widening restoration measures in Reach 2. In Reach 7, this Alternative includes the three daylighted streams included in the reach plan for Alternative 10 and the Arroyo Seco restoration included in Alternative 13 and 16, with the impacts as discussed in those alternatives. Instead of the restructuring of channel banks included in Alternatives 13 and 16, it restores freshwater marsh at the Los Angeles State Historic Park and terraces the existing channel bank adjacent to the Los Angeles State Historic Park, and the railroad line along the overbank would be trestled at grade to facilitate the terracing. Reach 2 and Reach 3 impacts are more extensive than Alternative 16 due to the increased area of restoration but are similar in nature and type. Reach 7 impacts are otherwise similar to those identified for Alternative 10 (daylighting streams outside the channel, in upland areas, and 13 (restoration of Arroyo Seco), but include terracing of the bank adjacent to the Los Angeles State Historic Park instead of the bank restructuring with implanted vegetation included in Alternative 13. The difference in the Reach 7 plan would involve less construction activity on the channel banks but would result in slightly more permanent and temporary impacts to waters of the U.S. than in Alternative 13 and 16 as discussed in Appendix M and below but no permanent loss of waters of the U.S., and other impacts to water resources associated with this Reach 7 plan are substantially similar to those identified for Alternative 13 and 16. In sum, construction impacts under Alternative 20, both adverse and beneficial, would be similar to Alternative 16, but would be more extensive due to the increased area over which the measures would be applied. In addition to the regional habitat connectivity restored under Alternatives 13 and 16, this alternative would also restore regional habitat connectivity to the Elysian Hills with the measures in Reach 7 and connectivity to the Verdugo Hills with the measures in Reach 3.

As part of the Corps' coordination with the FWS under the FWCA for this alternative, additional opportunities for restoration of habitat connectivity as part of the project, particularly within the River channel, were identified. The Corps will further evaluate these opportunities during the design phase, as their implementation is likely to require hydrologic and hydraulic modeling data and more detailed design. Prior to implementation of the additional measures identified, the Corps will assess whether supplemental analysis is required to address new or different effects than those already assessed in this IFR. The following potential measures may affect water resources.

- The Corps would further assess incorporation of anchored boulders and potential modifications to the channel bed in concrete reaches to provide improvements for aquatic habitat connectivity and fish refugia.

- Considerations for segregation of "spring fed waters" from surface water flows would also be made during the detailed design phase. This segregation would be considered to support refugia for fish, where groundwater would feed the refugia while surface flows might bypass such areas. Parameters required for engineering design would include groundwater levels as well as anticipated local fluctuations in groundwater conditions.

Similar to Alternative 10, there would be no permanent loss of waters of the U.S. Waters of the U.S. would be temporarily impacted by the construction of restoration features. Permanent and temporary impacts to waters of the U.S. would be slightly greater with this alternative than in Alternative 16 in Reaches 2, 3, and 7. New waters of the U.S. would be created by construction of this alternative. Temporary and permanent impacts to waters of the U.S. are further analyzed in Appendix M of this IFR. Similar to Alternative 10, no permanent loss of waters of the state regulated by the CDFW is anticipated.

Operational Impacts

Operations under Alternative 20 would not significantly affect hydrologic features, water quality, and groundwater resources, and would be the same as those under Alternative 16, but would occur over a larger area.

5.4.4 Best Management Practices and Impact Avoidance Measures

Implementation of BMPs would be guided through permitting, certification, and plan development, and through recommendations provided in the CEQA guidelines. The proposed erosion control measures, also listed under Section 5.1. BMPs, would include, but not be limited to, the following:

- Limiting most in-channel construction to the low-flow period between April 15 and October 31 to minimize soil erosion.
- Soils and all materials used for backfilling or stabilization must be certified to be free of contaminants.
- All sites with known and suspected HTRW soil contamination will be investigated and remediated prior to project construction. All groundwater contamination that cannot be remediated prior to project construction will be subject to appropriate handling, treatment and disposal ensured by the non-Federal sponsor. All work shall be consistent with Engineering Regulations 1165-2-132.
- In-channel work would be isolated from existing flows by the use of dewatering structures such as cofferdams constructed from k-rails and other suitable materials.
    - Cofferdam construction will be adequate to prevent seepage into or from the work area.
    - Cofferdams may be constructed from sand bags, concrete k-rails, sheet piles or other appropriate materials that would not leach contaminants into the water column or increase downstream turbidity.
    - Ensure that dewatering structures and coffer dams are in place and functional prior to in-water work.
    - Visually inspect all cofferdam components on a regular basis.
    - Check for water seepage under the dam and general integrity of the dam.
    - Fix all leaks immediately.
    - If turbid water is discharged from the work area despite the cofferdam, place wattles, filter fabric, silt fencing across the flow stream downstream of the work area as appropriate.
    - All cofferdams and associated structures will be removed upon completion of work.

- Require the construction contractor to prepare a storm water pollution prevention plan (SWPPP) consistent with State Water Board policy and guidelines. At a minimum, the SWPPP would include the following elements:

    - Work areas, staging areas, or stockpile areas that could be subject to erosion during storm events would be stabilized with erosion control measures as appropriate. These measures could typically include silt fencing, straw bales, sand bags, filter fabric, coir rolls or wattles.

    - Erosion control methods used to prevent siltation would be monitored weekly and maintained as needed.

    - Stabilize and reseed disturbed upland areas with native grasses, shrubs, and trees upon completion of construction.

    - Stationary equipment such as motors, pumps, generators and welders located within or adjacent to the channel or basin will be positioned over drip pans.

    - Any equipment or vehicles driven and/or operated within or adjacent to the channel or basin should be checked and maintained daily, to prevent leaks. All maintenance will occur in a designated offsite area. The designated area will include a drain pan or drop cloth and absorbent material to clean up spills.

    - Fueling and equipment maintenance will be done in a designated area removed from the area of the channel or basin such that no petroleum products or other pollutants from the equipment may enter these areas via rainfall or runoff. The designated area will include a drain pan or drop cloth and absorbent materials to clean up spills.

    - Materials for the containment of spills (i.e., absorbent materials, silt fencing, filter fabric, coir rolls) will be identified and be available onsite prior to commencement of construction or maintenance activities.

    - Any accidental spill of hydrocarbons or coolant that may occur within the work area will be cleaned immediately. Absorbent materials will be maintained within the work area for this purpose.

    - No wet concrete product will come into contact with any flowing or standing water at any time. Areas where raw cement or grout are applied or where concrete curing or finishing operations are conducted will be separated from any ponded or diverted water flows by a cofferdam or silt-free, exclusionary fencing. All equipment involved with the concrete or grouting operations will be located within a contained area while using any slurry or concrete product. A protective berm or other structure will be in place prior to maintenance and/or repair activities.

    - Any spill of the grout, concrete, concrete curing or wash water adjacent to or within the work area will be removed immediately.

5.5 BIOLOGICAL RESOURCES

5.5.1 Regulatory Framework

Federal Laws and Regulations

Clean Water Act (CWA)

The CWA has provisions for protecting biological resources within the aquatic environment through identification of beneficial uses and prohibitions on fill of wetlands or other Waters of the U.S. (WoU.S.). The primary functions of the CWA in protecting biological resources in this instance are to ensure that any impacts to wetlands or WoU.S. are compensated for and to provide a framework for ensuring that water quality is maintained or improved.

Endangered Species Act (ESA)

The Endangered Species Act (ESA) protects threatened and endangered species by prohibiting Federal actions that would jeopardize the continued existence of such species or result in destruction or adverse modification of any critical habitat of such species. If effects to listed species are anticipated, Section 7 of the Act requires consultation regarding protection of such species be conducted with the U.S. Fish and Wildlife Service (USFWS) and/or the National Marine Fisheries Service (NMFS) prior to project implementation. (16 USC 1531, 1536).

Fish And Wildlife Coordination Act (FWCA)

The purposes of the FWCA include recognizing the contribution of wildlife resources to the nation, acknowledging the increasing public interest and awareness of wildlife resources, and ensuring that wildlife conservation receives due consideration in water resources development programs (16 USC 661). Under the FWCA, the FWS provides its recommendations to the Corps to consider.

Migratory Bird Treaty Act (MBTA)

The MBTA implements various treaties and conventions between the U.S. and Canada, Japan, Mexico, and Russia for the protection of migratory birds. Under the act, taking, killing or possessing migratory birds, their nests, or eggs, is prohibited.

Several Executive Orders relating to biological resources would need to be complied with as future planning and implementation of any of the proposed restoration measures take place. Relevant EOs include the following:

- *Invasive Species*—EO 13112, issued on February 3, 1999, helps prevent the introduction of invasive species and provides for their control and minimizes the economic, ecological, and human health impacts that invasive species cause.
- *Protection of Wetlands*—EO 11990, issued on May 24, 1977, helps avoid the long-term and short-term adverse impacts associated with destroying or modifying wetlands and avoiding direct or indirect support of new construction in wetlands when there is a practicable alternative.
- *Migratory Birds*—EO 13186, issued on January 10, 2001, promotes the conservation of migratory birds and their habitats and directs Federal agencies to implement the Migratory Bird Treaty Act.
- *Protection and Enhancement of Environmental Quality*—EO 11514, issued on March 5, 1970, supports the purpose and policies of NEPA and directs Federal agencies to take measures to meet national environmental goals.

State Laws and Regulations

California Endangered Species Act, Sections 1600-1607

The California Endangered Species Act focuses on protecting all native species of fishes, amphibians, reptiles, birds, mammals, invertebrates, and plants, and their habitats threatened with extinction and those experiencing a significant decline which, if not halted, would lead to a threatened or endangered designation.

California Fish and Wildlife Code, Sections 1600-1607

Sections 1600 through 1607 which regulate work that would substantially divert, obstruct, or change the natural flow of a river, stream, or lake; that would substantially change the bed, channel, or bank of a river, stream, or lake; or that would use material from a streambed.

The Porter-Cologne Water Quality Control Act also applies to biological resource protections.

5.5.2 Significance Criteria

In evaluating the context and intensity of an environmental effect, a significance threshold provides a qualitative or quantitative benchmark for determining whether the impact is significant or less than significant. The thresholds for determining the significance of impacts for this analysis are based on the environmental checklist in Appendix G of the CEQA (2006) guidelines.

These thresholds also encompass the factors taken into account under NEPA to determine the significance of an action in terms of its context and the intensity of its impacts. The alternatives under consideration could result in a significant impact related to biological resources if they would:

- Have a substantial adverse effect, either directly or through habitat modification, on any species identified as endangered, threatened, candidate, rare, or of special concern in local or regional plans, policies, regulations, or on lists compiled by the CDFW, NOAA-Fisheries, or USFWS;
- Have a substantial adverse and unmitigated effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations, or by the CDFW, NOAA-Fisheries, or USFWS;
- Have a substantial adverse and unmitigated effect on Federal- and state-protected wetlands as defined by Section 404 of the CWA and as protected under the Porter-Cologne Water Quality Control Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means;
- Interfere substantially with the movement of any native resident or migratory fish or wildlife species, or with established native fish or wildlife migratory or dispersal corridors, or impede the use of native wildlife or fish nursery sites;
- Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance; or
- Conflict with the provisions of an adopted habitat conservation plan, natural community conservation plan, or other approved local, regional, or state habitat conservation plan.

5.5.3 Environmental Impacts

Impacts to biological resources would result from temporary construction efforts and construction of new habitat features. Impacts may include those to vegetation or wildlife resulting from site preparation, grading, bank lowering, channel widening, daylighting of storm drains, removal of concrete, excavation of side channels, riverside plantings, removal or alteration of existing structures and water infrastructure, and construction of new connections to water sources. The magnitude of the disturbance would determine

the significance of the impact to biological resources. However, the majority of the effects from the construction of the restoration measures proposed under the action alternatives would be highly beneficial to biological resources over the long term.

In this section, beneficial impacts are qualitatively described for each alternative, while also providing the quantitative measure of restoration benefits in terms of Habitat Units (HUs). Additional details regarding the calculation of HUs are provided in Sections 4.9 and 4.11.

No Action Alternative

Construction Impacts

No construction impacts would occur under the No Action Alternative since there would be no construction.

Operational Impacts

Current operations would be expected to continue into the future without the implementation of the proposed project. Authorized maintenance includes clearing of all vegetation and removal of sediment as needed within the channel to maintain the purpose of flood risk management, which may be implemented in the future as funding allows. While availability of funding has not allowed for complete vegetation removal since the river's channelization, it remains an authorized maintenance activity. Due to the limited funding, recent maintenance of vegetation in the study area has focused on removal of non-natives within existing habitat in soft bottom reaches and removal of sediment and aquatic vegetation in concrete reaches. Without implementation of the proposed project, removal of all vegetation in the channel would remain an authorized maintenance activity, although maintenance funding would be anticipated to be similar to existing levels.While non-natives are periodically removed when funding becomes available, this maintenance would not be consistent or widespread throughout the study area.

Under the No Action Alternative, trash that accumulates within existing habitat will only be removed occasionally under existing channel maintenance protocols, and will continue to degrade riparian and wetland habitats. In addition, pressures on available water supply may lead to reduced flows in the river channel. Under the No Action alternative, contaminant removal through adsorption, absorption and other biochemical processes would be limited to existing vegetation areas, and would not be increased or improved as no new plantings would be established.

Most dry season flow in the channel is due to wastewater releases from the upstream Tillman Treatment Plant or runoff from irrigation or industrial practices. If the climate of Southern California becomes drier, as some climate models predict, pressure on any available water supply will increase. Over time, this could result in greater water conservation measures as well as reuse of treated wastewater, which would reduce flows in the channel. Without the project, reduced flows could result in diminished aquatic and riparian habitat. With degraded habitat conditions and invasion by non-natives, use of habitats by wildlife species is also expected to decline. Although the CHAP evaluation (Appendix G) predicted that the same species of wildlife may still occur within the fifty year period of analysis, it is reasonable to assume that overall population numbers, as well as the ability of wildlife to successfully forage, reproduce and move through the area will decline as the habitat continues to degrade.

Based on CHAP, habitat value is projected to substantially decline within the Study area assuming no restoration activity is implemented over the next 50 years. Open water areas and urban areas mostly comprised of impervious surfaces (including the concrete channel banks) showed no change from the current habitat value. The remainder of the Study area is projected to decline steadily in habitat value, with an overall decline of 7 percent after 25 years and 14 percent after 50 years. In the absence of

restoration in the Study area, the existing riparian areas that currently provide the most habitat value per acre will continue to degrade. Ecosystem functions in the Study area will also continue to diminish.

Habitat connectivity within the study area would continue to be extremely limited, restricting movement of most wildlife to within the existing habitat corridor in the Glendale Narrows (Reaches 4-6) and in Reach 2. No restoration of habitat nodes would occur and there would be no improvement of local wildlife connectivity. The benefits of restoration of habitat nodes in the urban environment, including supporting source populations of wildlife and reduction of inbreeding depression, would not be attained. Opportunities for regional wildlife connectivity via tributary confluences to significant ecological areas such as the Santa Monica and San Gabriel Mountains could not be realized.

While limited habitat exists within the study area, supporting some native plants and wildlife, under the No Action Alternative it is anticipated that non-native species will continue to invade and that native habitat and wildlife diversity will decline. Due to the extensive urbanization in the study area, the existing habitat and ecological functions are extremely degraded. These degraded conditions would persist with implementation of the No Action Alternative.

Without consistent maintenance, native plant and wildlife diversity would continue to decline while existing habitats would be increasingly infested by non-native species. Non-native species do not provide adequate habitat to support a diverse population of fish and wildlife. Mechanical or chemical treatment would continue to be necessary, both as a means of maintaining native vegetation and to maintain the flood capacity of the channel to convey high flows, as funding allows.

Alternative 10 (ART)

Alternative 10 provides some restoration in all reaches and provides transitions or connections between existing riparian corridors and concrete lined river reaches. This alternative restores riparian, riverine, and other native aquatic habitats, including 251 acres of valley foothill riparian habitat. (Refer to Section 4.14 of this IFR for a detailed description of restoration measures associated with each alternative, per reach.) This alternative is expected to provide substantial benefits including the restoration of native habitat, expansion of habitats into overbank side channels and river adjacent areas, expansion of wildlife populations, and improved connectivity for local and regional wildlife movement. A total of 5,321 average annual HUs will be provided by this alternative. Restoration and expansion of native and structurally diverse riparian habitat will provide herbaceous, shrub, and tree layers needed to support existing wildlife species and potentially provide habitat for threatened and endangered species that have the potential to inhabit the area, such as the least Bell's vireo. Following completion of restoration, the improved size and quality of habitat patches will substantially benefit biological resources. As analyzed below, this alternative would not have significant adverse impacts to biological resources, while it would have beneficial impacts to biological resources.

Construction Impacts

In Reach 1, this alternative establishes riparian corridors along both sides of the River channel, restores riparian area at the Pollywog Park area of Griffith Park, and restores riparian habitat along the east overbank of the Burbank Western Channel. In Reach 2, this alternative would extend the riparian corridor on both sides of the River overbank. In Reach 3, two streams would be daylighted (with riparian and freshwater marsh restoration) on the east side of the River, and a single stream would be daylighted on the west side of the River. Restoration in Reach 4 would include establishment of a riparian corridor on the east overbank, creation of a side channel at the edge of Griffith Park Golf Course with inlet and outlet to the River, lowering a portion of the Los Feliz Golf Course on the east bank of the River to allow seasonal flooding through existing culverts, and daylighting of eight streams. Restoration in Reach 5 would extend the riparian corridor on the east overbank and daylight a stream at the downstream end. In Reach 6, this

alternative would widen the channel by approximately 80 feet at Taylor Yard, expanding in-channel habitat, and terrace a small area in the Bowtie parcel. In Reach 7, three streams would be daylighted. In Reach 8, at the LATC site, a historic wash and riparian habitat would be restored. This restoration would allow flows from the ephemeral wash to enter the river through existing culverts through the channel wall that runs below the railroad lines. Under this alternative, a total of 15 streams that currently connect to the river through culverts will be opened up and converted into wetland habitat. Beneficial impacts will result from the addition of wetland and riparian habitat, as well as an incidental improvement in water quality passing through wetlands at the daylighted streams. The creation of additional riparian and wetland habitat in the overbank side channels and widened areas will provide benefits to fish and wildlife in the area by expanding habitat and allowing for increased populations of wildlife in restored areas.

The impacts to biological resources during construction of the proposed restoration features could include removal of non-native vegetation both in the specific restoration features and as a general measure implemented throughout the project footprint, including in channel areas. Impacts may include disturbance to existing native vegetation in channel due to the non-native removal. Impacts may also include temporary displacement of wildlife species, temporary air and noise pollution, and temporary sediment runoff into the River. Vegetation removal would occur outside of the breeding season to minimize or avoid impacts to migratory bird species.

Although no specific recreation plan was formulated to correspond to Alternative 10, if this restoration alternative were to be selected for implementation, associated recreation facilities compatible with the restoration features would be anticipated to be implemented at similar but slightly reduced scale to those described for Alternative 13, increasing the quantity of existing trails within the project footprint, extending trails/paths, and connecting project features with pedestrian bridges. All recreation features would be designed to avoid and minimize effects on biological resources during construction and to be compatible with and not compromise the ecosystem restoration features.

Vegetation

During construction, existing native vegetation within the river channel would be left in place to the extent practicable, with removal of invasives throughout the project footprint, including areas in which restoration features are constructed and the existing channel and tributary bottom areas. Some existing vegetation may be disturbed during construction of features adjacent to the vegetated river channel, such as restructuring the channel walls and widening the channel in Reach 6.

Other portions of the study area, outside the vegetated river channel, are predominantly vegetated with non-native invasive weeds and/or ornamental vegetation. These invasives may spread further where construction efforts disturb soils. Increased presence of invasive weed species reduces ecological diversity and minimizes habitat value. However, restoration designs specifically call for revegetation of disturbed areas with native habitat, including those areas disturbed during the construction period. Non-native infestations would be treated either mechanically or chemically after construction is complete. Construction of the restoration features and invasives control would remove weedy and ornamental vegetation and replace it with native riparian and wetland habitat, which would be a benefit to the river ecosystem.

With the implementation of restoration measures, installation of native habitat, and control of invasives, construction of the proposed project would not cause significant adverse impacts to vegetation. Any impacts would be minimal, localized, and short term, and would ultimately be beneficial after native habitats are restored.

Fish

Currently no native fish inhabit this portion of the river (LADWP 2004, FoLAR 2008). Santa Ana sucker and arroyo chub, in particular, have been extirpated from most of their historic ranges and are now found in only a handful of isolated areas. Construction activities in the river channel may result in disturbance to non-native fish through disturbance of habitat and invertebrate prey items, as well as through increased turbidity with potential sediment runoff into the river. Construction equipment working in close proximity to the river has the potential to introduce sediment or pollutants into the water, although BMPs will be implemented to minimize this potential.

Fish may be exposed to suspended sediment concentrations during construction, which may cause clogging to gills of fish in the immediate vicinity. It is expected that most fish would avoid the immediate construction area due to increased noise levels, turbidity, and oxygen depletion resulting from increased sediment load in the river. The proposed project will implement water quality BMPs during construction (BMPs are outlined at the end of each resource category within this chapter, such as 5.4.4 [for protection of water quality] and 5.5.4 [for protection of biological resources]) and will operate under applicable Federal and state permits, which would protect water quality and minimize impacts to fish. Any construction-related impacts to fish would be temporary and less than significant.

Birds

Construction activities may temporarily remove vegetation, degrade water quality in the river, and increase ambient noise levels, which could cause disturbances to some birds causing them to vacate the construction area. Increased levels of activity may decrease birds' use of the study area for foraging, roosting, and nesting. Birds are expected to vacate the area and find alternate foraging, nesting, and roosting locations during the temporary construction activities. As there are no established populations of federally protected birds such as least Bell's vireo currently nesting in the project area, no effect to these species will occur. Construction would take place only in limited portions of the study area at any given time, and resident bird species would likely find similar habitat nearby in other portions of the vegetated channel or adjacent habitat areas. Birds are also expected to acclimate to construction noise, as noise levels in the study area are generally high due to the adjacent freeway and urban uses. Vegetation removal activities would take place outside the breeding season for birds to avoid impacts to nesting.

Birds would benefit from the proposed project via planting and expansion of native riparian and wetland habitats, which would improve opportunities for foraging, roosting, and nesting. Removal of trash and incidental improvement of water quality would also benefit bird species in the study area. With the implementation of restoration measures, adverse impacts to birds would be avoided and impacts would be considered less than significant, with an overall benefit to bird species in the study area.

Wildlife

Construction activities may temporarily disturb wildlife within the study area by removing vegetation and sediment, increasing noise levels, and increasing vibration levels. Wildlife is expected to vacate the area and find alternate habitat nearby during construction. Construction would take place in phases, and only be performed in limited portions of the study area at any given time. Much of the wildlife inhabiting the study area are urban adapted species that are acclimated to human presence, generally higher noise levels, and some level of disturbance. These species may adapt more readily to the type of disruptions that occur during construction. Wildlife is expected to re-colonize the construction areas after construction is complete. No significant adverse effects are expected to impact these commonly occurring wildlife species as a result of construction activities included in this alternative. Restoration and expansion of native vegetation by the project would provide additional and improved wildlife habitat.

Wildlife Movement

Wildlife movement within the study area may be disrupted during construction activities due to disturbance of vegetation, increased noise levels, and increased vibrations. Disturbance would be temporary and movement opportunities would be restored after construction is complete.

Opportunities for wildlife movement would be marginally improved in this alternative. Restoration at Taylor Yard establishes a large node of historic riparian habitat adjacent to the river corridor. The habitat at Taylor Yard is then connected to other habitats currently existing within the river channel in the Glendale Narrows (Figure 6-2). Restoration at Taylor Yard also establishes a natural hydrologic connection between the River and the historic floodplain, which restores key ecological processes such as a more natural disturbance regime, scour and deposition of sediment and vegetation, nutrient cycling, biotic interactions, and colonization of new habitat areas (Stromberg et al. 2007), as well as improved wildlife movement between the river and floodplain. Connectivity to other restored habitat in the Study area is more limited by the overbank locations (i.e. Ferraro Fields, Los Feliz golf course) and assisted the hydrologic process in those areas. Increases in nodal connectivity and regional habitat connectivity are also analyzed in Chapter 6 of this IFR.

Impacts to wildlife movement would be temporary and not significant, and overall the project would be beneficial for wildlife species in the study area by restoring and expanding native habitat.

Wetlands

The Los Angeles River is a Traditional Navigable Water (TNW), a water of the United States pursuant to 33 C.F.R. § 328.3(a)(1).A jurisdictional delineation identified Ordinary High Water Mark as halfway up the embankment of the River. No permanent loss of waters of the United States would occur. Wetland habitat has been observed within the River in Reaches 4-6 and appears on NWI maps (USFWS 2012). Wetlands may also be present in Reach 2 due to the presence of riparian vegetation and perennial flows. Jurisdictional wetlands within the non-concrete bottom portions of the LAR are generally located on sand banks and are variable, prone to changes in size and location depending on the severity of storm flows. Colonies of giant reed (*Arundo donax*) are interspersed throughout all in-channel riparian areas. Furthermore, because the channel conveys storm flows from an urban environment, trash and debris are present throughout the riparian areas. Storm flows also affect the location and extent of wetlands due to shifting sandbars. Furthermore, the wetlands are physically isolated from other aquatic environments. Therefore, wetlands present within the project footprint are limited in aquatic functions and services. Pool/riffle complexes may also be present in Reaches 2 and 4-6 and are subject to the same existing conditions as wetlands.

A 404(b)(1) analysis for the project is included as Appendix M of this IFR. As indicated in that analysis, this alternative would not have a substantial adverse and unmitigated effect on Federal- and state-protected wetlands. This alternative would also restore and create wetlands and other special aquatic sites (pool/riffle complexes). Since this project is an aquatic habitat restoration project with creation or restoration of special aquatic sites that offset any impacts, no mitigation for wetland impacts is required or proposed.

Any wetlands present may be affected during construction of the widening of the River channel at Taylor Yard under this alternative. During construction, in-water work in Reach 6 may affect riparian vegetation, especially near the toe of levees where excavation and dewatering activities would be located. However, surveys prior to construction would be undertaken in the existing channel areas affected by construction to further identify, avoid, and minimize effects to wetlands and pool/riffle. Impacts to wetlands would generally be temporary, as due to the existing seed bank and perennial flow, wetland vegetation and

hydric soils are expected to reestablish soon after completion of construction. Thus, there would be no permanent loss of wetlands under any build alternative. Areas disturbed by construction would be restored as needed. Moreover, invasive species will be removed during construction under each alternative, resulting in a more natural and functional plant community. Furthermore, construction of ecosystem restoration elements would increase connectivity to other riparian areas.

CDFW regulates waters of the State, and defines those waters as areas from top-of-bank to top-of-bank, as well as riparian areas that may be above the bank but still dependent on the waters within the bank. Although this is a substantial increase in area relative to Waters of the U.S., this larger area of regulated waters does not increase the potential for effects to wetlands since vegetated wetlands in the study reach are generally found only in the bottom of the river channel, while the increased regulated area is towards the top of the bank. Although waters of the State may be temporarily affected during construction similarly to waters of the U.S., impacts to wetlands would be temporary and avoided and minimized to the extent practicable. No mitigation is proposed since the project will result in a substantial increase in the amount and quality of Waters of the State.

Threatened and Endangered Species

Marginal habitat for the federally endangered least Bell's vireo (*Vireo bellii pusillus*) exists within the vegetated portions of the channel within the study area in Reaches 2, 4, 5, and 6. Riparian vegetation in these reaches is linear and confined, and lacks suitable adjacent foraging habitat. Vireo were observed within the study area in 2007, however the most recent protocol surveys in 2009 did not detect vireo. An incidental observation of an unpaired male vireo near Taylor Yard was documented in April 2013 during a one-day nesting bird survey of the area. A similar one-day nesting survey of the area in May 2013 did not detect vireo (Cooper 2013a, 2013b).

The Corps has determined that this alternative will have no effect to least Bell's vireo under ESA. Least Bell's vireo are not expected to be present in the study area and are not known to nest in the study area due to the marginal, linear and confined nature of existing habitat. In the locations where vireos were observed during 2007 protocol surveys and from incidental observations in 2013 (Reach 6), the proposed construction will target removal only of existing non-native vegetation. In areas where marginal habitat for the least Bell's vireo exists, non-native vegetation would be removed outside of the breeding season. Potential nesting habitat would be avoided.

Protocol level surveys for least Bell's vireo would be performed during the detailed design phase and in the nesting season(s) immediately prior to construction of each feature within any potentially suitable areas to confirm presence or absence of this species within the study area. The Corps will continue to coordinate with USFWS and CDFW throughout the design and construction period, and consult under the Endangered Species Act if conditions change such that the Corps determines the project may affect the vireo or other listed species. With implementation of the alternative, riparian vegetation would be further expanded through widening and restoration of river adjacent areas, which could potentially support future populations of vireo.

No other special status species, including the southwestern willow flycatcher and coastal California gnatcatcher, are expected to occur due to the degraded conditions within the study area and lack of suitable habitat. Therefore, no impacts to threatened and endangered species are expected to occur. This assessment is the same for all action alternatives.

Operational Impacts

Following completion of the construction phase, the operation of the restoration project will begin, which will result in (1) the maintenance necessary to ensure success of restored components, and (2) the long-

term benefits of restoration that would support fish and wildlife. In addition, the LACDA operations and maintenance plan would be modified to complement the restoration project.

Riparian areas planted through restoration activities will be preserved on overbank areas, where they will not inhibit flood conveyance. Access to the river will be necessary for operation and maintenance activities following completion of the restoration project.

Trucks and other heavy equipment will access the channel via established routes that cause the least disturbance to soils or vegetation. Operation and maintenance activities will also be required to implement similar BMPs used during construction (as applicable) to protect water quality, biological resources and other aspects of the environment. BMPs and other environmental commitments are listed at the end of each resource category within this chapter (such as 5.4.4 [for protection of water quality] and 5.5.4 [for protection of biological resources]).

Restoration of riparian and wetland habitat in the study area will require maintenance to ensure the establishment and survival of planted vegetation and to stay consistent with the constraints of the flood risk management project. This includes the ongoing mechanical and/or chemical removal of non-native species that become established after restoration, throughout the project footprint. Temporary irrigation will be used to ensure survival of vegetation through the establishment period. Riparian areas planted through restoration will be preserved on overbank areas, where they will not inhibit flood conveyance. Constructed restoration features would be maintained consistent with the operations and maintenance manual for the restoration project, which may include measures such as trimming or thinning of in-channel vegetation outside the breeding season to avoid impacts to the flood risk management function. Maintenance of the restored areas is anticipated to require minimal native vegetation removal or control to avoid impacts to flood risk management, as features will be designed to avoid such impacts. In addition, monitoring will be necessary to ensure that excessive scour or bank failures do not occur where natural channel features are restored, to avoid compromising the flood risk management function and adverse effects on water quality. These maintenance activities may result in minimal impacts due to entry of restoration staff into vegetated areas to perform maintenance; however, these activities will ultimately be beneficial for persistence of the restored habitats and are expected to be minimal and not significant. The non-Federal sponsor would have a direct responsibility to ensure that adequate flow is maintained to sustain habitat features.

Overall, operation and maintenance efforts will not have significant adverse impacts on the biological resources in the area. The restoration measures in this alternative have been designed specifically to improve the study area's biological resources and ecological functioning.

The Corps has determined that there will be no effect to least Bell's vireo from operations of the proposed project. Removal of non-native vegetation and trimming of in-channel vegetation to maintain flood conveyance would occur outside the breeding season. Overall, operations will support the establishment and expansion of native riparian vegetation in the restored areas, which has the potential to support future populations of vireo, and may support foraging and stop over habitat for southwestern willow flycatcher and coastal California gnatcatcher. Presence/absence surveys for these species will be performed during operation of the proposed project as part of the Monitoring and Adaptive Management Plan. The Corps and non-Federal sponsor will continue to coordinate with the USFWS and the CDFW during operations of the proposed project.

During initial operation and maintenance of each feature, the Corps would conduct monitoring to assess achievement of ecological success criteria (see Monitoring and Adaptive Management Plan, Appendix H (Part 2)). If success criteria are not being met, the Corps and non-Federal sponsor would determine which adaptive management measures should be implemented. Adaptive management measures could include

irrigation and supplemental watering, replanting, plant proteetion (e.g., cages or fcneing), erosion eontrol, importing of substrates, or regrading. Adaptive management measures would not be anticipated to have significant impacts on biologieal resources as impacts in most cases would be similar or less than those associated with similar aetivities during construction of the restoration features; however, prior to implementation, the Corps would determine whether supplemental analysis is required. Once ecological success has been documented by the District Engineer in consultation with the Fcderal and State resource agencies, and a determination has been made by the Division Commander that ecological success has been achieved, no further monitoring will be required.

The existing LACDA operations and maintenance would also be affected by implementation of the restoration project. Current LACDA operation and maintenance include those measures that are intended to ensure proper flood conveyance through the channel, such as clearing or thinning of vegetation or removing sediment or debris if necessary, and that maintain access into the channel and environs. The LACDA OMRRR plan would be modified to accommodate the restoration project, with maintenance of the restoration project a City responsibility under the restoration OMRRR plan. The LACDA OMRRR manual would be modified to exclude constructed restoration features and would exclude invasives management throughout the restoration project footprint. USACE would continue to be responsible for maintaining all other aspects of the portions of the LACDA project that overlap with the restoration project footprint. USACE would also modify the LACDA OMRRR plan for the ARBOR reach outside the specific eonstructed restoration features to preserve flood risk management function while complementing the restoration project. These modifications would allow native vegetation to remain in the rest of the reach to the extent that design conveyance capacities would be met or would experience only minimal changes from the design conditions. Detailed hydrologic and hydraulic analysis will be used during the design phase to further determine how much vegetation may be supported in the channel without affecting the flood risk management function. Such OMRRR would be contingent on funding and would be anticipated to be phased in over time.

Indirect Effects of and Related Actions to Construction and Operation

Once construction is complete and habitat meets success criteria, the project would be anticipated to result in greater diversity and intensity of use by a variety of species including birds, mammals and fish. With increased suitable habitat, least Bell's vireo may nest in the project area. Restoration of wildlife corridors would be expected to result in greater use of the river corridor as a path for wildlife to travel between major habitat nodes and nearby regional habitat areas such as Griffith Park. Nodal connectivity and regional habitat connectivity are further discussed and evaluated in Chapter 6.

Indirect benefits to open water areas in hard bottom reaches may include additional shading, inputs of leaf litter and small woody debris, and increased foraging opportunities for wildlife due to restoration in channel adjacent areas. Additional shading may provide improved conditions and refuge for amphibians and shorebirds in the channel. Increased inputs of leaf litter and small woody debris may support macroinvertebrates that provide improved foraging for birds and amphibians, and may provide shelter for reptiles and amphibians in the channel. Restoration in areas adjaeent to hard bottom reaches may also improve use as a dispersal corridor between soft bottom reaches, where leaf litter and small woody debris may provide cover and harbor moisture for use by reptiles and amphibians moving through the reach. These elements, along with proposed improvements for wildlife access in certain areas, and new nodal connections provided by the active restoration features, make the entire river channel within the study area more conducive for wildlife movement. The presence of edge habitat along the river channel may also improve use by neotropical migrants that nest near the edges of riparian habitats and forage in adjacent open spaces.

The proposed project could potentially support future populations of native fish species by restoring riparian/riverine habitat and riffle/pool complexes. Restoration of wetlands would incidentally improve water quality, which would also enhance conditions for native fish species.

The study area is large enough to support a self-sustaining, breeding population of historically occurring native fish. This would support recovery of the overall population of these species by providing new breeding grounds (which are extremely limited within all of the southern California watersheds), and establishing refuge populations that would enable the species to survive catastrophic events within existing territories. Fish are expected to re-colonize the proposed construction areas after construction is complete. Species such as the Santa Ana sucker and arroyo chub may naturally re-colonize the area from upstream tributary populations following restoration of appropriate habitat. After restoration of habitat suitable to support native fish, another agency or interested entity, separate from the restoration project, may also propose to reintroduce native fish directly into the restored project area and/or propose to remove non-native fish species to support successful establishment of native fish populations. The proponents and Federal and/or state agencies with jurisdiction over the reintroduction or removal of fish would conduct any necessary environmental reviews. The Corps and non-Federal sponsor would coordinate with the proponents and agencies with jurisdiction over removal or reintroduction of fish to ensure the compatibility of the program proposed with the restoration project function including operation and maintenance activities.

Due to enhanced habitat and additional recreational opportunities, human visitation to the study area is expected to increase. Increased human visitation to the site could lead to increased disturbance of habitat; however, designated trails, public use areas, educational signage and exclusionary fencing, as necessary, would be installed to minimize impacts from human intrusion into restored habitat areas. Although occasional adverse impacts of this nature are expected, they are expected to be minimal in comparison to the habitat benefits that would occur as a result of the project. Restoration features would be monitored and maintained to repair any damage that may occur from human visitation and recreation activities. Because the relocation of LATC site functions is anticipated to occur in an industrial area, effects to biological resources would be expected to be minimal. The impacts to biological resources from relocating LATC could include disturbance and/or removal of vegetation, temporary displacement of/disturbance to wildlife species, temporary air and noise pollution, temporary sediment runoff into a water body or storm drain, and temporary disturbance of wildlife movement pathways. However, a functionally equivalent site within an industrial zone would be unlikely to contain significant biological resources, and therefore any associated impacts would likely be minimal. Prior to site selection, the CEQA lead agency would conduct a detailed CEQA analysis, including analysis of potential effects on biological resources. Should any additional NEPA documentation be required, it would be undertaken by the NEPA lead agency. These effects are anticipated to be the same for all action alternatives.

Alternative 13 (ACE)

Alternative 13 is designed to restore riparian, and other native aquatic habitats, including 271 acres of valley foothill riparian communities throughout the study area, including overbank areas in all reaches except Reach 7 and within the expansive boundaries of LATC. This alternative also provides for the removal of invasives, similar to Alternative 10. Alternative 13 provides for daylighting a total of 12 streams entering the channel (three in Reach 3, eight in Reach 4, and one in Reach 5), where wetlands will be created, and includes 26 acres of freshwater marsh habitat in additional locations. Habitat will also be substantially increased from Alternative 10 with restoration of the confluence of Arroyo Seco, creation of side channel behind Ferraro Fields, and the expansion of the soft river bottom along Taylor Yard to a 300 foot width. This alternative is expected to provide substantial benefits including increased area of restoration of native habitat, expansion of habitats into overbank side channels and river adjacent areas,

expansion of wildlife populations, restoration of additional natural hydrologic connections, and further improved connectivity for local and regional wildlife movement. A total of 5,902 average annual HUs are provided by this alternative.

Construction Impacts

The nature of construction impacts will be the same as for Alternative 10. Alternative 13 would construct the same restoration features as Alternative 10 in Reaches 1, 2, 4, 5, and 8, and provides additional restoration in Reaches 3, 6, and 7. In Reach 3, in addition to the measures identified in Alternative 10, this alternative would create a side channel entering upstream from the LAR behind Ferraro Fields and re-entering the river at the downstream end of the reach. In Reach 6, this alternative would widen the River by 300 feet at Taylor Yard (instead of 80 feet in Alternative 10), restoring floodplain and freshwater marsh in the widened channel. In Reach 7, this alternative would restore the confluence of the River with the Arroyo Seco tributary through softening of the bed and banks with development of a riparian corridor in the tributary confluence and for one half mile upstream. The restoration of the Arroyo Seco confluence restores natural in-channel geomorphic characterin the currently channelized tributary. Restoration of this natural hydrologic connection between the River and tributary also benefits the River ecosystem by restoring key ecological processes in this area (Stromberg et al. 2007).

Instead of the daylighted streams included in this reach for Alternative 10, the banks of the River downstream from the Arroyo Seco are lined with overhanging vines and implanted vegetation. Although the total area that will be affected by construction will increase for this alternative, these impacts will be temporary, and for each of the reasons noted above for Alternative 10, will not be significant to biological resources. This alternative would have the same effects to wetlands and other special aquatic sites as Alternative 10, as the greater restoration footprint will not include additional areas with wetlands and other special aquatic sites.

Alternative 13 is a restoration plan, but if this plan were to be selected for implementation, a plan formulated for passive recreation corresponding with Alternative 13 would provide new recreational features compatible with the restoration plan. The recreation plan associated with this alternative would provide trails, bridges, restrooms, trail access points and signage, benches, trash receptacles, several wildlife viewing points, and pedestrian underpasses under bridges along the river. Hard structures such as parking lots will be placed at the periphery of the restored area. All recreation features would be designed to avoid and minimize effects on biological resources during construction and to be compatible with and not compromise the ecosystem restoration features.

Operational Impacts

As with Alternative 10, beneficial as well as temporary adverse impacts could potentially result from maintaining the restoration elements. Beneficial impacts will result from the newly restored habitats. Typical operation and maintenance of the channel will be the same as in Alternative 10. However, because of the larger scale of restoration under this alternative, there will be increased maintenance efforts to ensure that restoration is successful. Protection of restored elements during maintenance will be ensured through proper use of best management practices and implementation of a management plan for the restored areas as part of an OMRRR manual for the restoration project. Furthermore, the increased attraction of the site to the public will be managed through placement of signage, configuration of trails and exclusion fences, as necessary, to protect restoration.

The benefits of the proposed alternative will be the same as for Alternative 10, with the exception of the expanded area of restoration and improved local and regional wildlife movement opportunities in Alternative 13.

Indirect Effects and Related Actions to Construction and Operations

In addition to the indirect effects listed under Alternative 10, wildlife movement would be further improved in Alternative 13 with the restoration of the Arroyo Seco confluence. The restored habitat at Arroyo Seco would improve local connectivity for wildlife by serving as a new habitat node, with a connection to Taylor Yard via the river channel as a vegetated corridor (Figure 6-5). Improved nodal habitat connectivity promotes wildlife movement within the study area and prevents inbreeding depression and local extinction of wildlife populations. On a regional scale, restoration at Arroyo Seco confluence provides future opportunities to restore habitat connectivity between the river at the Study area and the San Gabriel Mountains via the Arroyo Seco tributary (Figure 6-6). Additional opportunity for connection in this area exists via the Corps' on-going Arroyo Seco Ecosystem Restoration Study. Additional neighborhood habitat in the communities of San Rafael Hills, Mount Washington, and Montecito Heights could also be incorporated into the movement corridor as regional habitat nodes. Increases in nodal connectivity and regional habitat connectivity are also analyzed in Chapter 6 of this IFR.

Alternative 16 (AND)

The benefits of the proposed alternative will be the same as for Alternative 10 and 13, with the exception of the expanded areas of restoration, removal of concrete in the channel bed and restoration of a natural hydrologic connection at the LATC site, and improved local wildlife movement within the study area via restoration of this connection. Though less valley foothill riparian habitat is established, greater areas of soft bottom channel, wetland, and side channels are created. Alternative 16 provides for the removal of culverts from 12 streams entering the channel, where wetlands will be created. Terraced areas are expanded, which provide for attenuation and habitat expansion. Restored area and vegetation in-channel are targeted for invasive plant removal and treatment.

Substantial benefits to biological resources will result from this alternative, including increased area of restoration of native habitat, expansion of habitats into overbank side channels and adjacent areas, removal of concrete from the channel bed, restoration of additional natural hydrologic connections, and further improved connectivity for local wildlife movement. A total of 6,610 average annual HUs are provided by this alternative.

Construction Impacts

Construction types and impacts are similar to those described above for Alternatives 10 and 13. However, the scale of construction would continue to increase with each alternative, resulting in greater earthwork requirements. This alternative includes the same features as Alternative 13 in Reaches 1-4 and 6-8 and includes greater restoration in Reaches 5 and 8. In Reach 5, this alternative widens the River channel by modifying the west bank from a trapezoidal bank to a vertical wall and adds vegetated terracing on the east bank. At the downstream end of this reach, the River channel will also be widened by modifying the east bank. The daylighed stream in Alternatives 10 and 13 is also included in this reach. In Reach 8, the alternative includes additional restoration by terracing upstream of LATC on the west bank of the River, terracing downstream on the east bank, and removing the east bank and the concrete bed adjacent to LATC. The channel bed will be naturalized to support freshwater marsh in the river. The river is widened in LATC by 500 feet on a low terrace and another 1000 feet on a second terrace. Another set of vegetated terraces are constructed along the downstream bank on the east side of the river. The restoration features at the LATC site would also include the restoration of the historic wash, along with wetland habitat. Greater channel widening measures, additional side channels, and more extensive changes would require a longer construction period and would affect a larger area. However, for the same reasons described above, adverse impacts would not be significant. Impacts to wetlands and pool/riffle may occur over a larger area than in Alternatives 10 and 13 due to the widening of the existing river bed in Reach 5.

However, as in Alternatives 10 and 13, wetlands and pool/riffle would be surveyed prior to construction to avoid and minimize effects to the extent practicable, wetlands would be expected to reestablish naturally, disturbed areas would be restored as needed, and wetlands and pool/riffle created by this alternative would offset any impacts to such special aquatic sites.

Like Alternative 10, no specific recreation plan was formulated to correspond to this alternative; however, were this alternative to be selected for implementation, construction of recreation features associated with this alternative would be anticipated to be similar to those described for Alternative 20 but at reduced scale for areas not within the restoration footprint of this alternative. All recreation features would be designed to avoid and minimize effects on biological resources during construction and to be compatible with and not compromise the ecosystem restoration features.

Operational Impacts

Operation of the project area following implementation of Alternative 16 would require similar maintenance and operations activities as those previously mentioned for Alternative 10 and 13. Truck and heavy equipment access, if needed, would be limited to the perimeter and to designated access points identified during construction.

Protection of restored elements during maintenance will be ensured through proper use of best management practices and implementation of a management plan for the restored areas as part of the OMRRR manual. Additional restrictions to human usage (i.e., signage, trail placement and exclusionary fencing) may be required and implemented to ensure successful establishment of restored elements.

Indirect Effects and Related Actions to Construction and Operations

In addition to the indirect effects listed under Alternative 13, local wildlife movement within the study area would be additionally improved by restoration of a natural hydrologic connection at LATC, where concrete would be removed from the channel bank and the channel bed to reconnect the river to the historic floodplain. Due to the large size of the restored LATC habitat, the connection to the River in Alternative 16 would allow the site to serve as a source population for other restored habitat areas along the river and minimize the risk of local extinction in smaller areas. The restored channel bed at LATC in Alternative 16 also provides a habitat corridor that connects to other habitat areas in the study area, which promotes wildlife movement and prevents inbreeding depression. Opportunities for regional wildlife movement will be the same as in Alternative 13. Nodal connectivity and regional habitat connectivity are further discussed and evaluated in Chapter 6.

Alternative 20 (RIVER)

Overall, restoration in this alternative provides the largest proposed area of aquatic, wetland, and riparian habitat of any alternative. Substantial benefits to biological resources will result from this alternative including increased area of restoration of native habitat, expansion of habitats into overbank side channels and river adjacent areas, expansion of wildlife populations, additional removal of concrete from the channel bed, restoration of additional natural hydrologic connections, and further improved connectivity for local and regional wildlife movement. A total of 6,883 average annual HUs are provided by this alternative.

Under this alternative, restoration measures would result in a total of 288 acres of valley foothill riparian habitat. A total of approximately 46 acres of freshwater marsh would be created, in addition to the wetlands created at 13 daylighted streams (one in Reach 3, eight in Reach 4, one in Reach 5, and three in Reach 7). The area of soft river bottom would be expanded to its maximum potential along Reaches 5, 6, and 8, creating the most open water habitat of any alternative. Construction of Alternative 20 would include

more restoration features than Alternative 16. This alternative would remove concrete and widen the confluence of the Verdugo Wash in order to support a more natural hydrologic regime and habitat, and to reconnect the tributary to the historic floodplain. Restoration of the Verdugo Wash confluence would provide an additional 34 acre habitat area, which would connect to the wildlife corridor in the Glendale Narrows (Figure 6-11) and other habitat areas restored in the downstream reaches. Alternative 20 also adds restoration at the Cornfields site in Reach 7. This provides an additional 10 acres of riparian habitat that is hydrologically connected to the River, decreasing the distance between habitat areas in the resource-poor downtown area. Future opportunities for widespread regional connectivity would be created via restoration of the Verdugo Wash confluence, in addition to the connection at the Arroyo Seco tributary confluence (Figure 6-12). Alternative 20 provides for the daylighting of a total of 13 streams entering the channel.

Construction Impacts

Construction impacts for this alternative would generally be the same as those described for the same components that occur in Alternatives 10, 13, and 16 above. However, areas targeted for restoration increase under Alternative 20. Alternative 20 would construct the same restoration features as Alternative 16 in Reaches 1, 4, 5, 6, and 8 and includes greater restoration in Reaches 2, 3 and 7. In Reach 2, this alternative widens the River channel by modifying the west bank from a trapezoidal bank to a vertical wall. In Reach 3, the alternative restores the confluence with Verdugo Wash by softening the bed of the stream and significantly widening the mouth of the wash, thus providing riparian habitat and an additional connection to the San Gabriels through the Verdugo Hills. In Reach 7, daylighted streams also included in Alternative 10 are reintroduced. Also in Reach 7, freshwater marsh is restored at the Los Angeles State Historic Park with a terraced bank connection to the River instead of the restructuring of the banks included in Alternative 13 and 16. Although the total area of impact compared to Alternative 13 and 16 would be slightly more extensive due to the inclusion of the three daylighted streams also included in Alternative 10 and the terracing of the bank adjacent to the Los Angeles State Historic Park instead of restructuring of the banks with implanted vegetation, these impacts will be temporary, and for each of the reasons noted above for Alternative 10, will not be significant to biological resources. The channel in the reach has a hard bottom and no impact to wetlands would occur, nor would different negative effects to wildlife, vegetation, fish, or birds be expected with the difference in measures. Impacts associated with the daylighted streams would be the same as identified for Alternative 10, occurring in areas largely disturbed or with non-native vegetation. .

Construction impacts would be the most extensive in this alternative. However, for the same reasons described for other alternatives, impacts are not anticipated to be significant. Benefits are generally similar to Alternative 10, 13, and 16, but more extensive due to the expanded areas of restoration, additional removal of concrete and restoration of a more natural hydrologic regime at the Verdugo Wash tributary confluence, and improved local and regional habitat connectivity for wildlife within the study area via restoration of the Verdugo Wash confluence and Cornfields sites.

Impacts to wetlands and pool/riffle may occur over a larger area than in Alternatives 10, 13, and 16 due to the widening of the existing river bed in Reach 2. However, as in Alternatives 10 and 13, wetlands and pool/riffle would be surveyed prior to construction to avoid and minimize effects to the extent practicable, wetlands would be expected to reestablish naturally, disturbed areas would be restored as needed, and wetlands and pool/riffle created by this alternative would offset any impacts to such special aquatic sites.

As part of the Corps' coordination with the FWS under the FWCA for this alternative, additional opportunities for restoration of habitat connectivity as part of the project, particularly within the River channel, were identified, as well as more detailed design considerations. These opportunities and considerations are summarized in part in Section 7.1.10 and included in the response to the FWS' recommendations in Appendix N. The Corps will further evaluate these measures during the design

phase, as their implementation or placement is likely to require hydrologic and hydraulic modeling data and/or more detailed design. Prior to implementation of the measures identified, the Corps will assess whether supplemental analysis is required to address new or different effects than those already assessed in this IFR. The following measures may have effects on biological resources, with temporary adverse effects similar to those identified for the construction features above but long term beneficial effects for vegetation and wildlife.

Considerations for incorporation of anchored boulders and potential modifications to the channel bed in concrete reaches to provide improvements for aquatic habitat connectivity and fish refugia would also be made during the detailed design phase. Implementation of these measures would depend on the detailed design and hydraulic analysis developed during the detailed design phase, to ensure that they are not in conflict with flow conveyance requirements or other constraints on the project. These measures could require temporary impacts to waters of the United States but no permanent loss of waters is anticipated.

Specific placement of measures for wildlife access will be further considered during the detailed design stage, and would depend on the detailed design and hydraulic analysis developed during the design phase, to ensure that they are not in conflict with flood damage reduction and flow conveyance requirements or other constraints on the project. Placement of wildlife access measures may include access in Reach 1 from Pollywog Park into the river channel, as practicable. In this area, wildlife access may be achieved through the creation of a slope along the currently vertical bank, as described in measure 3b in Section 4.4.5. Such a design would allow wildlife moving from Griffith Park into the river channel access to the restored Pollywog Park site, which is currently disconnected from the River by a vertical wall. Implementation of specific methods and location of access would be dependent on the detailed hydrologic and hydraulic modeling developed during the design phase. The implementation of a slope or similar design element would have similar effects to those identified for other short channel modifications and design requirements, and significant impacts are not anticipated.

Other design features specific to certain species may be incorporated in the detailed design phase and accommodated where practicable and appropriate. It is expected that while these features could potentially be installed artificially during restoration activities, many of these features will also evolve naturally over time as vegetation matures and natural hydrologic forces continue to shape the hydrologic regime of the widened areas. Such features may include artificial structures for nesting such as nest cavities (which could be used by wood duck, barn owl, tree swallow, and western bluebird among other species), large hollow snags (used by swifts), and steep sandy banks (used by northern rough-winged swallow and belted kingfisher). Installation of these structures within the project footprint would be anticipated to have temporary insignificant effects during construction similar to those analyzed above.

Considerations for segregation of "spring fed waters" from surface water flows would also be made during the detailed design phase. This segregation would be considered to support refugia for fish, where groundwater would feed the refugia while surface flows might bypass such areas. Parameters required for engineering design would include groundwater levels as well as anticipated local fluctuations in groundwater conditions. No significant adverse effects are anticipated from this segregation.

Operational Impacts

Potential temporary adverse impacts to biological resources that may result from operation and maintenance of Alternative 20 would not be substantially different than those described above for the other alternatives. However, once construction is complete, additional maintenance may potentially be required to ensure that this extensive riparian and wetland restoration alternative becomes successfully established and persists through the life of the project.

Indirect Effects and Related Actions to Construction and Operations

In addition to the indirect effects listed under Alternative 16, local wildlife movement within the study area would be additionally improved by restoration of a habitat node and natural hydrologic connection at LATC and at Verdugo Wash, where concrete would be removed from the channel bank and the channel bed confluence to reconnect the river tributary to the historic floodplain. Due to the large size of the restored LATC habitat, the connection to the River. This restored habitat node created in Alternative 20 would allow the Verdugo Wash site to serve as a source population for other restored habitat areas along the river and minimize the risk of local extinction in smaller areas. The restored channel bed at LATC in Alternative 20 also provides a habitat corridor that connects to other habitat areas in the study area, which promotes wildlife movement and prevents inbreeding depression. Terracing at the LA River State Historic Park (Cornfields) would provide an additional connection between the river and a node of habitat in Reach 7.

Opportunities for regional wildlife movement will be improved by the addition of restoration at the Verdugo Wash tributary, which provides connectivity to the Verdugo Mountains. The addition of the LA River State Historic Park (Cornfields) would provide opportunity for a regional connection to Elysian Park. Nodal connectivity and regional habitat connectivity are further discussed and evaluated in Chapter 6.

5.5.4 Best Management Practices and Impact Avoidance Measures

To avoid impacts to biological resources, the following BMPs would be followed:

- To the maximum extent practicable, vegetation clearing activities would not occur during the breeding season, which generally runs from March 1-August 31.
- If vegetation removal must occur during the breeding season, a qualified biologist would perform nesting bird surveys following established protocol prior to construction. If nests are detected during these surveys, a 300-foot no construction buffer would be delineated around the nest (500-foot buffer for raptors).
- Construction would be monitored by a qualified biologist.
- Construction would be phased to minimize impacts to wildlife species, so that the entire study area would not be under construction at the same time.
- Pre-construction surveys for special-status plants and wildlife would be performed as needed in coordination with USFWS.
- Protocol level surveys for least Bell's vireo would be performed during the detailed design phase and prior to construction to avoid impact to this species. If paired and potentially nesting vireo or other listed species are found, the Corps will coordinate with USFWS and consult as applicable, if it is determined that the project would affect the species.
- Trails and other recreational features will be designed and located to be compatible with restoration features and goals. For instance, trails may be placed around the perimeter, rather than through restored areas.

Operational impacts may be offset by implementing the following measures:

- Invasives control or maintenance of vegetation would be performed outside of the bird nesting season,
- Restored sensitive habitats would be avoided to the maximum extent practicable during maintenance. Designated access points for maintenance vehicles would be created to reduce impacts to restored areas.

- Informational signs would be installed to educate the public regarding the restored habitat, sensitive resources, and the impact that human intrusion may have. Exclusionary fencing will also be installed where and if necessary, as part of the Adaptive Management program (see Appendix H).

Operational impacts may be offset by implementing the following measures:

- Maintenance for weed/invasives control or flood conveyance would be performed outside of the bird nesting season,
- Sensitive habitat types would be avoided to the maximum extent practicable during maintenance. Designated access points for maintenance vehicles would be created to reduce impacts to restored areas.

Informational signs would be installed to educate the public regarding the restored habitat, sensitive resources, and the impact that human intrusion may have.

5.6 CULTURAL RESOURCES

5.6.1 Regulatory Framework

This section describes the Federal and State regulatory requirements applicable to the proposed project.

Federal

Overview of the National Historic Preservation Act

Section 106 of the National Historic Preservation Act (NHPA, 54 U.S.C. § 300101 *et seq.*) requires Federal agencies to consider the effects of their undertaking on historic properties. Furthermore, it requires an agency to afford the Advisory Council on Historic Preservation (ACHP) an opportunity to comment on any of the agency's undertakings that could affect historic properties. Federal undertakings include Federal projects, permits, grants, and loans. The purpose of section 106 is to avoid unnecessary impacts to historic properties from Federal undertakings. The section 106 review process is described in the ACHP regulations (36 C.F.R. Part 800, as amended August 5, 2004).

Historic properties include districts, archaeological sites, buildings, structures, and objects at least 50 years old that are eligible for inclusion, but not necessarily listed, on the National Register of Historic Places (NRHP) (36 C.F.R. §§ 60.4, 60.6; 40 C.F.R. § 1508.27, subd. (b)(8)). The NRHP is an inventory of historic resources in the United States maintained by the Secretary of the Interior. Section 106 applies to all properties already listed on the NRHP, to properties formally determined to be eligible for listing, and to properties not formally determined to be eligible but that meet specific eligibility criteria. The following criteria are used to evaluate properties for the NRHP:

> The quality of significance in American history, architecture, archeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association and

(a) that are associated with events that have made a significant contribution to the broad patterns of our history; or

(b) that are associated with the lives of persons significant in our past; or

(c) that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

(d) that have yielded, or may be likely to yield, information important in prehistory or history.

(36 C.F.R. § 60.4.)

The section 106 review process generally involves the following steps:

- **Step 1: Identify and Evaluate Historic Properties.** The Federal agency identifies and evaluates historic properties that could be affected by the Federal undertaking. Information is developed by literature review, consultation with the California State Historic Preservation Officer (SHPO),and field investigations (as necessary). The eligibility of potentially affected properties for inclusion on the NRHP is assessed.
- **Step 2: Assess Effects.** The effects of the undertaking are evaluated, resulting in a determination of either "no effect," "no adverse effect," or "adverse effect." The SHPO is then consulted.
- **Step 3: Consultation.** If an adverse effect could occur, the SHPO is consulted in order to identify methods to reduce the impacts. Other entities may be consulted, including Native Americans, the public, local government, and the ACHP. Consultation results in the development of a Memorandum of Agreement (MOA) or Programmatic Agreement (PA) that describes agreed upon measures to mitigate adverse effects.
- **Step 4: Filing MOA or PA with ACHP.** Upon execution of the MOA or PA, the agreement is filed with the ACHP if the ACHP did not participate in developing the MOA or PA.
- **Step 5: Proceed with Undertaking.** The Federal agency proceeds with its undertaking under the terms of the MOA or PA.

Programmatic Agreement

Regulations in 36 CFR 800.14 allow Federal agencies to adopt program alternatives to 36 CFR 800 and to tailor the Section 106 process to better fit agency procedures. The most common program alternative is embodied in a PA negotiated between the agency, the SHPO, and the ACHP. Project-specific programmatic agreements are often recommended when the preferred alternative is complex, will consist of multiple undertakings, or when the alternatives under consideration consist of corridors or large land areas where access to properties is restricted.

For this study, the USACE, in consultation and coordination with the SHPO, the City of Los Angeles, the California Department of Parks and Recreation and affected tribal organizations has developed a PA in accordance with 36 C.F.R. § 800.14, to fulfill its obligations under Section 106 of the NHPA (Appendix O). The PA process is summarized here. During the next phase of the study, Pre-construction Engineering and Design or PED, the USACE shall ensure that the APE for cultural resources is reviewed and updated as necessary to reflect any evolving project designs. Based on the refined APE, the USACE will ensure that appropriate cultural resource investigations occur early in PED for each reach of the project so that avoidance and impact minimization measures for cultural resources can be incorporated into the project design. These identification efforts would include the recordation and evaluation of the flood risk management system along the Los Angeles River and lower tributaries; an updated literature

review, block archaeological inventories, historic structures inventories. Focused, site-specific consultations would be conducted with Native American individuals, tribal organizations, and other ethnic communities to determine whether there are particular areas where there may be traditional cultural concerns. Any resources located during cultural resource investigations would be evaluated for inclusion on the NRHP. Additional investigations, such as test excavations may be needed to complete these evaluations. This work may occur in phases that correspond to the proposed sequence of development for the project, provided that analyses are ultimately prepared for the entirety of the APE.

The USACE would make every effort to avoid adversely affecting any cultural resources that were determined to be eligible for inclusion on the NRHP. If adverse effects cannot be completely avoided, the USACE will seek to minimize project effects and shall resolve adverse effects by implementing the prescriptions of a historic property treatment plan (HPTP). Treatment efforts will be tailored to the types and degree of anticipated project effects. Treatments may include data recovery, public outreach and interpretation, exhibits, publications, educational materials, and oral histories. Archaeological monitoring will likely be required during some phases of construction. As USACE continues through the PA process, the USACE will assess whether supplemental analysis is required under NEPA to address new or different effects than those already assessed or contemplated in the IFR.

State

Overview of the California Register of Historical Resources

In California, the term "historical resource" includes, but is not limited to, "any object, building, structure, site, area, place, record, or manuscript which is historically or archaeologically significant, or is significant in the architectural, engineering, scientific, economic, agricultural, educational, social, political, military, or cultural annals of California." (Pub. Resources Code, § 5020.1, subd. (j).) In 1992, the California legislature established the California Register of Historical Resources (CRHR) "to be used by state and local agencies, private groups, and citizens to identify the state's historical resources and to indicate what properties are to be protected, to the extent prudent and feasible, from substantial adverse change." (Pub. Resources Code, § 5024.1, subd. (a).) A resource is eligible for listing in the CRHR if the State Historical Resources Commission determines that it is a significant resource and that it meets any of the following NRHP criteria:

(1) Is associated with events that have made a significant contribution to the broad patterns of California's history and cultural heritage.

(2) Is associated with the lives of persons important in our past.

(3) Embodies the distinctive characteristics of a type, period, region, or method of construction, or represents the work of an important creative individual, or possesses high artistic values.

(4) Has yielded, or may be likely to yield, information important in prehistory or history.

(Pub. Resources Code, § 5024.1, subd. (c).) Resources less than 50 years old are not typically considered for listing in the CRHR, but may be considered if it can be demonstrated that sufficient time has passed to understand the historical importance of the resource. (Cal. Code Regs., tit. 14, § 4852, subd. (d)(2).)

Archaeological and Historic Resources Under CEQA

Under CEQA, a project may have a significant effect on the environment if it may cause "a substantial adverse change in the significance of an historical resource." (Pub. Resources Code, § 21084.1; Cal. Code Regs., tit. 14, § 15064.5, subd. (b).) If a site is either listed or eligible for listing in the CRHR, or if it is included in a local register of historic resources, it is a "historical resource" and is presumed to be historically or culturally significant for the purposes of CEQA. (Pub. Resources Code, § 21084.1; Cal. Code Regs., tit. 14, § 15064.5, subd. (a).) The lead agency is not precluded from determining that a resource is a historical resource even if it does not fall within this presumption. (Pub. Resources Code, § 21084.1; Cal. Code Regs., tit. 14, § 15064.5, subd. (a).)

A "substantial adverse change in the significance of an historical resource" reflecting a significant effect under CEQA means "physical demolition, destruction, relocation, or alteration of the resource or its immediate surroundings such that the significance of an historical resource would be materially impaired." (Cal. Code Regs., tit. 14, § 15064.5, subd. (b)(1); Pub. Resources Code, § 5020.1, subd. (q).) In turn, the significance of an historical resource is materially impaired when a project:

(1) Demolishes or materially alters in an adverse manner those physical characteristics of an historical resource that convey its historical significance and that justify its inclusion in, or eligibility for, inclusion in the California Register of Historical Resources; or
(2) Demolishes or materially alters in an adverse manner those physical characteristics that account for its inclusion in a local register of historical resources pursuant to section 5020.1(k) of the Public Resources Code or its identification in an historical resources survey meeting the requirements of section 5024.1(g) of the Public Resources Code, unless the public agency reviewing the effects of the project establishes by a preponderance of evidence that the resource is not historically or culturally significant; or
(3) Demolishes or materially alters in an adverse manner those physical characteristics of a historical resource that convey its historical significance and that justify its eligibility for inclusion in the California Register of Historical Resources as determined by a lead agency for purposes of CEQA.

(Cal. Code Regs., tit. 14, § 15064.5, subd. (b)(2).) Pursuant to these sections, the CEQA inquiry begins with evaluating whether a project site contains any "historical resources," then evaluates whether that project will cause a substantial adverse change in the significance of a historical resource such that the resource's historical significance is materially impaired.

Under CEQA, an EIR is also required to evaluate any impacts on unique archaeological resources. (Pub. Resources Code, § 21083.2.) A "unique archaeological resource" is defined as:

> [A]n archaeological artifact, object, or site about which it can be clearly demonstrated that, without merely adding to the current body of knowledge, there is a high probability that it meets any of the following criteria:
>
> (1) Contains information needed to answer important scientific research questions and that there is a demonstrable public interest in that information.
> (2) Has a special and particular quality such as being the oldest of its type or the best available example of its type.
> (3) Is directly associated with a scientifically recognized important prehistoric or historic event or person.

(Pub. Resources Code, § 21083.2, subd. (g).) An impact to a nonunique archaeological resource is not considered a significant environmental impact and such nonunique resources need not be further addressed in the EIR. (Pub. Resources Code, § 21083.2, subd. (a); Cal. Code Regs., tit. 14, § 15064.5, subd. (c)(4).)

State CEQA Guidelines section 15064.5 assigns special importance to human remains and specifies procedures to be used when Native American remains are discovered. These procedures are detailed in Public Resources Code section 5097.98.

5.6.2 Significance Criteria

The significance criteria listed below are derived from the State CEQA Guidelines section 15064.5 and Appendix G, and the criteria of adverse effects listed by 36 CFR 800.5.

The CEQA Guidelines were used by the City to determine the significance of the impacts of the proposed alternatives on historical resources. Impacts would be significant under CEQA if implementation of an alternative would:

(1) Cause a substantial adverse change in the significance of a historical resource as those terms are defined in State CEQA Guidelines section 15064.5.
(2) Cause damage to a unique archaeological resource pursuant to State CEQA Guidelines section 15064.5 and Public Resources Code section 21083.2, subdivision (g).
(3) Disturb any human remains, including those interred outside formal cemeteries.

The USACE must comply with NHPA section 106 and assess impacts to historic properties based on its definition of adverse effect. An adverse effect is found when an undertaking alters, directly or indirectly the characteristics that qualify the property for inclusion on the NRHP in a manner that diminishes the integrity of the property.

Integrity is the ability of a property to convey its significance, based on its location, design, setting, materials, workmanship, feeling, and association. Adverse effects can be direct or indirect. They include reasonably forseeable impacts that may occur later in time, be farther removed in distance, or be cumulative (ACHP, 2003). Examples of Adverse effects under 36 CFR 800.5 include:

- Physical destruction of or damage to all or part of the property;
- Alteration of a property, including restoration, rehabilitation, repair, maintenance, stabilization, hazardous material remediation and provision of handicapped access, that is not consistent with the Secretary's Standard for the Treatment of Historic Properties (36 4 CFR 68) and applicable guidelines;
- Removal of the property from its historic location;
- Change of the character of the property's use or of physical features within the property's setting that contribute to its historic significance;
- Introduction of visual, atmospheric or audible elements that diminish the integrity of the property's significant historic features;
- Neglect of a property which causes its deterioration, except where such neglect and deterioration are recognized qualities of a property of religious and cultural significance to an Indian tribe or Native Hawaiian organization; and
- Transfer, lease, or sale of property out of Federal ownership of control without adequate and legally enforceable restrictions or conditions to ensure long-term preservation of the property's historic significance.

Mitigation under Section 106 of the NHPA is defined as a measure to resolve specific adverse effects to historic properties. Resolution of adverse effects is referenced in the NEPA review and documented in the PA developed in consultation iwht the Section 106 consulting properties, which includes tribes, SHPO, City of Los Angeles, California Department of Parks and Recreation, and other interested parties.

The concept of adverse effect under the NHPA and significant impact under NEPA are similar in concept but are not equivalent terms. A broad range of impacts from very minor to major would be classified as an adverse effect but the context and intensity of these impacts may not meet the threshold of NEPA significance. NEPA requires us to consider the degree to which the action may adversely affect properties listed in or eligible for listing in the NRHP. For example, a farmhouse or TCP, that is eligible under Criterion A, may be adversely affected by the introduction of visual intrusions because these intrusions would diminish its integrity of location, setting, and feeling. This would be an adverse effect under NHPA but may not meet the threshold of significance under NEPA. The demolition of the property, however, would most likely constitute a significant impact because its destruction would preclude its eligibility for the NRHP.

An adverse effect would be considered a significant impact under NEPA if the following conditions are met:

1) Even after minimization and mitigation, the remaining impacts to the property would be substantial enough that implementation of the alternative would result in the loss of a propertys eligibility status under Criteria A-C.
2) The implementation of the alternative would result in the destruction of a site eligible under Criterion D with no mitigative data recovery.
3) The implementation of the alternative would result in a major modification of a National Historic Landmark or property meeting the criteria of a National Historic Landmark as defined in 36 CFR Part 65.

5.6.3 Environmental Impacts

Potential common sources of impacts on cultural resources associated with the construction of the proposed ecosystem restoration measures include ground disturbance, new construction, and structural alteration/removal of features.

Ground disturbance would result from site preparation, grading, bank lowering, channel widening, opening of storm drains, removal of concrete, excavation of side channels, riverside planting excavations, excavations for removal or alteration of existing structures and water infrastructure, and excavations for construction of new connections to water sources. If prehistoric or historic archaeological sites are present, ground disturbance can directly damage artifacts and features or alter the spatial relationship of artifacts, features, and other deposits and destroy their research potential. This can result in the permanent loss of information relevant to the site function, dates of use, plants and animals used, past environments, ethnicity and other important research questions. Ground disturbance can also damage unmarked burials or other sites that may be important to contemporary Native Americans as ancestral locations or for traditional cultural or religious purposes.

Proposed new construction may change the physical setting of historic buildings and structures. New construction for ecosystem restoration may also alter drainage patterns and channel morphology, exposing buried archaeological resources and causing impacts due to erosion.

The ecosystem restoration elements include the acquisition, removal or alteration of existing buildings and structures, including water control and conveyance infrastructure, and rail and other transportation facilities. Affected structures may be historic properties under the NHPA or historical resources under CEQA. If the proposed action of implementing the ecosystem restoration measures were to alter the characteristics of historic properties or historical resources that qualify them for inclusion on the NRHP or the CRHR, there would be an adverse effect if it diminishes the integrity of the property.

A potential cultural resource impact applicable to all of the proposed ecosystem restoration measures and reaches is the alteration of the River facilities. Although not formally documented or evaluated for historic significance, the containment and flood risk management facilities on the River and its tributaries appear eligible for listing on the NRHP because of their association with important events and their engineering innovations (Criteria A and C). The qualities of historic integrity typically considered for linear segments of water conveyance properties are integrity of location, design, feeling and association. Generally, modifications that maintain these qualities would not be seen as an adverse effect. Thus, modifications to facilities such as those proposed as ecosystem restoration measures involving removing portions of concrete structures, creating new structures and connections with the river and daylighting may not be considered an adverse effect on historic water conveyance facilities if the flood risk management function and location is maintained. Further evaluation and analysis during the next phase of the USACE planning process will clarify what features of the system contribute to its historic character and those qualities of integrity that are important to maintain. However, if integrity of design or other qualities are considered to contribute to the historic significance of the water conveyance facilities, there is potential for adverse effects under the NHPA and/or an adverse change under CEQA.

Under the terms of the PA (Appendix O) the Corps will work with the SHPO and the concurring parties to avoid, minimize and mitigate adverse effects to historic properties under the NHPA. Through the development and execution of a historic property treatment plan (HPTP) in accordance with the PA, it is likely that any impacts can be kept below the level of significance. This is especially true in the case of impacts to the river facilities where the proposed modifications would only impact focused sections of the facilities and leave the remaining system intact.

Through the same measures executed by the HPTP, it is anticipated that all the alternatives will also avoid a substantial adverse change under CEQA in the significance of a historic resource, a substantial adverse change in the significance of an archaeological resource, or disturbance to any human remains.

No Action Alternative

Construction Impacts

Under the No Action Alternative, impacts on cultural resources associated with the ecosystem restoration project would not occur in the study area. There would be no impacts resulting from the ground disturbing activities and altering of historic infrastructure that may occur under the proposed action. However, there would be no associated identification studies, monitoring, historic research, or other actions that would further define, afford protection to and increase the knowledge base, education and appreciation of the history associated with the River in Los Angeles, Burbank, and Glendale. Damage and loss of resources may occur from lack of knowledge or neglect. As infrastructure ages, many more building and structures may be considered historic and would need to be considered in future project planning. Cultural resource compliance actions would continue to be conducted for other projects that are Federal undertakings or that require NEPA or CEQA review. For these actions, surveys would be conducted, impacts would be assessed, and mitigation measures would be prescribed.

Operational Impacts

Under the No Action Alternative, there would be no change in potential impacts on cultural resources associated with the operations and maintenance of the containment and flood risk management facilities on the River and its tributaries. Ongoing O&M activities do not involve extensive ground disturbing activities or the removal or extensive alteration of existing structures including water control and conveyance infrastructure, and rail and other transportation facilities that may be historic. No significant impacts would be anticipated.

ALTERNATIVE 10 (ART)

Construction Impacts

Reaches 1-3

Impacts on cultural resources could occur from ground disturbance, new construction and structural alterations as a result of Alternative 10.

The immediate river corridor APE through Reaches 1, 2, and 3 has been minimally investigated for cultural resources. Pollywog Park and Bette Davis Park have not been inventoried. In Reaches 1 and 2 there have been small block surveys conducted that include portions of the approach to Pollywog Park at the River and a portion of the right bank between the Headworks Spreading Ground and Travel Town. Eligible NRHP and CRHR resources include the Riverside- Zoo Drive Bridge and portions of Griffith Park. No actions are proposed that would alter the setting or architectural qualities of the bridge that qualify it for inclusion in the NRHP. The small portions of Griffith Park in the APE have not been documented or evaluated and the current resource record focuses exclusively on historic structures elsewhere in the park. The Travel Town outdoor transportation museum, just outside the APE, is of historic age but has not been evaluated as a historic property. The containment and flood risk management facilities along the River and its tributaries are now of historic age, but have not been formally documented or evaluated for historic significance. Based on current information, modification of these structures to daylight storm drain outlets, create habitat corridors, restore open water habitat and construct River connections would likely impact historic structures. If determined eligible, this would result in an adverse effect to a historic property. Likely mitigation measures would include archival documentation and photo recordation according to National Park Service (NPS) Historic American Buildings Survey (HABS), Historic American Engineering Record (HAER), and Historic American Landscapes Survey (HALS) Standards. If these mitigation measures are successfully applied, it is expected that these impacts can be mitigated below the threshold of NEPA and CEQA significance.

No specific past land uses other than open space, river channel and parkland are observed on historic quadrangle maps in the APE. There is a record of an adobe structure occupied in 1868 in the vicinity of the River at Polliwog Park, but the location is imprecise and no physical remains are visible. Given the proximity to the channelized river and the effects of freeway construction it is doubtful that any foundations or features could be located again for further investigation. Disturbance in this reach is extensive, the result of river channelization, freeway construction, utility installation and roadwork.

Based on the record search, no additional impacts beyond the flood risk management facilities have been identified. However, identification and evaluation of cultural resources in the APE is incomplete.

While there is always the possibility of encountering buried cultural resources during ground disturbing activities, the potential for undiscovered intact buried resources that would meet the criteria for eligibility for NRHP or CRHR listing or other sensitive cultural resources appears to be low. Adverse effects are not anticipated.

Reaches 4-6

Impacts on cultural resources could occur from ground disturbance, new construction and structural alterations and removals in these reaches under Alternative 10.

The river corridor through Reaches 4, 5 and 6 has been minimally investigated for cultural resources and there are no surveys that are adjacent to and/or directly follow the River. Bridges across the River have been inventoried and evaluated for historic significance. The Glendale-Hyperion Viaduct, Riverside-Figueroa Street Bridge and Fletcher Drive Bridge, Arroyo Seco Parkway and portions of Griffith Park are eligible for listing on the NRHP and the CRHR for their architectural qualities and/or historic associations. There have been cultural resource surface surveys on adjacent parcels and along the edge of the Taylor Yard study area for this project, but there has been no inventory of the study area or subsurface excavation reported associated with other developments at Taylor Yard.

No actions are proposed that would alter architectural qualities of the historic bridges and the other properties or their settings that qualify them for inclusion in the NRHP and the CRHR. Daylighted storm drains and the narrow habitat corridors in Reaches 4 and 5 on the edge of the river channel would be developed on highly disturbed lands that are unlikely to contain or impact any intact cultural resources. Likewise, changes in channel morphology to provide habitat features are unlikely to encounter or impact intact cultural resources. Modification to the concrete channel for daylighting the storm drains and flow diversions would likely impact historic River structures. If determined eligible, this would result in an adverse effect to a historic property. Likely mitigation measures would include archival documentation and photo recordation according to National Park Service (NPS) Historic American Buildings Survey (HABS), Historic American Engineering Record (HAER), and Historic American Landscapes Survey (HALS) Standards. The excavation of the side channels through the two golf courses could encounter buried cultural resources. The potential for archaeological resources and the level of past disturbance of these locations is unknown.

Extensive ground disturbance is proposed for the Bowtie/Taylor Yard site. These sites are known to have HTRW contamination requiring remediation prior to construction of the Federal project. Remediation of identified known and suspected HTRW sites within the Bowtie and Taylor Yard would be conducted by the City prior to providing the lands to the restoration project for construction. Although it has not been inventoried for cultural resources, its history of past use as a rail facility dating back to 1925 would indicate a high likelihood for near surface and subsurface historic cultural resources including structural remains and foundations. Historic quadrangle maps show several structures, especially in the southern (Taylor Yard) part of the restoration site. Because of the extent and depth of excavation, there is also the potential for encountering intact archaeological sites predating 1925, including those that may have been encapsulated by floods on this terrace before the River was controlled. It is highly likely that historic resources could be encountered during remediation and there is potential for impacts to historic archaeological resources associated with implementing this remediation. Any impacts to historic resources would be adequately resolved by the City under state law.

The degree of ground disturbance that the City's remediation would entail is not known at this time; however, for the purposes of this analysis, we are assuming that some cultural resources would remain intact and will need to be addressed as part of the federal project. Based on our literature review, we do not expect to encounter any resources that would meet National Register Criteria A-C. There are no ethnographically known Native American sites, sites important for their association with major historical events, and as stated above no structures that meet the 50 year threshold for eligibility.

Following remediation, there is potential for adverse effects on historic and prehistoric archaeological sites that may be eligible under Criterion D. By completing the process in the PA to identify and evaluate

potential adverse effects, adverse effects may be either avoided or minimized through data recovery and other documentation. We anticipate that these impacts can be mitigated below the level of NEPA significance.

Likewise extensive modifications to the river channel and river facilities at this location are proposed. Based on current information, modification of these structures would likely impact historic structures. If determined to be eligible, possible mitigation measures might include archival documentation and photo recordation according to NPS Historic Buildings Survey (HABS), Historic American Engineering Record (HAER), and Historic American Landscape Survey (HALS) standards. If these mitigation measures are successfully applied, it is expected that these impacts can be mitigated below the threshold of NEPA and CEQA significance.

Reaches 7-8

Impacts on cultural resources could occur from ground disturbance, new construction, and structural alterations and removals in these reaches under Alternative 10.

There have been previous cultural resource investigations at the Arroyo Seco confluence site, but no investigations of the LATC study area. Bridges across the River have been inventoried and evaluated for historic significance. The First Street Viaduct, North Broadway Bridge (Buena Vista Viaduct), Cesar Chavez-Macy Street Bridge, North Main Street Bridge, North Spring Street Bridge are all eligible for listing on the NRHP and the CRHR for their architectural qualities and/or historic association.

No actions are proposed that would alter architectural qualities of the historic bridges or their settings that qualify them for inclusion in the NRHP and the CRHR. The Arroyo Seco Parkway (Pasadena Freeway), also eligible for listing on the NRHP and the CRHR, would not be impacted by the proposed restoration. Two other historic properties, the Department of Water and Power complex and the Mission Tower, would not be impacted under this alternative.

Daylighting storm drain outlets and constructing marsh habitat on the overbank areas of the channel would occur on highly disturbed lands that are unlikely to contain any intact cultural resources. Impacts are not anticipated. Modification of the concrete structures at the confluence would likely impact River and Arroyo Seco channel historic structures. If determined eligible, this would result in an adverse effect to a historic property. Likely mitigation measures would include archival documentation and photo recordation according to National Park Service (NPS) Historic American Buildings Survey (HABS), Historic American Engineering Record (HAER), and Historic American Landscapes Survey (HALS) Standards. If these mitigation measures are successfully applied, it is expected that these impacts can be mitigated below the threshold of NEPA and CEQA significance.

The LATC site is suspected of having contamination similar to that at Taylor Yard, and it is suspected that the City would either remediate or ensure the remediation of the site prior to providing lands for construction of the federal project. Investigation and remedial actions by the sponsor or others prior to construction of the restoration project may include the demolition of existing structures, removal of pavement, grading and excavation depending upon the extent of remedial actions. Any remaining structures and surface cover not required to be removed as part of the remediation or in relocating site functions would be part of the Federal project. The LATC is on the site of a Union Pacific rail facility that was established in the early 1900s. Historic quadrangle maps show several structures in the APE including a roundhouse and turntable. There is a high likelihood of near surface and subsurface historic cultural resources including historic debris concentrations and foundations. Based on the current plan, it is highly likely that historic archaeological resources could be encountered during investigation and remediation and there is potential for impacts to historic archaeological resources associated with

implementing remediation. Any impacts to historic resources would be adequately resolved by the City under state law.

As with the Taylor Yard in Reach 6, the extent of ground disturbance associated with remediation is not known. For the purposes of this analysis we are assuming that some cultural resources would remain intact and will need to be addressed as part of the federal project. Based on conceptual designs overlaid on aerial photography, there is one structure located along the very edge of the project boundary.

Because these are conceptual level designs and because the study intends to avoid as many relocations as possible, it is assumed that this structure will not be relocated to gain an additional foot of restoration. Currently there are trailers on the site but these have not been included in this analysis because they are movable.

The LATC site provides the largest acreage for restoration and also has a high likelihood of containing archaeological remains that are eligible for the NRHP for their ability to provide information about transportation, labor, and daily life in the early part of the 20th Century. Following remediation, there is potential for adverse effects on these archaeological sites (historic properties). By completing the process in the PA to identify and evaluate potential adverse effects, adverse effects may either be avoided or minimized through data recover and other documentation. With proper mitigation, it is anticipated that the adverse effects can be kept below the level of CEQA or NEPA significance.

The connection and confluence of the restored wash with the River would likely impact historic River structures. If determined eligible, this would result in an adverse effect to a historic property. Likely mitigation measures might include archival documentation and photo recordation according to NPS Historic Building Survey (HABS), Historic American Engineering Record (HAER), and Historic American Landscapes Survey (HALS) standards. If these mitigation measures are successfully applied, it is expected that these impacts can be mitigated below the threshold of NEPA and CEQA significance.

Operational Impacts

Under Alternative 10, minimal impacts on cultural resources would be anticipated associated with the O&M of the restoration project areas and the containment and flood risk management facilities on the River and its tributaries. In areas where concrete is removed, erosion may reveal buried undiscovered cultural resources. Ongoing O&M activities, however, typically do not involve extensive ground disturbing activities or the removal or extensive alteration of existing structures including water control and conveyance infrastructure, and rail and other transportation facilities that may be historic. No significant impacts would be anticipated.

O&M activities under this alternative are not anticipated to result in a substantial adverse change under CEQA and the potential adverse effects under NHPA would likely be minor and unlikely to reach a level of NEPA significance.

Indirect Effects and Related Actions to Construction and Operation

There is potential for sites of historic or archeological value to be present anywhere within the Los Angeles Basin due to the long history of human occupation. Changes in channel capacity and morphology could lead to changes in rates of bank erosion and flooding, which have potential to impact archaeological sites, historic structures, or important aspects of TCPs. Additional hydraulic modeling will be conducted during the detailed design phase to inform design refinements. If the impacts identified in the next phase are different from those anticipated in this IFR, supplemental analysis would be conducted.

Relocation of the LATC site functions to a new site within the Los Angeles Basin would have the potential to disturb cultural resources protected under the NHPA. Though the potential for unearthing new

sites would be low, because the new site would be situated where existing industrial development is already present and should have already undergone cultural evaluation, it would still be necessary to conduct all required analyses to ensure the protection of potentially occurring historic resources. Analysis of cultural resources in the area will be conducted pursuant to a site-specific EIR by the CEQA lead agency prior to final site selection. Should any additional NEPA documentation be required, it would be undertaken by the NEPA lead agency. These effects are anticipated to be the same for all action alternatives.

Alternative 13 (ACE)

Construction Impacts

Reaches 1-3

The ecosystem restoration measures proposed for Reaches 1 and 2 are the same as those for Alternative 10. Anticipated impacts on cultural resources would be the same as those described for these reaches under Alternative 10. In Reach 3, Alternative 13 adds narrow riparian corridors along the upstream edge of Ferraro Fields and along Zoo Drive. A side channel cutting diagonally behind Ferraro Fields to a freshwater marsh and then to the River would be established by daylighting a storm water culvert. Potential impacts on cultural resources could occur from ground disturbance, new construction and structural alterations as described above.

The APE adjacent to the channelized River and Zoo Drive has not been inventoried, but has been extensively disturbed. Ferraro Fields has been investigated for cultural resources. Although the athletic fields were built on a portion of an old airfield, no cultural resources have been recorded there. While there is always the possibility of encountering buried cultural resources during ground disturbing activities, the potential for undiscovered intact buried resources that would meet the criteria for eligibility for NRHP or CRHR listing or other sensitive cultural resources appears to be low. Adverse effects are not anticipated.

Reaches 4-6

The ecosystem restoration measures proposed for Reaches 4, 5 and 6 are similar to Alternative 10. Additional measures include more extensive work on channel geomorphic character to support in-stream habitat in Reach 4, additional modification on both banks of the channel walls to support herbaceous riparian vegetation in Reaches 5 and 6, and the daylighting of a large storm drain at the Bowtie site in Reach 6 to create a freshwater marsh. Anticipated impacts on cultural resources would be the same as described for these reaches under Alternative 10 and would include the potential for impacts to historic archaeological properties at the Bowtie/Taylor Yard site associated with implementing the ecosystem restoration project.

Reaches 7-8

Work in Reach 7 includes modifying the channel walls on both banks to support herbaceous riparian vegetation, removing concrete, reconfiguring the Arroyo Seco channel cross section, and planting to support riparian habitat restoration. No actions are proposed that would alter architectural and historic qualities or the settings of the NRHP- and the CRHR-eligible historic bridges, buildings or the Arroyo Seco Parkway. The narrow habitat corridors on the edge of the river channel and Arroyo Seco channel modifications would be developed on highly disturbed land that are unlikely to contain any intact cultural resources. Modification of the concrete structures at the confluence would likely impact River and Arroyo Seco channel historic infrastructure. If determined eligible, this would result in an adverse effect to a historic property. Likely mitigation measures would include archival documentation and photo

recordation according to NPS Historic Building Survey (HABS), Historic American Engineering Record (HAER), and Historic American Landscapes Survey (HALS) standards. If these mitigation measures are successfully applied, it is expected that these impacts can be mitigated below the threshold of NEPA and CEQA significance.

Ecosystem restoration measures proposed for Reach 8 are the same as those for Alternative 10. Anticipated impacts on cultural resources would be the same as those described for this reach under Alternative 10.

Operational Impacts

Under Alternative 13, minimal impacts on cultural resources would be anticipated associated with the O & M of the restoration project areas and the containment and flood risk management facilities on the River and its tributaries. In areas where concrete is removed, erosion may reveal buried undiscovered cultural resources. Ongoing O&M activities typically do not involve extensive ground disturbing activities or the removal or extensive alteration of existing structures including water control and conveyance infrastructure, and rail and other transportation facilities that may be historic. No significant impacts are anticipated.

O&M activities under this alternative are not anticipated to result in a substantial adverse change under CEQA and the potential adverse effects under NHPA would likely be minor and unlikely to reach a level of NEPA significance.

Alternative 16 (AND)

Construction Impacts

The ecosystem restoration measures proposed for Reaches 1, 2, 3, 4, 6, and 7 are the same as those for Alternative 13. Anticipated impacts on cultural resources would be the same as those described for these reaches under Alternative 13.

In addition to the restoration measures proposed for Reach 5 under Alternative 13, Alternative 16 adds reshaping of the right bank of the channel from trapezoidal to vertical configuration and widening the channel invert to provide additional in-stream habitat. A bioengineered notch along the top of right channel would be constructed for hanging vines. The left bank of the channel would be constructed to transition from trapezoidal to vegetated terraces. Modifications to the channel morphology are unlikely to encounter or impact intact buried archaeological resources, but modification to the concrete channel would likely impact historic River structures. If determined eligible, this would result in an adverse effect to a historic property. Likely mitigation measures would include archival documentation and photo recordation according to NPS Historic Building Survey (HABS), Historic American Engineering Record (HAER), and Historic American Landscapes Survey (HALS) Standards. If these mitigation measures are successfully applied, it is expected that these impacts can be mitigated below the threshold of NEPA and CEQA significance.

Reaches 7-8

Additional restoration measures proposed for Reach 8 include riparian planting and restoration of riparian habitat corridors outside of the channel along the LATC site and channel alterations including terraces and widening provide habitat features supportive of in-stream biota. Modification to the concrete channels and channel wall would likely impact historic River structures. If determined eligible, this would result in an adverse effect to a historic property. Likely mitigation measures would include archival documentation and photo recordation according to NPS Historic Building Survey (HABS), Historic

American Engineering Record (HAER), and Historic American Landscapes Survey (HALS) standards. If these mitigation measures are successfully applied, it is expected that these impacts can be mitigated below the threshold of NEPA and CEQA significance.

There is also a high likelihood of near surface and subsurface historic cultural resources, including historic debris scatters and foundations in the LATC site. Removing the channel wall and creating a bench would require more extensive excavation and the potential for deeper erosion than the other alternatives. This increases the likelihood of impacts by exposing archaeological sites from the historic railroad uses and perhaps earlier periods. It is highly likely that historic properties could be encountered during construction and there is potential for impacts on historic archaeological resources associated with implementing this measure. Similar to Alternative 10, following remediation, there is potential for adverse effects on remaining historic properties at the LATC site. Adverse effects may either be avoided or minimized through data recovery and other documentation activities as laid out in the PA; therefore, impacts are considered less than significant.

Operational Impacts

Under Alternative 16, minimal impacts on cultural resources would be anticipated associated with the O&M of the restoration project areas and the containment and flood risk management facilities on the River and its tributaries. In areas where concrete is removed, erosion may reveal buried undiscovered cultural resources. Ongoing O&M activities typically do not involve extensive ground disturbing activities or the removal or extensive alteration of existing structures including water control and conveyance infrastructure, and rail and other transportation facilities that may be historic. No significant impacts would be anticipated.

O&M activities under this alternative are not anticipated to result in substantial adverse change under CEQA and the potential adverse effects under NHPA would likely be minor and unlikely to reach a level of NEPA significance.

Alternative 20 (RIVER)

Construction Impacts

The ecosystem restoration measures proposed for Reaches 1, 4, 5, 6, and 8 are the same as those for Alternative 16. Anticipated impacts on cultural resources would be the same as those described for these reaches under Alternative 16.

The additional measure for Reach 2 of reshaping the right bank of the channel from a trapezoidal to vertical configuration and hanging vines from the top of the channel would likely impact historic River structures. If determined eligible, this would result in an adverse effect to a historic property. Likely mitigation measures would include archival documentation and photo recordation according to NPS Historic Building Survey (HABS), Historic American Engineering Record (HAER), and Historic American Landscapes Survey (HALS) standards.

The measures proposed for Reach 3 on the west side of the River for Ferraro Fields and along Zoo Drive would be the same as Alternatives 13 and 16 with the same anticipated impacts on cultural resources. On the east side of the River in Reach 3, the Verdugo Wash would be widened under the SR-134 Freeway and a soft bed riverbed would be configured to support an open water marsh through removal of the concrete bed. The downstream banks would be lowered and sloped adding riparian vegetation. Portions of the study area above the River and wash level have been inventoried and no cultural resources have been recorded. Reconfiguring the confluence and creating the sloped downstream banks could potentially impact 20 structures and/or their surrounding features, however, only approximately 10 of these structures

would be removed. Much of the project will only intrude on parking lots or other external features of the remaining buildings. Base on the LA County Assessors' database, the structures range in age from 1948 to 1977 but clustered from 1950-1953 and 1970-1973. Many of these buildings have been modified by later improvements. The area is heavily industrialized and almost all appear to be warehouses. It is unlikely that these properties will be found to be eligible for the NRHP.

Deep excavations would be needed to lower the banks. In the immediate vicinity of the Verdugo Wash and freeway supports and in the channel the soil is likely to be highly disturbed, but the potential for intact buried archaeological resources is unknown in other areas proposed for lowering. Modification to the concrete channels would likely impact historic River structures. If determined eligible, this would result in an adverse effect to a historic property. Likely mitigation measures would include archival documentation and photo recordation according to NPS Historic Building Survey (HABS), Historic American Engineering Record (HAER), and Historic American Landscapes Survey (HALS) standards.

In addition to the restoration measures proposed for Reach 7 under Alternatives 13 and 16, under Alternative 20 three storm drains would be daylighted. Terraces on the right bank would be added adjacent to the Cornfields site and the western edge of the terrace would be sloped back up to the original ground elevation, creating a freshwater marsh. The daylighted storm drains are in disturbed areas where the potential for undiscovered intact buried resources would be low. Modification to the concrete channel for daylighting the storm drains and flow diversions would likely impact historic River structures. If determined eligible, this would result in an adverse effect to a historic property. Likely mitigation measures would include archival documentation and photo recordation according to NPS Historic Building Survey (HABS), Historic American Engineering Record (HAER), and Historic American Landscapes Survey (HALS) standards. The Cornfields site is the former location of the Southern Pacific River Station and freight yard. Archaeological excavations at the Cornfields have confirmed the presence of significant historical cultural resources on the site. Impacts to historic archaeological properties would be possible from ground disturbing activities associated with creating the freshwater marsh at this site and connecting it with the River. According to the preliminary real estate analysis, two standing structures, built in 1982 and 1988 respectively, would be removed under this alternative. Due to the presence of historic archaeological properties and the level of ground disturbance proposed, there is potential for adverse effects on historic properties and adverse changes on historic resources at these locations. By completing the process in the PA, adverse effects may either be avoided or minimized through data recovery and other documentation activities as laid out in the PA. With early involvement of cultural resource professionals in the further development of project designs and with appropriate mitigation it is expected that significant impacts under NEPA and CEQA can be avoided. No actions are proposed that would alter architectural and historic qualities or the settings of the NRHP- and the CRHR- eligible historic bridges and buildings.

Operational Impacts

Under Alternative 20, little change in potential impacts on cultural resources would be anticipated associated with the O&M of the restoration project areas and the containment and flood risk management facilities on the River and its tributaries. In areas where concrete is removed, erosion may reveal buried undiscovered cultural resources. Ongoing O&M activities typically do not involve extensive ground disturbing activities or the removal or extensive alteration of existing structures including water control and conveyance infrastructure, and rail and other transportation facilities that may be historic. No significant impacts would be anticipated.

O&M activities under this alternative are not anticipated to result in substantial adverse change under CEQA and the potential adverse effects under NHPA would likely be minor and unlikely to reach a level of NEPA significance.

5.6.4 Best Management Practices and Impact Avoidance Measures

- CR-1 - An archaeologist meeting the Secretary of the Interior's Qualification Standards shall monitor all construction activities in areas where there is a potential for buried resources. The monitor shall immediately notify the USACE's on-site construction supervisor of any discovery. The USACE on-site construction supervisor shall temporarily stop construction in the area of the discovery. The discovery area and a surrounding buffer zone shall then be clearly delineated. Ground disturbing activities can resume outside the delineated buffer zone. Should previously unknown historic or archaeological remains be discovered, the USACE would comply with 36 CFR 800.13. At the conclusion of monitoring activities, a detailed letter report shall be prepared. This report shall be submitted to the SHPO for review and comment.

- CR-2 - When construction crews are working within 50 meters of an eligible or unevaluated cultural resource, the edge of the site, including a 25-meter site buffer will be fenced off, thus ensuring that no construction equipment inadvertently strays into the culturally sensitive area.

- CR-3 - Cultural resource block inventories and evaluations shall be conducted early in the next design phase so that avoidance and impact minimization measures for cultural resources can be incorporated into project design.

- CR-4 - Recordation and evaluation of the constructed features of the flood risk management system on the river and lower tributaries within the APE will be prioritized in PED. The recordation and evaluation shall be conducted in one effort and in reference to and in the context of the entirety of the flood risk management system constructed on the Los Angeles River and lower tributaries.

- CR-5 - Comply with the terms and conditions of the PA executed by and between the Corps and SHPO, and any amendments thereto.

5.7 TRAFFIC AND CIRCULATION

5.7.1 Regulatory Framework

Federal Regulations

Federal management of transportation facilities in the area is under the authority of the Federal Highway Administration and the Federal Transit Administration. Federal programs related to roads and highways, mass transit, and pedestrian and bicycle facilities include Metropolitan and Statewide Planning (49 USC Sections 5303, 5304, 5305), Large Urban Cities (49 USC Section 5307), Rail and Fixed Guideway Modernization (49 USC Section 5309), Bus and Bus Facilities (49 USC Sections 5309, 5318), the Surface Transportation Program, and Congestion Mitigation and Air Quality Improvement Program. The Surface Transportation Board (STB) has jurisdiction over transportation by rail carriers, with respect to rates, rules, practices, routes, services and facilities. The STB has jurisdiction over the construction, acquisition, operation, abandonment, or discontinuance of spur, industrial team, switching, or side tracks or facilities. (49 USC 10501).

State Regulations

Coordination with Caltrans would be necessary where construction of restoration measures would involve highways, regulations, and standards under Caltrans jurisdiction. Where proposed projects would affect state highways and freeways, coordination with Caltrans would require developing traffic management plans and obtaining encroachment permits for work within state ROWs and permits to transport equipment or materials in oversized vehicles. Caltrans would also likely participate in decisions related to Federal transportation agency involvement.

Local Regulations

Local jurisdictions, including the Cities of Los Angeles, Glendale, and Burbank, and Los Angeles County, have primary responsibility for managing the various roadways that make up the area street network. The Los Angeles County Metropolitan Transportation Authority is responsible for preparing the Congestion Management Program for Los Angeles County. This program addresses the impact of local growth on the regional transportation system and monitors the operations of the designated Congestion Management Plan roadway network.

City of Los Angeles regulations include significance levels of construction-related activities, designated truck routes and hours of operation, noise restrictions from construction and excavation activities, and construction clearance requirements. These regulations are discussed below.

LADOT considers construction-related traffic to be an adverse impact, but not significant. This is because such impacts, while they are often inconvenient to local roadway users, are short-term. However, LADOT requires implementation of worksite traffic control plans for construction projects in order to ensure that construction-related impacts are minimized to the extent possible.

The City of Los Angeles allows major and secondary arterials to be used as truck routes. However, some local streets have weight limitations or other restrictions that would limit truck traffic. Typically, trucks would not travel on those streets except to obtain access to a specific project site. The City of Los Angeles policy is to allow trucks to travel in a "reasonable fashion" to and from a project site. The City of Los Angeles reviews each haul route permit application on a project basis and may adjust its general guidelines as appropriate for particular situations.

The City of Los Angeles also restricts the speed limit to 25 mph in construction areas. The city has the following construction clearance requirements:

- Five-foot clearance between a traffic lane and the nearest vertical obstruction, which can be reduced to three feet in certain circumstances with the approval of LADOT;
- Two-foot clearance to a raised curb, which can be reduced to zero in certain situations with the approval of LADOT;
- A minimum of 10-foot-wide traffic lanes must be maintained through construction zones; and
- The minimum taper requirement for channeling traffic flow lanes ranges from 25:1 to 30:1 (length to horizontal distance).

5.7.2 Significance Criteria

The City of Los Angeles CEQA Guidelines (2002) traffic significance thresholds have been used to determine the level of impacts. Although in some cases these thresholds are worded slightly differently than thresholds used by the City of Burbank to assess potential effects of implementing the recently-completed Burbank2035 General Plan (Burbank 2013c), they are still consistent with those thresholds.

Because the City of Glendale has not established CEQA significance criteria, the criteria from the City of Los Angeles' CEQA Guidelines have been applied for the portions of the project in Glendale.

The project would have a significant impact on traffic, transportation, and the circulation system if it would:

- Conflict with an applicable plan, ordinance, or policy establishing measures of effectiveness for the performance of the circulation system,
- Conflict with an applicable congestion management program, including, but not limited to level of service (LOS) standards and travel demand measures, or other standards established by the county congestion management agency for designated roads or highways,
- Substantially increase hazards due to a design feature (e.g. sharp curves or dangerous intersections) or incompatible uses (e.g. farm equipment),
- Result in inadequate emergency access,
- Result in an increased demand for public transit, beyond the current transit capacity,
- Provide less parking than was needed for the project, as determined through a project-specific analysis of parking demand, or
- Conflict with adopted policies, plans, or programs regarding public transit, bicycle, or pedestrian facilities, or otherwise decrease the performance or safety of such facilities.

5.7.3 Environmental Impacts

No Action Alternative

Construction Impacts

No impacts to transportation would occur from construction under this alternative because construction would not occur.

Operational Impacts

Under the No Action Alternative, the project would not be implemented and no construction would occur; therefore, the existing transportation network and travel demand would not be altered and there would be no impacts.

Population, employment, and goods movement are all projected to increase under the future without-study conditions (Wilbur Smith Associates 2008). This would result in increased pressure on the transportation system, including increased numbers of vehicles and vehicle miles traveled on Federal and state highways and local streets, increased demand for freight and passenger rail capacity, increased public transit ridership, increased parking demand, and increased numbers of pedestrians and bicyclists. Many of these systems, especially the road and rail networks, are already operating near capacity and increased use would be expected to reduce operating efficiency and cause increased delays.

A high-speed rail network is planned that would have three routes passing through Union Station that would accommodate a projected 14,100 riders. The study is currently undergoing a phased study planning and environmental review to determine the best route alignment and station locations, and assess the environmental impacts. Construction in the Central Valley may begin in early 2013 and will take several years to complete. In the Los Angeles area, high-speed rail would provide a new transportation alternative that would divert trips from existing road, passenger rail, and bus routes and serve California's growing population (California High Speed Rail Authority 2012). High speed rail trains would pass through the study area.

Transportation stakeholders have developed plans to achieve an efficiently functioning transportation system such as the Transportation Element of the City of Los Angeles's General Plan (City of Los Angeles 1997) and the Multi-County Goods Movement Action Plan (Metrolink 2007). The stakeholders including governments, transportation planning agencies, and commercial businesses such as Union Pacific and BNSF would be expected to continue efforts to analyze the region's transportation needs and implement projects to address growing demand and evolving needs. However, issues such as funding and land use conflicts may prevent or cause delays in implementing major changes or upgrades to the transportation network.

Alternative 10 (ART)

Construction Impacts

The project would add additional traffic to area roads during construction, which would occur over a period of 9 years under this alternative. Trips would involve construction equipment and materials being delivered to and removed from the site and workers commuting to and from the site. Construction vehicles would be scheduled and routed to minimize conflicts with other traffic. However, workers commuting to and from the site would travel during peak morning and afternoon commute periods, adding traffic to areas roads when they are busiest. Table 5-22 contains estimates for the number of worker commute trips and haul truck trips that would be generated by the action alternatives; the numbers are estimates and actual numbers may vary.

Table 5-22 Construction and Demolition Debris Removal

Alternative	Average Daily Worker Round Trips (2 people per vehicle)	Daily Haul Truck Trips*	Estimated Number of Work Days
10-ART	24	12 cubic yard truck: 6 16 cubic yard truck: 28 Total truck trips: 34	1980
13-ACE	29	12 cubic yard truck:11 16 cubic yard truck: 32 Total truck trips: 43	2200
16-AND	90	12 cubic yard truck: 17 16 cubic yard truck: 63 Total truck trips: 80	3300
20-RIVER	107	12 cubic yard truck: 18 16 cubic yard truck: 87 Total truck trips: 105	3300

*Assumes 220 days/year construction

Construction activities could result in delays in traffic movements due to the presence of slow-moving construction trucks and vehicles delivering or removing equipment and supplies from construction sites, and from temporary closure of travel lanes or roads or from traffic detours. A construction traffic management plan would be prepared and submitted to LADOT for review and approval prior to project implementation to ensure that construction impacts are minimized. The plan would include:

- Designated routes and access points for construction vehicles and equipment,
- Any turning movement restrictions,
- Travel time restrictions to avoid peak travel periods on selected roadways, and
- Designated staging and parking areas for workers and equipment.

With implementation of a traffic management plan and traffic control plan, and the appropriate BMPs, additional construction traffic and temporary closures and diversions would have a minimal impact on effected roadways and intersections. LADOT considers temporary impacts to be less than significant.

If construction required temporary closures or partial closures of streets or traffic diversions to accommodate construction activities, public transit routes on the affected streets would also be temporarily disrupted. Transit vehicles could be routed, and riders could be delayed, resulting in short-term impacts. The construction traffic management plan and traffic control plan would describe impacts to public transit in detail and efforts would be made to minimize impacts. The project proponent would also coordinate with local transit providers prior to project implementation. In the unlikely event that a significant impact was identified, the project design or construction plan would be altered to reduce the impact to less than significant.

This alternative, like the other alternatives, would convert an existing railyard (LATC) to restored habitat and occur near railroad lines in Reach 8. The LATC is located in Reach 8, owned by Union Pacific, and used as a freight-forwarding area. The yard has multiple rail spurs running through it and rail lines on its north, west, and south perimeters. The passenger and freight rail lines along the west perimeter are owned by LA Metro and are referred to as the "East Bank" tracks. The tracks at the Yard's northern perimeter consist of the "Yuma Main Line," owned by Union Pacific, and one Amtrak track. The lines south of the Yard are Metrolink tracks owned by Metro, also known as the "San Gabriel Subdivision." All of these tracks would remain in place and continue to operate; however, the spur lines in the Yard's interior and the intermodal railyard storage capacity would be permanently removed. It is anticipated that the reduction in railyard capacity at LATC would be relocated within the Los Angeles Basin, as discussed in the indirect effects analysis below. Effects would be less than significant. There are not conversions of rail facilities anywhere else in the project, although construction is proposed in parcels adjacent to these facilities. Construction would also occur at a former railyard in Reach 6 at Taylor Yard west of Rio de Los Angeles State Park to provide area for habitat corridors and riparian plantings; these lines are not in use.

Construction would occur near rail lines in Reaches 6 and 7 and existing maintenance yard in Reach 7. The construction traffic management plan and traffic control plan would describe impacts to railroads in detail and coordination with railroad operators would be essential to determine methods for minimizing impacts. Proper coordination will ensure that impacts would be less than significant. Construction of features along the east bank of the river in Reach 6 would be designed to avoid or address maintenance access for relevant railroad facilities. Construction in Reach 7 will preserve access from Baker Street to the Gold Line maintenance yard in that reach during and after construction. Work performed adjacent to rails would maintain SCRRA published clearances from tracks during and after construction. The rail track that runs north from CMF to the south end of Taylor Yard would remain in place and continue to be used for emergency storage and switching of cars.

During construction, staging areas would provide parking for construction equipment and construction workers, so parking demand on surrounding roads would not increase. If road or lane closures were necessary to accommodate construction activities, on-street parking spaces in those areas could also be temporarily closed. The construction traffic management plan and traffic control plan would describe impacts to parking in detail and efforts would be made to minimize impacts. This impact would be less than significant.

Construction could have short-term adverse iinpacts on the Los Angeles River Bike Path. Sections of the path may be temporarily closed or rerouted to accommodate construction activities. If construction required closures or partial closures of streets to accommodate construction activities, bike lanes and

sidewalks on these streets would also be temporarily closed, resulting in short-term moderate adverse impacts. A construction traffic management plan would be prepared prior to project implementation. The plan would describe in detail any closures or rerouting of the bike path to accommodate construction activities. Efforts would be made to minimize any necessary closures. If closures were necessary, signs would be posted to alert users to the closure and fencing or other access restrictions would be used if necessary to ensure safety. This impact would be less than significant.

Operational Impacts

The project would not alter the roadway network. No existing roads, intersections, or bridges would be permanently closed and no new roadway features would be added. Because no new roadway features would be added during maintenance, the project would not introduce hazards due to design features such as sharp curves or dangerous intersections or incompatible uses such as farm equipment and there would be no impact related to this significance criterion. There would also be no change in roadway capacity. The project would not result in changes to emergency access. As previously stated, the project would not alter the roadway network, so existing emergency access routes would not be affected. Emergency access routes to the river for swiftwater rescue personnel and law enforcement may be improved by construction of maintenance ramps.

Indirect Effects of and Related Actions to Construction and Operation

The project would result in additional vehicle trips to area roads from increased visitation because it would make portions of the River a recreational destination. Estimated increases in recreational use at particular locations were compared to figures showing access points, point draws, and new or refurbished trails. With this data, estimates of increases in daily vehicle trips, reflecting seasonal variation, were developed to estimate the potential for impacts to traffic flow and parking. Although this analysis indicated the potential for minor increases in vehicle trips and parking needs at certain locations such as Pollywog Park in Glendale, many of these trips would likely occur during off-peak travel hours and therefore would not affect the performance of the roadway network when it is at its busiest. Therefore the project would not conflict with established measures of effectiveness for the performance of the roadway network and the area's adopted congestion management program and impacts would be less than significant.

Parking demand on roads near the River would be expected to increase because more people would be expected to access the River for recreational purposes. Thus, the existing parking in the study area, which is primarily on-street parking on residential roads, would be more heavily used and would see more use by persons not living or working in the area. The project will provide two new parking areas at Taylor Yard and LATC, providing 30-50 parking spaces at each of these two sites. While visitors will be encouraged to use these locations to access the park, a project-specific analysis of parking demand within each reach will be prepared prior to project implementation and the final design will provide for adequate parking, resulting in a less than significant adverse impact. The need for additional parking beyond that identified in the recreation plan is not anticipated.

Ridership on public transit routes with stops near portions of the study area where public access is enhanced would increase because people would use public transit to access the River. However, the restored River is not expected to be a public draw to the extent that it causes overcrowding on public transit resources. Long-term ridership on commuter rail lines with stops near portions of the study area where public access is enhanced would increase because people would use commuter rail to access the River. Additional riders would likely travel during off-peak travel times since they would primarily be accessing the River for recreational purposes. Since they would generally travel during off-peak times, the additional riders would not likely cause ridership to exceed peak ridership and would not add

substantially to demand for commuter rail service; thus, existing capacity should be sufficient to accommodate the increase. Therefore, impacts would be less than significant.

Because the restoration would result in aesthetic enhancement, new multi-use walking and biking paths would be constructed, and public access would increase, more people would be expected to use the River corridor for local and recreational trips. Travel on the existing Los Angeles River Bike Path would also increase. The capacity of the Los Angeles River Bike Path and the new multi-use paths that would be constructed as part of the project should be sufficient to accommodate demand.

Relocating the functions of the LATC facility may result in indirect effects to traffic and transportation in another part of the Los Angeles Basin during the process of transferring equipment and portable infrastructure from the old facility, during construction of the relocated facility, and as a result of operations at that site. Construction activities that require introduction of heavy equipment and numerous truck trips could result in temporary traffic closures or delays at the new location. Operation of the new site may require permanent changes to existing roadway or rail traffic patterns if truck or rail traffic increases as a result of its use. It is presumed that most of the impacts would be avoided or minimized through selecting a new site that is functionally equivalent to the old site with reasonable proximity to existing UPRR rail lines. The new site is anticipated to be in an industrial zone with adequate capacity for industrial traffic. The CEQA lead agency will conduct a detailed CEQA analysis in analyzing the relocation of LATC site functions, including assessment of traffic and transportation impacts. Should any additional NEPA documentation be required, it would be undertaken by the NEPA lead agency. These effects are anticipated to be the same for all action alternatives.

Alternative 13 (ACE)

Construction Impacts

Construction activities would occur over a period of 10 years, a longer time period compared to Alternative 10-ART, so the temporary effects of construction would last longer. As shown in Table 5-22, the number of daily worker commute trips would be slightly higher than under Alternative 10-ART but the number of round trip truck trips would be lower. Construction impacts would be less than significant since the inconvenience to vehicles and other types of traffic would be temporary.

Operational Impacts

Operational impacts on traffic and transportation would be similar to those described for Alternative 10-ART, but would be more extensive due to the larger footprint of the proposed project; however, impacts would still be less than significant. Under this alternative, existing railroad alignments would not be affected during construction or operation. Through coordination and implementation of BMPs, impacts are considered to remain less than significant for both construction and operation.

Alternative 16 (AND)

Construction Impacts

Construction activities would occur over 15 years, a longer time period compared to Alternatives 10-ART and 13-ACE, so the temporary effects of construction would last longer. As shown in Table 5-22, the number of daily worker commute trips would be approximately three times as many as Alternative 13-ACE due to the additional construction in Reaches 5 and 8. The number of round trip truck trips would also be higher; however, because the trucks would not travel the same routes, would not likely travel during peak commute hours, and would only last for the duration of construction, the additional trips would result in a less than significant impact. Most construction impacts to circulation and traffic would be less than significant since the inconvenience to vehicles and other types of traffic would be temporary.

Under this alternative, to accommodate construction, operation, and maintenance of the restoration features, existing railroad alignments would be kept at grade but placed onto trestles in Reach 8 on the left bank south of Main Street to Cesar Chavez Avenue through LATC, with excavation below the existing grade. The railroad would be trestled to provide right-of-way for additional channel capacity and space to implement other restoration measures. Uninterrupted service to rail traffic is a primary design criterion and temporary shoofly trestles or bypass lines are not currently anticipated to be needed to allow for uninterrupted service. However, the existing track alignments, construction of new trestle alignments, the configuration of the proposed ecosystem restoration features and existing and anticipated train traffic will be further evaluated during the design phase to verify that temporary shoofly trestles or bypass lines are not needed. If during the design phase, such temporary measures are identified as needed, supplemental analysis would be performed at that time.

Operational Impacts

Operational impacts on traffic and transportation would be similar to those described for Alternatives 10 and 13, but would be more extensive due to the larger footprint of the proposed project; however, impacts would still be less than significant. Once construction was complete, road and rail operations could return to a before-project state; thus, there would be no long-term operational impact on railroads. Through coordination and implementation of BMPs, impacts are considered to remain less than significant for operation.

Alternative 20 (RIVER)

Construction Impacts

Construction activities would occur over a period of 15 years, a longer time period compared to the other alternatives, so the temporary effects of construction would last longer. As shown in Table 5-22, the number of daily worker commute trips would be higher than the other alternatives, with the increase from Alternative 16 attributable to additional construction in Reaches 2 and 3 and additional construction and relocation work (trestling) in Reach 7. The number of round trip truck trips would also be higher; however, because the trucks would not travel the same routes, would not likely travel during peak commute hours, and would only last for the duration of construction, the additional trips would result in a less than significant impact. Construction impacts for vehicular commuting and traffic would be less than significant since the inconvenience to vehicles and other types of traffic would be temporary.

Construction of features along the east bank of the river in Reaches 6 and 7 would be designed to avoid or address maintenance access for relevant railroad facilities. Like Alternative 16, under this alternative, to accommodate construction, operation, and maintenance of the restoration features, existing railroad alignments would be kept at grade but put onto trestles in Reach 8 on the left bank south of Main Street to Cesar Chavez Avenue through LATC, with excavation below the existing grade. The rail line on the right bank in Reach 7 between North Spring Street and North Broadway would also be placed onto trestles to facilitate construction, operation and maintenance of the restoration features. The rail line would be trestled to provide right-of-way to implement terracing of the bank. Impacts to rail service would be avoided or minimized to less than significant under this alternative in a similar fashion as under Alternatives 16 by providing trestles that would be operational by the time the original rail lines were removed.

Operational Impacts

Operational impacts on traffic and transportation would be similar to those described for Alternatives 10 13, and 16 but would be more extensive due to the larger footprint of the proposed project; however, impacts would still be less than significant. Once construction was complete, road and rail operations could return to a before-project state; thus, there would be no long-term operational impact on railroads.

Through coordination and implementation of BMPs, impacts are considered to remain less than significant for operation.

Indirect Effects of Construction and Operation

To allow for construction of Alternative 20, the non-Federal sponsor will have to acquire all lands required for the project, including some that currently have operating businesses. As businesses are displaced during acquisition, it is anticipated business owners would relocate their operations elsewhere. Transfer of existing equipment and fixtures to new business locations would involve some minor impacts on the existing roadway system over the project implementation timeline. Their operation at new locations would not be anticipated to have significant effects on traffic or transportation.

5.7.4 Best Management Practices and Impact Avoidance Measures

The following BMPs would be implemented to reduce transportation impacts:

- The location and duration of any lane or street closures, including impacts on public transit, railroads, bicycle lanes, sidewalks, and parking would be fully coordinated with local cities and nearby residents,
- Detour routes would be provided if needed (including detour routes for public transit, bicycles, and pedestrians when effected),
- Local traffic and emergency vehicle access would be maintained or accommodated,
- Traffic protective devices and control measures would be implemented such as barricades, cones, flaggers, lights, warning beacons, temporary turning restrictions, temporary traffic signals, and warning signs,
- Advance notice would be provided to affected residents, businesses, emergency services providers (police, fire, ambulance) and public transit providers,
- Temporary bus stops would be located within a reasonable walking distance of any displaced bus stops when public transit stops are affected,
- Safety improvements would be made to existing at-grade street-rail crossings where traffic increases would be expected, and
- The project would coordinate with railroad companies to ensure continuous operation and appropriate safety measures.

5.8 NOISE

5.8.1 Regulatory Setting

Federal

Federal law (Noise Control Act of 1972, 42 U.S.C. 4901 et seq., P.L. 92-574) legislates that each state provide for the protection of its citizens from noise. The following sections describe each of the regulations that have been developed at the state, county, and city level for noise control. Though each of the regulations described in the following sections applies to the proposed project, some regulations are stricter than others and would become the basis for significance criteria.

State of California

The State of California requires each local government to perform noise surveys and implement a noise element as part of its general plan as guided by the General Plan Guidelines (OPR 1998). The study area is located within the jurisdictions of the Los Angeles County, City of Los Angeles, City of Glendale, and City of Burbank, each of which have specific noise guidelines in place, as well as ordinances established as enforcement mechanisms for noise control.

Title 24 of the California Code of Regulations (CCR), Part 2, Chapter 12, Section 1208A.8.2 establishes the statewide regulations for allowable interior noise and states that interior noise levels attributable to exterior sources shall not exceed 45 decibels in any habitable room. This noise metric is to be measured as the day-night level (DNL) or the community noise equivalent level (CNEL), consistent with the Noise Element of the local General Plan. The CNEL is applicable for this analysis and adds a 5 dBA penalty to evening hours (7:00 p.m. to 10:00 p.m.) and a 10 dBA penalty to nighttime hours (10:00 p.m. to 7:00 a.m.).

Meaningful noise regulations come from average noise levels over the course of a 24-hour period referred to as the day-night average and denoted as DNL. These values are calculated from 24-hour averages in which nighttime values (10pm to 7am) are increased by 10 dB to account for the greater disturbance potential from nighttime noises. The community noise equivalent level (CNEL) is another measurement type that provides additional weighting for communities. It describes cumulative noise exposure over 24 hours, increased overnight by 10 dB to account for nighttime sensitivity, but also includes an additional increase by 5 dB for events between 7pm and 10pm.

Los Angeles County

The Los Angeles County Code (LACC) provides applicable noise regulations for exterior noises, specific guidelines for allowable noise in particular land use zones, allowable noise levels for construction activities and duration considerations for construction activities. The Los Angeles County General Plan reinforces the County Codes in its 2012 revised Noise Element. However, current ambient noise levels have not been updated in this document (Los Angeles County 2012b). The LACC provides noise level regulations for exterior, interior, and construction noise.

Exterior Noise

LACC Section 12.08.390 regulates exterior noise levels for four noise zones based on noise sensitivity as shown in Table 5-23. Section 12.08.390 limits apply to exterior operational noise levels caused by project-related on-site fixed sources such as industrial processing or manufacturing machinery. Unless a variance is allowed, these exterior noise levels apply to all receptor properties within a designated noise zone.

Table 5-23 Los Angeles County Code Exterior Noise Limits

Noise Zone	Designated Noise Zone Land Use (Receptor property)	Time Interval	Exterior Noise Level (dB)
I	Noise-sensitive area	Anytime	45
II	Residential properties	10:00 pm to 7:00 am (nighttime)	45
		7:00 am to 10:00 pm (daytime)	50
III	Commercial properties	10:00 pm to 7:00 am (nighttime)	55
		7:00 am to 10:00 pm (daytime)	60
IV	Industrial properties	Anytime	70

Interior Noise

Table 5-24 lists the allowable noise levels for residential dwellings.

Table 5-24 Los Angeles County Code Interior Noise Limits

Designated Land Use	Time Interval	Allowable Interior Noise Level (dB)
Multifamily	10 pm—7 am	40
Residential	7 am—10 pm	45

Construction Zones

Section 12.08.440 of the LACC restricts construction activity, where construction disturbs a commercial or residential property, to the hours between 7:00 a.m. and 7:00 p.m. Monday through Saturday and prohibits construction activity at any time on Sundays, or national holidays. Section 12.08.440 includes noise level limits at residential properties for mobile and stationary construction equipment (Table 5-25). Section 12.08.440 limits construction noise at commercial properties to a maximum of 85 dBA any time.

Operating or causing the operation of any tools or equipment used in construction, drilling, repair, alteration or demolition work between weekday hours of 7:00 p.m. and 7:00 a.m., or at any time on Sundays or holidays, such that the sound therefrom creates a noise disturbance across a residential or commercial real-property line, except for emergency work of public service utilities or by variance issued by the health officer is prohibited.

Table 5-25 Los Angeles County Code Construction Limits

	Single-family Residential	Multi-family Residential	Semi Residential/ Commercial
Mobile Equipment. Maximum noise levels for nonscheduled, intermittent, short-term operation (less than 10 days) of mobile equipment:			
Daily, except Sundays and legal holidays, 7:00 a.m. to 8:00 p.m.	75dBA	80dBA	85dBA
Daily, 8:00 p.m. to 7:00 a.m. and all day Sunday and legal holidays	60dBA	64dBA	70dBA
Stationary Equipment. Maximum noise level for repetitively scheduled and relatively long-term operation (periods of 10 days or more) of stationary equipment:			
Daily, except Sundays and legal holidays, 7:00 a.m. to 8:00 p.m.	60dBA	65dBA	70dBA
Daily, 8:00 p.m. to 7:00 a.m. and all day Sunday and legal holidays	50dBA	55dBA	60dBA

In addition, the LACC states that all mobile or stationary internal-combustion-engine powered equipment or machinery shall be equipped with suitable exhaust and air-intake silencers in proper working order. In case of a conflict between this chapter and any other ordinance regulating construction activities, provisions of any specific ordinance regulating construction activities shall control. Variances from the requirements of this chapter may be granted by the health officer. Every applicant for a variance shall file with the health officer a written application on a form prescribed by the health officer. The application shall state the name and address of the applicant, the nature of the noise source involved, and such other information as the health officer may require.

City of Los Angeles

The City of Los Angeles Municipal Code (LAMC) provides its own set of regulations for exterior noise and construction (City of Los Angeles 2012).

Exterior Noise

The LAMC limits exterior noise from fixed equipment, Section 112.02. Section 112.02 limits noise increase from air conditioning, refrigeration or heating equipment for any residence or other structure or to operate any pumping, filtering or heating equipment for any pool or reservoir to no more than 5 dB relative to the allowed ambient noise levels shown in in Table 5-26.

Table 5-26 Presumed Ambient Noise Level by Zone within Los Angeles

Zone	Day (7:00 a.m.–10:00 p.m.)	Night (10:00 p.m.–7:00 a.m.)
Agricultural, Suburban, Residential including Single and Multiple Family Homes (A1, A2, RA, RE, RS, RD, RW1, RW2, R1, R2, R3, R4, and R5)	50 dBA	40 dBA
Parking Areas and Commercial (P, PB, CR, C1, C1.5, C2, C4, C5, and CM)	60 dBA	55 dBA
Limited and Restricted Light Industrial (M1, MR1, and MR2)	60 dBA	55 dBA
Light and Heavy Industrial (M2 and M3)	65 dBA	65 dBA

Source: City of Los Angeles 2012.

Construction Noise

Construction activity is regulated in Section 40.41 of the LAMC, which restricts construction activity to occur between the hours of 7:00 a.m. and 9:00 p.m. Section 40.41 further restricts construction activities within 500 feet of residential properties to between the hours of 8:00 a.m. and 6:00 p.m. on Saturdays, or national holidays and prohibits construction at any time on Sundays. Section 112.05 further restricts construction equipment operating within 500 feet of residential uses between the hours of 7:00 a.m. and 10:00 p.m. to 75 dBA DNL. Section 112.05 states that construction and industrial machinery shall not exceed a maximum of 75 dBA at a distance of 50 feet, except where compliance is technically infeasible.

City General Plans

Noise control objectives and guidelines have been prepared in the General Plan Noise Elements for each of the cities of Los Angeles, Burbank and Glendale. The most comprehensive noise planning is provided in the City of Los Angeles General Plan Noise Element; it provides noise and land use compatibility guidelines for exterior noise, reinforces the state and county regulations, provides an additional construction ordinance, and provides the basis for the Burbank and Glendale General Plan Noise Elements (City of Los Angeles 1998). No additional noise elements are found in the Glendale General Plan, and the noise elements are consistent with those of Burbank's Burbank2035 General Plan (City of Burbank 2013b). City General Plans are required to indicate the extent of airport noise exposure, where those lands are subject to additional noise controls. The study area is not within an airport noise exposure contour of 65dB in any of the city jurisdictions.

Exterior Noise

The City of Los Angeles General Plan Noise Element guidance for noise and land use compatibility is provided in a matrix taken from the Governor's General Plan Guidelines (OPR 1998). Land use categories are similar to state and county land uses. A range of dBA measurements is shown for each land use for normally acceptable, conditionally acceptable, normally unacceptable, and clearly unacceptable noise levels.

Table 5-27 City of Los Angeles Noise Element and Land Use Compatibility Matrix

Land Use Category	Normally Acceptable	Conditionally Acceptable	Normally Unacceptable	Clearly Unacceptable
Residential – Low Density	50-60	60-70	70-75	75-85
Residential – Multiple Family	50-65	65-70	70-75	75-85
Transient Lodging – Motels, Hotels	50-65	65-70	70-80	80-85
Schools, Libraries, Churches, Hospitals, Nursing Homes	50-60	60-65	65-80	80-85
Auditoriums, Concert Halls, Amphitheaters	NA	50-70	NA	70-85
Sports Arenas, Outdoor Spectator Sports	NA	50-75	NA	75-85
Playgrounds, Neighborhood Parks	50-67.5	NA	67.5-75	75-85
Golf Courses, Riding Stables, Water Recreation, Cemeteries	50-70	NA	70-80	80-85
Office Buildings, Business Commercial and Professional	50-67.5	67.5-77.5	77.5-85	NA
Industrial, Manufacturing, Utilities, Agriculture	50-70	70-80	80-85	NA

Source: OPR 1998, City of Los Angeles 1998.

Construction Noise

There are no additional construction noise regulations provided in the City General Plans.

Wildlife

There are no established regulations for controlling noise for protection of noise sensitive wildlife. However, through the NEPA/CEQA agency consultation process, the USFWS service may provide noise control measures to protect sensitive wildlife during implementation of the selected project. Previous studies have established a 60 dB limit during the nesting season for protecting sensitive bird species such as the least Bell's vireo in relation to highway noise (AASHTO 2008).

5.8.2 Significance Criteria

The following thresholds of significance for noise impacts are derived from state, county, and city regulations and ordinances described in Section 5.8.1. Construction limits allow for some leeway in noise levels without a variance if the project complies with work windows and makes all feasible efforts to reduce noise impacts. Impacts to noise would be considered significant if an alternative results in:

- **Noise Significance Criterion 1**: Interior noise levels attributable to an exterior source exceeds 45 dB in any habitable room from 7 a.m. to 10 p.m. (Title 24), or exceeds 40 dB from 10 p.m. to 7 a.m. (LACC).

- **Noise Significance Criterion 2**: Exterior noise levels exceed those limits set by LACC for four noise zones shown in Table 5-23, or exceeds those set by the LAMC shown in Table 5-26 by 5 decibels or more. LACC Section 12.08.390 limits apply to exterior operational noise levels caused by project-related on-site fixed sources such as industrial processing or manufacturing machinery. LAMC Section 112.02 limits noise increase from air conditioning, refrigeration or heating equipment for any residence or other structure or to operate any pumping, filtering or heating equipment for any pool or reservoir to no more than 5 dB relative to the allowed ambient noise levels shown in Table 5-23.
- **Noise Significance Criterion 3:** Exterior noise levels increase by 3 decibels or more within the "normally unacceptable" or "clearly unacceptable" categories shown in Table 5-27.
- **Noise Significance Criterion 4**: A violation of LACC restrictions on construction activity, where construction disturbs a commercial or residential property, which must only occur between 7 a.m. and 7 p.m. Monday through Saturday, and must not occur anytime on Sundays or national holidays.
- **Noise Significance Criterion 5**: Exceeding any noise limits established by USFWS during consultation for sensitive wildlife species.
- **Noise Significance Criterion 6:** A violation of LAMC restrictions on construction activity, which must only occur between the hours of 7 a.m. and 9 p.m., and within 500 feet of residential properties between the hours of 8 a.m. and 6 p.m. on Saturdays and national holidays, and must not occur anytime on Sundays.
- **Noise Significance Criterion 7**: A violation of LAMC restrictions on construction equipment operating within 500 feet of residential uses to 75 dBA (Ldn).
- **Noise Significance Criterion 8:** A violation of LACC restrictions on construction noise levels at residential properties (see Table 5-25).
- **Noise Significance Criterion 9**: A violation of LAMC requirements that *construction* and industrial machinery shall not exceed a maximum of 75 dBA at a distance of 50 feet, except where compliance is technically infeasible.

5.8.3 Environmental Impacts

Methodology

Construction, although typically short-term, can be a significant source of noise. Construction noise levels are most notable when it takes place near sensitive land uses, occurs at night, and/or occurs in early morning hours. For most construction activities, the dominant noise source is usually an internal combustion engine. Mobile off-road equipment such as bulldozers and loaders would move around the construction site while on-road trucks and automobiles would transport equipment, material, and workers to and from the construction area. Noise generated by construction activities generally fluctuates depending on the construction phase, the quantity and type of equipment in use, and the duration of use. The impact of construction noise on a receptor would depend upon the level of construction activity on a given day and the related noise generated by that activity; the distance between construction activities and the noise-sensitive use; the presence or absence of barriers between the noise source and the receptor; and the ambient noise levels in the area.

Construction noise impacts were evaluated using the FHWA reference noise levels for various types of construction equipment and activities. This method references noise descriptors including:

Leq: The equivalent sound level is the average noise exposure level over a specified time period of interest, typically one hour.

Lmax: The instantaneous maximum noise level measured during the period of interest.

Ldn: The energy average of A-weighted sound levels over a 24-hour period, including a "penalty" to account for the greater sensitivity of most people to nighttime noise. Noise that occurs between 10 p.m. and 7 a.m. is weighted (penalized) by adding 10 dBA to account for the greater annoyance of such noise. The DNL is also referred to as L_{dn}.

Construction equipment that would be used for each action alternative is listed in Table 5-28 through 5-31. The FHWA L_{max} reference noise level is given for each piece at 50 feet away from the noise source. Estimated sound levels at incremental distances up to 400 feet are also listed. Since spherically radiating point sources of noise are atmospherically attenuated by a factor of 6 dB per doubling of the distance, sound levels incrementally decrease as distance from the sound source increases.

Impacts

Significance Criteria with No Impacts

No impacts are associated with the following significance criteria for all action alternatives. As the significance criteria will not be exceeded, no impacts are expected to occur:

Noise Significance Criterion 1: Interior noise levels attributable to an exterior source exceeds 45 dB in any habitable room from 7 a.m. to 10 p.m., or exceeds 40 dB from 10 p.m. to 7 a.m. This type of impact is associated with development of dwellings, which would not occur under the proposed action alternatives. Therefore, there will be no effects associated with this significance criterion.

Noise Significance Criterion 2: Exterior noise levels exceed those limits set by LACC for four zones shown in Table 5-23, or exceeds those set by the LAMC shown in Table 5-26 by 5 decibels or more. LACC Section 12.08.390 limits apply to exterior operational noise levels caused by project-related on-site fixed sources such as industrial processing or manufacturing machinery. LAMC Section 112.02 limits noise increase from air conditioning, refrigeration or heating equipment for any residence or other structure or to operate any pumping, filtering or heating equipment for any pool or reservoir to no more than 5 dB relative to the allowed ambient noise levels shown in Table 5-23.

There would not be any stationary noise sources permanently affixed to a specific location or structure under any alternative. Therefore, there will be no effects associated with this significance criterion.

Noise Significance Criterion 3: Exterior noise levels increase by 3 decibels or more within the "normally unacceptable" or "clearly unacceptable" categories shown in Table 5-27. This type of impact is associated with development of noise-generating land uses in areas with existing ambient noise levels in excess of Normally Acceptable, Conditionally Acceptable, Normally Unacceptable, or Clearly Unacceptable noise levels; or if operations of the proposed action alternatives causes the ambient noise levels measured at the property line at such land uses to increase by the levels stated above. Development of such land uses would not occur under any alternative. Therefore, there will be no effects associated with this significance criterion.

Noise Significance Criterion 4: A violation of LACC restrictions on construction activity, where construction disturbs a commercial or residential property, which must only occur between 7 a.m. and 7 p.m. Monday through Saturday, and must not occur anytime on Sundays or national holidays. Activities associated with construction and operations would generally occur between the hours of 8 a.m. and 6 p.m. Monday through Friday, and 8 a.m. and 5 p.m. Saturday. Construction and operations would not occur on Sunday or a national holiday. Therefore, there will be no impacts associated with this significance criterion.

Noise Significance Criterion 5: Exceeding any noise limits established by USFWS during consultation for sensitive wildlife species. Consultation with USFWS under the ESA was not considered necessary based on the existing conditions. Thus, noise limits were not placed on the project in consideration of possible impacts to listed species. Therefore, there will be no impacts associated with this significance criterion.

Noise Significance Criterion 6: A violation of LAMC restrictions on construction activity, which must only occur between the hours of 7 a.m. and 9 p.m., and within 500 feet of residential properties to the hours of 8 a.m. and 6 p.m. on Saturdays and national holidays, and must not occur anytime on Sundays. Construction and operations generally would occur between the hours of 8 a.m. and 6 p.m. Monday through Friday, and from 8:00 a.m. to 5:00 p.m. Saturday. Construction would not occur on Sundays or national holidays. Therefore, there will be no impacts associated with this significance criterion.

No Action Alternative

Construction Impacts

Under the No Action Alternative, no action would be taken and the project would not be constructed.

Noise Significance Criterion 7: A violation of LAMC restrictions on construction equipment operating within 500 feet of residential uses between the hours of 7 a.m. to 10 p.m. to 75 dBA (Ldn)

Construction equipment would not be used within 500 feet of residential structures. There would be no impacts under this significance criterion.

Noise Significance Criterion 8: A violation of LACC restrictions on construction noise levels at residential properties (see Table 5-25).

There would be no construction within the vicinity of single-family residential, multi-family residential, or semi residential/commercial structures. There would be no exceedence of construction noise limits. There would be no impacts under this significance criterion.

Noise Significance Criterion 9: A violation of LAMC requirements that construction and industrial machinery shall not exceed a maximum of 75 dBA at a distance of 50 feet, except where compliance is technically infeasible.

There would be no construction or industrial machinery within 50 feet of residential structures. There would be no impacts under this significance criterion.

Operational Impacts

Assuming that operations and maintenance continue at current levels, there would be no significant increase in noise levels. Noise would occur as a result of occasional use of work trucks and maintenance equipment but such effects would be occasional and temporary. Some gradual increases in operations and maintenance may be needed as facilities and structures age and require replacement or increased maintenance. In this instance, noise levels may increase but would still be less than significant under significance criteria 7-9.

Alternative 10 (ART)

Construction Impacts

Noise Significance Criterion 7: A violation of LAMC restrictions on construction equipment operating within 500 feet of residential uses between the hours of 7 a.m. to 10 p.m. to 75 dBA (Ldn).

The 75 dBA (Ldn) threshold in Noise Significance Criterion 7 is an average of sound levels over a 24-hour period. The sound levels associated with equipment in Table 5-28 are maximum sound levels. For the purpose of comparing these maximum sound values to an averaged regulatory threshold, the average sound level associated with each type of construction equipment is equated to the maximum values. Thus, the analysis is conservative since sound levels of equipment averaged over a work day would be less than their maximum sound levels.

Construction in Reaches 1 through 4 would primarily occur near open space and recreational land uses. Construction at Reach 7 and Reach 8 would primarily occur near industrial and commercial land uses. Construction at these locations would not violate LAMC restrictions because equipment would not be located within 500 feet of residential structures.

Construction in Reach 5 and 6 would primarily occur in residential land uses. Many residential structures directly abut the channel embankments throughout these two reaches. The Los Angeles River is a soft bottom trapezoidal channel with an average invert width of 200 feet through Reaches 5 and 6. Thus, most equipment would be near or within 100 feet of residential structures. Table 5-28 shows the estimated sound levels at various distances from the noise source. At 100 feet, the Lmax associated with most equipment would exceed 75 dBA during daytime hours. However, most construction work would occur within the invert, approximately 20 to 25 feet below grade. Thus, the sloped embankments would attenuate sound levels to varying degrees. Furthermore, since there would be no construction during the night, the potential for exceeding the 75 dBA (Ldn) is low. In cases where construction is expected to occur on the embankments, a temporary sound wall would be constructed. Sound walls can further attenuate sound levels by 5 dB. With implementation of sound walls as needed, sound levels would be sufficiently attenuated to below 75 dBA (Ldn). Impacts would be less than significant.

Noise Significance Criterion 8: A violation of LACC restrictions on construction noise levels at residential properties (see Table 5-25).

Construction in Reaches 1 through 4 would primarily occur near open space and recreational land uses. Construction at Reach 7 and Reach 8 would primarily occur near industrial and commercial land uses. Construction at these locations would not violate LACC restrictions because equipment would not be located near residential structures such that the 75 dBA (Leq) restriction would be exceeded.

Construction in Reach 5 and 6 would primarily occur in residential land uses. Many residential structures directly abut the channel embankments throughout these two reaches. Construction may require the use of mobile and stationary equipment within the vicinity of residential structures under or over a 10 day period. As listed in Table 5-28, the maximum sound levels associated with construction equipment at 50 feet from residential structures range from 73 dBA (Lmax) to 86 dBA (Lmax). Maximum sound levels associated with construction equipment at 100 feet from residential structures range from 67 dBA (Lmax) to 80 dBA (Lmax). However, the estimates are maximum sound levels associated with equipment operating under full power. It is unlikely that construction equipment will operate at full power for the duration of the work day. Thus, the maximum sound level for equipment operating at or under 100 feet from residential structures would likely be lower. Furthermore, temporary sound walls would be deployed when constructing within the vicinity of residential structures. In general, these structures reduce the

sound level by 5 dB. Based on the above, it is unlikely that the average sound level would exceed 75 dBA. In addition, other avoidance measures identified in section 5.8.4 would be employed, such as the use of construction equipment with state-of the-art noise shielding and muffling devices. Impacts would be less than significant.

Noise Significance Criterion 9: A violation of LAMC requirements that construction and industrial machinery shall not exceed a maximum of 75 dBA at a distance of 50 feet, except where compliance is technically infeasible.

Construction in Reaches 5 through 8 could occur within 50 feet of residential, recreational, industrial, and commercial land uses. Reaches 5 and 6 would primarily occur in residential land uses. Many residential structures directly abut the channel embankments throughout these two reaches. Construction at Reach 7 and Reach 8 would primarily occur near industrial and commercial land uses. The Los Angeles River is a trapezoidal channel with an average invert width of 200 feet from Reaches 5 through 8. Thus, most equipment would be near or within 100 feet of residential, commercial, and industrial structures. Table 5-28 shows the estimated sound levels at various distances from the noise source. At 50 feet, the Lmax associated with most equipment would range from 75 dBA to 85 dBA.

At 50 feet from these structures, most construction work would need to occur on the embankment. As a result, the sloped embankments would attenuate sound levels to varying degrees. Temporary sound wall would be constructed for such work. Sound walls can further attenuate sound levels by 5 dB. With implementation of sound walls as needed as well as other measures at Section 5.8.4, such as using construction equipment with state-of-the art noise shielding and muffling devices, sound levels at 50 feet could be attenuated below 75 dBA. Therefore, impacts would be less than significant.

Table 5-28 Alternative 10 (ART) Temporary Received Construction Noise Level

Construction Phase	Equipment Type	Sound Level at 50 feet from Equipment (Lmax)[a]	Sound Level at 100 feet from Equipment (Lmax)[a]	Sound Level at 200 feet from Equipment (Lmax)[a]	Sound Level at 400 feet from Equipment (Lmax)[a]	Applicable Reach(es)
Topsoil	Tractor	86	80	74	68	1, 6
	Loader	78	72	66	60	
	Water Truck	80	74	68	62	
	Roller – Compactor	73	67	61	55	
Place Storm Drain and Piping	Hydraulic Excavator	85	79	73	67	3, 4, 5, 7
	Tractor	86	80	74	68	
	Crane	85	79	73	67	
	Grader	85	79	73	67	
	Paver	85	79	73	67	
	Compactor	80	74	68	62	
Excavation Grade Control	Hydraulic Excavator	85	79	73	67	4
Grouted Riprap	Hydraulic Excavator	85	79	73	67	4
Compacted Fill	Tractor	86	80	74	68	4
	Loader	78	72	66	60	
	Water Truck	80	74	68	62	
	Roller – Compactor	73	67	61	55	
Excavation Embankment	Scraper	85	79	73	67	4, 6, 8
Riprap	Hydraulic Excavator	85	79	73	67	4, 8
Aggregate Base Course	Loader	78	72	66	60	6
	Grader	85	79	73	67	
	Roller – Compactor	73	67	61	55	
Asphalt Pavement	Paver	85	79	73	67	6

(a) Source: FHWA 2006.

Operational Impacts

Noise impacts during operations and maintenance would be slightly increased over existing conditions due to increased maintenance of vegetation. In general, maintenance of the restored areas would be performed with light trucks and equipment. Occasional use of heavy trucks and machinery may be necessary. During operations, maintenance crews will use equipment that uses the best available mufflers and other features to reduce noise. Maintenance will occur between the hours of 8 a.m. to 6 p.m. Monday through Friday, and between 8 a.m. and 5 p.m. on Saturdays. Occasional use of machinery within 500 feet of residences may be necessary on occasion, but this impact will be short-term (generally lasting less than 2 hours) and expected to be less than 75 dBA (Ldn) at distance of 50 feet. Therefore, operational impacts would be less than significant under significance criteria 7-9.

Indirect Effects of and Actions Related to Construction and Operation

Indirect effects of construction and operation on noise levels are not anticipated to be significant. Restoration of the project area may over time lead to changes to development type in the surrounding area with some changes to noise levels. Because the conversion to riparian habitat of a portion of the existing LATC site would likely preclude the railroad from continuing its current use on the remainder of the parcel not required for the project, the remainder would be anticipated to be utilized for other purposes by the City or sold for private use as industrial, commercial, or residential. Use by the City for public purposes or by others for commercial or residential use could result in changes in noise levels on that portion of the site in addition to the portion required for the project. However, such uses would require

rezoning before being implemented. Indirect effects associated with relocation of LATC site functions could include increases in noise at another location within the basin during construction of the relocated site functions. Temporary effects would be associated with construction of new facilities or alteration of existing facilities to accommodate the amount of freight moving through the facility. These temporary effects would come from use of construction machinery and haul trucks used to import construction materials and site equipment and fixtures and export construction debris. Permanent localized noise increases may occur as a result of increased train traffic and movement of freight from one train to another, although the site functions are anticipated to be relocated to an existing industrial area. Prior to relocation, the CEQA lead agency will conduct a detailed CEQA analysis of the relocation of LATC site functions, including assessment of noise effects. Should any additional NEPA documentation be required, it would be undertaken by the NEPA lead agency. These effects are anticipated to be the same for all action alternatives.

Alternative 13 (ACE)

Construction Impacts

Construction would be slightly increased under Alternative 13 as compared to Alternative10 due to additional construction phases, a longer construction schedule. Larger scale modification of the channel at Arroyo Seco would also occur, but there are no residential structures near the construction area at that location. Construction would occur over a period of 10 years.

Noise Significance Criterion 7: A violation of LAMC restrictions on construction equipment operating within 500 feet of residential uses between the hours of 7 a.m. to 10 p.m. to 75 dBA (Ldn).

The 75 dBA (Ldn) threshold in Noise Significance Criterion 7 is an average of sound levels over a 24-hour period. The sound levels associated with equipment in Table 5-29 are maximum sound levels. For the purpose of comparing these maximum sound values to an averaged regulatory threshold, the average sound level associated with each type of construction equipment is equated to the maximum values. Thus, the analysis is conservative since sound levels of equipment averaged over a work day would be less than their maximum sound levels.

Construction in Reaches 1 through 4 would primarily occur near open space and recreational land uses. Construction at Reach 7 and Reach 8 would primarily occur near industrial and commercial land uses. Construction at these locations would not violate LAMC restrictions because equipment would not be located within 500 feet of residential structures.

Construction in Reach 5 and 6 would primarily occur in residential land uses. Many residential structures directly abut the channel embankments throughout these two reaches. The Los Angeles River is a soft bottom trapezoidal channel with an average invert width of 200 feet through Reaches 5 and 6. Thus, most equipment would be near or within 100 feet of residential structures. Table 5-29 shows the estimated sound levels at various distances from the noise source. At 100 feet, the Lmax associated with most equipment would exceed 75 dBA during daytime hours. However, most construction work would occur within the invert, approximately 20 to 25 feet below grade. Thus, the sloped embankments would attenuate sound levels to varying degrees. Furthermore, since there would be no construction during the night, the potential for exceeding the 75 dBA (Ldn) is low. In cases where construction is expected to occur on the embankments, a temporary sound wall would be constructed. Sound walls and other measurs identified in Section 5.8.4 can further attenuate sound levels by 5 dB. With implementation of sound walls as needed, sound levels would be sufficiently attenuated to below 75 dBA (Ldn). Impacts would be less than significant.

Noise Significance Criterion 8: A violation of LACC restrictions on construction noise levels at residential properties (see Table 5-25).

Construction in Reaches 1 through 4 would primarily occur near open space and recreational land uses. Construction at Reach 7 and Reach 8 would primarily occur near industrial and commercial land uses. Construction at these locations would not violate LACC restrictions because equipment would not be located near residential structures such that the 75 dBA restriction would be exceeded.

Construction in Reach 5 and 6 would primarily occur in residential land uses. Many residential structures directly abut the channel embankments throughout these two reaches. Construction may require the use of mobile and stationary equipment within the vicinity of residential structures under or over a 10 day period. As listed in Table 5-29, the maximum sound levels associated with construction equipment at 50 feet from residential structures range from 73 dBA (Lmax) to 86 dBA (Lmax). Maximum sound levels associated with construction equipment at 100 feet from residential structures range from 67 dBA (Lmax) to 80 dBA (Lmax). However, the estimates are maximum sound levels associated with equipment operating under full power. It is unlikely that construction equipment will operate at full power for the duration of the work day. Thus, the maximum sound level for equipment operating at or under 100 feet from residential structures would likely be lower. Furthermore, temporary sound walls would be deployed when constructing within the vicinity of residential structures. In general, these structures reduce the sound level by 5 dB. Based on the above, it is unlikely that the average sound level would exceed 75 dBA. In addition, other avoidance measures identified in section 5.8.4 would be employed, such as the use of construction equipment with state-of the-art noise shielding and muffling devices. Impacts would be less than significant.

Noise Significance Criterion 9: A violation of LAMC requirements that construction and industrial machinery shall not exceed a maximum of 75 dBA at a distance of 50 feet, except where compliance is technically infeasible.

Construction in Reaches 5 through 8 could occur within 50 feet of residential, recreational, industrial, and commercial land uses. Reaches 5 and 6 would primarily occur in residential land uses. Many residential structures directly abut the channel embankments throughout these two reaches. Construction at Reach 7 and Reach 8 would primarily occur near industrial and commercial land uses. The Los Angeles River is a trapezoidal channel with an average invert width of 200 feet from Reaches 5 through 8. Thus, most equipment would be near or within 100 feet of residential, commercial, and industrial structures. Table 5-28 shows the estimated sound levels at various distances from the noise source. At 50 feet, the Lmax associated with most equipment would range from 75 dBA to 85 dBA.

At 50 feet from these structures, most construction work would need to occur on the embankment. As a result, the sloped embankments would attenuate sound levels to varying degrees. Temporary sound wall would be constructed for such work. Sound walls can further attenuate sound levels by 5 dB. With implementation of sound walls as needed as well as other measures at Section 5.8.4, such as the use of equipment witih state-of-the-art noise shielding and muffling devices, sound levels at 50 feet could be attenuated below 75 dBA. Therefore, impacts would be less than significant.

Table 5-29 Alternative 13 (ACE) Received Construction Noise Levels

Construction Phase	Equipment Type	Sound Level at 50 feet from Equipment (Lmax)[a]	Sound Level at 100 feet from Equipment (Lmax)[a]	Sound Level at 200 feet from Equipment (Lmax)[a]	Sound Level at 400 feet from Equipment (Lmax)[a]	Applicable Reach(es)
Topsoil	Tractor	86	80	74	68	1, 6
	Loader	78	72	66	60	
	Water Truck	80	74	68	62	
	Roller – Compactor	73	67	61	55	
Place Storm Drain and Piping	Hydraulic Excavator	85	79	73	67	3, 4, 5
	Tractor	86	80	74	68	
	Crane	85	79	73	67	
	Grader	85	79	73	67	
	Paver	85	79	73	67	
	Compactor	80	74	68	62	
Excavation Grade Control	Hydraulic Excavator	85	79	73	67	4
Grouted Riprap	Hydraulic Excavator	85	79	73	67	4
Compacted Fill	Tractor	86	80	74	68	3, 4
	Loader	78	72	66	60	
	Water Truck	80	74	68	62	
	Roller – Compactor	73	67	61	55	
Excavation Embankment	Scraper	85	79	73	67	3, 4, 6, 7, 8
Riprap	Hydraulic Excavator	85	79	73	67	4, 8
Aggregate Base Course	Loader	78	72	66	60	6, 7
	Grader	85	79	73	67	
	Roller – Compactor	73	67	61	55	
Asphalt Pavement	Paver	85	79	73	67	6, 7
Geotextile Turf Reinforcement	Loader	78	72	66	60	6
Rock at Geotextilet Tie-In	Loader	78	72	66	60	6
	Grader	85	79	73	67	
Concrete Demolition	Loader	78	72	66	60	7
	Hydraulic Excavator	85	79	73	67	
Remove Spalls	Hydraulic Excavator	85	79	73	67	7
Chain Link Fence Demolition	Loader	78	72	66	60	7
Utility Pole Relocation	Tractor	86	80	74	68	6,7,8
	Crane	85	79	73	67	

(a) Source: FHWA 2006.

Operational Impacts

Alternative 13 would have no significant adverse effect on noise in the study area. Impacts would be similar to those discussed under Alternative 10 above.

Alternative 16 (AND)

Construction Impacts

Construction would be more extensive under Alternative 16 compared to Alternatives 10 and 13 due to additional construction phases, a longer construction schedule, and additional truck trips due greater amounts of construction and excavation. Construction would occur over a period of 15 years.

Noise Significance Criterion 7: A violation of LAMC restrictions on construction equipment operating within 500 feet of residential uses between the hours of 7 a.m. to 10 p.m. to 75 dBA (Ldn).

The 75 dBA (Ldn) threshold in Noise Significance Criterion 7 is an average of sound levels over a 24-hour period. The sound levels associated with equipment in Table 5-30 are maximum sound levels. For the purpose of comparing these maximum sound values to an averaged regulatory threshold, the average sound level associated with each type of construction equipment is equated to the maximum values. Thus, the analysis is conservative since sound levels of equipment averaged over a work day would be less than their maximum sound levels.

Construction in Reaches 1 through 4 would primarily occur near open space and recreational land uses. Construction at Reach 7 and Reach 8 would primarily occur near industrial and commercial land uses. Construction at these locations would not violate LAMC restrictions because equipment would not be located within 500 feet of residential structures.

Construction in Reach 5 and 6 would primarily occur in residential land uses. Many residential structures directly abut the channel embankments throughout these two reaches. The Los Angeles River is a soft bottom trapezoidal channel with an average invert width of 200 feet through Reaches 5 and 6. Thus, most equipment would be near or within 100 feet of residential structures. Table 5-30 shows the estimated sound levels at various distances from the noise source. At 100 feet, the Lmax associated with most equipment would exceed 75 dBA during daytime hours. However, most construction work would occur within the invert, approximately 20 to 25 feet below grade. Thus, the sloped embankments would attenuate sound levels to varying degrees. Furthermore, since there would be no construction during the night, the potential for exceeding the 75 dBA (Ldn) is low. In cases where construction is expected to occur on the embankments, a temporary sound wall would be constructed. Sound walls can further attenuate sound levels by 5 dB. With implementation of sound walls as needed, sound levels would be sufficiently attenuated to below 75 dBA (Ldn). Impacts would be less than significant.

Noise Significance Criterion 8: A violation of LACC restrictions on construction noise levels at residential properties (see Table 5-25).

Construction in Reaches 1 through 4 would primarily occur near open space and recreational land uses. Construction at Reach 7 and Reach 8 would primarily occur near industrial and commercial land uses. Construction at these locations would not violate LACC restrictions because equipment would not be located near residential structures such that the 75 dBA restriction would be exceeded.

Construction in Reach 5 and 6 would primarily occur in residential land uses. Many residential structures directly abut the channel embankments throughout these two reaches. Construction may require the use of mobile and stationary equipment within the vicinity of residential structures under or over a 10 day period. As listed in Table 5-28, the maximum sound levels associated with construction equipment at 50 feet from residential structures range from 73 dBA (Lmax) to 86 dBA (Lmax). Maximum sound levels associated with construction equipment at 100 feet from residential structures range from 67 dBA (Lmax) to 80 dBA (Lmax). However, the estimates are maximum sound levels associated with equipment operating under full power. It is unlikely that construction equipment will operate at full power for the duration of the work day. Thus, the maximum sound level for equipment operating at or under 100 feet from residential structures would likely be lower. Furthermore, temporary sound walls would be deployed when constructing within the vicinity of residential structures. In general, these structures reduce the sound level by 5 dB. Based on the above, it is unlikely that the average sound level would exceed 75 dBA. In addition, other avoidance measures identified in section 5.8.4 would be employed, such as the

use of construction equipment with state-of the-art noise shielding and muffling devices. Impacts would be less than significant.

Noise Significance Criterion 9: A violation of LAMC requirements that construction and industrial machinery shall not exceed a maximum of 75 dBA at a distance of 50 feet, except where compliance is technically infeasible.

Construction in Reaches 5 through 8 could occur within 50 feet of residential, recreational, industrial, and commercial land uses. Reaches 5 and 6 would primarily occur in residential land uses. Many residential structures directly abut the channel embankments throughout these two reaches. Construction at Reach 7 and Reach 8 would primarily occur near industrial and commercial land uses. The Los Angeles River is a trapezoidal channel with an average invert width of 200 feet from Reaches 5 through 8. Thus, most equipment would be near or within 100 feet of residential, commercial, and industrial structures. Table 5-28 shows the estimated sound levels at various distances from the noise source. At 50 feet, the Lmax associated with most equipment would range from 75 dBA to 85 dBA.

At 50 feet from these structures, most construction work would need to occur on the embankment. As a result, the sloped embankments would attenuate sound levels to varying degrees. Temporary sound wall would be constructed for such work. Sound walls can further attenuate sound levels by 5 dB. With implementation of sound walls as needed as well as other measures at Section 5.8.4, sound levels at 50 feet could be attenuated below 75 dBA. In addition, other measures identified in Section 5.8.4, such as the use of equipment with state-of the-art noise shielding and muffling devices, would be used. Therefore, impacts would be less than significant.

Table 5-30 Alternative 16 (AND) Received Construction Noise Levels

Construction Phase	Equipment Type	Sound Level at 50 feet from Equipment (Lmax)[a]	Sound Level at 50 feet from Equipment (Lmax)[a]	Sound Level at 100 feet from Equipment (Lmax)[a]	Sound Level at 200 feet from Equipment (Lmax)[a]	Applicable Reach(es)
Topsoil	Tractor	86	80	74	68	1, 5, 6, 8
	Loader	78	72	66	60	
	Water Truck	80	74	68	62	
	Roller – Compactor	73	67	61	55	
Place Storm Drain and Piping	Hydraulic Excavator	85	79	73	67	3, 4, 5
	Tractor	86	80	74	68	
	Crane	85	79	73	67	
	Grader	85	79	73	67	
	Paver	85	79	73	67	
	Compactor	80	74	68	62	
Excavation Grade Control	Hydraulic Excavator	85	79	73	67	4, 8
Grouted Riprap	Hydraulic Excavator	85	79	73	67	4, 8
Compacted Fill	Tractor	86	86	74	68	3, 4,5,8
	Loader	78	72	66	60	
	Water Truck	80	74	68	62	
	Roller – Compactor	73	67	61	55	
Excavation Embankment	Scraper	85	79	73	67	3, 4, 5, 6, 7, 8
Riprap	Hydraulic Excavator	85	79	73	67	3, 5, 8
Aggregate Base Course	Loader	78	78	66	60	6, 7
	Grader	85	79	73	67	

Construction Phase	Equipment Type	Sound Level at 50 feet from Equipment (Lmax)[a]	Sound Level at 50 feet from Equipment (Lmax)[a]	Sound Level at 100 feet from Equipment (Lmax)[a]	Sound Level at 200 feet from Equipment (Lmax)[a]	Applicable Reach(es)
	Roller – Compactor	73	67	61	55	
Asphalt Pavement	Paver	85	79	73	67	6, 7
Geotextile Turf Reinforcement	Loader	78	72	66	60	6
Rock at Geotextile Tie-In	Loader	78	72	66	60	6
	Grader	85	79	73	67	
Concrete Demolition	Loader	78	72	66	60	7
	Hydraulic Excavator	85	79	73	67	
Remove Spalls	Hydraulic Excavator	85	79	73	67	7
Chain Link Fence Demolition	Loader	78	72	66	60	7
Utility Pole Relocation	Tractor	86	80	74	68	6,7,8
	Crane	85	79	73	67	
Grouted Riprap Demolition	Loader	78	72	66	60	5
	Hydraulic Excavator	85	79	73	67	
Riprap Demolition	Hydraulic Excavator	85	79	73	67	5
Sheet Pile Demolition	Crane	85	79	73	67	5
Asphalt Demolition	Loader	78	72	66	60	5
Retaining Wall Gravel	Loader	78	72	66	60	5
Subdrain System	Loader	78	72	66	60	5
Railroad Trestle	Loader	72	66	60	78	8
	Crane	79	73	67	85	

(a) Source: FHWA 2006.

Operational Impacts

Alternative 16 would have no significant adverse effect on noise in the study area. Impacts would be similar to those discussed under Alternative 10 above.

Alternative 20 (RIVER)

Construction Impacts

Construction would be greater than under Alternative 16 as this alternative would entail more excavation. Construction would occur over a period of 15 years.

Noise Significance Criterion 7: A violation of LAMC restrictions on construction equipment operating within 500 feet of residential uses between the hours of 7 a.m. to 10 p.m. to 75 dBA (Ldn).

The 75 dBA (Ldn) threshold in Noise Significance Criterion 7 is an average of sound levels over a 24-hour period. The sound levels associated with equipment in Table 5-31 are maximum sound levels. For the purpose of comparing these maximum sound values to an averaged regulatory threshold, the average sound level associated with each type of construction equipment is equated to the maximum values. Thus, the analysis is conservative since sound levels of equipment averaged over a work day would be less than their maximum sound levels.

Construction in Reaches 1 through 4 would primarily occur near open space and recreational land uses. Construction at Reach 7 and Reach 8 would primarily occur near industrial and commercial land uses. Construction at these locations would not violate LAMC restrictions because equipment would not be located within 500 feet of residential structures.

Construction in Reach 5 and 6 would primarily occur in residential land uses. Many residential structures directly abut the channel embankments throughout these two reaches. The Los Angeles River is a soft bottom trapezoidal channel with an average invert width of 200 feet through Reaches 5 and 6. Thus, most equipment would be near or within 100 feet of residential structures. Table 5-31 shows the estimated sound levels at various distances from the noise source. At 100 feet, the Lmax associated with most equipment would exceed 75 dBA during daytime hours. However, most construction work would occur within the invert, approximately 20 to 25 feet below grade. Thus, the sloped embankments would attenuate sound levels to varying degrees. Furthermore, since there would be no construction during the night, the potential for exceeding the 75 dBA (Ldn) is low. In cases where construction is expected to occur on the embankments, a temporary sound wall would be constructed. Sound walls can further attenuate sound levels by 5 dB. With implementation of sound walls as needed, and other measures identified in Section 5.8.4, such as the use of equipment with state-of-the-art noise shielding and muffling devices,sound levels would be sufficiently attenuated to below 75 dBA (Ldn). Impacts would be less than significant.

Noise Significance Criterion 8: A violation of LACC restrictions on construction noise levels at residential properties (see Table 5-25).

Construction in Reaches 1 through 4 would primarily occur near open space and recreational land uses. Construction at Reach 7 and Reach 8 would primarily occur near industrial and commercial land uses. Construction at these locations would not violate LACC restrictions because equipment would not be located near residential structures such that the 75 dBA restriction would be exceeded.

Construction in Reach 5 and 6 would primarily occur in residential land uses. Many residential structures directly abut the channel embankments throughout these two reaches. Construction may require the use of mobile and stationary equipment within the vicinity of residential structures under or over a 10 day period. As listed in Table 5-31, the maximum sound levels associated with construction equipment at 50 feet from residential structures range from 73 dBA (Lmax) to 86 dBA (Lmax). Maximum sound levels associated with construction equipment at 100 feet from residential structures range from 67 dBA (Lmax) to 80 dBA (Lmax). However, the estimates are maximum sound levels associated with equipment operating under full power. It is unlikely that construction equipment will operate at full power for the duration of the work day. Thus, the maximum sound level for equipment operating at or under 100 feet from residential structures would likely be lower. Furthermore, temporary sound walls would be deployed when constructing within the vicinity of residential structures. In general, these structures reduce the sound level by 5 dB. Based on the above, it is unlikely that the average sound level would exceed 75 dBA. In addition, other avoidance measures identified in section 5.8.4 would be employed, such as the use of construction equipment with state-of the-art noise shielding and muffling devices. Impacts would be less than significant.

Noise Significance Criterion 9: A violation of LAMC requirements that construction and industrial machinery shall not exceed a maximum of 75 dBA at a distance of 50 feet, except where compliance is technically infeasible.

Construction in Reaches 5 through 8 could occur within 50 feet of residential, recreational, industrial, and commercial land uses. Reaches 5 and 6 would primarily occur in residential land uses. Many residential

structures directly abut the channel embankments throughout these two reaches. Construction at Reach 7 and Reach 8 would primarily occur near industrial and commercial land uses. The Los Angeles River is a trapezoidal channel with an average invert width of 200 feet from Reaches 5 through 8. Thus, most equipment would be near or within 100 feet of residential, commercial, and industrial structures. Table 5-28 shows the estimated sound levels at various distances from the noise source. At 50 feet, the Lmax associated with most equipment would range from 75 dBA to 85 dBA.

At 50 feet from these structures, most construction work would need to occur on the embankment. As a result, the sloped embankments would attenuate sound levels to varying degrees. Temporary sound wall would be constructed for such work. Sound walls can further attenuate sound levels by 5 dB. With implementation of sound walls as needed as well as other measures at Section 5.8.4, such as the use of equipment with state-of-the-art noise shielding and muffling devices, or limiting the pieces of construction equipment used simultaneously, sound levels at 50 feet could be attenuated below 75 dBA.. Therefore, impacts would be less than significant.

Operational Impacts

Alternative 20 would have no significant adverse effect on noise in the study area. Impacts would be similar to those discussed under Alternative 10 above.

1 **Table 5-31 Alternative 20 (RIVER) Received Construetion Noise Levels**

Construction Phase	Equipment Type	Sound Level at 50 feet from Equipment (Lmax)[a]	Sound Level at 50 feet from Equipment (Lmax)[a]	Sound Level at 100 feet from Equipment (Lmax)[a]	Sound Level at 200 feet from Equipment (Lmax)[a]	Applicable Reach(es)
Topsoil	Tractor	86	80	74	68	1, 2, 3, 5, 6, 8
	Loader	78	72	66	60	
	Water Truck	80	74	68	62	
	Roller – Compactor	73	67	61	55	
Place Storm Drain and Piping	Hydraulic Excavator	85	79	73	67	3, 4, 5, 7
	Tractor	86	80	74	68	
	Crane	85	79	73	67	
	Grader	85	79	73	67	
	Paver	85	79	73	67	
	Compactor	80	74	68	62	
Excavation Grade Control	Hydraulic Excavator	85	79	73	67	4, 8
Grouted Riprap	Hydraulic Excavator	85	79	73	67	4, 8
Compacted Fill	Tractor	86	80	74	68	2, 3, 4, 5, 7, 8
	Loader	78	72	66	60	
	Water Truck	80	74	68	62	
	Roller – Compactor	73	67	61	55	
Excavation Embankment	Scraper	85	79	73	67	3, 4, 5, 6, 8
Riprap	Hydraulic Excavator	85	79	73	67	2, 3, 5, 7, 8
Aggregate Base Course	Loader	78	72	66	60	2, 3, 5, 6, 8
	Grader	85	79	73	67	
	Roller – Compactor	73	67	61	55	
Asphalt Pavement	Paver	85	79	73	67	2, 3, 5, 6, 8
Geotextile Turf Reinforcement	Loader	78	72	66	60	2, 3, 6
Rock at Geotextile Tie-In	Loader	78	72	66	60	2, 3, 6
	Grader	85	79	73	67	
Concrete Demolition	Loader	78	72	66	60	2, 3, 5, 8
	Hydraulic Excavator	85	79	73	67	
Remove Spalls	Hydraulic Excavator	85	79	73	67	2, 5, 8
Chain Link Fence Demolition	Loader	78	72	66	60	2, 3, 5, 8
Utility Pole Relocation	Tractor	86	80	74	68	6, 7, 8
	Crane	85	79	73	67	
Grouted Riprap Demolition	Loader	78	72	66	60	2, 5
	Hydraulic Excavator	85	79	73	67	
Riprap Demolition	Hydraulic Excavator	85	79	73	67	2, 4, 5
Sheet Pile Wall Demolition	Crane	85	79	73	67	2, 5
Asphalt Demolition	Loader	78	72	66	60	2, 5
	Hydraulic Excavator	85	79	73	67	
Retaining Wall Gravel	Loader	78	72	66	60	2, 5
Subdrain System	Loader	78	72	66	60	2, 3, 5
Railroad Trestle	Loader	78	72	66	60	7, 8
	Crane	85	79	73	67	

(a) Source: FHWA 2006.

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5.8.4 Best Management Practices and Impact Avoidance Measures

To minimize the impact of construction activities associated with implementation of all alternatives, construction contractors will adhere to the following:

- Develop and implement a project noise control plan that identifies when construction activities would occur and where and how avoidance measures shall be used. Construction activities would generally occur between the hours of 8 a.m. and 6 p.m. Monday through Friday, and 8 a.m. and 5 p.m. Saturday. Construction and operations would not occur on Sunday or a national holiday. The plan will require the identification of a Noise Control Coordinator, who will be available to receive and respond to any concerns from residents regarding construction noise. Residents shall be notified prior to the start of construction activities and informed of the Coordinator's contact information. Signage will also be posted on the construction site with Noise Control Coordinator's contact information.
- Use power construction equipment state-of-the-art noise shielding and muffling devices.
- Whenever construction occurs witihin 500 feet of occupied residences, temporary barriers shall be constructed around the construction sites to shield the ground floor of the noise-sensitive uses. These barriers shall be of ¾-inch medium density plywood sheeting, or equivalent, and shall achieve a Sound Transmission Class of 30 or greater, based on certified sound transmission loss data taken according to American Society for Testing and Materials Test Method E90 or as approved by the City of Los Angeles Building Department.
- Construction equipment staging areas shall be located as far as practicable from residential areas.
- Quieter "sonic" pile drivers shall be used as necessary, unless engineering studies are submitted to the City of Los Angeles showing this is not feasible and cost effective, based on geotechnical considerations.
- Routes for heavy construction site vehicles shall be identified to minimize noise impacts to residences and noise-sensitive receptors.
- Impose construction hours that are more restrictive than those set forth in the LAMC if necessary and when practical.
- Require vehicle parking and deployment activities to be separated and buffered from sensitive uses.
- Limit haul truck or other vehicle speed on roads adjacent to residences and on unpaved roadways.
- Notify residents about type and schedule of construction.

5.9 RECREATION

5.9.1 Regulatory Framework

Federal

The main Federal regulation that pertains to recreation is the Americans with Disabilities Act (ADA). ADA standards for accessible public facilities require that reasonable accommodation be made to allow disabled citizens access to recreational and other facilities.

State

Two state parks have been developed within the study area. These are the Rio De Los Angeles State Park in the Taylor Yard area (Reach 6) and the Los Angeles State Historic Park in the Cornfields area (Reach 7). General plans for these two parks provide guidelines for land use and recreational development.

The Quimby Act allows California municipalities to require that new residential subdivisions set aside parklands or to charge fees to developers in lieu of setting aside parklands. The City of Los Angeles has enacted ordinances that implement the Quimby Act, requiring that land be set aside for parks and establish fees for other types of permits and approvals.

Local

Within the City of Los Angeles, the Department of Recreation and Parks operates over 16,000 acres of parkland, made up of some 150 recreation centers and over 350 park sites citywide. Parks in Glendale are operated and maintained by the City of Glendale Department of Parks, Recreation & Community Services. Parks in Burbank are operated and maintained by the City of Burbank Park, Recreation & Community Services Department.

In 1978, the City of Los Angeles prepared the Griffith Park Master Plan, which is currently under revision. A draft version of the master plan was circulated in 2005 but was rejected. It is not known when the revised draft of the master plan would be prepared.

5.9.2 Significance Criteria

The proposed project alternatives under consideration would result in a significant impact related to recreation if they would (City of Los Angeles 2002):

- Increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated,
- Include recreational facilities or require the construction or expansion of recreational facilities that might have an adverse physical effect on the environment,
- Substantially restrict or reduce the availability or quality of existing recreational opportunities in the project vicinity, or
- Implement operational or construction-related activities related to the placement of project facilities that would cause a substantial long-term disruption of any institutionally recognized recreational activities.

5.9.3 Environmental Impacts

No Action Alternative

Construction Impacts

No impacts to recreational resources would occur from construction under this alternative because construction would not occur.

Operational Impacts

Because the study area is largely developed, the potential for substantial conversion of land to recreational uses is limited. However, recreational features will continue to be pursued by state or local entities wishing to develop recreational park areas along the River corridor. State and local groups, such as the Santa Monica Mountains Conservancy and Mountains Recreation Conservation Authority, are likely to continue working to enhance the Los Angeles River Greenway through improvements of existing facilities along the River and installation of new park features.

The Metropolitan Transportation Agency (MTA) and City of Los Angeles are actively planning a bridge across the river that will provide a safe and convenient bicycle and pedestrian link between the Los Angeles River Bikeway on the right bank and the Taylor Yard on the east bank of Reach 6. The proposed

bikeway improvement will consist of a minimum 15-foot-wide bridge over the River, and a minimum 12-foot-wide connection to the Union Pacific's Taylor Yard property (LARRC 2011d). As part of the North Atwater Park Expansion Project, a multimodal bridge is proposed to provide a connection from North Atwater Park, across North Atwater Creek and up to the banks of the River in Reach 3. This bridge will provide pedestrians and bicyclists access to the River (LARRC 2011d).

Demand for recreation in the area is expected to increase proportionally to growth of population in the study area. Continued implementation of the Los Angeles River Revitalization Master Plan (City of Los Angeles 2007) could increase recreational opportunities significantly over the long term in the study area.

Alternative 10 (ART)

Construction Impacts

Alternative 10 would have no significant adverse effect on recreation and public access resources in the study area. During the construction period, the alternative may result in minor and temporary adverse recreation and public access effects, including:

- Temporary closure of trail systems, access points, bridges, or crossings along the River (Reaches 1-3),
- Temporary partial closure of Harding golf course (Reach 3) during construction of side channel
- Temporary full closure of Los Feliz golf course during construction (Reach 3)
- Realignment/relocation of trail, access points, bridges, or crossings (Reaches 2-3),
- Temporary increase in noise and air pollution in the vicinity of construction, which may degrade the recreation experience at adjacent facilities, and
- Temporary restrictions on activities such as walking/jogging, cycling, equestrian, non-motorized boating, and bird watching.

Temporary closure of recreational facilities or reduction in access or availability of recreational features during the construction period would occur. This includes Pollywog Park and Bette Davis Park, and associated trails and parsk along the river corridor. However, adverse effects associated with any temporary closures of trail systems, access points, or crossings along the River and adjacent areas would be temporary and less than significant. Effects would include temporarily reduced access to the River as well as diminished walking, biking, and golfing opportunities at specific locations during the construction period. Los Feliz golf course may require temporary full closure, and Harding Golf Course will likely require partial closure and remain open during construction of the side channel in Reach 4. Affected golfers would be likely to visit another course during construction at these sites, possibly substituting the nearby Roosevelt course in Griffith Park. The Harding Golf Course would not be permanently modified by the adjacent restoration feature.

Los Feliz Golf Course will be modified permanently. A portion of the Los Feliz Golf Course property will be lowered and restored with riparian and wetland vegetation, but the greens would not be altered. The alteration would not impact the long-term use of the facility, but would result in temporary impacts to use of the course. Flood inundation is not expected to last more than a day at a time during and just after a rainfall event. The addition of restoration features along Rio De Los Angeles State Park (Taylor Yard) is consistent with the park's General Plan, and is expected to complement and expand upon existing resources.

Although no specific recreation plan was formulated to correspond to Alternative 10, if this restoration alternative were to be selected for implementation, associated recreation facilities compatible with the restoration features would be anticipated to be implemented at similar but slightly reduced scale to those described for Alternative 13, increasing the quantity of existing trails within the project footprint,

extending trails/paths, and connecting project features with pedestrian bridges. Recreation features will be planned to connect to City of Burbank facilities whenever practicable. Construction of any recreation features would have minimal impacts on other resource categories.

Operational Impacts and Indirect Effects of Project Construction and Operation

The alternative would not decrease the quality or quantity of recreation and public access resources in the study area. Since recreational features that fall within the footprint of this project and which are affected by the project or experience increased use due to the project will be constructed or repaired in compliance with applicable building codes and health and safety regulations. Benefits include:

- Improved aesthetic quality of the River
- Increased quality, quantity, and diversity of recreation resources along the River, such as trails, bike paths, benches, signage, River access points, maintenance ramps, etc. Enhanced recreation resources along the river, such as new opportunities for outdoor education, or recreation-based businesses (recreation equipment rental, riding, or cycling trips, etc.), and
- Increased quantity of approved access points to the River, reducing use of unapproved access points.

Alternative 10 would benefit recreation and public access over the long term, in ways that are compatible with ecosystem restoration. Visitation to the river and adjacent lands for passive recreational purposes would be expected to increase due to restoration construction and operation. Visitors would view the restored area, utilize the trails within restoration features, use bike path extensions, and engage in other passive recreation activities compatible with the restored river. Because many restoration areas are in or adjacent to lands already in public preservation or park status, visitors to these areas would experience the effects of the restored environment at these sites. Other beneficial effects include increased public awareness of the recreation resources in the project reach and increased public health and safety from improved water quality along the River. Habitat quality improvements may have larger beneficial effects on specific recreation activities which are heavily dependent on health of the river, such as bird watching.

Relocation of LATC site functions to a location elsewhere in the Los Angeles Basin could potentially result in effects to recreation in the Los Angeles Basin, if the new site were located adjacent to existing recreation facilities. Construction activities, such as the presence of trucks and other equipment, could reduce the quality of nearby recreation or result in closures to adjacent bicycle or hiking trails or parks. Operation of the site could result in permanent closures of recreation sites, if it is necessary for expansion of an existing site or development of a new site. However, because the relocated site functions would be located within an industrial zone, no permanent or significant effects to recreation are anticipated. Prior to site selection, the CEQA lead agency would conduct detailed CEQA analysis to assess effects of relocation. Should any additional NEPA documentation be required, it would be undertaken by the NEPA lead agency. These effects would be the same for all action alternatives.

Alternative 13 (ACE)

Construction Impacts

Alternative 13 would have no significant adverse effect on recreation and public access resources in the study area. Alternative 13 would result in minor and temporary adverse effects similar to those described for Alternative 10, with the addition of temporary adverse effects on access to playing fields at Ferraro Fields, where side channel and daylighted stream features would be constructed Alternative 13. Access would not be fully restricted, but there may be occasions when the fields are not accessible by car due to construction closures.

In addition, construction of new and extended recreation features would be anticipated to occur along with construction of Alternative 13. Alternative 13 is a restoration plan, but if this plan were to be selected for implementation, a plan formulated for passive recreation corresponding with Alternative 13 would provide new recreational features compatible with the restoration plan. The recreation plan associated with this alternative would provide several miles of new unpaved non-motorized multi-use trail with signage, a short extension of the current southerly end of the LA River Bike Path, one small bridge within Taylor Yard, one bridge within the LATC site, two parking lots (one at Taylor Yard and one at LATC), four restrooms (at Bette Davis Park, Taylor Yard, and LATC), trail access points throughout the study area, including signage, benches, and trash receptacles, several wildlife viewing points, and pedestrian underpasses under bridges along the river. Construction of the recreation features would have minimal impacts on other resource categories.

Operational Impacts and Indirect Effects of Construction and Operation of the Project

Similar to Alternative 10, Alternative 13 would have no significant adverse effect on recreation and public access resources in the study area. The alternative would not decrease the long-term quality or quantity of recreation and public access resources in the study area. In contrast, the alternative would benefit recreation and public access over the long term through increased quality, quantity, and access to parks and trails along the River, increasing public recreation resource opportunities for local and regional visitors. Potential benefits to recreation may be slightly higher than for Alternative 10 due to the increased level of restoration under Alternative 13.

Alternative 16 (AND)

Construction Impacts

Alternative 16 would have no significant adverse effect on recreation and public access resources in the study area. Minor and temporary adverse recreation and public access effects during the construction period would be the same as those described for Alternative 13. Like Alternative 10, no specific recreation plan was formulated to correspond to this alternative; however, were this alternative to be selected for implementation, construction of recreation features associated with this alternative would be anticipated to be similar to those described for Alternative 20 but at reduced scale for areas not within the restoration footprint of this alternative. Recreation features would not have more than minimal effects on other resource categories.

Operational Impacts and Indirect Effects of Project Construction and Operation

Alternative 16 would have no significant adverse effect on recreation and public access resources in the study area. The alternative would not decrease the long-term quality or quantity of recreation and public access resources in the study area. In contrast, the alternative would benefit recreation and public access over the long term. Potential benefits to recreation may be slightly higher than for Alternative 13 due to the increased level of restoration under Alternative 16. In addition to the beneficial impacts mentioned for Alternative 13, the inclusion of channel bed deepening and terrace bank submeasures may further increase the aesthetic quality of the recreation resource and the quality of the recreation experience to visitors.

Alternative 20 (RIVER)

Construction Impacts

Alternative 20 would have no significant adverse effect on recreation and public access resources in the study area. During the construction period, the alternative would result in the same minor and temporary adverse recreation and public access effects as detailed for Alternative 16. In addition, in Reach 7 temporary partial closure of Los Angeles State Historic Park for construction of marsh/wetland

restoration features would be required. The addition of restoration features at Los Angeles State Historic Park is consistent with the park's General Plan and is expected to complement existing recreation and educational opportunities at the park.

Alternative 20 is a restoration plan, but the features of a recreation plan compatible with the restoration would be constructed as well. Along with the features included with the recreation plan corresponding with Alternative 13, the recreation plan corresponding to Alternative 20 would provide additional unpaved trail (Reaches 3, 7, and 8), additional extension of the LA River Bike Path (Reaches 6-8), two bridges spanning the River (Reaches 4 and 8), three additional bridges within the LATC site in Reach 8, additional trail access points (Reaches 3 and 8), and two additional pedestrian underpasses along the river (Reach 7) to support trail connectivity. Recreation features would not have more than minimal effects on other resource categories.

Operational Impacts and Indirect Effects of Project Construction and Operation

Alternative 20 would have no significant adverse effect on recreation and public access resources in the study area. The alternative would not decrease the quality or quantity of recreation and public access resources in the study area. In contrast, the alternative would benefit recreation and public access over the long term. Potential benefits would be similar to those discussed under Alternative 16 above, but may be slightly higher for Alternative 20 due to the increased level of restoration.

5.9.4 Best Management Practices and Impact Avoidance Measures

No impact avoidance measures are required for recreation and public access resources since no significant adverse effects have been identified.

Any minor and temporary adverse effects from construction could be offset through a variety of public outreach and information measures in cooperation with local parks departments, business owners, and residents, such as:

- Public media/meetings to provide clear information on the types and durations of disruptions to the River and adjacent resources,
- Signed detour routes for affected roads as well as pedestrian, bicycle, and equestrian trails, and river access points, and
- Signage at construction areas with information relevant to recreation users (length of closure, alternative access points, etc.).
- Working with park representatives on timing of park and golf club closures to minimize effects on recreational access and use.
- Consult with park maintenance personnel prior to implementation of measures to coordinate maintenance during construction and operations.

5.10 AESTHETICS

5.10.1 Regulatory Framework

The Conservation Element of the City of Los Angeles General Plan contains objectives, policies, and programs for the City's resources, which include land forms and scenic vistas. The conservation element contains the following land form and scenic vista objective and policy:

Objective: Protect and reinforce natural and scenic vistas as irreplaceable resources and for the aesthetic enjoyment of present and future generations.

Policy: Continue to encourage and/or require property owners to develop their properties in a manner that would, to the greatest extent practical, retain significant existing land forms (e.g., ridge lines, bluffs, unique geologic features) and unique scenic features (historic, ocean, mountains, unique natural features) and/or make possible public view or other access to unique features or scenic views.

The Los Angeles County General Plan (currently being updated) contains goals and policies pertaining to scenic resources (Los Angeles County 1993). One of the goals is to conserve aesthetic resources and protect the environment. General policies for this goal include the following:

Policy 15 – Protect areas that have significant natural resources and scenic values, including significant ecological areas, the coastal zone, and prime agricultural lands.

Policy 21 – Develop community parks, particularly in areas of the greatest deficiency, and take advantage of opportunities to preserve large natural and scenic areas.

Guidelines for maintaining aesthetic value are developed from a combination of criteria established for CEQA, and those put forth in applicable city, county, or state General Plans. For this project, applicable guidelines are derived from the City of Los Angeles CEQA guidelines, as well as the General Plans of the Burbank and Glendale.

5.10.2 Significance Criteria

The restoration measures would be considered to have a significant adverse effect if any of the following were to occur as a result of the project:

- Conflict with plans, policies, or regulations governing scenic resources,
- Permanent and substantial loss or degradation of a scenic vista or public viewshed,
- Permanent and substantial loss or degradation of components of scenic resources, such as natural features, parks, historic buildings, or architectural character,
- Creation of a new source of substantial light or glare that would adversely affect day or nighttime views in the area, or
- Obfuscation of existing light sources that result in reduced safety.

5.10.3 Environmental Impacts

No Action Alternative

Construction Impacts

No impacts to aesthetic resources would occur from construction under this alternative because construction would not occur.

Operational Impacts

Since channelization of the River, aesthetic conditions have declined. The natural setting of the River is gone and replaced with concrete that leads to the collection and proliferation of trash aud graffiti. However, over time, substrate and debris deposits have amassed soils suitable for establishment of vegetation, thereby softening the look of the concrete channel and creating a more natural appearance.

Without restoration efforts, these trends are expected to continue. The area would continue to be vandalized and collect trash, and homeless encampments may increase with the growing population. Continued discharge of greywater and stormwater would contribute to unpleasant odors. Increased use of

tertiary treated water for irrigation and other uses may reduce the amount of water flowing in the River during the dry months, further reducing the visual quality of the channel. Lighting conditions are not expected to change significantly under current city or county guidelines.

Although continued deposition of substrate and growth of vegetation is likely to occur under the No Action Alternative, attracting increasing numbers of shorebirds, waterfowl, and wading birds to the area, removal of this vegetation is likely to occur. Channel maintenance is required to facilitate flood flows in the channel, and the removal of all vegetation within the channel is generally prescribed although it is subject to funding availability.

Small and localized improvement projects for recreation or independent restoration efforts are anticipated to occur in the foreseeable future even if this larger study is not pursued; these projects would slowly improve the aesthetics of the River a small area at a time. For example, FoLAR organizes a river cleanup event each year, inviting citizens to assist in removing trash and debris from the River.

Alternative 10 (ART)

Construction Impacts

Impacts to aesthetic condition would occur during the construction phase of this alternative. The proposed restoration measures under this alternative require large equipment to be present, extensive earthwork be done, and mechanical or chemical removal of vegetation over expansive areas.

Many of the areas targeted for restoration are already in industrial use and therefore visually degraded. Furthermore, the River channel and staging areas are not generally located in areas that are readily visible from roadways, neighborhoods, or nearby parks and are not in areas that have special aesthetic value.

Riparian plantings would occur in all reaches under this alternative, as would non-native plant removal, trash removal, installation of linear strips for biofiltration, greening of River channel walls, and creation of buffer zones and planted swales. These components require little to no machinery, can be built or installed quickly, and would have less than significant impacts on aesthetic resources.

In areas regularly utilized for recreation, where aesthetic appeal is particularly desirable, construction efforts would be streamlined to occur quickly, to avoid interfering with recreational opportunities, and to affect as small an area as possible in order to minimize impacts. Staging areas would be located away from recreation sites as much as possible. Overall, due to the temporary nature of the impacts to visual resources, and the objective of creating dramatically improved visual conditions as a result of restoration, the adverse impacts are less than significant.

Operational Impacts

Adverse impacts of operation may result as measures are taken to ensure proper flood flow conveyance within the channel, a constraint of the project. This may require removal of vegetation, both native and non-native, if it is deemed necessary to avoid impacts to flood risk management through the life of the project. Within the restored areas, native vegetation removal to avoid impacts to flood risk management would be anticipated to be minimal, as features will be designed to avoid such impacts. The sponsor would perform invasives management throughout the restoration footprint, including all constructed restoration features and in-channel areas of the River and lower tributaries. The LACDA OMRRR plan would be modified to accommodate the restoration project, with maintenance of the restoration project a City responsibility under the restoration OMRRR plan. The LACDA OMRRR manual would be modified to exclude constructed restoration features and would exclude invasives management throughout the restoration project footprint. USACE would continue to be responsible for maintaining all other aspects of

the portions of the LACDA project that overlap with the restoration project footprint. USACE would also modify the LACDA operation and maintenance to allow native vegetation to remain in the channel to the extent it does not have more than minimal effect on conveyance. Detailed hydrologic and hydraulic analysis will be used during the design phase to further determine how much vegetation may be supported in the channel without affecting the flood risk management function. Riparian areas planted through restoration will be preserved on overbank areas, where they will not inhibit flood conveyance. Similarly, plantings on the channel walls or greening of the channel will also be designed in this way.

Maintenance of the restoration features will require presence of trucks, which could potentially compromise aesthetics. However, given their temporary presence and need to maintain visual conditions, their adverse impact is less than significant.

Aesthetics along the River will improve immediately following completion of the construction phase and will continue to improve over time, resulting in substantial and significant beneficial impacts that increase with each year. Riparian plantings along daylighted culverts, side channels, and overbank areas will mature and flourish, providing a greening and softening of the River channel. A total of 251 acres of valley foothill riparian community will be restored on overbank areas of the river, including those areas within the historic wash of LATC in Reach 8. The project area will be treated for invasive plant removal, addressing a total of 338 acres throughout all reaches. A total of 15 streams entering the river will be daylighted, or removed from culverts, creating visually appealing swales or wetlands in Reaches 3, 4, 5, and 7. Overbank terraces, creation of side channels, and widening of the channel will further create additional habitat, which contributes to improvements in visual quality in Reaches 2-8. Because the effluent that is the primary source of water for existing and restored vegetation is tertiary treated, reducing nutrient levels in the water, nutrient issues are not anticipated to negatively affect restoration success or associated aesthetics. Aesthetics associated with water quality are expected to be improved with implementation of restoration alternatives through incidental "polishing" and filtration from restored vegetation. Overall, the final restoration project will substantially improve the current aesthetic condition, providing a greener corridor and better habitat for native wildlife, and thereby increasing enjoyment by human visitors. Impacts will be substantial and beneficial.

Indirect Effects and Actions Related to Construction and Operation

Indirect effects on aesthetic quality could result from relocating the LATC site functions to a different location within the Los Angeles Basin, although such effects would not be anticipated to be significant. Construction activities typically result in temporarily reduced visual quality of a site, as a result of construction equipment or earthwork. However, once construction is complete, equipment is removed. Operation of the new facility could result in impacts to the surrounding area if the facility creates a visual contrast to the existing landscape. However, any future site would be located within an industrial zone, where aesthetic quality is presumably already reduced and native vegetation is not expected to be present. Prior to site selection, the CEQA lead agency would conduct detailed CEQA analysis of the relocation of the site functions, including analysis of potential impacts to aesthetic quality. Should any additional NEPA documentation be required, it would be undertaken by the NEPA lead agency. These effects are anticipated to be the same for all action alternatives.

Alternative 13 (ACE)

Construction Impacts

Construction under Alternative 13 will create temporary adverse impacts to the study area that are the same as Alternative 10 in nature, but would affect an incrementally larger area. Again, construction efforts would temporarily affect visual appeal, but would be less than significant as they will be minimized by construction management protocols and the existing degraded visual condition. Some

proposed measures are anticipated to take longer to implement due to the expanded area covered by the alternative, therefore visual impacts would extend for an additional 121 work days compared to Alternative 10. Operation and maintenance activities would not interfere with visual appeal.

Operational Impacts

Once completed, beneficial impacts to visual condition will be incrementally improved over Alternative 10. A greater area of native riparian habitat will be established, and more side channels, wetlands, and open water habitat will be restored. Specifically, Alternative 13 provides the following improvements over Alternative 10; 22 additional riparian acres created throughout all reaches, three times greater soft river bottom habitat in Reach 6, 26 acres of freshwater marsh throughout all reaches, and adds vegetation to channel walls in Reaches 6 and 7. These additional habitats will further improve aesthetic value of the river.

Alternative 16 (AND)

Construction Impacts

Similar to Alternatives 10 and 13, construction efforts would temporarily affect the visual quality of all reaches within the study area. Some proposed measures are anticipated to take longer to implement due to the expanded area covered by the alternative, resulting in an additional 565 work days compared to Alternative 10. However, for the same reasons noted above, adverse impacts to visual condition will not be significant.

Operational Impacts

Once completed, beneficial impacts to visual condition will be incrementally improved over Alternatives 10 and 13. More side channels, wetlands, and open water habitat will be restored. Specifically, Alternative 16 provides the following improvements over Alternative 13; creates an additional 500 feet of soft river bottom habitat in Reach 8, 12 additional acres of freshwater marsh, creates additional terraces in Reaches 5, 6, and 8, and adds side channels within the historic wash within LATC in Reach 8. These additional habitats will further improve aesthetic value of the River.

Alternative 20 (RIVER)

Construction Impacts

Similar to Alternatives 10, 13 and 16, construction efforts would temporarily affect the visual quality of some areas within the study area. Some proposed measures are anticipated to take longer to implement due to the expanded area covered by this largest alternative, resulting in an additional 667 work days compared to Alternative 10. Construction impacts in Alternative 20 are more extensive in Reaches 2, 3, and 7 compared to Alternative 16. Aesthetic impacts in Reach 2 would be similar to other alternatives, as channel widening will occur within the existing river right of way. Aesthetic impacts in Reach 3 would be more extensive during construction due to the larger footprint for widening of the Verdugo Wash confluence. Aesthetic impacts in Reach 7 would be more extensive and may be longer in duration than Alternative 13 and 16 due to the larger footprint including construction at the Los Angeles State Historic Park and terracing of the adjacent river bank, with trestling of the railroad line along the bank. However, for the same reasons noted above, adverse impacts to visual conditions will not be significant.

Operational Impacts

Once completed, beneficial impacts to visual condition will be incrementally improved over all other alternatives. Additional channel improvements will be made at Verdugo Wash, and additional wetlands will be created at the Los Angeles River State Historic Park in Reach 7. This alternative provides the greatest potential for improved aesthetic value of the river.

5.11 PUBLIC HEALTH AND SAFETY, INCLUDING HAZARDOUS, TOXIC AND RADIOACTIVE WASTE

5.11.1 Regulatory Framework

Federal

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) established prohibitions and requirements concerning closed and abandoned hazardous waste sites. The law authorizes two kinds of response actions: short-term removal to address releases or threatened releases requiring prompt response, and long-term remedial responses that permanently and significantly reduce the dangers from releases or threats of releases of hazardous substances that are serious but not immediately life threatening. CERCLA was amended by the Superfund Amendments and Reauthorization Act (SARA). Title 40 CFR part 312 provides standards and practices for All Appropriate Inquiries.

The Resource Conservation and Recovery Act (RCRA) governs the disposal of solid and hazardous waste. RCRA goals are to protect human health and the environment from the potential hazards of waste disposal, to conserve energy and natural resources, to reduce the amount of waste generated, and to ensure that wastes are managed in an environmentally sound manner. The solid waste program, under RCRA Subtitle D, encourages states to develop comprehensive plans to manage non-hazardous industrial solid waste and municipal solid waste. It also sets criteria for municipal solid waste landfills and other solid waste disposal facilities and prohibits the open dumping of solid waste. The hazardous waste program, under RCRA Subtitle C, establishes a system for controlling hazardous waste from the time it is generated until its ultimate disposal—in effect, from "cradle to grave." The underground storage tank program, under RCRA Subtitle I, regulates underground storage tanks containing hazardous substances and petroleum products.

Brownfields are real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant. Numerous EPA programs and regulations (such as RCRA and Superfund) are involved with the remediation of brownfields.

The Occupational Safety and Health (OSH) Act was enacted to ensure safe and healthful conditions for working men and women. The OSH Act created the Occupational Safety and Health Administration (OSHA) at the Federal level and provided that states could run their own safety and health programs as long as those programs were at least as effective as the Federal program.

The USACE's Engineering Regulation 1165-2-132, HTRW Guidance for Civil Works Projects, defines an HTRW project, methods for performing HTRW surveys, and the USACE's and sponsor's involvement at, and responsibility for, HTRW sites. USACE policy is to identify HTRW issues early in the project process and avoid construction within HTRW-contaminated areas or properties, where practicable. The USACE will cost share the sponsor's costs of surveys to identify the existence and extent of HTRW, but any response or remediation activities required, including studies to determine the appropriate response, are 100 percent non-project costs and the responsibility of the sponsor to undertake or ensure.

State

California Hazardous Waste Control Law

RCRA allows individual states to develop their own programs for regulating hazardous waste, provided that the state program is at least as stringent as RCRA (City of Los Angeles 2005). California has

developed the California Hazardous Waste Control Law (Health and Safety Code sec. 25100 et seq; 22 CCR sec. 66260.1 et seq.), which is modeled closely on RCRA. These regulations identify standards for the classification, management, transportation, and disposal of hazardous waste.

California operates a complete state plan covering both the private sector and state and local government employees. California Code of Regulations, Title 8, contains California OSHA regulations. The California OSHA program is administered and enforced by the Division of Occupational Safety and Health, a unit of the California Department of Industrial Relations.

Section 2002(j) of the State Health and Safety Code, for the purposes of vector control and prevention, defines a public nuisance (City of Los Angeles 2005). Section 2060 enables the Greater Los Angeles County Vector Control District to abate a public nuisance pursuant to "the person … who controls the diversion, delivery, conveyance, or flow of water shall be responsible for the abatement of a public nuisance that is caused by, or as a result of, that property or the diversion, delivery, conveyance, or control of that water."

Government Code § 65962.5 (Cortese List)

Government Code § 65962.5 was originally enacted in 1985, and requires the California Department of Toxic Substances Control to compile, update, and submit to Cal EPA annually a list of the following:

> (1) All hazardous waste facilities subject to corrective action pursuant to Section 25187.5 of the Health and Safety Code.
> (2) All land designated as hazardous waste property or border zone property pursuant to Article 11 (commencing with Section 25220) of Chapter 6.5 of Division 20 of the Health and Safety Code.
> (3) All information received by the Department of Toxic Substances Control pursuant to Section 25242 of the Health and Safety Code on hazardous waste disposals on public land.
> (4) All sites listed pursuant to Section 25356 of the Health and Safety Code.
> (5) All sites included in the Abandoned Site Assessment Program.

Local

Additional requirements pertaining to hazardous materials management are set forth in the City of Los Angeles Fire Code (City of Los Angeles 2005). The LAFC regulates the types, configuration, and quantities of hazardous materials that can be managed at a facility. Also, LAFC specifies design standards for the storage and management of hazardous materials. Citywide emergency response planning and emergency evacuation plans are coordinated by the Emergency Preparedness Department and the Emergency Operations Board of the City of Los Augeles. These plans are documented in the Emergency Operations Master Plan and Master Plan Procedures and Annexes of the City of Los Angeles. Operational units of the City of Los Angeles (e.g., departments) maintain emergency plans for their operations and facilities within the framework of the citywide plan. These plans are updated annually or when appropriate due to changed conditions.

In 2004, the City of Los Angeles approved Ordinance No. 175,790 amending Section 91.106.4.1 and Division 71 of Article 1, Chapter IX of the Los Angeles Municipal Code to establish citywide methane mitigation requirements and to include more current construction standards to control methane intrusion into buildings (City of Los Angeles 2005).

The City of Los Angeles Safety Element and Conservation Element address public health and safety with respect to hazardous materials, fires, methane, and brownfields (City of Los Angeles 2001). The safety

element goals, objectives, policies, and programs (which are also applicable to conservation element issues) are broadly stated to reflect the comprehensive scope of the Emergency Operations Organization (EOO). The EOO is the only program that implements the safety element. The safety element's policies outline administrative considerations, which are addressed by EOO procedures, including its master plan, or which are observed in the carrying out of the plan. All City of Los Angeles agencies are part of the EOO, and all emergency preparedness, response, and recovery programs are integrated into EOO operations and are reviewed and revised continuously.

5.11.2 Significance Criteria

Potential public health and safety impacts, including HTRW impacts, are assessed based on changes to public health and safety from the restoration alternatives. Under CEQA thresholds adopted by the cities of Los Angeles and Burbank, and applied for the City of Glendale, a significant adverse impact would be considered to occur if the selected project resulted in any of the following:

- Creation of a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials,
- Creation of a significant hazard to the public or the environment through reasonably foreseeable release of hazardous materials into the environment,
- Utilizes hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school;
- Construction or ground disturbance on a site that is included on a list of hazardous materials sites compiled pursuant to California Government Code Section 65962.5 and, as a result, creates a significant hazard to the public or the environment,
- Impairs implementation of or physically interferes with an adopted emergency response plan or emergency evacuation plan,
- Exposes people or structures to a significant risk of loss, injury, or death involving fires, or
- Exposes people to a significant risk of water-related injury of death, or
- Exposes people to infectious diseases.

5.11.3 Environmental Impacts

The impacts analysis in this subsection considers direct of construction together with indirect effects of construction as well as related actions such as the sponsor's remediation of HTRW contamination necessary to facilitate the project alternatives. The impacts analysis in this subsection considers direct and indirect effects of operation together.

No Action Alternative

Construction Impacts

No impacts to public health and safety would occur from construction under this alternative because construction would not occur.

Operational Impacts

The baseline conditions regarding risks to public health and safety in the study area would be similar to present conditions under the future without-study conditions. River safety risks would not be expected to change substantially, and much of the River would likely continue to be fenced to reduce public access, although transient use would be expected to continue to occur, with associated water safety risks to those individuals. Public recreational access would be expected to remain similar to existing conditions, with seasonal recreational use of Reaches 4-6. Sensitive receptors would continue to exist in the area, and health and safety risks to these receptors would not change if the project was not implemented. Wildfire

hazard zones would likely stay the same because most of the undeveloped areas where vegetation is present are designated as parks and likely to remain as parks. Methane zones in general are naturally occurring deposits and thus would not be likely to change substantially. Vector-borne diseases would continue to be a risk, but would also continue to be controlled by GLACVCD and similar public health agencies.

The baseline conditions regarding releases of HTRW would likely improve under the future without-study conditions. Parties responsible for the release of HTRW to the environment are required by law to address these sites through investigation and monitoring, and by carrying out remediation when warranted. Remediation has already reduced contaminant levels and is ongoing. Therefore, the trend over time would likely be toward remediation and natural attenuation (i.e., at the San Fernando Valley Superfund Site and Taylor Yard G2 site. Industrial remediation goals have been achieved at the Taylor Yard G1 site. Remediation and natural attenuation at some HTRW sites could occur within the life of the project; however, these activities may take longer to complete at some locations. For example, groundwater contamination associated with the San Fernando Valley Superfund Site is pervasive in the region and is not likely to be fully remediated over the next 50 years.

Alternative 10 (ART)

Construction Impacts

Los Angeles River Water Safety

Although construction activities would bring workers into contact with the River, OSHA and USACE safety standards will be diligently followed to avoid or minimize any dangers of water-related injuries. Construction would be suspended during any high flow events.

Wildfire

Construction equipment or activities could potentially cause an accidental fire in high fire hazard zones. Project activities would comply with all applicable Federal, state, and local laws, ordinances, and regulations related to fire prevention and fire safety. BMPs related to fire prevention would be implemented during and after construction to ensure that fires were not started and that if they did start, would be immediately extinguished, resulting in a less than significant impact.

Methane Zones

Construction would be done in accordance with regulations pertaining to development within methane zones and buffer zones; therefore, no adverse impacts from methane are expected.

HTRW

According to USACE policy, construction should be avoided in HTRW project areas where practicable. However, it would not be possible to implement any of the alternatives and still avoid sites with known or suspected contamination. Sites with known or suspected contamination include the San Fernando Valley Superfund Site, the Taylor Yard G1 and G2 sites, and the LATC site. Investigation and remediation of the identified known and suspected HTRW sites in the study area would be conducted before construction activities are undertaken at affected sites and are not part of project construction. For contaminated groundwater that cannot be addressed prior to construction activities, such as the San Fernando Valley Superfund Site, the sponsor would be responsible at 100 percent non-project cost for addressing treatment and disposal of contaminated groundwater during dewatering activities.

The USACE would share the cost of investigations for HTRW contamination but would not contribute funds for, or be involved in, preparing response plans and conducting remediation activities. The City would be responsible for conducting remediation or ensuring remediation by responsible parties at contaminated sites to support the project with the oversight of the appropriate regulatory agencies in accordance with all applicable laws, regulations, and ordinances, as described in the HTRW appendix for this IFR. In addition, it is possible that undocumented soil or groundwater contamination is present in the study area and could be identified after completion of this feasibility study. The risk of encountering unknown contamination during design or construction would be minimized through review of the existing American Society for Testing and Materials (ASTM) type Phase I and Phase II Environmental Site Assessments, and also by the sponsor undertaking industry-standard inquiries according to ASTM standards that are consistent with the CERCLA brownfields amendments and the All Appropriate Inquiries Rule prior to land acquisition and providing lands to the project.

Soil and water quality in the River would be tested at locations where contamination is suspected. Sampling locations and procedures would be coordinated with the Los Angeles Regional Water Quality Control Board, Department of Toxic Substances Control, USEPA, and the Los Angeles, Glendale, or Burbank environmental departments, as applicable. Any contamination found would be addressed in accordance with all applicable laws, regulations, and ordinances in a manner that would be protective of human and ecological health, so no adverse HTRW impacts are expected. Furthermore, BMPs will be in place, including standard procedures for addressing any contaminants uncovered or inadvertently released during construction, including containment, handling, disposal and reporting requirements.

Approach to HTRW Impacted Soil

The City would conduct remediation activities, or ensure they are conducted, prior to restoration project construction at the affected sites, not as part of the restoration project. For groundwater contamination that is infeasible to remediate prior to construction, the sponsor would be responsible for addressing treatment and disposal of such contamination during construction at 100 percent non-project costs. In the event that unknown contamination were to be discovered during construction despite making all appropriate inquiries, the approach to such contamination as relates to the project will be governed by the Project Partnership Agreement.

All HTRW impacted soil within the project footprint must be remediated to the requirements of the local environmental regulatory agencies and be compatible with the future land uses for and needs of the restoration project. At this time, those areas with HTRW impacted soil to be addressed by the sponsor are anticipated to be the Taylor Yard G1 and G2 sites and the LATC. The methodologies utilized to remediate HTRW impacted soils, regardless of the nature and extent of contamination must be compatible with the planned ecosystem restoration features and must be protective of human health and the environment. To preclude the adverse impact of contaminated soil leaching downward and further contaminating the shallow groundwater system, contaminated soil would be removed from areas that are planned as wetlands, areas that will be irrigated and areas that will be subject to erosion and infiltration of surface water runoff. Within areas where contaminated soil is remediated by removal and off-site disposal, the resulting excavations would not be filled with clean soil beyond the level of the planned ecosystem restoration grades. The sponsor must complete remediation that is acceptable to the environmental regulatory agencies and appropriate for the land use for the project selected prior to restoration project construction at those sites.

Although restoration project construction would occur on sites currently listed on the Cortese list, all necessary soil remediation will be completed prior to project construction, and therefore there would be no resulting significant hazard to the public or the environment from ground disturbing activities on those sites whether they remain listed at the time of construction.

Approach to HTRW Impacted Groundwater

Remediation of contaminated groundwater within the limits of the SFVSS site is on-going and is expected to continue for the foreseeable future. Localized groundwater contamination from remnant contamination at some of the adjacent sites may also be encountered during dewatering activities. Contaminated groundwater encountered in excavations during construction and during dewatering operations must be treated and disposed of in accordance with the requirements of the local regulatory agencies. The persistent and shallow nature of the groundwater beneath the proposed restoration features, the widespread nature of the groundwater contamination, and potential impacts associated with local soil contamination make total remediation of the groundwater prior to construction of the restoration features infeasible. As a result, it is anticipated that regulator-supervised (USEPA) responsible-party remediation of contaminated groundwater will be ongoing during construction of the ecosystem restoration features. Therefore the Sponsor will design, implement, coordinate and fully fund all treatment and disposal of contaminated groundwater during construction, with regulator concurrence and any necessary permits. These temporary operations should also be consistent with current management of contaminated groundwater at SFVSS and Pollock Well Field.

Restoration Project Construction Transport, Use, and Disposal of Hazardous Materials

Construction of the project would involve the routine transport, use, and disposal of common hazardous materials, such as fuels (gasoline and diesel), oils and lubricants, and cleaners (e.g., solvents, corrosives, soaps, detergents). The project would not require the use of unusual or acutely hazardous materials. Accidental spills could occur; however, minor spills are not likely to have significant effects. BMPs would be implemented to minimize potential for the public to come into contact with or be exposed to hazardous materials during the routine transport, use, or disposal of hazardous materials or as a result of an accidental release.

Indirect effects of and Related Actions to Construction and Operation

Relocation of the LATC site functions is not anticipated to have significant impacts to public health and safety. It is assumed that the new site will be located within already developed industrial areas and that any necessary site remediation would occur prior to relocation of site functions. Requirements in place for protection of safety in construction areas, including from fire, water, hazardous wastes, vector-borne disease and methane zones would further reduce impacts. Prior to site selection, the CEQA lead agency will conduct a detailed CEQA analysis of the relocation of LATC site functions, including environmental and safety analysis. Should any additional NEPA documentation be required, it would be undertaken by the NEPA lead agency. These effects are anticipated to be the same for all action alternatives.

Operational Impacts

Los Angeles River Water Safety

Implementation of the project would increase opportunities for the public to interact with the River. The potential for the public to enter the river channel during flooding would be greater than under current conditions, where much of the River is fenced and public access is impeded. Therefore, there is potential for water-related injuries and accidental drownings to increase.

However, operation of the restoration project would also involve greater oversight and incorporate restrictions on public access during hazardous conditions. Although the project would increase opportunities for the public to be near and access the River, the operation would incorporate public education to notify the public of dangers associated with water-related injury and drowning. The project construction and increased oversight associated with operation could also deter or reduce human habitation within the river. River channel designs would include, where consistent with the ecosystem

restoration, features that would allow people to vacate the River channel quickly and facilitate swift water rescues. As a result, impacts are anticipated to be less than significant.

Wildfire

Potential impacts from wildfire during maintenance activities associated with operation are the same as those from construction, and would be less than significant assuming implementation of BMPs.

Vector-Borne Diseases

The project would increase the amount of surface water in the River corridor, increase the amount of riparian habitat and wetlands, and alter drainage patterns and water flow. As such, there is concern that breeding grounds such as standing water for disease vectors such as mosquitoes would increase under the project, potentially resulting in an increase in the incidence of infectious diseases. Although the extent of surface water is expected to increase under the proposed measures, the suitability of habitat for vectors will depend on microhabitat features that are subject to change with each large flow event. As in any natural system, pools and backwater areas may be formed or abandoned as new flow paths emerge. Once the project is constructed, the City of Los Angeles will continue to monitor and coordinate with vector control agencies as needed to provide treatment. Current measures to control rodent populations will continue and will be increased as needed to account for the greater amount of cover that will be afforded these species in the restored areas.

HTRW

Physical maintenance is typically limited to activities such as vegetation maintenance. Routine maintenance and adaptive management activities would generally not involve dewatering or other activities requiring direct human interaction with the groundwater. Maintenance activities are not anticipated to involve substantial disturbance of channel sediments, although O&M of widened areas may require some removal of sediment based on a sediment management plan that would be developed during PED.

Currently, contaminated groundwater does not result in contaminant levels in the river in non-concrete bottom areas requiring treatment. After construction of the restoration features, which would require localized dewatering as described above, the groundwater system would be expected to return to its present configuration, and no effects on the SFVSS groundwater plume are anticipated after construction and during operation and maintenance. The volume of contaminants from current and known sites entering groundwater will likely not change, the restoration project features would not contribute contaminants to groundwater, and the remediation underway for the SFVSS, as managed by LADPW, will continue to occur. The low or de minimis levels of contamination in the portion of the river in the study area directly interacting with groundwater do not currently impact ecological performance for existing vegetation in the river, and no different effect would be expected on the restored areas including widening of the river at Taylor Yard and at LATC. The widening of the river into restored areas at Taylor Yard and temporary irrigation during plant establishment infiltrating to groundwater could have some localized effects on the elevation of the groundwater table, but they are not anticipated to be significant. The upper extent of the groundwater system throughout the ARBOR Reach is roughly positioned at the flow line of the river and construction will not change this configuration. The position of the groundwater table at any given time is a function of permeability and the difference between subsurface inflow (recharge) and subsurface outflow (use). The permeability of the alluvial deposits beneath the river is a fundamental physical property that cannot be altered or changed by construction of any of the proposed features. Recharge to the groundwater system is largely a function of weather and climate conditions which are not controllable but over the long term is expected to be relatively uniform. Water rights, including pumping of groundwater, were decided for the Upper Los Angeles River Area in 1979 and as a

result groundwater use and the elevation of the water table have remained relatively constant and would not be altered by this alternative. The restoration features and their operation and maintenance would not change the properties of the alluvial soils or configuration of the groundwater system. Therefore, the constructed features and their operation would not impact the existing groundwater contamination plume. With respect to surface flows, discharges into the river today from storm drains are regulated by the Regional Water Quality Control Board . Potential impacts from HTRW exposure during maintenance activities during operation would be less than significant assuming implementation of BMPs and remediation of contaminated areas prior to construction.

Methane Zones

Maintenance activities during operation would not include subsurface activities that would have impacts on methane zones and buffer zones; therefore, there would be no adverse impacts.

Alternative 13 (ACE)

The larger project footprint for this alternative is not anticipated to result in significant adverse impacts during construction or operation. There would be no difference in the nature or type of impacts to water safety, wildfire, vector-borne diseases, or methane associated with this alternative compared to Alternative 10. As with other alternatives, although restoration project construction would occur on sites currently listed on the Cortese list, all necessary soil remediation will be completed prior to project construction, and therefore there would be no resulting significant hazard to the public or the environment from ground disturbing activities on those sites whether they remain listed at the time of construction. As with other alternatives, the sponsor would remediate or ensure remediation of contaminated sites prior to construction at those sites to provide sites compatible with the necessary land use for the project, and would address contaminated groundwater during dewatering activities. As with the other alternatives, BMPs would reduce potential impacts to less than significant.

Alternative 16 (AND)

The larger project footprint for this alternative is not anticipated to result in significant adverse impacts during construction or operation. There would be no difference in the nature or type of impacts to water safety, wildfire, vector-borne diseases, or methane associated with this alternative compared to Alternative 10. As with other alternatives, although restoration project construction would occur on sites currently listed on the Cortese list, all necessary soil remediation will be completed prior to project construction, and therefore there would be no resulting significant hazard to the public or the environment from ground disturbing activities on those sites whether they remain listed at the time of construction. As with other alternatives, the sponsor would remediate or ensure remediation of contaminated sites prior to construction at those sites to provide sites compatible with the necessary land use for the project, and would address contaminated groundwater during dewatering activities. As with the other alternatives, BMPs would reduce potential impacts to less than significant.

Alternative 20 (RIVER)

The larger project footprint for this alternative is not anticipated to result in significant adverse impacts during construction or operation. There would be no difference in the nature or type of impacts to water safety, wildfire, vector-borne diseases, or methane associated with this alternative compared to Alternative 10. As with other alternatives, although restoration project construction would occur on sites currently listed on the Cortese list, all necessary soil remediation will be completed prior to project construction, and therefore there would be no resulting significant hazard to the public or the environment from ground disturbing activities on those sites whether they remain listed at the time of construction. As with other alternatives, the sponsor would remediate or ensure remediation of contaminated sites prior to

construction at those sites to provide sites compatible with the necessary land use for the project, and would address contaminated groundwater during dewatering activities. As with the other alternatives, BMPs would reduce potential impacts to less than significant.

5.11.4 Best Management Practices and Impact Avoidance Measures

The types of BMPs that would reduce dangers associated with water safety, wildfire, methane, vector-borne diseases, and HTRW include the following:

- City will request increased police presence along the River, particularly during episodes of increased water levels and flow velocities,
- Fire extinguishers or other firefighting equipment (such as drums of water) would be close at hand during construction, regularly inspected, and maintained in proper working condition,
- Equipment with internal combustion engines would be placed so that exhaust is not near combustible materials,
- Combustible or flammable materials would be properly stored and proper clearance around these materials would be maintained,
- City will coordinate as needed with Vector Control agencies after project completion,
- A rigorous review of the HTRW sites identified as those with potential impacts on the project would be conducted. The review would include obtaining and reviewing regulatory files, site visits, and discussions with regulators and others about the severity of the contamination. Following this review, Phase I or II environmental site assessments would be conducted as necessary. In areas where existing information is limited, environmental investigations shall follow industry approved protocols for conducting Phase I and Phase II investigations as needed. The sponsor shall not provide lands for project construction without first ensuring that it has undertaken adequate investigation and determined there is no contamination of concern for the relevant parcel or, where contamination is identified, has remediated or ensured remediation of the parcel to the standards necessary to support the restoration project, as agreed by the relevant regulatory agency and USACE. Coordination and consultation with the appropriate regulatory agencies, including the USEPA and California lead agency (usually the LARWQCB or the DTSC), and responsible parties, as necessary, would begin as early as possible regarding investigation and remediation at the San Fernando Valley Superfund Site and Taylor Yard G1 and G2 sites, as well as the LATC site as needed. The City would conduct remediation at contaminated sites prior to construction of restoration features at those sites.
- A new ecological risk assessment would be performed for the Taylor Yards G1 and G2 properties. The risk assessment would include risk calculations and analyses for recreational human health standards.
- Prior to the start of construction, the USACE will develop engineering specifications and plans that will include a written environmental protection plan. This plan will include a written pollution prevention plan that outlines the actions needed to respond spill or release of hazardous materials during construction or maintenance activities. The environmental protection plan would describe hazardous materials management and spill prevention and response methods. The plan would be reviewed with all site workers.
- A site-specific health and safety plan would be prepared and reviewed with all workers detailing methods of compliance with occupational health and safety regulations, emergency response actions, and include the route to the nearest emergency medical facility,
- Relevant paperwork such as material safety data sheets and chain-of-custody documents recording the transport and disposal of hazardous materials and waste would be maintained and available for inspection,
- All hazardous materials would be removed from the site when construction or maintenance activities were completed if not before,

- Construction sites would be fenced to prevent unauthorized access.
- Operations of the project would include public education on hazards associated with the river channel, including risk of water-related injury and drownings.

Health Considerations Overview

In response to comments from the public, the Corps and City developed the following overview of health considerations of the Los Angeles River Ecosystem Restoration Project (Project), based on issues identified in "A Guide for Health Impact Assessment" prepared by the California Department of Public Health and issued in October 2010 (Bhatia 2010). As stated in the guide, a Health Impact Assessment (HIA) is designed to "make visible the potentially signficant human health consequences of public decisions and thus to facilitate the greater consideration of health in policy decisions." The following discussion is not meant to follow the above guide in its entirety, but to put together in one place an analysis of information provided in the IFR of the Guide's health-related issues. This information addresses human health generally and is not intended as a separate evaluation according to the significance criteria in this section of the IFR.

Employment

Table 5-32 lists parameters that may be affected by projects of this type, and the connection between those parameters and human health.

Table 5-32 Health Determinants Potentially Affected by Plans and Projects (Employment)

Potential Effects	Connection between Potential Effects and Health Outcomes
Employment and Livelihood Will the action affect: • Level and security of employment? • Proportion of the population living in relative or absolute poverty? • Hazardous employment conditions? • Employment quality or job benefits? • Industrial diversity and resilience?	Unemployment results in material poverty, chronic stress, and low self-esteem. There is a dose-response relationship beween income and life expectancy across the income distribution. Health care and sick leave benefits support the use of preventative care. Job autonomy predicts reduced mortality from cardiovascular disease.

All action alternatives result in a net creation of jobs, both during construction and in operation, as shown in Table 5-33.

Table 5-33 Temporary and Permanent Changes in Employment (Action Alternatives)

	Alt. 10	Alt. 13	Alt. 16	Alt. 20
Construction-related jobs	2200	3300	7800	14200
Permanent jobs	630	675	675	2670

According to an economic analysis performed for this project (Appendix B of the Feasibility Study), the project alternatives should have no impact on the proportion of population living in relative or absolute poverty, nor impact on hazardous employment conditions. Jobs may be affected by relocation of existing businesses and the LATC facility to other locations within the Los Angeles Basin. While it is assumed that jobs would be transferred to the relocated site, some individuals may be unable to or choose not to commute to the new location. Construction-related jobs and permanent jobs resulting from the project are projected to be substantial although they may differ in type from jobs transferred outside the project area.

Housing

Table 5-34 lists potential determinants involving housing and the connection between those parameters and human health.

Table 5-34 Health Determinants Potentially Affected by Plans and Projects (Housing)

Potential Effects	Connection between Potential Effects and Health Outcomes
Housing Will the decision affect: • Housing affordability? • Adequacy of housing supply? • Quality or safety of housing? • Residential segregation?	Crowded conditions can increase the potential for infections, respiratory disease, fires and poor mental health. Unaffordable rents or mortgages result in trade-offs between material needs such as housing, food, and medical care.

None of the alternatives would directly result in a change in housing stock in the project area, nor in the adequacy, quality, or safety of housing. Connections via new pedestrian crossings could have a positive effect on reducing residential segregation that may have been exacerbated by the barrier created by the waterways and industrial sites. Gentrification can affect the local economy and land uses, but no clear trends have emerged at the time of this assessment. No direct or indirect health effects are anticipated due to housing issues.

Nutrition

Table 5-35 lists potential determinants involving nutritional issues and the connection between those parameters and human health.The connection between nutrition issues and health are summarized in Table 5-35.

Table 5-35 Health Determinants Potentially Affected by Plans and Projects (Nutrition)

Potential Effects	Connection between Potential Effects and Health Outcomes
Food Safety and Nutrition Will the decision affect: • Supply or cost of food? • Food safety? • Access to food resources?	Adequate nutrition is necessary for normal development and growth, normal body homeostasis, immunity, and the prevention of obesity and diet related diseases.

There would be no effects on food supply, cost of food, or food safety, nor access to food resources. No direct or indirect health effects are anticipated due to food issues.

Environmental Hazards

Table 5-36 highlights the connection between environmental hazards, such as chemical and biological pollutants, and potential health outcomes.

Table 5-36 Health Determinants Potentially Affected by Plans and Projects (Environmental Hazards)

Potential Effects	Connection between Potential Effects and Health Outcomes
Environmental Quality Will the decision affect: • Level of hazardous chemical or biological pollutants in outdoor air, soil, or drinking water? • Level of hazardous chemical or biological pollutants in indoor air? • Level of environmental noise? • Exposure to non-ionizing or ionizing radiation?	Air pollutant exposure retards lung growth, exacerbates respiratory disease, and increases cardio-pulmonary mortality. Indoor aero-allergens cause or exacerbate asthma. Water is a vehicle for communicable diseases. Chronic noise exposure harms sleep, temperament, hearing, and blood pressure. Solar and ionizing radiation are known carcinogens.

Investigation and remediation of the identified known and suspected HTRW sites in the study area would be conducted by the sponsor before construction activities are undertaken at affected sites. For contaminated groundwater that cannot be addressed prior to construction activities, such as the San Fernando Valley Superfund Site, the sponsor would be responsible at 100 percent non-project cost for addressing treatment and disposal of contaminated groundwater during dewatering activities. There should be no effects on the health of nearby residents, or on construction workers.

Construction noise will be present when work is occurring near sensitive receptors, including residences. Such activities will occur regardless of the build alternative, though the duration will vary greatly among the alternatives, ranging from 9 years for Alt. 10, 10 years for Alt. 13, 15 years for Alt. 16, and Alt. 20. Work in any one location, however, would be for a much shorter time period, with the loudest sound at 83 dbA at 100 feet. Nearly all construction would occur between 8 a.m. and 6 p.m. Monday through Friday, and from 8:00 a.m. to 5:00 p.m. Saturday. Because construction will be temporary, noise would not be a chronic issue at any given location, especially with appropriate best management practices.

The project would increase the spatial extent of surface water in the River corridor, increase the amount of riparian habitat and wetlands, and alter drainage patterns and water flow. As such, there is concern that breeding grounds such as standing water for disease vectors such as mosquitoes would increase under the project, potentially resulting in an increase in the incidence of infectious diseases. Although the extent of surface water is expected to increase under the proposed measures, the suitability of habitat will depend on microhabitat features that are subject to change with each large flow event. As in any natural system, pools and backwater areas may be formed or abandoned as new flow paths emerge. Once the project is constructed, the City of Los Angeles will continue to monitor and coordinate with vector control agencies as needed to control outbreaks of pests.

Social Cohesion

The links between social cohesion and public safety with potential health concerns are summarized in Table 5-37.

Table 5-37 Health Determinants Potentially Affected by Plans and Projects (Social Cohesion)

Potential Effects	Connection between Potential Effects and Health Outcomes
Safety Will the decision affect: • Demographic composition or social cohesion in an area? • Risk and response to fire hazards? • Hazard or frequency of transportation accidents or unintentional injuries?	Social cohesion inhibits crime and violence which can result in injury or property loss and provokes fear or stress. Projects can stress capacity of public safety institutions, limiting their response capacity to emergency events. Projects may increase motor vehicle traffic and vehicle collisions.

Implementation of the project would increase opportunities for the public to interact with the River. The potential for the public to enter the river channel during flooding would be greater than under current conditions, where much of the River is fenced and public access is impeded. Therefore, there is potential for water-related injuries and accidental drownings to increase.

However, operation of the restoration project would also involve greater oversight and incorporate restrictions on public access during hazardous conditions. Although the project would increase opportunities for the public to be near and access the River, the operation would incorporate public education to notify the public of dangers associated with water-related injury and drowning. The project construction and increased oversight associated with operation could also deter or reduce human habitation within the river. River channel designs would include, where consistent with the ecosystem restoration, features that would allow people to vacate the River channel quickly and facilitate swift water rescues.

Transportation

Transportation decisions can have potential effects on human health. This link is highlighted in Table 5-38.

Table 5-38 Health Determinants Potentially Affected by Plans and Projects (Transportation)

Potential Effects	Connection between Potential Effects and Health Outcomes
Transportation Will the decision affect: • Access to jobs, goods, services, and educational resources? • Number of trips walking and bicycling? • Vehicle miles traveled? • Vehicle volumes or speeds? • Availability and convenience of public transit services?	Access to employment, education, parks, and health care are critical for meeting health needs. Public transit provides such access for those without automobiles. Pedestrian and bicycle facilities facilitate active transport, reducing heart disease, diabetes, obesity, blood pressure, osteoporosis, symptoms of depresion, anxiety, and falls in the elderly. Vehicle volume is proportional to collision rates and vehicle speeds are proportional to injury severity.

The project would add vehicle trips to area roads because it would make portions of the River a recreational destination. However, these trips would likely occur during off-peak travel hours and therefore would not affect the performance of the roadway network when it is at its busiest. Increased traffic would be offset by improved pedestrian and bicycle facilities in terms of overall pedestrian and bicycle safety.

Ridership on public transit routes with stops near portions of the study area where public access is enhanced would increase because people would use public transit to access the River.

Because the River corridor would be enhanced aesthetically and new multi-use walking and biking paths would be constructed, and public access would increase, more people would be expected to use the River corridor for local and recreational trips. Travel on the existing Los Angeles River Bike Path would also increase. The capacity of the Los Angeles River Bike Path and the new multi-use paths that would be constructed as part of the project should be sufficient to accommodate demand.
The new walking and bike paths would provide an opportunity for nearby residents to exercise with the long-term potential to reduce certain types of disease and illness, including heart disease, diabetes, obesity, blood pressure among others. The greater the coverage of the bike and pedestrian paths, the better the project is in terms of overall public health benefits among the alternatives.

Education

The availability and quality of education resources have potential effects on human health as shown in Table 5-39.

Table 5-39 Health Determinants Potentially Affected by Plans and Projects (Educational Opportunities)

Potential Effects	Connection between Potential Effects and Health Outcomes
Education Will the decision affect: • Access and capacity of schools for children or adults? • Quality of education resources?	Educational success predicts both health status and life-expectancy. Children commuting to school get less sleep and exercise, and greater exposure to vehicle pollution. Quality community schools can promote parent participation and good educational outcomes.

Impacts on the education system should be minimal. The exception is that the restored river corridor may provide educational opportunities for students, especially those in nearby schools.

Outdoor Access

Availability of parks and natural space can have potential effects on health as shown in Table 5-40.

Table 5-40 Health Determinants Potentially Affected by Plans and Projects (Outdoor Access)

Potential Effects	Connection between Potential Effects and Health Outcomes
Parks and Natural Space Will the decision affect: • Quality, proximity, or access to parks and public spaces? • Natural spaces or habitats?	Contact with nature facilitates cognitive and physical development and serves a restorative function throughout life. Park access increases physical activity which reduces the risk of developing heart disease, diabetes, osteoporosis, and obesity. Trees and green space remove air pollution from the air and mitigate urban heat island effects.

For all action alternatives, there would be benefits to recreation and public access over the long term, in ways that are compatible with ecosystem restoration. The addition of restoration features along Rio De Los Angeles State Park (Taylor Yard) and at Los Angeles State Historic Park (Cornfields) is consistent with the parks' General Plans, and is expected to complement and expand upon existing resources. Benefits include:

- Improved aesthetic quality of the River,
- Increased public awareness of the recreation resources in the project reach,
- Increased visitation to recreation facilities in the project reach,

- Increased public health and safety from improved water quality along the River,
- Increased quality, quantity, and diversity of recreation resources along the River, such as trails, bike paths, benches, signage, River access points, maintenance ramps, etc., and
- Habitat quality improvements may have larger beneficial effects on specific recreation activities which are heavily dependent on the health of the river, such as bird watching.

Social/Economic Support

Table 5-41 shows potential connections between the proximity and quality of selected goods and services and human health.

Table 5-41 Health Determinants Potentially Affected by Plans and Projects (Social/Economic Support)

Potential Effects	Connection between Potential Effects and Health Outcomes
Goods and Services Will the decision affect: • Quality and proximity of financial institutions? • Quality and proximity of child care services? • Quality and proximity of health services?	Timely access and utilitization of primary health services can prevent serious hospitilizations. Quality child care increases childhood education and job outcomes. Local financial institutions help familiies create and maintain wealth.

None of the action alternatives will have any adverse effect on essential services.

Community Involvement

Involvement in the community can have connections to health as well as shown in Table 5-42.

Table 5-42 Health Determinants Potentially Affected by Plans and Projects (Community Involvement)

Potential Effects	Connection between Potential Effects and Health Outcomes
Social Cohesion Will the decision affect: • Quality or frequency of contacts with friends, family members, and neighbors? • Attitudes towards or stereotypes of racial, social, and ethnic groups? • Participation in voluntary organizations and activities?	Physical and emotional support buffers stressful situations, supports illness recovery, prevents isolation, constributes to self-esteem, and reduces the risk of early death.

Increase pedestrian connections over the river could lead to increased social cohesion linking residential and commercial areas on either side of the river. Such improvement in social cohesion, as well as the overall aesthetic and recreational improvements planned as part of the project, could lead to the easing of stressful situations and, ultimately, improvement in the overall health of the community.
Decisions related to the project should have no appreciable effect on stereotypes or attitudes, though there may be some feeling that certain neighborhoods or communities received a greater share of improvements along the river than did others.

Social Equity

Connections between segregation, inequality, and health outcomes are shown in Table 5-43.

Table 5-43 Health Determinants Potentially Affected by Plans and Projects (Socioeconomics)

Potential Effects	Connection between Potential Effects and Health Outcomes
Social Equity Will the decision affect: • Segregation by race, ethnicity, or income? • Degree of inequality in income or wealth?	Social contact across ethnic and income groups ensures equitable access to public health and educational services. Residents of low-income and ethnically segregated neighborhoods experience high rates of teenage childbearing, tuberculosis, cardiovascular disease, and homicide. Income inequality in a region or country predicts population life expectancy independent of income in wealthy countries.

The project is not expected to result in substantive changes in social equity, including increased segregation or increase inequality of income or wealth. Factors such as gentrification, poverty rates, and local businesses can affect the local economy and land uses, but no clear trends have emerged at the time of this assessment. No meaningful changes in health related to social equity issues are anticipated as a result of the project.

Community Empowerment

Participation in the public decision-making process can influence health outcomes as summarized in Table 5-41.

Table 5-44 Health Determinants Potentially Affected by Plans and Projects (Community Empowerment)

Potential Effects	Connection between Potential Effects and Health Outcomes
Social Inclusion Will the decision affect: • Degree or quality of participation in public decision-making? • Distribution of political power?	Participation and power in the political process affects government responsiveness to health needs and crises.

The project partners have done considerable public outreach since the start of the project; outreach will continue through final decision-making and into project construction. The project itself should not have any substantive bearing on participation rates in the decision-making process. To the extent that communities get more involved in a project due to either beneficial or adverse perceptions of one or more alternatives, the more likely they are to participate in the public process and, thus, influence the final decision.

5.12 UTILITIES AND PUBLIC SERVICES

5.12.1 Regulatory Framework

No Federal agencies or regulations are applicable to utilities and service systems associated with the array of restoration measures proposed for this project. Applicable California regulations include the Solid Waste Reuse and Recycling Access Act and the Integrated Waste Management Act. The Board of Public Works is the Bureau of Sanitation's oversight agency. Oversight for energy-related utilities at the state

level is under the California Public Utilities Commission and the California Energy Commission. The California Public Utilities Commission and the Federal Energy Regulatory Commission both regulate Southern California Gas operations.

5.12.2 Significance Criteria

An alternative would have a significant impact if it:

- Resulted in the need for new systems or supplies, or if it substantially altered power, natural gas, communications, local or regional water treatment or distribution facilities, sewer or septic tanks, stormwater drainage, solid waste disposal, or local or regional water supplies,
- Resulted in relocation of a utility to greater than 10 miles in any direction,
- Would use or take up the remaining capacity or capability of systems or eliminate the ability for facilities to accommodate new inputs,
- Exceeded wastewater treatment requirements of the RWQCB,
- Required or resulted in the construction of new water or wastewater facilities or expansion of existing facilities to serve the project's projected demand, the construction of which could cause significant environmental affects,
- Required or resulted in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects,
- Resulted in insufficient water supplies available to serve the project from existing entitlements and resources, or would require new or expanded entitlements,
- Resulted in a determination by the wastewater treatment provider which serves or may serve the project that it has inadequate capacity to serve the project's projected demand in addition to the provider's existing commitments,
- Was served by a landfill with insufficient permitted capacity to accommodate the project's solid waste disposal needs,
- Failed to comply with Federal, state, and local statues and regulations related to solid waste, or
- Created a need for additional government services related to police, fire protection, schools, parks, libraries, or other public facilities.

5.12.3 Environmental Impacts

This section considers direct and indirect effects and related actions together in the analysis.

No Action Alternative

Construction Impacts

No impacts to utilities would occur from construction under this alternative because construction would not occur.

Operational Impacts

Although conservation efforts and energy-efficient technology are helping to slow growth in demand for some utilities, continued population growth in the Los Angeles area would generally continue to result in increased energy demand under the future without-project conditions. The possible exception is natural gas, which may experience a slight decline in demand. In the study area, the owners and operators of the major utility systems (electric, natural gas, sewer, water, and storm systems) would be expected to maintain, repair, update, and augment these systems on an ongoing basis in order to protect supply and provide reliable service to customers. Infrastructure planning documents would continue to be developed, implemented, and updated and would forecast demand, analyze demand relative to capacity, and make plans to alter infrastructure so that capacity is sufficient to meet forecasted demand. Some capital

improvements would be expected to occur, resulting in increased capacity; however, funding for and completion of major improvements may lag behind demand. The market for telecommunications and solid waste management is characterized by multiple private service providers, which increases competition for customers. Due to this competition, these utilities would be expected to respond readily to customers' needs and keep pace with demand.

Alternative 10 (ART)

Construction Impacts

Where utilities overlap the study area, it is possible that these utilities could be affected by construction activities. LADPW power lines occur in the study area within Reaches 6 and 7, and the project would require that the sponsor ensure the relocation of 6 electrical towers in Reach 6 (Taylor Yard) and 2 in Reach 7 to allow construction, operation, and maintenance of the project. This impact would be less than significant as the power lines would be relocated less than 10 miles away. No other relocations have been identified at this time.

A utility management plan would be prepared prior to the start of construction and would describe in detail:

- Procedures for marking utilities prior to construction,
- Any utilities that would be temporarily rendered inoperable during construction,
- Any utilities that would have to be permanently relocated a distance of greater than 10 miles from their current location, and the plan for their relocation,
- Practices for working safely around utilities, particularly overhead transmission lines,
- Response procedures if a utility line were accidentally breached or impacted,
- Procedures for coordinating construction activities with utility owners, and
- Any permanent impacts to utility infrastructure and capacity.

California Government Code Section 4216 requires anyone planning an excavation in Los Angeles to call Underground Service Alert of Southern California, also known as DigAlert or Call Before You Dig, at least two working days before starting excavation to ensure that underground utilities are marked so they would not be damaged. Underground Service Alert would be called to mark utilities prior to construction. If necessary, a private utility locator would also be contracted to supplement the utility locations provided by Underground Service Alert. Relocation of segments of utility easements or corridors of less than 10 miles would be less than significant.

Altemative 10 would involve daylighting selected stormwater outfalls in Reaches 3, 4, 5, and 7 as part of project construction. During construction, stormwater flow would have to be redirected to other stormwater outfalls, temporarily reducing overall stormwater system capacity, resulting in a short-term impact. The reduction in capacity would be less than significant and capacity would be restored when construction was complete.

Concrete and soils removed during construction would contribute to the debris that requires disposal. However, as much as possible, concrete and soils would be reused in other study areas or recycled. The amount of construction and demolition debris that would be generated by the project is shown in Table 5-45. The estimates provided in the table are based on the total debris generated by the project being divided by the number of days of construction to generate a daily amount of debris. The assumption then is that the daily amount that would be disposed in a landfill. Finally, based on reported recycling rates for similar materials throughout Los Angeles, it is assumed that 60 percent of the debris is reused or recycled rather than disposed in a landfill (Los Angeles Bureau of Sanitation 2007).

Table 5-45 Construction and Demolition Debris

Material	Total Debris Generated by Project (tons)	Debris Generated by Project Per Day (tons per day)	Debris Disposed at Landfill Assuming 60% is Reused or Recycled (tons per day)
Alternative 10 (ART)			
Excavated Material	837,650	5,203	2,081
Alternative 13 (ACE)			
Excavated Material	995,718	3,531	1,412
Concrete Demolition	33,681	119	48
Spalls Removal	26,626	94	38
Total	1,056,026	3,745	1,498
Alternative 16 (AND)			
Excavated Material	2,839,552	4,551	1,820
Concrete Demolition	113,146	181	73
Spalls Removal	107,691	173	69
Grouted Riprap Demolition	78,643	126	50
Riprap Demolition	12,192	20	8
Asphalt Removal	3,502	6	2
Total	3,154,725	5,056	2,022
Alternative 20 (RIVER)			
Excavated Material	4,044,573	5,571	2,228
Concrete Demolition	87,302	120	48
Spalls Removal	92,125	127	51
Grouted Riprap Demolition	70,563	97	39
Riprap Demolition	24,938	34	14
Asphalt Demolition	5,030	7	3
Total	4,324,531	5,957	2,383

Debris would likely be disposed of at the Sunshine Canyon Landfill. This landfill is projeeted to reaeh capacity and close in 2037 (Browning Ferris Industries of California, Inc. 2008). Alternative 10 is scheduled to be completed in 2017, so the landfill would be operational throughout construction of the project. The landfill is permitted to receive up to 12,100 tons of solid waste per day and is currently receiving approximately 9,000 tons of solid waste per day (Browning Ferris Industries of California, Inc. 2008; Republic Services 2012).

Alternative 10 would generate 2,081 additional tons of debris per day, which would result in a total daily disposal of 11,081 tons of debris at the Sunshine Canyon Landfill. This would not exceed the landfill's capacity. In addition, there are additional landfills in the area that could accommodate debris, if necessary.

Because construction personnel would follow safe construction practiees and comply with health and safety requirements, accidents during construction are not likely and thus would not have an adverse

impact on local police, fire, and emergency medical personnel. Police, fire, or emergency medical would respond if accidents or incidents occur during construction. Construction would not impact schools or libraries.

Operational Impacts

The project would enhance stormwater management by creating more pervious surfaces in multiple Reaches, which would increase potential for stormwater to infiltrate into the ground.

The project may require temporary irrigation water to support restoration features until plants establish and for extreme drought conditions. Drought-tolerant native plants would be used; and the water budget has shown that there is sufficient water to support the alternatives.

Operation of the project would not likely alter the amount of solid waste generated in the study area or alter demand for natural gas or telecommunications infrastructure; therefore, there would be no impact on these utilities.

Increased public access would result in more people in the study area. Minor modifications or increases in police, fire, and emergency medical personnel, equipment, or facilities could be required in order to maintain an acceptable level of service and response time in the study area. The cities in the project area will request increased presence if necessary. The USACE would incorporate design measures to promote public safety and reduce incidences requiring police, fire, or emergency medical response such as adequate public lighting, signage stating rules and public access hours, and flood warning devices. Adverse impacts to public services would be less than significant.

Operation of the project would provide beneficial impacts to outdoor education opportunities for local schools. Operation of the project would have no effect on libraries.

The relocation of the LATC site functions to a new location within the Los Angeles Basin could result in impacts to existing utility lines and services as a result of construction or operation of a new facility. Construction activities are coordinated in a way to ensure that utilities services are not interrupted. However, if it is necessary, interruptions would be anticipated to be temporary. Following construction, the relocated site functions could place additional pressure on available utilities, beyond their existing capacity. However, selection of the site will be based on functional compatibility, ensuring that adequate facilities are in place. Operation of the site functions elsewhere in the basin is not anticipated to increase indirect effects on utilities and public services, since relocation is presumed to occur in an area with adequate capacity to support the new facility. Prior to site selection, the CEQA lead agency will conduct detailed CEQA analysis, including assessment of utilities and public services. Should any additional NEPA documentation be required, it would be undertaken by the NEPA lead agency. These effects are anticipated to be the same for all alternatives.

Alternative 13 (ACE)

Construction Impacts

The project footprint for this alternative is the same as Alternative 10 except in Reaches 3, 6, and 7; therefore, the effects in Reaches 1, 2, 4, 5, and 8 would be the same as Alternative 10. In Reaches 3, 6, and 7, a different design would be implemented but the utility relocations required to implement the project would be the same as in Alternative 10. Fewer stormwater outfalls would be daylighted than under Alternative 10; therefore, the temporary impacts associated with that measure would be less than under Alternative 10. All impacts would be less than significant.

As shown in Table 5-45, Alternative 13 would generate 1,498 tons of debris per day that would require landfill disposal, the least amount of any alternative. This would result in a total daily disposal rate of 10,498 tons of debris at the Sunshine Canyon Landfill. This would not exceed the landfill's capacity, so the project would be served by a landfill with sufficient permitted capacity and there would be no adverse impact. In addition, there are additional landfills in the area that could accommodate debris, if necessary.

Construction activities would occur over a longer time period compared to Alternative 10, so the temporary effects of construction would last longer.

Operational Impacts

Impacts to public services during operation would be similar as those described for Alternative 10 but would be slightly more extensive due to the larger project footprint. The project may require temporary irrigation water to support restoration features until plants establish and for extreme drought conditions. The side channel proposed in Reach 3 may also require pumps and electricity supply, although it will be designed to be self-sustaining to the extent practicable. Drought-tolerant native plants would be used; and the water budget has shown that there is sufficient water to support the alternatives. Impacts would be less than significant.

Alternative 16 (AND)

Construction Impacts

The project footprint for this alternative is the same as Alternative 10 in Reaches 1, 2, and 4 and the same as Alternative 13 in Reaches 3 and 6. The effects in those Reaches would be the same as described for those alternatives. In Reaches 5, and 8, a different project design would be implemented and different specific utilities would be affected; however, there would be no unique impacts on utilities. Utility relocations required under this alternative would include those identified for Alternatives 10 and 13. Five additional towers and associated power lines in Reach 8 would require relocation. The proposed excavation within Reach 8 would also require the relocation of two sewer lines. The power lines and towers would be relocated outside the project footprint, and the sewer lines would be relocated to avoid conflicts with project construction, operation, and maintenance but within the project footprint. All impacts would be less than significant.

Alternative 16 would involve daylighting the same stormwater outfalls as Alternative 13, therefore impacts from this measure would be the same as Alternative 13.

As shown in Table 5-45, Alternative 16 would generate 2,022 tons of debris per day that would require landfill disposal, which is less than Alternative 10 but more than Alternative 13. This would result in a total daily disposal of 11,022 tons of debris at the Sunshine Canyon Landfill. This would not exceed the landfill's capacity, so the project would be served by a landfill with sufficient permitted capacity and there would be no adverse impact. In addition, there are additional landfills in the area that could accommodate debris, if necessary.

Construction activities would occur over a longer time period compared to Alternatives 10 and 13, so the temporary effects of construction would last longer.

Operational Impacts

Impacts to public services during operation would be similar as those described for Alternatives 10 and 13 but would be slightly more extensive due to the larger project footprint. Impacts would be less than significant.

Alternative 20 (RIVER)

Construction Impacts

The project footprint for this alternative is the same as Alternative 16 in Reaches 1, 4, 5, 6 and 8. The effects in those reaches would be the same as described for Alternative 16. In Reaches 2, 3, and 7, a different project design would be implemented and utility towers in Reach 7 along the bank would require relocation. There would be no unique impacts on utilities. Although the project footprint would be larger, no utility relocations other than those identified for Alternative 16 are required for project construction, operation and maintenance. All impacts would be less than significant.

Alternative 20 would involve daylighting the same streams currently encased in culverts/stormdrains outfalls as Alternatives 13 and 16, and would also daylight the three streams in Reach 7 included in Alternative 10, therefore impacts from this measure would be slightly greater than the previous alternatives.

As shown in Table 5-45, Alternative 20 would generate 2,383 tons of debris per day that would require landfill disposal, which is the most of any alternative. This would result in a total daily disposal of 11,383 tons of debris at the Sunshine Canyon Landfill. The increased debris is associated with the construction of expanded features in Reaches 2 and 3, and the different set of features included in Reach 7, as compared to Alternative 16. The expanded features of modifying the channel bank in Reach 2, and expansion of the Verdugo Wash in Reach 3 require additional construction that would generate additional debris from channel bank removal and other measures. The construction debris generated by measures in Reach 7 would be the same as Alternative 13 and 16 with respect to the Arroyo Seco restoration and the same as Alternative 10 with respect to the daylighting of streams; however, the terracing of the bank and trestling of the railroad line would be anticipated to generate more debris than the restructured banks measure included in Alternative 13. The total daily disposal would not exceed the landfill's capacity, so the project would be served by a landfill with sufficient permitted capacity and there would be no adverse impact. In addition, there are additional landfills in the area that could accommodate debris, if necessary.

Construction activities would occur over a longer time period compared to the other alternatives, so the temporary effects of construction would last longer.

Operational Impacts

Impacts to public services during operation would be similar as those described for the previous alternatives but would be slightly more extensive due to the larger project footprint. The project may require temporary irrigation water to support restoration features until plants establish and for extreme drought conditions. The freshwater marsh proposed in Reach 7 may also require pumps and electricity supply, although it will be designed to be self-sustaining to the extent practicable. Drought-tolerant native plants would be used; and the water budget has shown that there is sufficient water to support the alternatives. Impacts would be less than significant.

5.12.4 Best Management Practices and Impact Avoidance Measures

Measures that would be implemented and would provide BMPs for reducing impacts include:

- Development of a utility management plan
- Obtaining a Private Solid Waste Hauler Permit from the City's Bureau of Sanitation prior to collecting, hauling and transporting waste,
- Recycling/reuse of construction debris to the extent possible;
- Disposing of excess debris to City certified waste processing facility, and

- Staggering construction of daylighting outfalls in order to minimize reduction in capacity of the stormwater system.

5.13 SOCIOECONOMICS AND ENVIRONMENTAL JUSTICE

5.13.1 Regulatory Framework

Federal

Federal Executive Order 12898 was signed by President Bill Clinton on February 11, 1994, to focus Federal attention on the environmental and human health conditions of minority and low-income populations with the goal of achieving environmental protection for all communities. The Order directed Federal agencies to develop environmental justice strategies to help Federal agencies identify and address disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority and low-income populations. Environmental justice concerns may arise from impacts on the natural and physical environment, such as human health or ecological impacts on minority populations, low-income populations, and Indian tribes, or from related social or economic impacts.

State

In addition to its prioritization by the Federal government, California was one of the first states in the Nation to pass legislation to codify environmental justice in state statute, defining "environmental justice" as "The fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations and policies." (Government Code Section 65040.12)

Local

The City of Los Angeles General Plan, Housing Element includes the City's policies in regards to housing issues (City of Los Angeles 2001), Policy 2.3.2 states that the City will "...allow for the provision of sufficient public infrastructure and services to support the projected needs of the population and businesses of the City within the patterns of use established in the community plans." Burbank's General Plan (Burbank 2013b) specifies a set of housing goals that address equal housing opportunities, housing constraints, affordability and variety of housing, and conservation and improvement of existing housing stock.

5.13.2 Significance Criteria

The proposed project alternatives could cause significant impacts related to population, socioeconomics, and environmental justice if they would be inconsistent with the City of Los Angeles' General Plan, Housing Element (City of Los Angeles 2002) or those of other affected communities, in the following ways:

- Induce substantial population growth in an area, either directly (e.g., by proposing new homes and businesses) or indirectly (e.g., through extension of roads or other infrastructure),
- Cause growth (e.g., new housing or employment generators) or accelerate development in an undeveloped area that exceeds projected/planned levels for the year(s) of project occupancy/buildout, or
- Cause a substantial number of residents, businesses, or employees to be displaced (includes displacement of affordable housing), necessitating the construction of replacement housing elsewhere.

Additionally, alternatives would cause significant impacts under NEPA if they would:

- Have disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority and, or low-income populations. The CEQ guidance identifies three factors to be considered to the extent practicable when determining whether environmental effects are disproportionately high and adverse (CEQ 1997):
    - Whether there is or would be an impact on the natural or physical environment that significantly (as the term is employed by NEPA) and adversely affects a minority population, low-income population, or Indian tribe. Such effects may include ecological, cultural, human health, economic, or social impacts on minority communities, low-income communities, or Indian tribes when those impacts are interrelated to impacts on the natural or physical environment;
    - Whether the environmental effects are significant (as the term is employed by NEPA) and are or may be having an adverse impact on minority populations, low-income populations, or Indian tribes that appreciably exceeds or is likely to appreciably exceed those on the general population or other appropriate comparison group; and
    - Whether the environmental effects occur or would occur in a minority population, low income population or Indian tribe affected by cumulative or multiple adverse exposures from environmental hazards.

5.13.3 Environmental Impacts

Direct and indirect effects of construction and operation are considered together in the analysis below.

No Action Alternative

No impacts to socioeconomics would occur from construction under this alternative because construction would not occur.

The socioeconomic assessment area consists of a predominantly residential and densely populated area in Los Angeles County. Due to the existing dense level of development, it is unlikely that changes in the local or regional economy will result in drastic changes in land use, population, or demographics in the assessment area. Other factors such as gentrification, poverty rates, and local businesses can affect the local economy and land uses, but no clear trends have emerged at the time of this assessment. Any changes that do occur in the period of analysis would likely be coincident with larger regional trends and would not materially alter the conditions in which an ecosystem restoration study would be constructed. Environmental justice considerations would not likely be altered substantially. Income and poverty in the assessment area appear to reflect national and regional trends of slow but increasing recovery from the recent recession. Unemployment in the assessment area is below that of the City or the County. The demographics of the assessment area may shift slowly in proportion to larger regional trends, but there is no indication for large shifts in demographics over the period of analysis.

Alternative 10 (ART)

Temporary closure of recreational facilities such as bike lanes and horseback riding areas or reduction in access or availability of recreational features during the construction period would occur. However, adverse effects associated with any temporary closures of trail systems, access points, or crossings along the River would be temporary and less than significant. Effects would include temporarily reduced access to the River as well as diminished walking, biking, and golfing opportunities at specific locations during the construction period. Los Feliz golf course may require temporary full closure, and Harding golf course will likely require partial closure and remain open. All construction areas where employment and facility operation would be disrupted would be prioritized and expedited as much as possible. No net

employment effects are expected at Los Feliz Golf Course. Because construction at Los Feliz is expected to take no longer than two months, employees could be temporarily reassigned with the Los Angeles Department of Parks and Recreation to reduce impacts. Affected golfers would be likely to visit another course during construction, possibly substituting the nearby Roosevelt course in Griffith Park.

Proposed staging areas are typically open lots near the River. Staging areas may result in temporary minor nuisances on adjacent businesses (traffic congestion, noise, etc.) but these effects would be managed by implementing BMPs, such that the effects remain less than significant. Proposed staging areas do not require business relocations. A phased construction approach that prioritizes areas with potential for temporary adverse socioeconomic effects would limit the quantity of closures at any one time and result in less than significant impacts.

As detailed in the Economic Appendix (see Appendix B), the infusion of construction funds into the regional economy will generate beneficial economic effects such as increased sales, additional jobs, increased labor income, and increased gross regional product during the construction period. The top three industries affected include construction, food and drink services, and engineering services. See Appendix B for detailed results of economic analysis.

This alternative is not expected to significantly affect environmental justice populations during construction. The alternative may result in other minor and temporary adverse effects, such as increased noise or dust around the construction area, which would affect adjacent populations. However, these effects would be managed by implementing BMPs and staying within noise limits and construction periods specified in city and county plans. All populations adjacent to the construction area would be affected equally, rather than environmental justice populations being disproportionately affected. It is likely that all communities adjacent to the river would experience similar levels of temporary adverse effects mentioned above. However, the nature of this restoration project is such that project location is entirely driven by the location of the River, and cannot be located elsewhere. Moreover, adverse effects are temporary in nature.

Alternative 10 would not induce substantial population growth in an area, either directly or indirectly, cause growth or accelerate development in an undeveloped area, or cause a substantial number of residents, businesses or employees to be displaced such that replacement housing must be constructed. Therefore, effects would be less than significant. The alternative does not require relocation or removal of existing residences, indicating that population and housing would not be directly affected. However, commercial and industrial infrastructure at Los Angeles Trailer and Container Intermodal Facility (LATC), also known as LATC, would be partially replaced with riparian and wetland habitat. Information indicates that approximately 157 workers are employed at LATC. Site functions would relocate to a new location within the Los Angeles Basin, as discussed below. For all private-sector relocations, the sponsor would provide relocation assistance for the affected business per the Uniform Relocation Act of 1970, as amended.

Furthermore, this alternative may also result in beneficial impacts to socioeconomic conditions in the study area. Improved aesthetic quality of the River, improved habitat value, improved quality and quantity of recreation resources along the River, and improved River accessibility would be the catalyst for these beneficial effects, which may include the following:

- Improvement in quality and quantity of recreation resources along the River may result in indirect economic benefits to businesses near or reliant upon the River, such as recreation equipment rentals, educational activities, restaurants and food service, etc.,

- Any improvements in environmental quality (such as water quality) in the region as a result of a cleaner, active River system would benefit all populations in the study area, and
- Potential long term urban renewal/redevelopment benefits such as increased local economic output, job growth, and labor income following completion of the restoration project (see Appendix B for further discussion of redevelopment impacts).

Alternative 10 is likely to yield beneficial effects to adjacent communities over the long term. These beneficial impacts include enhanced visual aesthetics, reconnection of communities divided by the river with pedestrian bridges, increased environmental education opportunities, and new, enhanced recreational opportunities. With fewer project elements than the other three alternatives, however, it would provide fewer long-term benefits as well, including in the environmental justice communities.

While most of the study area demographics reflect a similar percentage of low-income and minority populations as the rest of the City of Los Angeles, communities in the census tracts immediately surrounding LATC include minority and low-income populations, and are considered to be environmental justice communities. These communities have less than 20 percent white residents on average, and approximately 31 percent of residents of these tracts live in poverty, which is 11 percent higher than the City of Los Angeles on the whole. Of the two census tracts on the east side of the Los Angeles River and immediately adjacent to LATC, the unemployment rate ranges from 12.7 to 21.8 percent, the latter the highest in the overall study area.

Though rail and freight operations would be relocated to another location within the Los Angeles Basin, it is unlikely that the operations will be relocated near the communities in and around the ARBOR reach due to lack of a suitable alternative location, and commuting to the new location may no longer be feasible for some local residents. Working class jobs at LATC may be transferred elsewhere in the Los Angeles regional economy. To determine whether the potential transfer or conversion of jobs that could occur if LATC were converted from industrial uses into green space would have a high and disproportionate effect on EJ communities, the number of "trade, transportation, and utilities" sector jobs provided by businesses in the eight census tracts surrounding and including LATC was calculated. Based on U.S. Census data, there are 635 such jobs in these eight census tracts, but only 27 of the holders of these jobs live in these census tracts. The balance of workers live in other parts of the greater Los Angeles area, so transfer of jobs to a new location within the Basin would not be expected to have disproportionately high and adverse effects on EJ communities. Therefore, this impact is considered less than significant.

In addition, although the conversion would result in relocation of site functions to a new location, with associated transfer of jobs, a much higher number of jobs are expected to be created during construction of the project. Depending on the alternative, cumulative construction jobs are projected to range from 2,200 to 14,100. The work at LATC is one of the largest single elements of the entire project and may account for up to 1,000 working class jobs during construction. While these jobs may be filled by persons throughout the greater Los Angeles area, many could be filled locally as well, and may result in providing at least a similar number of jobs as those relocated from the existing LATC. Based on the analyses presented in the Economics Appendix (Appendix B), any job growth predicted from urban renewal/redevelopment may not directly offset any initial job transfers resulting from relocation of LATC, as redevelopment will be a long term process, and the specific skilled labor jobs at LATC are not likely to be replaced in kind in the immediate area either during construction or over the long term.

Indirect impacts may also occur to other businesses in the area that rely on the LATC facility or clientele from the LATC workforce. Businesses that have operations linked to LATC functions may choose to relocate over time to be closer to the location of the relocated site functions. The LATC workforce would

no longer be present in the existing location to patronize nearby businesses, but these businesses could benefit from increased visitation by the public to the restoration project area.

Under each of the action alternatives, relocating the LATC to a new location within the Los Angeles Basin may result in impacts to populations surrounding the future site. If operations at the new facility resulted in growth inducement and larger populations in the area, it could increase neighborhood density, increase environmental disturbance in the form of reduced air quality or noise effects in neighborhoods that already endure environmental pressures, or cause increased housing prices. However, the relocation would not be expected to induce substantial population growth in an area, either directly or indirectly, cause growth or accelerate development in an undeveloped area, or cause a substantial number of residents, businesses or employees to be displaced such that replacement housing must be constructed. Selection of the future site would be based on finding a site that can provide equivalent functionality in an area already zoned for industrial use within the Los Angeles Basin. It is presumed that the areas that fulfill these requirements would not be near residential neighborhoods and that the relocated site functions would require equivalent employees to the current site. It is also possible that indirect effects could include benefits to surrounding populations, as a result of having an additional source of industrial employment in the area. Prior to site selection, the CEQA lead agency would conduct a detailed CEQA analysis, including assessment of socioeconomic effects. Should any additional NEPA documentation be required, it would be undertaken by the NEPA lead agency. These impacts are anticipated to be the same for all action alternatives.

Alternative 13 (ACE)

Impacts for Alternative 13 would be similar to those for Alternative 10 in nature, though they may be slightly increased in duration due to the increase in overall level of restoration associated with the inclusion of channel reshaping in Reaches 6 and 7 and additional side channel work at Ferraro Fields in Reach 3.

Alternative 13 expands upon the features in Alternative 10 and adds additional measures. Impacts at LATC would be the same as those described under Alternative 10. The current project footprint does not necessitate removal/relocating of any additional buildings, although some parking lots or open areas adjacent to the channel which are currently used for equipment storage may be reduced in size to accommodate channel reshaping. Additional analysis would occur during later stages of design. Should any acquisitions or condemnations be required, the sponsor would provide necessary assistance per the Uniform Relocation Act. Socioeconomic impacts, therefore, would be less than significant.

Alternative 13 may also result in beneficial impacts in the study area. These beneficial impacts would be same as for Alternative 10, with the possibility of slightly greater impact due the increased level of restoration for Alternative 13. Potential environmental justice effects would be the same as those described for Alternative 10.

Alternative 16 (AND)

Impacts for Alternative 16 would be to the same as those for Alternative 13 in nature, though they may be increased in extent and duration due to the increase in overall level of restoration associated with the addition of channel deepening in Reach 5 and bank terracing submeasures in Reaches 5 and 8.

Alternative 16 may also result in beneficial impacts in the study area. These beneficial impacts would be same as for Alternatives 10 and 13, with the possibility of slightly greater impact due to the increased level of restoration for Alternative 16. Potential environmental justice effects would be the same as those described for Alternatives 10 and 13.

Alternative 20 (RIVER)

The footprint for Alternative 20 is the largest of the alternatives, including additional areas of restoration at Verdugo Wash, Los Angeles State Historic Park, and additional in-channel work compared to Alternative 16. As with previous alternatives, it is assumed than any minor adverse effects from construction would be managed using BMPs such that they remain less than significant. Alternative 20 would require temporary partial closure of Los Angeles State Historic Park for construction of marsh/wetland restoration features, a less than significant impact. At the Verdugo Wash confluence, a number of commercial/industrial parcels which fall within the project footprint would need to be acquired to allow construction, operation and maintenance of the project. Based on preliminary analysis, approximately 11 businesses would be displaced at Verdugo Wash. These businesses include warehousing, manufacturing, and industrial uses. In Reach 7, features at and adjacent to Los Angeles State Historic Park would affect two parcels zoned for warehouses would be affected and structures found there would need to be removed. As businesses are displaced during acquisition, it is anticipated business owners would relocate their operations elsewhere. For all relocations, the sponsor would provide relocation assistance per the Uniform Relocation Act of 1970, as amended. The project would not be expected to cause substantial population growth in an area, either directly or indirectly, cause growth or accelerate development in an undeveloped area, or cause a substantial number of residents, businesses or employees to be displaced such that replacement housing must be constructed. Thus socioeconomic impacts would therefore be less than significant.

The alternative may also result in beneficial impacts to the study area. These beneficial impacts would be same as for Alternatives 10, 13, and 16, with the possibility of greater beneficial impact due the increased level of restoration for Alternative 20.

Like Alternatives 10, 13, and 16, Alternative 20 does not require relocation or removal of existing residences, and as such would not displace any low-income or minority populations. Overall, it is expected that low-income and minority populations in the study area would experience the same long-term beneficial effects from this alternative as described for the previous alternatives. As described for Alternatives 10, 13, and 16, although there is potential for adverse effects on environmental justice communities from the conversion of LATC, these effects are determined to be less than significant.

5.13.4 Environmental Justice Summary

Table 5-46 summarizes the adverse and beneficial effects of the project on environmental justice communities (primarily along Reaches 7 and 8). While Environmental Justice determinations are based on disproportional high and adverse effects, the summary that follows also looks at the benefits that accrue to low-income, minority, and disabled communities along the Los Angeles River corridor.

Table 5-46 Impacts and Benefits to Environmental Justice Communities

	Alternative 10	Alternative 13	Alternative 16	Alternative 20
Impacts				
Air Quality	Construction effects – esp. related to LATC; substantial portion of overall project	Construction effects – esp. related to LATC; smaller portion of overall project than Alt. 10	Construction effects – esp. related to LATC; smaller portion of overall project than Alt. 13	Construction effects – esp. related to LATC; relatively small portion of overall project compared to other alternatives
Land Use	Proposed action in Reach 8 conflicts with current land use designation	Proposed action in Reach 8 conflicts with current land use designation	Proposed action in Reach 8 conflicts with current land use designation	Proposed action in Reach 8 conflicts with current land use designation
Noise	Construction-related noise, esp. at LATC; substantial portion of overall project, but short overall timeframe	Construction-related noise, esp. at LATC; smaller portion of overall project, but duration of all components likely longer than Alt. 10	Construction-related noise, esp. at LATC; smaller portion of overall project, but duration of all components likely longer than Alt. 13	Construction-related noise, esp. at LATC; smaller portion of overall project, but duration of all components longer than other alternatives
Public Health	Air quality impacts during construction; noise impacts during construction; substantial portion of overall project	Air quality impacts during construction; noise impacts during construction; small portion of overall project than Alt. 10	Air quality impacts during construction; noise impacts during construction; smaller portion of overall project than Alt. 10	Air quality impacts during construction; noise impacts during construction; smaller portion of overall project than other alternatives
Socioeconomics	Up to 157 jobs relocated from LATC; indirect impact other neighborhood businesses may occur	Up to 157 jobs relocated from LATC; indirect impact other neighborhood businesses may occur	Up to 157 jobs relocated from LATC; indirect impact other neighborhood businesses may occur	Up to 157 jobs relocated from LATC; indirect impact other neighborhood businesses may occur
Benefits				
Water Resources	Improved water quality and flow rates due to habitat improvements at LATC; substantial portion of overall project	Improved water quality and flow rates due to habitat improvements at LATC; smaller portion of overall project than Alt. 10	Improved water quality and flow rates due to habitat improvements at LATC and River in Reach 8; smaller portion of project than Alt. 13	Improved water quality and flow rates due to habitat improvements at LATC and River in Reach 8; smaller portion of project than other alternatives
Biological Resources	Habitat improvements at LATC; substantial portion of overall project	Habitat improvements at LATC; smaller portion of overall project than Alt. 10	Habitat improvements at LATC and River in Reach 8; smaller portion of overall project than Alt. 13	Habitat improvements at LATC and River in Reach 8; smaller portion of project than other alternatives
Recreation/ Aesthetics	Improved aesthetic quality of River, increased recreational resources along River due to habitat improvements at LATC	Improved aesthetic quality of River, increased recreational resources along River due to habitat improvements at	Improved aesthetic quality of River, increased recreational resources along River due to habitat improvements at	Improved aesthetic quality of River, increased recreational resources along River due to habitat improvements at

	Alternative 10	Alternative 13	Alternative 16	Alternative 20
		LATC	LATC	LATC and LASHP
Public Health & Safety	Remediation of soil contamination required prior to construction.	Remediation of soil contamination required prior to construction.	Remediation of soil contamination required prior to construction.	Remediation of soil contamination required prior to construction.
Socioeconomics	Up to 2,200 construction jobs (up to 1,000 in immediate area) created by project, increased visitation may benefit local businesses	Up to 3,300 construction jobs (up to 1,000 in immediate area) created by project, increased visitation may benefit local businesses	Up to 7,700 construction jobs (up to 1,000 in immediate area) created by project, increased visitation may benefit local businesses	Up to 14,100 construction jobs (up to 1,000 in immediate area) created by project, increased visitation may benefit local businesses

5.13.5 Best Management Practices and Impact Avoidance Measures

As currently analyzed, implementation of all alternatives would require conversion of the LATC property. Alternatives 13v and 20 would also require acquisition of multiple structures at the Cornfields site. Alternative 20 would also require acquisition of businesses at the confluence with Verdugo Wash. Under CEQA, economic and social effects are not considered significant (CEQA Article 5 Section 15064(e)). While impacts identified to these properties do not constitute a significant impact to socioeconomics or environmental justice under NEPA based on the analysis above, the LATC facility and businesses are anticipated to relocate and acquisition and compensation would occur in accordance with principles of just compensation. Acquisition and compensation would be carried out in accordance with the Federal Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended, Pub. L. 91-646, 42 U.S.C. 4601. As a component of the acquisition, businesses would have the opportunity to participate in the relocation assistance program. The non-Federal sponsor would actively participate in relocation of these businesses to ensure fair and equitable compensation.

5.14 CUMULATIVE IMPACTS

The CEQA guidelines and the regulations implementing NEPA require that the cumulative effect of a proposed action be assessed (14 CCR Section 15130; 40 CFR Parts 1500-1508). A cumulative effect is an "impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions" (40 CFR § 1508.7). In addition, they are defined as "two or more individual effects, which, when considered together, are considerable or which compound or increase other environmental impacts" (CEQA Guidelines Sec. 15355). Cumulative effects can result from individually minor but collectively significant actions taking place over time (40 CFR § 1508.7). CEQ's guidance for considering cumulative effects states that NEPA documents "should compare the cumulative effects of multiple actions with appropriate national, regional, state, or community goals to determine whether the total effect is significant" (CEQA 2010). The following sections discuss local and regional growth trends and projects that may result in cumulative effects when combined with effects from the actions discussed above.

In general, past, present, and reasonably foreseeable future projects are assessed by resource area. Cumulative effects may arise from single or multiple actions and may result in additive or interactive effects. Interactive effects may be countervailing, where the adverse cumulative effect is less than the sum of the individual effects, or synergistic, where the net adverse cumulative effect is greater than the sum of the individual effects (CEQA 2010). The factors considered in determining the significance of cumulative effects are similar to those presented for each resource earlier in Chapter 5.

An integral part of the cumulative effects analysis involves determining whether effects from the project would contribute to ongoing or foreseeable resource trends. Where effects from the project contribute to regional resource trends, there is a potential for a cumulative effect. The cumulative effects analysis does not assess all expected environmental impacts from regional projects but only those resulting from the project and other past, present, and reasonably foreseeable future actions.

The timeframe for analysis of cumulative effects can be described as the reasonable and foreseeable estimate for implementation of cumulative projects, in addition to the proposed action. For purpose of this analysis and discussion of existing, ongoing, or planned projects, this timeframe would extend from the present to approximately 2035. This timeframe is based on the recent and pending adoption of various general, community, and resource plans proposing land use and resource projects incrementally being developed through that year, in addition to site-specific projects. Implementation of the restoration measures proposed in the Alternatives is also likely to be a long-term project that would coincide with the development schedule of the projects discussed below.

5.14.1 Existing, Ongoing or Planned Projects

This section is a discussion of projects that could contribute to cumulative effects, in addition to the project assessed in this IFR. Because of the large geographic region affected by the proposed project, the cumulative analysis primarily focuses on regional plans and planning documents in growth and development in addition to specific projects when identifying past, present, and reasonably foreseeable future actions for the effects analysis.

Analysis of cumulative effects considers past, present and reasonably foreseeable projects in addition to the proposed project. These projects include those potentially affecting environmental resource areas including land use, utilities, services, hydrology, parks and recreation, biological and cultural resources, and other issue areas.

The following are projects and plans that could potentially contribute to or address cumulative effects associated with implementation of the ARBOR alternatives. These include local and regional plans as well as public and private projects either recently adopted or in preparation by Los Angeles, Glendale, Burbank, utility and power agencies as well as regional planning agencies that could result in cumulative effects.

Hollywood Community Plan

In the City of Los Angeles, the Hollywood Community Plan encompasses portions of Reaches 1-6. This Plan has recently undergone a comprehensive update, and was adopted by the Los Angeles City Council in June 2012 (City of Los Angeles 2012). The major highlights of the Plan are the increased land use density and residential height limits for the central section of Hollywood, including sections of Hollywood Boulevard and Vine Avenue. No significant changes in zoning or land use designations affecting the portion of the Plan within Reaches 1-6 were adopted (City of Los Angeles 2012).

Boyle Heights Community Plan

In the City of Los Angeles, the Boyle Heights Community Plan, which includes portions of Reaches 7 and 8, has been undergoing a comprehensive update since 2006 (City of Los Angeles, 2012). This Plan update is focusing on the various challenges facing the Boyle Heights community, including promoting new businesses, preserving existing industrial uses, preserving and creating affordable housing, and promoting new and expanded park and recreational opportunities. It is unknown when this update would be finalized and adopted by the City.

Northeast Los Angeles Community Plan

The Northeast Los Angeles Community Plan, revised in 1999, includes portions of Reaches 3 through 7 (City of Los Angeles 1999). The Plan addresses community issues and opportunities. Pertinent issues to this project include lack of amenities and access to the Los Angeles River, destruction and deterioration of open space, and open space corridors. Opportunities enumerated in the Plan include preservation of open space, and enhancement of amenities and public access near flood control facilities.

Los Angeles River Improvement Overlay Supplemental Use District (LA-RIO)

The Los Angeles River Improvement Overlay Supplemental Use District was established by the Los Angeles City Council in 2009 to promote watershed improvements, promote sustainable habitats, and improve pedestrian, bicycle, and transit mobility along the River Greenway and the surrounding neighborhoods. The LA-RIO extends from Topanga Canyon Boulevard near the headwaters of the river downstream to the Boyle Heights area.

Los Angeles Convention and Event Center/Farmers Field Stadium Plan

The Los Angeles Convention Center is preparing an expansion plan that would add new exhibit space and a new football stadium at its adjacent Farmers Field site. Part of the existing convention center would be razed, but the new stadium would also be used for large events. Completion of the stadium is contingent upon securing a commitment from an NFL team to play in the stadium. If such a commitment is not secured, other parts of the expansion are still planned to move forward.

Los Angeles State Historic Park

The Los Angeles State Historic Park, located on the former 32-acre Cornfields site in Reach 7, opened in September 2006. The park is under development, and operates a number of amenities, including a natural amphitheater, a multiuse plaza, approximately four acres of open turf area for informal recreation and events, temporary classroom structures, interpretive panels, and walking trails (California Department of Parks and Recreation 2012).

Rio de Los Angeles State Park

The Rio de Los Angeles State Park is located on a portion of the Taylor Yard site in Reach 6. Jointly managed by the California State Parks Department and the Los Angeles Department of Recreation and Parks, park construction began in 2005 upon adoption of a general plan for the site. Facilities include an amphitheater, soccer fields, tennis courts, baseball fields, trails, play areas, natural areas, and picnic areas (California Department of Parks and Recreation 2012).

Los Angeles and San Gabriel Rivers Watershed Projects

A series of ongoing flood risk management and water quality projects and studies have been underway in coordination with the USACE and the Los Angeles County Department of Public Works (LACDPW) since 2000. The objective is to develop a framework for an integrated basin management plan in the Los Angeles County drainage area. The USACE and LACDPW are investigating solutions to flood risk management problems, while addressing environmental issues and impacts. These efforts are ongoing (LACDPW 2012).

Arroyo Seco Watershed Management and Restoration Plan

Prepared for the State Water Resources Control Board in 2006, this Plan developed policies to manage and restore water quality and habitat in the Arroyo Seco watershed. The Plan focused on water quality and habitat, and included a series of recommended projects to enhance water quality and habitat improvement, including restoration of riparian areas with native plants (North East Trees 2006).

Green Visions Plan

The Green Visions Plan is a joint venture between the University of Southern California and the region's land conservancies, including the Rivers and Mountains Conservancy, Santa Monica Mountains Conservancy, Coastal Conservancy, and Baldwin Hills Conservancy. The mission of the Green Visions Plan for 21st Century Southern California is to provide a guide to habitat conservation, watershed health, and recreational open space for the Los Angeles metropolitan region and to design planning and decision support tools to nurture green land use patterns in southern California. Their goals are to protect and restore natural areas, to restore natural hydrological function, to promote equitable access to open space, and to maximize support via multiuse facilities (University of Southern California 2012).

2005 Los Angeles Urban Water Management Plan

The Urban Water Management Plan serves as the City's master plan for water supply and resources management. The Plan describes how the City would address the following:

- Pursue cost-effective water conservation and recycling projects to increase supply reliability and offset increases in water demand due to growth and environmental enhancements;
- Protect groundwater supplies from contamination and provide treatment to optimize their use;
- Ensure access to reliable and affordable supplemental water supplies through active and effective representation at the Metropolitan Water District of Southern California;
- Maintain the operational integrity of the Los Angeles Aqueduct and the City's water distribution system; and
- Secure needed funds, including outside funding, to develop more efficient use of existing supplies, such as by conservation and recycling projects, and resource management programs.

Los Angeles Integrated Resources Plan

This Plan describes the wastewater, recycled water, and runoff systems in Los Angeles, identifies system inadequacies based on the needs projected for 2020, and provides recommended alternatives to address the future needs of the systems. Los Angeles owns and operates four wastewater treatment plants and water reclamation plants that manage the wastewater generated in the City and other areas in neighboring jurisdictions. Future population increases in Los Angeles and its service areas would result in increased wastewater flows that must be managed safely. This Plan addresses the alternatives to manage the facilities effectively and ensure a continued supply of water for the City (City of Los Angeles 2012).

Integrated Regional Water Management Plan

The LACDPW adopted an *Integrated Regional Water Management Plan* in 2006 to define a clear vision and direction for the sustainable management of water resources in the Greater Los Angeles County Region. The Plan presents analysis and information regarding possible solutions and the costs and benefits of addressing water quality and quantity needs for the region (LACDPW 2006, 2012).

Water Quality Compliance Master Plan

In 2009, Los Angeles adopted the *Water Quality Compliance Master Plan (WQCMP)*, a 20-year strategy for clean stormwater and urban runoff to reduce the pollution flowing into local rivers, creeks, lakes and beaches. By promoting green infrastructure, the WQCMP seeks a broad watershed-based perspective using green and natural solutions to improve water quality and maintain Los Angeles' compliance with current and emerging water quality regulations. The master plan describes the existing status of urban runoff management in Los Angeles and watershed management efforts by Los Angeles and other organizations, identifies key issues for the future of urban runoff management, provides strategic guidelines for improving the quality of Los Angeles' rivers, creeks, lakes and ocean, identifies opportunities for collaboration among City departments and with non-governmental organizations, and describes how rainwater can be used beneficially to augment the water supply (City of Los Angeles 2009).

Multi-County Goods Movement Action Plan

Various local and regional transportation agencies and private rail operators have been addressing long-term needs to ensure the continued viability of freight rail operations throughout the Los Angeles region and southern California. Metrolink has sponsored the *Multi-County Goods Movement Action Plan* to work with various transportation providers, community groups, and private rail companies to study intermodal transportation means of moving goods throughout the region. The Plan, prepared in 2008, provides guidelines for various agencies and recommends planning efforts to ensure that key freight corridors remain viable while addressing environmental concerns, economic benefits, and community needs (Metrolink 2008).

Johnny Carson Park

Johnny Carson Park is a 17.6-acre park in the City of Burbank. The amenities offered at this park include: a picnic area; an outdoor exercise course; a playground; two pedestrian bridges; a small performance stage; an abundant amount of mature trees; and vast areas of shaded green passive open parkland. The park's topography and potential for streambed restoration provide some very exciting opportunities for sustainability-driven improvements. The City has recently received grant funding to enhance the existing loop trail with interpretative signage, performing Americans with Disability Act (ADA) improvements to two existing bridges, providing new par course exercise equipment and creating a secondary trail system complete with benches.

Glendale Narrows Riverwalk

The City of Glendale, in association with various state and Federal agencies, is developing the Glendale Narrows Riverwalk. This park and open space feature will provide a half mile of landscaped recreational trail along the north bank of the Los Angeles River across from Griffith Park. It will include a small entry park that will serve as a staging area for hikers and bicyclists, a separate staging area for equestrians using local trails, another small park area for walking and picnicking, enhancement of wildlife habitat in the river channel, and educational and interpretive exhibits. The project is funded by grants from the California River Parkways program and the Los Angeles County Regional Park and Open Space District. Most of Phase II of the project has been built as part of the Fairmont Avenue flyover extension off the 134 Freeway that is now nearing completion. Master Planning efforts for the remainder of Phase II and all of Phase III are now under way as the result of a Community-Based Planning grant from Caltrans. This effort will include linking Phases I and II, as well as exploring the potential for a bridge across the Verdugo Wash. Phase III will explore the prospect for what may become the signature element of the project – a multi-user bridge across the Los Angeles River from the Riverwalk to the Los Angeles Bike Path and on to Griffith Park, specifically for non-motorized travel between these recreational facilities.

Headworks Ecosystem Restoration Feasibility Study

The Headworks Ecosystem Restoration Feasibility Study will evaluate ecosystem restoration through the development of riparian habitat and wetlands, creating a multi-objective project that also include water quality improvement and passive recreation opportunities. Currently, alternatives are undergoing analysis, including habitat evaluation via the Combined Habitat Assessment Protocol methodology. Several alternatives involve the redirection of water from the main LA River channel to the overbank (Headworks site) to help encourage ecosystem restoration in the region. One of the alternatives involves the capture and redirection of surface water runoff and overland flow to the Headworks site to encourage ecosystem restoration. Construction of the selected alternative is not anticipated until at least 2018, pending construction of a reservoir on the site. The project is located in the southeastern portion of the San Fernando Valley off Forest Lawn Drive at the Los Angeles River, adjacent to Griffith Park.

Sennett Creek Park

The proposed Sennett Creek Park would create a park along the south bank of the LA River on a narrow strip between the River and Forest Lawn Drive in the City of Los Angeles. The park would connect Griffith Park and the Warner Bros. studio complex and would be adjacent to the Forest Lawn Memorial Park complex. The non-profit Friends of the LA River (FoLAR) and North East Trees are working with the City of Los Angeles, the USACE and major stakeholders, including Forest Lawn and Warner Bros., to implement a vision for this park and secure funding sources for its development. Proposed features of this park would include a river bicycle and pedestrian path, picnic areas, riparian restoration, and connectivity to wildlife corridors and nearby trails, including Sennett Creek.

Griffith Park Trail Planning

The City of Los Angeles, working with other agencies and non-profit groups, are proposing new trails or improvements to existing trails throughout Griffith Park. These improved or new trails are designed to enhance the visitor experience to Griffith Park as well as highlight the parks natural resources and connections with its historic past. These activities include developing a concept plan for Anza National Trail enhancement and management through the Griffith Park-L.A. River corridor promoting community connectivity, native habitat restoration, increased awareness of the trail, improved maintenance, and an enhanced user experience.

Griffith Park on the East Bank

The City of Los Angeles and various local non-profits are working on plans to transform a 28-acre portion of Griffith Park now being used as a service yard into usable parklands. The site is located next to the LA River, the existing North Atwater Park, and the City of Glendale water reclamation plant, and is near the Chevy Chase Recreation Center. Current plans call for a combination of playgrounds and picnic areas, athletic fields and recreation areas, and bicycle and pedestrian trails.

Senate Bill No. 1201

This law, adopted in 2012, amends the Los Angeles County Flood Control Act to include a provision that provides for public use of navigable waterways under the district's control suitable for recreational and educational purposes. This provision codified that the river was subject to Section 4 of Article X of the California Constitution, which guarantees the public a right of access to navigable waters of the state. The LA River must be held in trust for the public and the state and its local governments are directed to manage it for public use and access when compatible with flood risk management.

Dreamworks Animation Campus

This entertainment media project in Glendale would create a 495,000 square foot entertainment production campus and employ approximately 1400 people at full build-out. The project would be constructed in two phases and would eventually encompass seven buildings with a distinct Mediterranean theme. The project would combine the studios design and production staff into an integrated setting for the creation and production of animated films and related media (City of Glendale 2006, 2008).

Cornfield-Arroyo Seco Specific Plan

The Cornfield-Arroyo Seco Specific Plan will guide the future development of the Arroyo Seco area within and adjacent to portions of Reach 7 by creating a series of mixed-use zoning districts that allow private, public, and nonprofit sector developers to combine retail, residential, commercial, civic, and industrial uses while ensuring that this development contributes to an engaging, human-scale urban fabric. The plan would create four new zoning districts that would result from implementation of the Specific Plan, including the following: Greenways, Urban Village, Urban Innovation, and Urban Center. Two existing, primarily residential zoning districts will remain. The specific plan area would encompass the River channel for several miles (City of Los Angeles 2010, 2012).

Albion Dairy Park Project

This project, located in Reach 7, would transform the Los Angeles River adjacent to the old Swiss Dairy site into a river greenway park. The 6-acre site is located next to Downey Park in the community of Lincoln Heights in the City of Los Angeles. The site would undergo a redevelopment and revitalization process which would incorporate multi-functional and multi-benefit design features that would serve as an amenity for the community while improving stormwater quality in the city. The Mitigated Negative Declaration for the project was approved in April 2011 (City of Los Angeles 2011).

Atwater Bridge

This project, headed by the Los Angeles River Revitalization Corp., is located in the Atwater areas of the study area and would construct a pedestrian, equestrian, and bicycle bridge across the Los Angeles River to connect Atwater Village with Griffith Park and the Los Angeles River bikeway. This project is in the approval process with the City of Los Angeles and the USACE.

Burbank2035 General Plan

The City of Burbank recently updated its General Plan. Named *Burbank2035*, its goals and policies affect a wide range of issues including housing, traffic circulation and mobility, parks and recreation, resource conservation, and public safety. Although parts of the City's General Plan have been revised through the years, the Plan has not been comprehensively updated since the mid-1960s. In that time, both the City and the surrounding influences of southern California have experienced massive growth and environmental, physical, economic, social, and demographic changes. Due to the changing times, some community priorities have also shifted and evolved. An EIR for Burbank2035 has been certified as of 2013 (City of Burbank 2013c).

City of Los Angeles Proposition O

In November 2004, voters in the City of Los Angeles approved Proposition O, allowing the City to issue general obligation bonds to protect public health and meet the requirements of the Clean Water Act. In the Los Angeles River watershed, eight projects are designed to improve the quality of stormwater reaching the Los Angeles River, as well as providing open space, education opportunities, and recreation facilities.

5.14.2 Cumulative Impact Analysis

This section discusses the impacts of the alternatives when considered cumulatively with impacts of other past, present, and reasonably foreseeable future actions. The geographic scope for each resource is provided as part of the discussion.

Geology, Soils, and Seismic Hazards

The study area for cumulative impacts for this resource type includes the watershed of the River and its tributaries. The potential for cumulative impacts related to geology, soils, and seismic hazards is minimal under both the action alternatives and the No Action Alternative, since no significant issues related to these resources or hazards were identified for this project. Although most of the area within Reaches 1-8 is in a liquefaction zone, and the Raymond Fault is located within portions of Reach 5, the proposed action alternatives would not affect these features, and would not contribute to cumulative impacts related to past, present, or reasonably foreseeable future projects.

Soil erosion could occur due to the extensive amount of ground clearing and earthwork involved with construction of the project. However, the proposed channel restoration measures in the action alternatives would be required to meet modern construction criteria including stormwater pollution prevention, These criteria would also apply to cumulative projects in the study area; therefore, cumulative impacts would be considered less than significant.

Implementation of any of the alternatives would result in negligible impacts on sand and gravel deposits and underground oil and gas fields, so there would be no cumulative impacts on mineral resources expected with the project.

Air Quality

Due in part to the highly urbanized and dense areas, the SCAB currently does not meet all NAAQS or the equivalent California Ambient Air Quality Standards. With respect to the NAAQS, the SCAB is currently in extreme nonattainment for ozone (precursors: VOC or NOx); nonattainment for PM2.5; and partial nonattainment for lead. As noted in Section 5.2, the SCAQMD typically considers projects that exceed the RSTs to be cumulatively significant. This approach to assessing cumulative impacts was applied under both CEQA and NEPA. Estimated construction and operational emissions associated with all action alternatives would not exceed RSTs. Thus, construction and operational emissions would not result in significant cumulative impacts to air quality.

Land Use

The study area includes the applicable community plan areas within the jurisdiction of the City of Los Angeles proposed for restoration measures, as well as the Cities of Glendale and Burbank. These cities include policies generally supporting the restoration of the River in their General Plans and applicable community plans. The implementation of any of the alternatives would be consistent with the applicable general plans and community specific plans of these cities, with the exception of industrial land uses on several key sites. These general plans, as well as the land use plans by county and regional planning agencies such as the Southern California Association of Governments (SCAG), are addressing the River as an asset for the region along with its long-term and recognized importance for flood risk management, water quality, and fish and wildlife habitat. The City of Burbank recently prepared a comprehensive update of its General Plan, which addresses the impacts of cumulative projects, including this one, on transportation, utility, and public service expansions through the year 2035; therefore, none of the alternatives would contribute significantly to cumulative impacts in Burbank (City of Burbank 2013b, City of Glendale 2012e).

There would be no significant cumulative land use impacts with the No Action Alternative, since present land uses would continue in conformance with adopted community and general plans. Implementing the restoration measures within the reaches would result in significant impacts from converting industrial land uses to non-industrial uses. The degree of impact is most significant with Alternative 20, since the industrial land area affected is greatest, though impacts the other action alternatives would be significant as well. Impacts on industrial land use are a focused issue within Los Angeles and the applicable Community Plan updates as well. The viability of continued industrial uses in the vicinity of the study area is also an issue due to the age of some of these uses. Their continued operation may be subject to other factors independent of any change in land uses due to the proposed project or any other similar efforts in the area. Encroachment of other uses, including the Rio de Los Angeles State Park, poses the greatest challenge to the continued viability of adjacent and nearby industrial uses in this area. This could impact the City's efforts to maintain areas that provide an economic base for long-term employment and fiscal health, and would contribute to significant adverse cumulative land use impacts (City of Los Angeles 2012).

Hydrology, Floodplains, and Water Quality

The study area for hydrology, floodplains, and water quality includes the watershed of the River and its tributaries. Cumulative impacts to hydrology, floodplains, and water quality are expected to be beneficial under both the No Action Alternative and the restoration Alternatives. In addition to the various restoration measures in the action alternatives, other past, present, or reasonably foreseeable future projects include various master planning efforts by the Los Angeles County Department of Public Works and other local and regional agencies to develop comprehensive plans addressing hydrologic conditions, floodplains, and water quality from a regional perspective. These plans address hydrologic and water quality issues throughout Los Angeles County and in particular the various water courses and tributaries that eventually flow into the River. These collectively influence flood risk management and water quality issues within the River channel. Cumulative impacts related to floodplains would be beneficial since the implementation of these comprehensive plans favorably address floodplain and associated water release issues from various major and minor tributaries in addition to the main River channel.

Another beneficial cumulative impact would result from the various measures within the alternatives that would increase the riparian and native habitats. These measures would reduce the amount of impermeable surface area in the River channel. Vegetation features would help improve hydrologic conditions and water quality for cumulative projects located within and in the vicinity of the reaches, including the Rio de Los Angeles State Park, Griffith Park on the East Bank, Glendale Narrows Riverwalk, and the Albion Dairy Park (City of Los Angeles 2012; Los Angeles County 2006, 2012).

Biological Resources

The study area for biological resources includes the watershed of the River and its tributaries. The restoration measures in the action alternatives would contribute to beneficial cumulative impacts to biological resources. These impacts would increase the amount of fish and wildlife habitat; provide greater ecological/biological benefits; aid in linking isolated habitats; help increase the amount of open space; help expand species diversity; and reduce the amount of impermeable surface area in the study area. These impacts would be beneficial from a regional perspective since they would benefit fish and wildlife species that may migrate outside of the study area. These benefits would also accrue to past, present, and reasonably foreseeable projects including the Albion Dairy Park, Griffith Park on the East Bank, Sennett Creek Park, and the Rio de Los Angeles State Parks that are located along or in the vicinity of the River. These projects would be developed under the No Action Alternative as well, so cumulative impacts would continue to be beneficial.

Construction activities would require excavation of surface and sub-surface materials and the subsequent disposal of these materials. However, any cumulative adverse impacts to biological resources as a result of construction activities would be addressed through the implementation of BMPs and stormwater requirements of local and state agencies as well as the USACE. These measures would be implemented as part of any other planned or reasonably foreseeable developments within the study area, including the development of Taylor Yard, the Cornfields site, and the Albion Dairy Park. In conjunction with other habitat restoration efforts proposed or being planned in the area, including significant restoration efforts on Arroyo Seco and other projects under consideration by watershed groups and local agencies, these measures would have a significant, beneficial cumulative impact (City of Los Angeles, California Department of Parks and Recreation 2012).

Cultural Resources

The study area for cultural resources includes the area within and in the vicinity of the River channel as well as the areas proposed for development of cumulative projects identified above. Overall, the project will contribute to the ongoing transformation of the LA River and its associated infrastructure.

Past developments in the study area have resulted in the loss or destruction of the spatial integrity of prehistoric and historic archaeological resources through ground-disturbing activities. Paleontological resources may have been lost through excavation as well. Historic buildings and structures have been lost or impacted due to demolition, substantial alteration, neglect, or incompatible construction. The impacts of current and future cumulative actions in the study area that are not subject to extensive cultural or historic resource review or result from neglect or vandalism would continue whether the proposed restoration measures were implemented or not. Restoration measures may stimulate the adaptive reuse, rehabilitation, or restoration of adjacent historic buildings and structures, but associated economic development may encourage removal of historic buildings and structures or incompatible construction. However, much of the current and future development would be subject to Federal, state, and local reviews that include some level of consideration and protection for cultural and paleontological resources which would lessen these impacts.

The restoration measures, combined with cumulative developments in, and in the vicinity of, the study area would be conducted in the context of environmental and cultural resource compliance review as proscribed by Los Angeles, Glendale, and Burbank ordinance provisions as well as state and Federal guidelines and regulations for the identification, handling, and preservation of cultural resources. Development of cumulative projects, including Rio de Los Angeles State Park, and Los Angeles State Historic Park, has already been subject to these multi-jurisdictional provisions. Cumulative developments in the planning stage within and in the vicinity of the study area, including Albion Dairy Park, Sennett Creek Park, and Griffith Park on the East Bank, would be subject to these provisions as these parklands are developed. These provisions are designed to identify cultural and paleontological resources, assess impacts, and avoid adverse effects.

To the extent that other cumulative projects have caused or may cause cultural resource impacts, NEPA and CEQA require consideration of mitigation for significant cultural impacts. After application of the mitigation measures identified in Section 5.6, the cumulative impacts would be less than significant. With adoption of these measures, the project's contribution to the cumulative impact is rendered less than cumulatively considerable, and cumulative cultural resources impacts are less than significant.

Traffic and Transportation

The study area for traffic and transportation includes the highways, streets, railways, and transit corridors in Los Angeles County that serve both the project vicinity as well as the greater southern California region and beyond. Many elements of the current transportation network (past projects) are operating near or at their capacity. Current projects, including the expansion of I-5 in Burbank and Glendale, are addressing capacity and utilization requirements; however, long-term capacity is likely to lag behind projected population growth of the region and the lack of adequate space and faeilities to expand the network. Other current or reasonably foreseeable future projects in the study areas include a TEA-21 project to upgrade the southern terminus of SR-2 and Glendale Boulevard, and the $898 million Metro Gold Line Eastside Extension project. The added capacity of these transportation elements will help to offset temporary increases in construction-related traffic.

The restoration measures in the various alternatives, together with these past, present, and reasonably foreseeable future projects, would expand open space and parkland opportunities primarily serving a local population, and would not likely result in a significant cumulative impact to the regional transportation system (Metrolink 2012).

The restoration measures, combined with cumulative developments within the study area, could result in cumulative impacts to current and planned rail operations. Various commuter and passenger rail projects, such as the Metrolink's Metro Gold Line extension and the State-sponsored high-speed rail, include routes that overlap several project reaches. In addition, both Union Pacific and BNSF maintain both active rail lines and storage tracks along both sides of the River. These cumulative project efforts would occur either with the restoration measures or the No Action Alternative; therefore, cumulative impacts would be similar. These projects would be coordinated with Metrolink, SCAG, and other local and regional transportation agencies and private rail operators through the *Multi-County Goods Movement Action Plan* and similar regional planning efforts to ensure that any cumulative impacts would be less than significant.

Noise

Cumulative noise impacts typically occur when multiple projects affect the same geographic areas simultaneously or when sequential projects extend the duration of noise impacts on a given area over a longer period. Noise impacts are primarily localized because sound levels decrease relatively quickly with increasing distance from the source; therefore, the cumulative noise setting would be limited to the area subject to audible increase in noise levels with construction and development of cumulative projects. Cumulative noise impacts from implementing the proposed project, together with other reasonably foreseeable development activities in the study area, would result primarily from temporary construction activities. These construction activities would include several parks and recreation areas in the vicinity of the study area, including the Glendale Narrows Riverwalk, Sennett Creek Park, and the Albion Dairy Park. However, given the planned facilities for these parks and recreation areas, including trails, pathways, and small structures, construction activities would likely not necessitate use of heavy equipment for most activities. The potentially highest levels of cumulative noise impacts would take place if several development projects were to take place at the same time and be in fairly close proximity. However, these increases would be due to construction activities and would be temporary, and would be subject to local noise ordinance provisions from the Cities of Los Angeles, Glendale and Burbank. These ordinance provisions would be applicable to the cumulative projects under the No Action Alternative as well. Therefore, no significant cumulative adverse noise impacts would occur.

Recreation

The study area for recreation comprises the community plan areas of Los Angeles proposed for restoration measures, as well as the Cities of Glendale and Burbank. Implementation of any of the alternatives would contribute to cumulative beneficial recreation impacts for the residents of the study area. The restoration measures would increase riparian habitats that could present a recreation resource through attractive and aesthetic features both within and along the River channel. All communities in the study area have documented the need for more parks and open space in general plans and in various community plans. These planning efforts, including the development of the Rio de Los Angeles State park and the Los Angeles State Historic Park, have introduced new parklands along and adjacent to the River channel. Although these new parklands would continue to be developed under the No Action Alternative, the impact would be less beneficial without the comprehensive river parkland measures under the restoration measures. Additional planning efforts, including the *Boyle Heights Community Plan* update currently in progress, are addressing that neighborhood's need for additional parks and recreational opportunities along Reaches 7 and 8, where there is currently little land available for parks and recreation spaces or amenities. The restoration measures would occur in areas that could connect with reasonably foreseeable parklands that could be identified through the update of this Plan as well as future community plan updates (City of Los Angeles, 2012). In addition, recreation and open space amenities are identified within the vicinity of the River in the *Burbank 2035 General Plan*, and cumulative impacts of the restoration measures within Reach 1 in Burbank would result in beneficial cumulative impacts as well (City of Burbank 2013c).

Aesthetics

Implementation of any of the alternatives, combined with cumulative projects in Los Angeles, Glendale, and Burbank would result in cumulative beneficial impacts for aesthetic resources. These reasonably foreseeable future projects would result primarily in the conversion of older industrial and industrial-serving uses to open space uses within the study area comprising the community plan areas of Los Angeles and areas of Glendale and Burbank with River frontage proposed for restoration. These projects include the Rio de Los Angeles State Park, Los Angles State Historic Park, and improvements in the Glendale Bicycle Transportation Plan, and would result in new parklands, River access, bicycle and pedestrian paths, and landscaping features. Under the No Action Alternative, these projects would provide a beneficial cumulative impact to aesthetic resources. Combined with the LA River project, these projects would result in greater improvement to the aesthetic appearance of the study area and surrounding areas in the cumulative setting. In addition, the proposed project in itself and when combined with cumulative projects would not likely result in new sources of significant light or glare that would result in potential impacts. Therefore, the overall cumulative aesthetic impacts would be beneficial.

Public Health and Safety, Including Hazardous, Toxic and Radioactive Waste

The study area for public health and safety includes the River channel, and the immediate vicinity providing nearby or direct River access. Implementation of River restoration measures could result in less-than-significant potential cumulative impacts involving school safety, HTRW, methane zones, and infectious diseases associated with the project. However, because implementation of the River restoration measures and other reasonably foreseeable future parkland and recreation projects would increase the opportunities for the public to interact with the River, the cumulative risk of water-related injury could increase. This cumulative risk would be greatest with the development of parks and recreational activities with direct or nearby River access, such as Griffith Park on the East Bank, Sennett Creek Park, and the Glendale Narrows Riverwalk. Since these parks would be developed regardless of whether the restoration measures are implemented, the cumulative risks would be similar under a No Action Alternative. This risk would be greatest during and following seasonal flooding events. However, existing public health

and safety agencies in the Cities of Los Angeles, Glendale, and Burbank, including police, fire and other emergency services would be utilized to address any cumulative impacts to public health and safety.

Other large-scale projects in the region may remediate HTRW prior to construction, in addition to those efforts that the sponsor will ensure are completed to allow construction, operation and maintenance of the restoration project. In combination with remediation that would occur prior to construction for this project, significant beneficial impacts on the overall environment through less HTRW could occur.

Utilities and Public Services

The continued population and economic growth of Los Angeles, Glendale, Burbank, and the surrounding region requires commensurate growth in infrastructure and utility capacity. The study area, including the River channel and surrounding lands within the reach areas would continue to be used as a utility corridor and as a conduit for stormwater treatment and discharge. The increase in demand for power and telecommunications would likely result in the need for replacing, upgrading, and installing new transmission lines. Some of these replacements, upgrades, and installations would take place within the study reaches and would be in addition to, or parallel with, the movement of any lines required by expanding the river channel. These upgrades would occur under either the No Action Alternative or any of the restoration measures, and cumulative impacts would be similar. Implementation of any of the proposed alternatives would occur within areas primarily designated for open space and public facilities, and would not conflict with these upgrades or potential new facilities. Cumulative impacts would be addressed through various plans currently adopted or in progress, including the Greater Los Angeles County Integrated Water Resources Management Plan, Integrated Regional Water Management Plan, 2005 Urban Water Management Plan, Solid Waste Integrated Resources Plan, and related projects address long-term infrastructure and utility needs. These planning efforts would ensure that cumulative impacts associated with the restoration measures, and cumulative utility projects within the reaches and vicinity, are less than significant.

Socioeconomics and Environmental Justice

Under the No Action Alternative, no displacement of housing or industrial uses would occur and no significant impacts to socioeconomic and environmental justice would result.

Implementation of any of the alternatives would not result in the displacement of housing; however, all would result in the conversion of industrial land uses to open space and recreational land uses, resulting in a potential transfer of jobs and employment centers from the study area and vicinity. The study area comprises the community plan areas of Los Angeles including the applicable River reaches as well as the Cities of Glendale and Burbank. This conversion would be greatest with Alternative 20, due to the amount of industrial land at the LATC and Verdugo Wash sites identified for River restoration measures. However, it would occur with Alternatives 10, 13, and 16 as well due to the impacts at the LATC site. This, combined with present and reasonably foreseeable future projects including the Rio de Los Angeles State Park at the Taylor Yard site and the Los Angeles State Historic Park, would not result in significant cumulative socioeconomic impacts, nor would the combined projects be anticipated to result in significant cumulative impacts to environmental justice communities.

Cumulative impacts to children's health and safety are not anticipated to be significant. The restoration measures, combined with current and foreseeable recreation and rehabilitation projects by the Cities of Los Angeles, Glendale and Burbank, would enhance the River and its vicinity as a recreational resource for the surrounding community; this would have a net positive effect on minority and low-income populations as well as children's health and safety. Increased access to the River and enhanced recreational opportunities would also be consistent with recommendations from several groups that

advocate River enhancement measures as a means to unite various groups and populations and ameliorate environmental justice issues including minimal opportunities to access parks and other recreational facilities in neighborhoods dominated by minority and low-income populations, many of which are found along reaches in the study area. Present and reasonably foreseeable future projects in the study area, including the proposed project, could result in air quality and noise impacts due to the potential conversion of older industrial uses to open space uses. However, these impacts would primarily be due to construction, and would therefore be temporary. In addition, construction measures to address potential air quality and noise concerns, such as dust controls and adherence to local noise ordinances, would reduce any potential cumulative impact on environmental justice populations to a less than significant level. Furthermore, the same areas that would be affected during construction will receive a long-term benefit with the increased recreational amenities.

5.15 GROWTH-INDUCING IMPACTS

All of the proposed alternatives include efforts to provide additional environmental restoration. These are likely to decrease potential growth, rather than induce growth, since these lands would be converted to open space. The conversion of lands from high density uses to open space may have the effect of decreasing the potential for growth. Many restoration submeasures in are within marginal lands at the edge of the River or existing open space that can easily be converted to native habitat. Where larger-scale restoration measures are suggested such as at LATC, these measures would convert industrial and rail facilities into restored habitat and remove them from the potential of being developed into higher density commercial or industrial uses or converted into housing developments. Conversely, it is possible that large scale restoration would attract a greater number of residents to the surrounding areas, particularly as a result of the area becoming a desirable place to live due to its proximity to restored open space.

5.16 UNAVOIDABLE SIGNIFICANT ADVERSE IMPACTS

Table 5-47 Unavoidable Significant Adverse Impacts

Resource	Alternative 10 (ART)	Alternative 13 (ACE)	Alternative 13v	Alternative 16 (AND)	Alternative 20 (RIVER)
AIR QUALITY	The construction phase of the proposed project is expected to exceed the CEQA localized significance thresholds for NOx. This results in a significant unavoidable impact under CEQA. Impacts under NEPA would be less than significant.	Same as Alt 10.	Impacts under all air quality significance criteria would be less than significant.	Same as Alt 10.	Same as Alt 10.
LAND USE	Restoration in Reach 8 would conflict with the Industrial land use designation. This results in a significant adverse impact under NEPA and a significant and unavoidable impact under CEQA.	Same as Alt 10.	Same as Alt 10.	Same as Alt 10.	Same as Alt 10, additional impacts in Reach 3.

5.17 RELATIONSHIP BETWEEN SHORT-TERM USES OF THE ENVIRONMENT AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The National Environmental Policy Act (NEPA) (40 CFR 1502.16) requires that an EIS consider the relationship between short-term uses of the environment and the impacts that such uses may have on the maintenance and enhancement of long-term productivity of the affected environment. This section compares the short and long term environmental effects of the proposed restoration action. Overall, the proposed restoration project would provide minor and temporary short-term losses, while resulting in significant beneficial impacts to the long-term productivity of the affected area.

The period of construction of the proposed project represents the cause of short-term impacts. These temporary and minor impacts or losses are considered non-significant and will include increases in noise, disruption to traffic and recreation in the area, demolition of existing features, removal of materials, reduction in air, water, and aesthetic quality, and disturbance to biological resources. Significant adverse impacts that will occur during construction include the exceedance of air quality thresholds. Long-term adverse impacts will also result from the project, once the construction period is complete. These impacts will result entirely from the proposed transformation of LATC from its current industrial use condition to a restored historic wash condition. The long-term adverse impacts include the permanent loss of industrial land uses at LATC, the permanent closure of railroads and the resulting loss of rail capacity at LATC, and the loss of working class employment within the LATC neighborhood where minority and low-income populations will be disproportionately affected by that loss.

Long-term beneficial impacts will result from the restoration of the aquatic, wetland, and riparian habitats within the Los Angeles River. Additional in water habitat will provide greater habitat for fish and wildlife in the area, as well as provide other cumulative benefits, such as water attenuation for flood abatement, and aesthetic improvements. Daylighting streams will create new wetland habitat and removing non-native vegetation and replacing it with native plants will further increase fish and wildlife habitat. Secondary long-term benefits of restoration efforts will include improvements to aesthetic quality, air quality, water quality, recreation access and availability, and to those populations that do not have equal availability of recreational opportunities. Ecological restoration will provide a significant and long-term improvement in the condition of the River for the native wildlife populations that once occurred, and in doing so, will enhance the well-being of the human population that surrounds the River. These long-term benefits have been envisioned and designed to outweigh the short-term adverse impacts that are necessary to achieve the restoration goals.

5.18 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

The irreversible environmental changes that would result from implementation of the proposed projects involve the consumption of material resources, energy resources, and human resources that affect the sustainability of resource use in future generations. The use of these resources is considered to be permanent because the use or destruction of the resource cannot be replaced within a reasonable timeframe.

Overall, the proposed action would result in the use of materials, energy, and human resources that would be irreversible and irretrievably lost. Losses would include those from materials demolished, fill material removed, vegetation uprooted, energy resources utilized, and labor hours spent. Levels of significance of these losses, both adverse and beneficial, are described in further detail in subsequent paragraphs. For all of the alternatives proposed, a variety of materials in place within the study area would be demolished, removed, or altered in a way that would result in their irretrievable loss. This loss would be offset in part by the reuse of materials where possible. For example, it may be feasible to utilize

demolished concrete as bank protection where new channel or side channel features are implemented. Transfer of non-reusable materials for disposal will also create irretrievable losses as landfill capacity is occupied. Alternatives increase in footprint with increasing number (10, 13, 16, 20) and consequently, a greater amount of materials will be removed for each alternative. See Appendix C for a complete description of material volume to be removed or demolished for each alternative.

Materials used for construction would also be irretrievably lost, as they would no longer be available for other projects. This includes all materials noted in Appendix C, again with increasing commitments with each alternative. In addition, use of water for dust abatement will be irretrievable. These needed materials are not in short supply and would not limit other unrelated construction activities. The land itself will be committed to the selected restoration alternative and unavailable for use in future project. However, the River channel is already committed as a Federal project for flood reduction and management and cannot be otherwise apportioned.

Energy resources used would include fuels and electricity, which would be utilized during construction and continue to be used during operation of the channel and maintenance of restoration elements. These uses would constitute an irretrievable loss of energy. However, consumption of energy would not place a significant demand on energy in the region.

Use of human resources during construction would be an irreversible loss of labor supply for other projects. However, labor opportunities are desired in the study area and this use of human resources represents beneficial employment opportunities. Transfer of industrial land uses into recreational land uses represents an irreversible loss of employment opportunities in the downtown industrial area of Los Angeles for all alternatives, while Alternative 20 represents an additional loss of industrial land uses and opportunities within the Verdugo Wash vicinity.

Vegetation that would be altered would be irretrievably lost, though this is a designated objective of the restoration project in many portions of the study area. The irretrievable loss of non-native and invasive vegetation is a preferred outcome. In other areas, loss of vegetation due to construction will be remedied with revegetation efforts. Biological resources will be protected from irretrievable loss through construction management BMPs and site surveys conducted prior to groundbreaking.

Construction and operation of the selected alternative would result in the loss of cultural resources that are ineligible for listing on the NRHP or the CRHP. While not significant, the loss of these sites would constitute an irreversible and irretrievable commitment of a resource. The resources would be recorded and the information would be incorporated into agency and statewide data repositories. Impacts to resources eligible for listing on the NRHP or the CRHP would be avoided and minimized as outlined in the PA and when necessary mitigated as prescribed in the HPTP. However, a site's full data potential can never be fully retrieved. Similarly, impacts to historic properties eligible under Criteria A-C, such as the flood control structures, cannot be completely mitigated. Residual, less than significant impacts would remain resulting in an irreversible and irretrievable commitment of a resource.

6 COMPARISON OF ALTERNATIVE PLANS

The comparison of the final array alternative plans is used to assist in the identification of the National Ecosystem Restoration (NER) Plan and the recommended plan.

As part of the planning process, the USACE identifies the NER Plan. As described in USACE planning guidance, the NER Plan is the alternative and scale having the maximum monetary and non-monetary beneficial effects over monetary and nonmonetary costs. This plan occurs where the incremental beneficial effects just equal the incremental costs, or alternatively stated, where the extra environmental value is just worth the extra costs. The guidance also notes that in all but the most unusual cases, the NER Plan should be derived from the final set of "Best Buy" solutions. To put it simply, the USACE and City have to answer the question about whether the plan's benefits are worth the costs, but this is a difficult process because monetary calculations do not capture all ecosystem benefits. Environmental benefits analysis is still developing as an area of study. Therefore, other comparisons between ecosystem benefits are provided within this chapter as well.

This section provides a comparison of the final array of alternatives that were described in Section 4. As described in that section, the final array in the Draft IFR consisted of the "No Action" alternative and 4 action alternatives. In this Final IFR, a variation on Alternative 13, referred to as 13v, includes substituting the Reach 7 plan from Alternative 20 is also evaluated as part of the final array. This variation is within the spectrum of alternatives analyzed in the Draft IFR. This variation was identified through further cost analysis subsequent to the circulation of the Draft IFR as described in Section 6.6.3 and has been integrated into the comparison of plans below as appropriate.

As noted in Chapter 4, there is a significant cost difference among the alternatives in the final array. The results of the CE/ICA for the final array of alternatives also show significant increases in the incremental cost per habitat unit among alternatives. The environmental outputs and the CE/ICA are one measure of the merits of the alternatives that must be weighed against other evaluation criteria. As part of the 6-step planning process, alternatives are compared against the No Action Alternative as well as each other. This section describes how the NER Plan was identified. This section also includes additional analysis to confirm or change that selection. The details of each alternative were independently described in previous chapters and will be compared in this step.
In each evaluation step, the significant contributions or effects of each individual plan are quantified and judged. The further comparison and evaluation of alternatives considers each plan's effects on:

- Project Objectives
- Project Constraints
- Policy Issues
- National Objectives and the Four Accounts
    - National Economic Development
    - Environmental Quality
    - Regional Economic Development
    - Other Social Effects
- Principles and Guidelines Criteria
    - Completeness
    - Efficiency
    - Effectiveness
    - Acceptability

Sections 6.1 and 6.2 compare the alternatives, including updates to address the variation on Alternative 13, with respect to objectives (6.1) and policy issues, risks, and constraints (6.2).

Section 6.3 addresses the four accounts. Section 6.3.1 provides the NED analysis associated with the recreation plans that are compatible with ecosystem restoration for the NER Plan and Recommended Plan. Section 6.3.2 provides the Environmental Quality account comparison, including the effects analysis from Section 5. Section 6.3.3 and 6.3.4 present the RED and OSE analysis used in the Draft IFR.

Sections 6.4 and 6.5 show the cost comparison and analysis used in initially identifying the NER Plan and Tentatively Selected Plan in the Draft IFR as Alternative 13. Section 6.6 then describes the public and Independent External Peer Review comments received on the Draft IFR, explains the additional analysis and comparison in this Final IFR utilized to refine the NER plan with the variation on Alternative 13, and identifies the request and grant of permission to recommend Alternative 20 for authorization.

The updated costs associated with Alternative 13v are provided in Chapter 7 and compared to Alternative 20. They are not comparable to costs reported for the Draft IFR because the updated costs are based on 2015 price levels, a full Cost Schedule Risk Analysis (CSRA), and updates to LERRD costs through more detailed analysis. The RED analysis for Alternative 13v is presented in Chapter 7 and compared to Alternative 20.

6.1 FINAL ARRAY COMPARISON BY PROJECT OBJECTIVE

The planning objectives for this study, described in detail in Section 4, are summarized below.

1. Restore Valley Foothill Riparian Strand and Freshwater Marsh Habitat: Restore Valley Foothill Riparian wildlife habitat types, aquatic freshwater marsh communities, and native fish habitat within the ARBOR reach throughout the period of analysis, including restoration of supporting ecological processes and biological diversity, and a more natural hydrologic and hydraulic regime that reconnects the river to historic floodplains and tributaries, reduces velocities, increases infiltration, and improves natural sediment processes.

2. Increase Habitat Connectivity: Increase habitat connectivity between the river and the historic floodplain, and increase nodal connectivity for wildlife between restored habitat patches and nearby significant ecological zones such as the Santa Monica Mountains, Verdugo Hills, Elysian Hills, and San Gabriel Mountains within the ARBOR reach throughout the period of analysis.

3. Increase passive recreation: Include recreation that is compatible with the restored environment in the ARBOR reach throughout the period of analysis.

Table 6-1 and Table 6-2 below include information pertaining to performance criteria for the two objectives related to ecosystem restoration and describe how each meets the criteria. Each is ranked from 1 to 4 with 4 being the highest. A zero is given if there is no value added for that objective target. The third objective related to recreation is described in the recreation plan analysis in Section 4.16, with further analysis provided in Section 6.3.

Table 6-1 Objectives Performance Criteria Analysis of Final Array for Objective 1

OBJECTIVE 1: RESTORE VALLEY FOOTHILL RIPARIAN AND FRESHWATER MARSH HABITAT					
	Analysis of Target Objective by Alternative[1]				
Target Objective	**Alt 10 (ART)**	**Alt 13 (ACE)**	**Alt 13v**	**Alt 16 (AND)**	**Alt 20 (RIVER)**
Removal and management of invasives to less than 10 percent within 5 to 7 years post-construction of each feature. Includes both proposed restoration features and existing habitat in soft bottom reaches during construction and adaptive management.	1-Provides invasives management in 528 acres	2-Provides invasives management in 588 acres	2-Provides invasives management in 598 acres	3-Provides invasives management in 659 acres	4-Provides invasives management in 719 acres
For Valley Foothill Riparian Habitat:					
Restore structurally diverse riparian habitat consisting of herbaceous (e.g. herbaceous vine cover), shrub (e.g. shrubby willow thicket), and tree (e.g. mature cottonwood-willow trees) layers in a minimum of five reaches resulting in 3 contiguous reaches. Restore riparian habitats with a varying number of structural layers (one, two, and three layers) to support survival and reproductive requirements for riparian obligate and transient wildlife species, including food, water, shelter, breeding, migration, and dispersal (Knueper, 1995).	1-Restores eight contiguous reaches, 528 acres providing a net increase of 93% in habitat or 5321 habitat units	2-Restores eight contiguous reaches, 588 acres providing a net increase of 104% in habitat or 5902 habitat units	2-Restores eight contiguous reaches, 598 acres providing a net increase of 106% in habitat or 5989 habitat units	3-Restores eight contiguous reaches, 659 acres providing a net increase of 114% in habitat or 6509 habitat units	4-Restores eight contiguous reaches, 719 acres providing a net increase of 119% in habitat or 6782 habitat units
Restore a minimum of 2 aquatic habitat nodes with a natural hydrologic connection to the river and riparian communities with a minimum distance of 150 meters from the water's edge to create areas capable of functioning as core habitat and refuge for native reptiles and amphibians (Semlitsch and Bodie 2003) and to minimize the risk of localized extinction due to natural disasters (IE flood, fire, drought) (Schippers et al. 1996; Dunning et al. 1995).	1- Restores 1 aquatic habitat node with natural hydrologic connection and width of 150 meters in reaches 6	2- Restores 2 aquatic habitat node with natural connection and width of 150 meters in reaches 6 and 7 (Arroyo Seco) providing 309% more nodal connections than Alternative 10.	2- Restores 2 aquatic habitat nodes with natural connection and width of 150 meters in reaches 6 and 7 (Arroyo Seco) providing 33% more nodal connections than Alternative 13 with the addition of the Cornfields node	3-Restores 3 aquatic habitat nodes with natural hydrologic connections and a width of 150 meters in reach 6, 7 and 8 providing 39% more nodal connections than Alternative 13v	4- Restores 4 aquatic habitat nodes with 4 natural hydrologic connections and a width of 150 meters in reach 3. 6, 7 and 8 providing 120% more in nodal connections than Alternative 16
Within 5-10 years of construction, restore and maintain dense, structurally diverse riparian habitat sufficient to maintain survival and reproductive needs of wildlife. Restore a minimum of one habitat node with a minimum width of 250 meters (820 feet) to support high frequencies of the Federally endangered least Bell's vireo (Kus 2002).	3-Restores one reach with strand widths of at least 250 meters (820 feet)	3-Restores one reach with strand widths of at least 250 meters (820 feet)	3-Restores one reach with strand widths of at least 250 meters (820 feet)	3-Restores one reach with strand widths of at least 250 meters (820 feet)	4-Restores two reaches with strand widths of at least 250 meters (820 feet)
For Freshwater Marsh and Fish Habitat:					
Restore functioning freshwater marsh habitat consisting of emergent herbaceous vegetation (i.e., cattails, rushes, sedges) adapted to saturated soil conditions.	1-Fourteen acres restored in 15 daylighted streams and in widened area of Taylor Yard	2-Twelve acres restored in 12 daylighted streams and 21 additional acres in Reach 6 to Taylor Yard	1-Fifteen acres restored in 15 daylighted streams, 21 additional acres in Reach 6 to Taylor Yard, and 10 acres in Reach 7	3-Twelve acres restored in 12 daylighted streams, 27 acres added in Reach 5, 21 additional acres in Reach 6 to Taylor Yard, 44 acres in LATC	4-Thirteen acres restored in 13 daylighted streams,20 acres in Reach 27 acres added in Reach 2, 10 acres in Reach 3, Reach 5, 21 additional acres in Reach 6 to Taylor Yard, 10 acres in Reach 7, 44 acres in LATC
Restore aquatic habitat to support survival and reproductive requirements for fish and wildlife species, including food, water, shelter, breeding, migration, and dispersal.	1-Minimal main stem restoration of aquatic habitat in Reach 6, 138 acres	2-In addition to Alt 10, increase in main stem aquatic habitat in Reach 6, 17 acres	2-In addition to Alt 10, increase in main stem aquatic habitat in Reach 6, 17 acres	3-In addition to Alt 10, increase in main stem channel aquatic habitat in Reaches 5, 6 and 8 – 27, 38, and 44 acres respectively	4-In addition to Alt 10, increase in channel aquatic habitat in Reaches 2, 5, 6 and 8 – 17, 27, 38, and 44 acres respectively *_Reach 2 did not count entire area between Victory and Freeway, not as much restoration_
For a More Natural Hydrologic and Hydraulic Regime:					
Expansion of the River into at least one large, contiguous river adjacent area within the study area that promotes hydrologic connections to the floodplain and overbank areas.	1-Minimal restored hydrologic connection Reach 4 Griffith Park side channel & Los Feliz seasonal flooding, Reach 6 to Taylor Yard	2-Increased restored hydrologic connection in Reach 6 to Taylor Yard and Reach 3 side channel, in addition to Alt 10 connections	2-Increased restored hydrologic connection in Reach 6 to Taylor Yard and Reach 3 side channel, in addition to Alt 13 connections	3-Increased restored hydrologic connection in Reach 8 to LATC in addition to Alt 13 connections	4-Increased restored hydrologic connection in Reach 3 Verdugo Wash
Widen channel to accommodate meandering of the River in at least one reach	1-Widens channel by approximately 24 feet in Reach 6	2-Widens channel to approximately 544 feet in Reach 6, modification of Arroyo Seco confluence in Reach 7	2-Widens channel to approximately 544 feet in Reach 6, modification of Arroyo Seco confluence in Reach 7 and Reach 7 LA State Historic Park terracing into river	3-Reach 5 is widened approximately 24 feet x 1.6 miles by modification of channel walls from trap to vertical and terracing of left bank, and Reach 8 includes terracing on the right and left banks upstream and downstream of LATC and channel widening in channel 500 feet and on a bench in LATC of 1,000 ft in addition to Alt 13	4-Reach 2 is widened approximately 24 feet by converting right bank from trapezoidal to vertical, in addition to Alt 16 changes and Reach 7 LA State Historic Park terracing into river as in Alt 13v

Table 6-1 Objectives Performance Criteria Analysis of Final Array for Objective 1

OBJECTIVE 1: RESTORE VALLEY FOOTHILL RIPARIAN AND FRESHWATER MARSH HABITAT					
	Analysis of Target Objective by Alternative[1]				
Target Objective	**Alt 10 (ART)**	**Alt 13 (ACE)**	**Alt 13v**	**Alt 16 (AND)**	**Alt 20 (RIVER)**
Connect river hydrologically (assisted or naturally) to overbank with at least one such connection per reach	1-Daylights 15 small tributary streams and adds two side channels, adds a minimal amount of restored natural riverbed in Reach 6 with some terracing, historical wash in Reach 8	2-Daylights 12 small tributary streams, terraces and widens significantly in Reach 6, in addition to Alt 10	2-Daylights 15 small tributary streams, terraces and widens significantly in Reach 6, adds terracing in LA State Historic Park in Reach 7 in addition to Alt 10	3-Daylights 12 small tributary streams, Reaches 8, widens minimally in Reach 5, terraces in Reaches 5, and 8, and adds 3 side channels historical wash in Reach 8 in addition to changes in Alt 13	4-Daylights 13 small tributary streams, Verdugo Wash confluences, widens minimally in Reach 2, adds terracing in LA State Historic Park in Reach 7 in addition to changes in Alt 16
Within the main stem of the river, when increasing vegetation, target velocity should be less than 12 ft/s and ideally 8 ft/s	3 - Velocities >12ft/s existing within Reach 6. All other Reaches have velocities within the target range. -	2- Velocities >12ft/s existing within Reach 6. All other Reaches have velocities within the target range.	2 - Velocities >12ft/s existing within Reach 6. All other Reaches have velocities within the target range-	2- Velocities >12ft/s existing within Reaches 5 and 6. All other Reaches have velocities within the target range	4-Velocities >12ft/s existing within Reaches 5 and 6. All other Reaches have velocities within the target range
Restore seasonal overbank flooding to river adjacent areas for sustainability of habitat and natural ecological, hydrologic processes	2-Minimal seasonal overbank flooding on terracing in Reach 6	2-Minimal seasonal overbank flooding on terracing in Reach 6	2-Minimal seasonal overbank flooding on terracing in Reach 6	3-Minimal seasonal overbank flooding on terracing in Reaches 5, and 6	4-Increasing overbank flows in greater area in Reach 6 and 8, and on terracing in Reaches 2, 5, 6, and 8

1 **Table 6-2 Objectives Performance Criteria Analysis of Final Array for Objective 2**

OBJECTIVE 2: INCREASE HABITAT CONNECTIVITY					
	Analysis of Target Objective by Alternative[1,2]				
Target Objective	**Alt 10 (ART)**	**Alt 13 (ACE)**	**Alt 13v**	**Alt 16 (AND)**	**Alt 20 (RIVER)**
Restoration of riparian and wetland aquatic wildlife habitat at tributary confluences to create connectivity to similar upstream habitats on the tributaries with ultimate nodal connection to the aquatic habitats in the San Gabriel and Verdugo Mountains (at least one major tributary connection should be restored.)	0-No connection	3-Reconnection hydrologically with Arroyo Seco	3-Reconnection hydrologically with Arroyo Seco	3-Reconnection hydrologically with Arroyo Seco	4-Reconnection hydrologically with Arroyo Seco and Verdugo Wash
Restore habitat corridors between large nodes in the ARBOR area to maximize connectivity for wildlife movement and dispersal on the local scale and minimize the risk of habitat sinks in an urban environment (Hilty et al. 2006, Hanski & Thomas 1994, Rudd 2002, Noss 1983), and to provide opportunities for regional wildlife movement	0-no habitat corridors created between nodes	2-connection created between Taylor Yard (Reach 6) and Arroyo Seco (Reach 7)	2-connection created between Taylor Yard (Reach 6) and Arroyo Seco (Reach 7)	3-connections created between Taylor Yard (Reach 6), Arroyo Seco (Reach 7), and LATC (Reach 8)	4- connections created between Verdugo Wash (Reach 3), Taylor Yard (Reach 6), Arroyo Seco (Reach 7), and LATC (Reach 8)
Restoration of wildlife habitat on channel banks	1-Restores 12 acres of habitat on channel banks	2-Restores 54 acres of habitat on channel banks	2-Restores 64 acres of habitat on channel banks	3-Restores 95 acres of habitat on channel banks	4-Restores 105 acres of habitat on channel banks
Improved aquatic-habitat connectivity within the ARBOR area through restoration of habitat nodes with wetland and riparian habitat that are naturally hydrologically connected to the river corridor upstream and downstream of the Glendale Narrows. (Rudd et al. 2002)	0-No Nodal Connectivity upstream or downstream of the Glendale Narrows	2-Increased Nodal Connectivity of 309% over Alt 10	2-Increased Nodal Connectivity of 33% over Alt 13	3- Increased Nodal Connectivity of 39 % over Alt 13v	4- Increased Nodal Connectivity of 120 % over Alt 16
Lengthen the extent of contiguous vegetated pathways for reptile and small/medium mammal movement (currently limited to Reaches 4 to 6, to achieve upstream and/or downstream connections to at least one additional tributary or open space area that is currently isolated from the soft-bottom reach. This may be achieved by either in-channel or side-channel vegetated corridors.	Reaches 1-6	Reaches 1-8	Reaches 1-8	Reaches 1-8	Reaches 1-8
Reconnect hydrologically with at least one main tributary-Confluence restoration provides an improved hydraulic connection to the LA River. Widening or laying back the side slopes adds capacity. Removal of concrete sides slopes and/or inverts allow establishment of vegetation which reduces velocities, increases infiltration, and improves the natural sediment processes.	0-No connection	3-Reconnection hydrologically with Arroyo Seco	3-Reconnection hydrologically with Arroyo Seco	3-Reconnection hydrologically with Arroyo Seco	4-Reconnection hydrologically with Arroyo Seco and Verdugo Wash

OBJECTIVE 2: INCREASE HABITAT CONNECTIVITY					
	Analysis of Target Objective by Alternative[1,2]				
Target Objective	**Alt 10 (ART)**	**Alt 13 (ACE)**	**Alt 13v**	**Alt 16 (AND)**	**Alt 20 (RIVER)**
Ideally, the alternatives will also achieve the following:					
Expansion of riparian and wetland wildlife habitat into large, contiguous river adjacent lands within the study area to support higher abundance of wildlife and more significant nodal connections to nearby ecological zones. Connections to Santa Monica Mountains created through Headworks, Ferraro Fields, and side channels.	1-Restores 202 acres of habitat on river adjacent and contiguous areas	2-Restores 207 acres of habitat on river adjacent and contiguous areas	2-Restores 207 acres of habitat on river adjacent and contiguous areas	3-Restores 234 acres of habitat on river adjacent and contiguous areas	4-Restores 234 acres of habitat on river adjacent and contiguous areas
Include Reach 7 to provide nodal connections to San Gabriel Mountains via Arroyo Seco confluence and/or other smaller tributaries and to provide potential for future direct connections to the mountains via other projects upstream on Arroyo Seco.	0-Does not include Arroyo Seco watershed connections	4-Iucludes Arroyo Seco confluence restoration	4-Includes Arroyo Seco confluence restoration	4-Includes Arroyo Seco confluence restoration	4-Includes Arroyo Seco confluence restoration

1 Rating from 1 to 4, with 4 being highest. A zero is given if there is no value added for that objective target.

2 Percent increase in nodal "connectedness" was performed based on the sizes of habitat nodes in the study area and the minimum distance of vegetated corridors between nodes (Rudd et al. 2002). "Connectedness" was calculated based on the size of habitat nodes with natural hydrologic connections to the river and the length of natural habitat corridors between them. Restoration of large nodes that are close together, connected by natural habitat corridors, increase the level of "connectedness". For each alternative in the final array, additional nodes and/or corridors are restored, increasing the level of "connectedness" in the project area.

6.1.1 Use of CHAP to Assess Alternatives by Restoration Objective

USACE Guidance on the objective of Civil Works ecosystem restoration (ER 1105-2-100) states, "Restored ecosystems should mimic, as closely as possible, conditions which would occur in the area in the absence of human changes to the landscape and hydrology. Indicators of success would include ... the ability of the restored area to continue to function and produce the desired outputs with a minimum of continuing human intervention." Guidance goes on to state "Restoration projects should be conceived in a systems context ... in order to improve the potential for long-term survival as self-regulating, functioning systems. This system view will be applied both in examination of the problems and the development of alternative means for their solution. Consideration should be given to the interconnectedness and dynamics of natural systems...." (USACE 2000).

The habitat model (CHAP) outputs as described in Section 4.9 and CE/ICA analysis as described in Section 4.11 were utilized to compare the ecosystem benefits of the alternatives under consideration. Results of the incremental analysis must be synthesized with other decision-making criteria. IWR Report 95-R-1, Evaluation of Environmental Investments Procedures Manual describes that "In some cases, the economic and environmental models used to estimate the effects of environmental restoration plans are not capable of capturing the full range of such effects. The models may be incapable of accounting for all considerations that impact upon the decision process. For example, concerns about endangered species, support by a local sponsor or other interest group, cost sharing arrangements, and other factors may lead to the continuing consideration and selection of solutions that may not be the most cost effective, or that may incur substantial incremental costs.

CHAP was the primary tool used to assess habitat value restored by the study alternatives. The HU output measured habitat value as described in Section 4.9, but did not distinguish the value of in-channel habitat and natural hydrologic connectivity. Equal weight was given to in channel habitat and out of channel habitat. In-channel habitat and natural hydrologic connections support sediment and nutrient exchange with floodplain habitats, and in-channel restoration is only possible by providing additional area for the river to naturally meander and widen. Widening of the river channel does not just seek to restore habitat and hydrologic connectivity along the river but to: "restore significant structure, function and dynamic processes that have been degraded" (EP 1165-2-501) and to partially "reestablish the attributes of a naturalistic, functioning, and self-regulating system" (EP 1165-2-502). Restoration of a more natural hydrologic regime and connections between the river and historic floodplain also removes barriers (such as concrete or high overbank elevations) which supports wildlife movement for a greater variety of species. The HU output also did not fully capture habitat nodal connectivity within the study area and regionally. Restoration of habitat patches and vegetated corridors to link them improves connectivity for the movement of wildlife within the study area and to nearby ecological areas by reducing habitat fragmentation, restoring corridors, and removing barriers. Section 6.1.2 provides the analysis used to further compare restoration of natural hydrologic function and habitat connectivity. Section 6.1.3 provides additional quantitative comparison of habitat connectivity in response to concerns from the public and a recommendation from the IEPR panel to more fully quantify connectivity benefits, as described in 6.1.2 and 6.1.3 below.

6.1.2 Comparison of Restoration of Natural Hydrological Function and Habitat Connectivity

A comparison was performed for the final array of alternatives to assess their responsiveness to the hydrologic restoration component of Objective 1 and habitat connectivity in Objective 2. This provides a comparison of the factors not captured by the CE/ICA results necessary to support NER plan selection.

A comparison of restoration habitat connectedness was performed based on the sizes of habitat nodes in the study area and the minimum distance of vegetated corridors between nodes (Rudd et al. 2002). "Connectedness" was calculated using equations found in Rudd et al. 2002, which was measured based on the size of habitat nodes with natural hydrologic connections to the river and the length of natural habitat corridors between them. This is based on the knowledge that in order for wildlife to move through a landscape they need large patches of habitat to support resources for survival (foraging, resting, breeding, "live-in" habitat) and accessible vegetated corridors to allow for movement between the habitat patches. Restoration of large nodes that are close together, connected by natural habitat corridors, increase the level of "connectedness".

The direct natural hydrologic connections between the river and historic floodplain would occur in the final array at Taylor Yard in all four alternatives in the Draft IFR (with less acres of habitat in Alternative 10), LATC (Alt 16, 20), Arroyo Seco (Alt 13, 16, 20), and at Verdugo Wash (Alt 20). These direct hydrologic connections, where the river/tributary can spread and naturally meander into the adjacent floodplain and establish riparian and wetland habitat, provide the most natural habitat connections and the best opportunities for wildlife movement between the river and the historic floodplain. Assisted hydrologic connections, where water is fed to the historic floodplain sites via culverts (i.e. Ferarro Field, Griffith Park, Pollywog Park, Los Feliz Golf Course, LATC (Alt 13)), can support riparian and wetland habitat and create habitat connectivity by increasing the amount and availability of resources (food, shelter, nesting habitat) within the historic floodplain, where it is currently extremely limited to "soft-bottom" portions of the channelized river. This habitat would attract and could support higher populations of wildlife that are now limited to the scarce riparian habitat in the river channel. However, movement to and from these floodplain sites with assisted watering would be more limited to birds and other small wildlife that would not be hindered by using culverts or climbing channel walls to reach the river adjacent habitat. As stated previously, a variation the Alternative 13, substituting the Reach 7 plan from Alternative 20 is also evaluated. This variation is within the spectrum of alternatives analyzed in the Draft IFR. Comparisons for Alternative 13 for reaches 1- 6 and 8 is the same for Alternative 13v and comparisons for reach 7 in Alternative 20 apply to reach 7 for Alternative 13v.

The comparison of local and regional habitat connectivity and the nature of the hydrologic regime (natural vs. assisted) to support ecosystem functioning and wildlife movement is discussed for the final array of alternatives below. It includes a comparison of restoration of a more natural hydrologic and hydraulic regime with increased connectivity to the floodplain. It also includes evaluation of local habitat connectivity within the study area. Restoration of connectivity to the floodplain and local habitat connectivity would improve movement opportunities for native fish, including arroyo chub and Santa Ana sucker, as well as riparian obligate bird species, including the least Bell's vireo, yellow warbler, and yellow breasted chat, seasonal migrants, amphibians, reptiles, and mammals, possibly including larger carnivores such as coyote and bobcat. This comparison also evaluates opportunities for connectivity over longer distances to regional significant ecological zones. Restored regional habitat connectivity is expected to improve movement opportunities for larger mammals including coyote and bobcat. The two comparisons for hydrologic and habitat connectivity are provided together as they are closely linked.

Interactions with Surrounding Environments

The project has been designed to widen the channel where feasible, which will provide space to accommodate slower flows and restored habitat.

The restored habitat will continue to be flanked by highly urbanized areas. This may have negative effects on the restoration area in the form of trash, human intrusion and trampling, and invasion by non-native weeds. However, implementation of OMRRR requirements for invasives management and implementation of the Recreation Plan, which will designate trails for human use, will lessen these effects

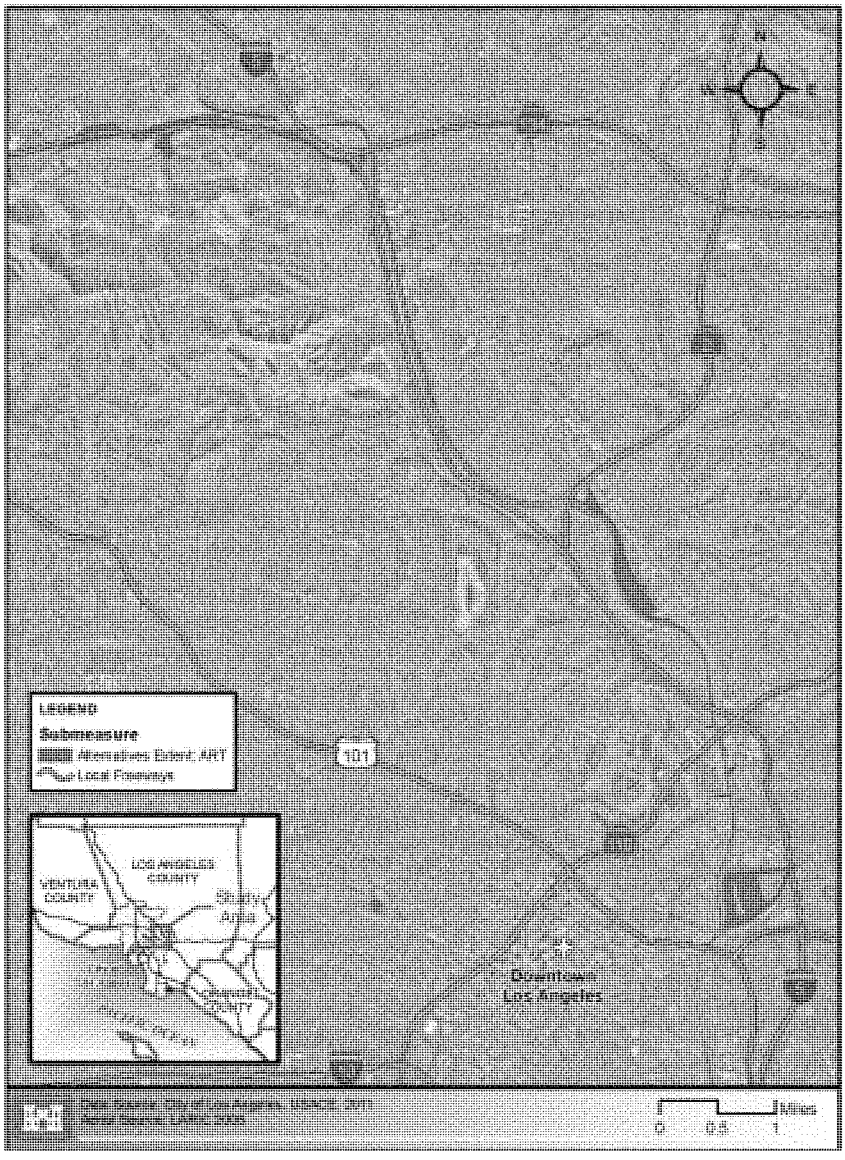
from the surrounding environment. Restoration in a highly urbanized area provides the benefits of improving nodal connectivity for wildlife. Where habitat is extremely scarce, addition of patches of habitat in an urban setting provides opportunity for both resident and migrating wildlife to live in and move through the landscape, providing refuge, improving transfer of genetic material, reducing inbreeding depression, and promoting increased biodiversity.

Semi-natural areas outside the riparian corridor may serve as buffers against the urban environment, as well as contribute to movement of wildlife to and from other significant regional habitat. Certain areas may support non-natives that could intrude upon the restored area; however, OMRRR within the project area would help address this effect.

Alternative 10

Alternative 10 consists of a corridor of 528 acres along the approximately 11-mile stretch proposed for restoration on the LA River. The plan consists of restoring valley foothill riparian wildlife habitat, freshwater marsh aquatic habitat, and native fish habitat (though currently native fish no longer exist in the Study area). Alternative 10 has the least cost of the four proposed plans in the final array and minimally meets planning objectives.

Alternative 10 (Figure 6-1) restores a natural hydrologic connection between the River and the historic floodplain at the Taylor Yard Site in Reach 6, which re-establishes lost functions and supports more sustainable habitat in that area. This restoration at Taylor Yard establishes a large node of historic valley foothill riparian and marsh habitat adjacent to the River corridor. The habitat at Taylor Yard is then connected to other habitats currently existing within the river channel in the Glendale Narrows (Figure 6-2). Connectivity to other restored habitat in the Study area is more limited by the overbank locations (i.e. Ferraro Fields, Los Feliz golf course) and assisted watering in those areas.



1 **Figure 6-1 Alternative 10 Footprint Map**

1 **Figure 6-2 Alternative 10 Local Habitat and Hydrologic Connectivity**

Restoration of habitat in Reaches 1, 2, and 3 provides regional habitat connections to Griffith Park, leading to the greater Santa Monica Mountains and the Pacific Ocean (Figure 6-3). Additional opportunity for connection in this area may exist via the USACE's on-going Headworks Ecosystem Restoration Study.

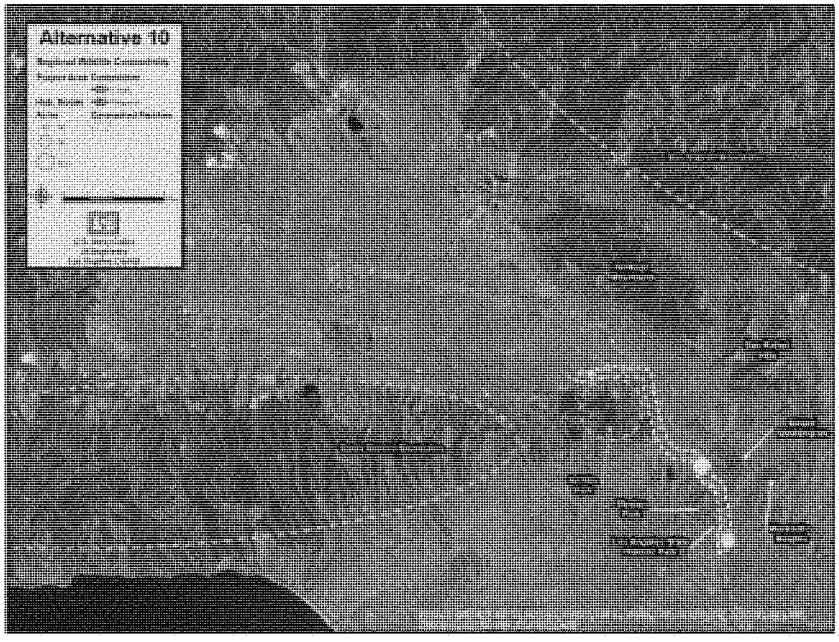


Figure 6-3 Alternative 10 Regional Habitat Connectivity Illustrated by Red Lines

Alternative 13

Alternative 13 restores 588 acres along the 11 mile study area. Below is a map (Figure 6-4) showing the footprint of Alternative 13 ACE. While the footprint is very similar to that of Alternative 10, the added measures in Reaches 3, 6 and 7 provide additional connectivity benefits, including natural hydrologic and hydraulic connectivity between the river, floodplain, and overbank areas, and habitat connectivity for wildlife movement. Natural hydrologic connectivity supports additional ecological processes such as natural disturbance, nutrient cycling, biotic interactions, and population dynamics which improve the sustainability of the restored ecosystem pursuant to the definition of connectivity found in planning guidance.

Alternative 13 adds additional increments of restoration that contribute to the planning objectives by:

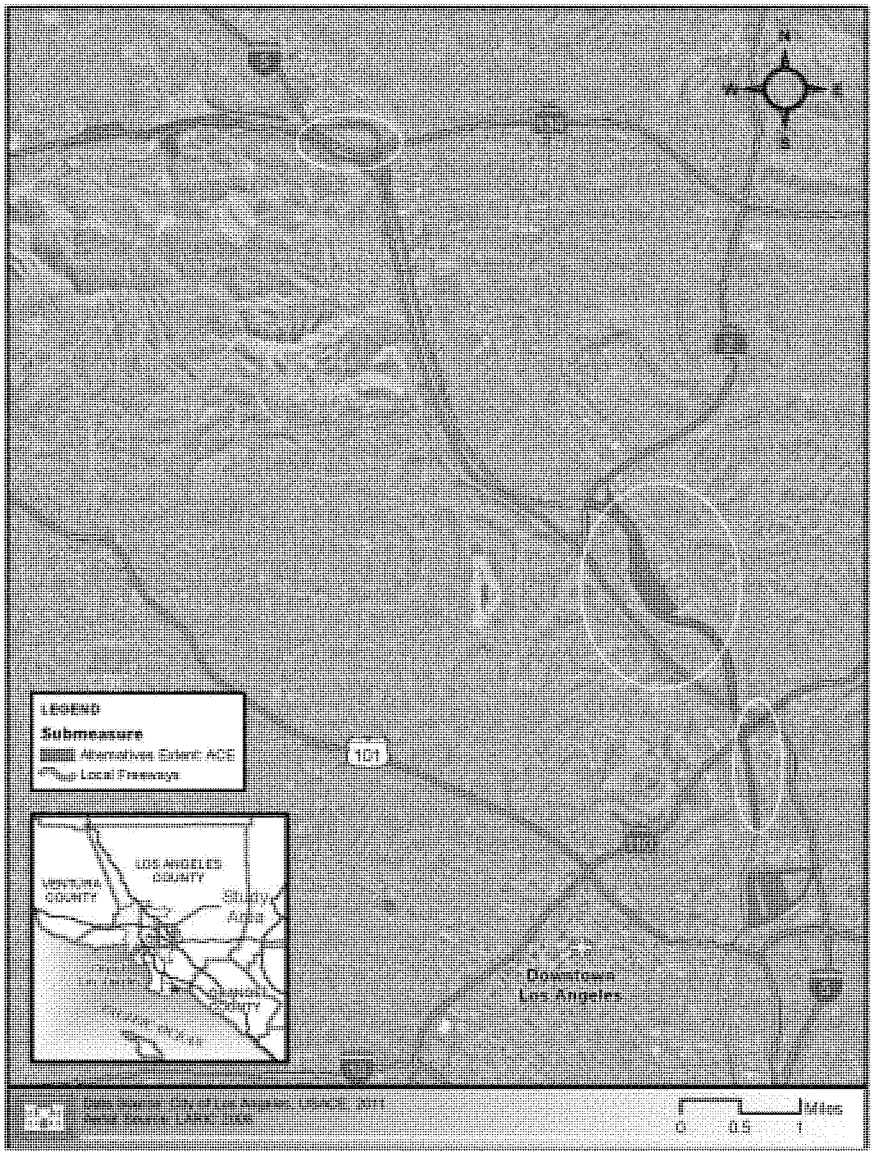


Figure 6-4 Alternative 13 ACE Footprint with Yellow Highlight Areas Showing Additions over Alternative 10

Objective 1: Restore Valley Foothill Riparian Strand and Freshwater Marsh Habitat

- Reach 3 provides 17 additional acres of riparian and marsh habitat and Reach 6 provides 21 acres of additional marsh. Arroyo Seco restoration in Reach 7 adds 22 acres of additional riparian habitat.
- A more natural hydrologic and hydraulic regime is incrementally increased with the widening in Reach 6 of over 200 additional feet of river bed and naturalization of the major tributary confluence on the Arroyo Seco. Assisted hydrologic connections are made at the overbank side channel in Ferraro Fields, Griffith Park Golf Course, and Los Feliz Golf Course.

Objective 2: Increase Habitat Connectivity

- This alternative provides 309 percent more connectedness (Rudd et al. 2002) within the Study Area over Alternative 10 via the restored nodal connections between Taylor Yard and Arroyo Seco (Figure 6-5). In Alternative 13, by adding the natural hydrologic connection at Arroyo Seco, which is very close in proximity to Taylor Yard, the level of connectedness is substantially increased from Alternative 10, where there is very limited connectivity (assisted watering). Increased channel bed restoration in Reach 6 and in Arroyo Seco in Reach 7 allow for creation of riffle/pool complexes which supports habitat for and movement of native fish species.
- Increased regional habitat connectivity through Arroyo Seco confluence to the San Gabriel Mountains.

Alternative 13 adds to the regional connection through Griffith Park to the Santa Monica Mountains with addition of a side channel at Ferraro Fields, and restores a natural hydrologic connection between the river and historic floodplain at the Arroyo Seco confluence, which restores natural ecosystem processes as well as improved nodal and regional habitat connectivity. In addition, the increased widening in Reach 6 and modified bank allow for more habitat and hydrologic connectivity in this reach.

Alternative 13 would remove the bank and widen the river channel bed at the Taylor Yard site more substantially than in Alternative 10. This alternative restores a natural hydrologic and habitat connection between the river and the site. This would allow for natural in-channel geomorphic character and habitat to establish and for the currently confined river to spread into its historic floodplain. This natural hydrologic connection between the river and the floodplain restores key processes that exist in a native river ecosystem such as a more natural disturbance regime, scour and deposition of sediment and vegetation, nutrient cycling, biotic interactions, and colonization of new habitat areas (Stromberg et al. 2007).

The restoration of the Arroyo Seco confluence restores natural in-channel geomorphic character and riparian and aquatic habitat in the currently channelized tributary at the confluence with the river. This natural hydrologic connection between the river and tributary also restores key ecosystem processes that normally exist in a native river ecosystem. The restored habitat at Arroyo Seco would also improve local connectivity for wildlife by serving as a new habitat node, with a connection to Taylor Yard via the river channel as a vegetated corridor (Figure 6-5). Improved nodal connectivity promotes wildlife movement within the study area and prevents inbreeding depression and local extinction of wildlife populations. Nodal habitat connectivity would increase 309 percent within the study area over Alternative 10, through restoration of a more natural hydrologic regime and habitat at the Arroyo Seco confluence and its extremely close proximity to habitat at Taylor Yard.

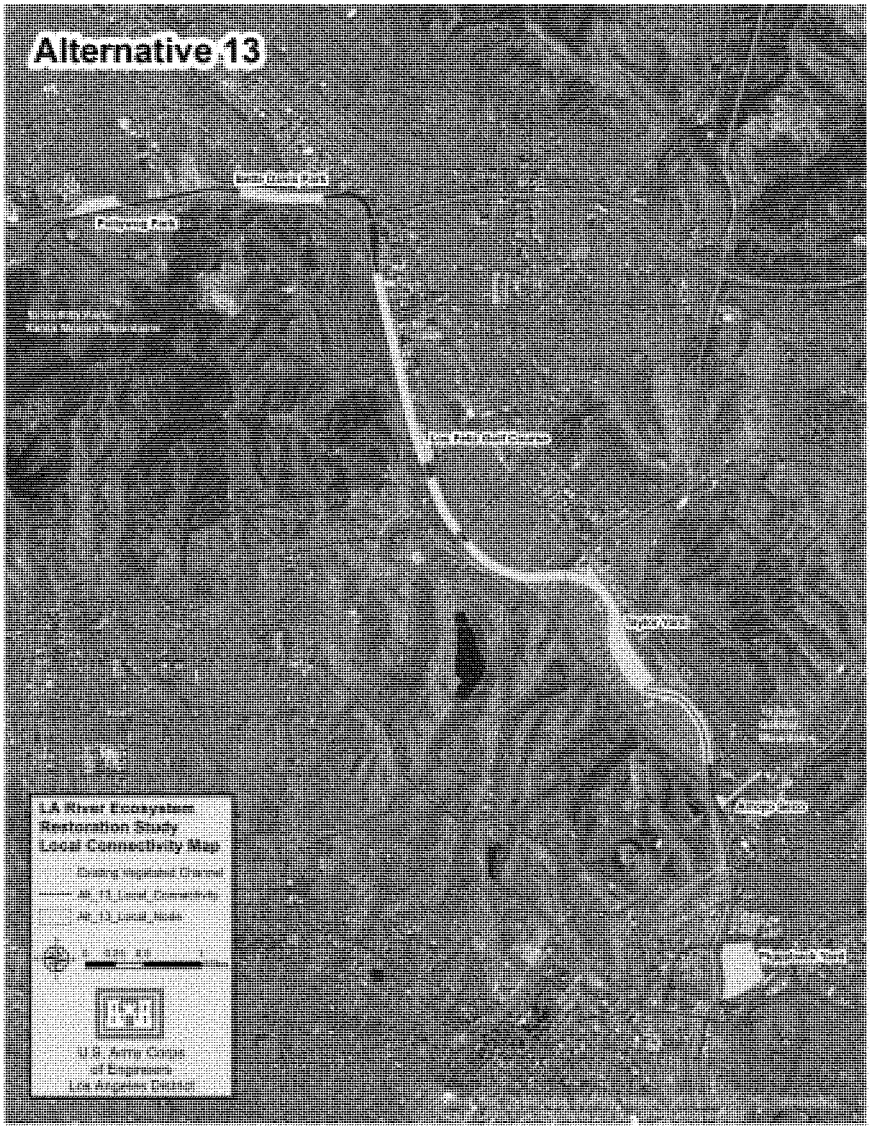


Figure 6-5 Alternative 13 Local Habitat and Hydrologic Connectivity

On a regional scale, restoration at Arroyo Seco confluence provides future opportunities to restore aquatic habitat connectivity between the river at the Study area and the San Gabriel Mountains via the Arroyo Seco tributary (Figure 6-6). Additional opportunity for connection in this area exists via the USACE's on-going Arroyo Seco Ecosystem Restoration Study. Urbanization has eliminated the historic habitat corridor that once existed on the Arroyo Seco tributary, and without restoration of the confluence reconnection of the river to the San Gabriel Mountains could not be realized in the future. Additional neighborhood habitat in the communities of San Rafael Hills, Mount Washington, and Montecito Heights could eventually be incorporated into the movement corridor as regional habitat nodes.

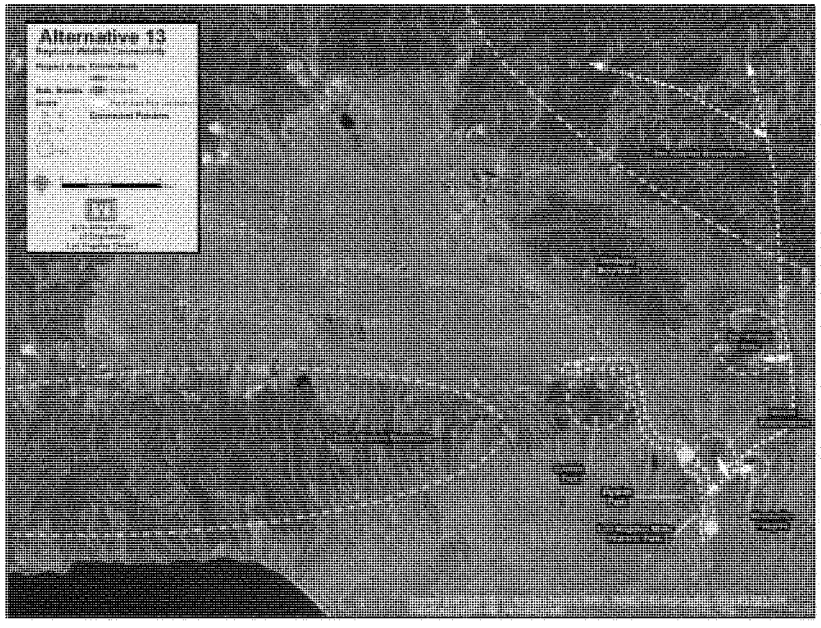


Figure 6-6 Alternative 13 Regional Habitat Connectivity Illustrated by Red Lines

Alternative 13v

Alternative 13v restores 598 acres of habitat along the 11-mile study area, the difference between this variation plan and Alternative 13 is in Reach 7. Connections for Alternative 13v are the same in reaches 1-6 and 8 as in Alternative 13 as discussed in the text above. In Reach 7, this alternative includes the same reach plan as in Alternative 20, which restores habitat at the LA River State Historic Park (Cornfields) site and provides an additional habitat connection within Reach 7 through terracing on the west bank. Regional habitat connectivity is further improved by restoring connections between the river and the 575-acre habitat node at Elysian Park via restoration of the Cornfields site.

The added increments of restoration that contribute to the planning objectives are summarized below:

Objective 1: Restore Valley Foothill Riparian Strand and Freshwater Marsh Habitat

- Reach 7 restores 10 acres of habitat at the LA State Historic Park (Cornfields) site, utilizing the same reach plan as in Alternative 20.
- Reach 7 restores a natural habitat connection between the river and the LA State Historic Park via removal of the concrete bank between the river and the site, terracing the area with potential for seasonal flooding on the terraces from the LA River mainstem.

Objective 2: Increase Habitat Connectivity

- Nodal connectivity is increased 33 percent over Alternative 13 through the restoration at the LA State Historic Park (Cornfields).
- Increased regional connectivity through the LA River State Historic Park to the Elysian Hills and upstream to Griffith Park and the Santa Monica Mountains.

Alternative 16

Alternative 16 restores 659 acres of habitat along the 11 mile study area. Below is a map (Figure 6-7) showing the footprint of Alternative 16. Alternative 16 adds the following benefits and incremental increase in objectives criteria as follows:

Objective 1: Restore Valley Foothill Riparian Strand and Freshwater Marsh Habitat

- Reach 5 provides an added 17 acres of in channel riverine habitat via channel widening from a trapezoidal to vertical configuration
- Reach 8 provides an added 21 acres of in channel riverine habitat via removal of the concrete channel bed
- Reach 8 restores a natural hydrologic connection between the river and LATC via removal of the concrete bank between the river and the site
- Reach 8 provides an additional 17 acres in wetland marsh habitat via restoration of a large side channel in LATC.

Objective 2: Increase Habitat Connectivity

- 39 percent more connectedness (Rudd et al. 2002) within the Study Area over Alternative 13v through the restored hydrologic connection at LATC. (Figure 6-8)
- Reach 8 modifies 0.75-miles of concrete channel to natural river bed, which restores a more natural geomorphic character and habitat in approximately 30 acres of river channel and supports a new wildlife movement corridor.
- Reach 8 removes the concrete bank at LATC to directly connect restored in-channel habitat to approximately 90 acres of floodplain habitat.
- Reach 8 restored historic wash and two smaller tributary streams at LATC with 1.6 miles of tributary restoration.
- Reach 8 modifies channel banks upstream and downstream of LATC with planted terraces which connect the naturalized river bed with overbank areas (increasing regional habitat connectivity).
- Reach 5 widens 1.6 miles of channel which supports a wider vegetated movement corridor for wildlife.
- Channel bed restoration in Reaches 5 and 8 allow for creation of riffle/pool complexes which supports habitat for and movement of native fish species.

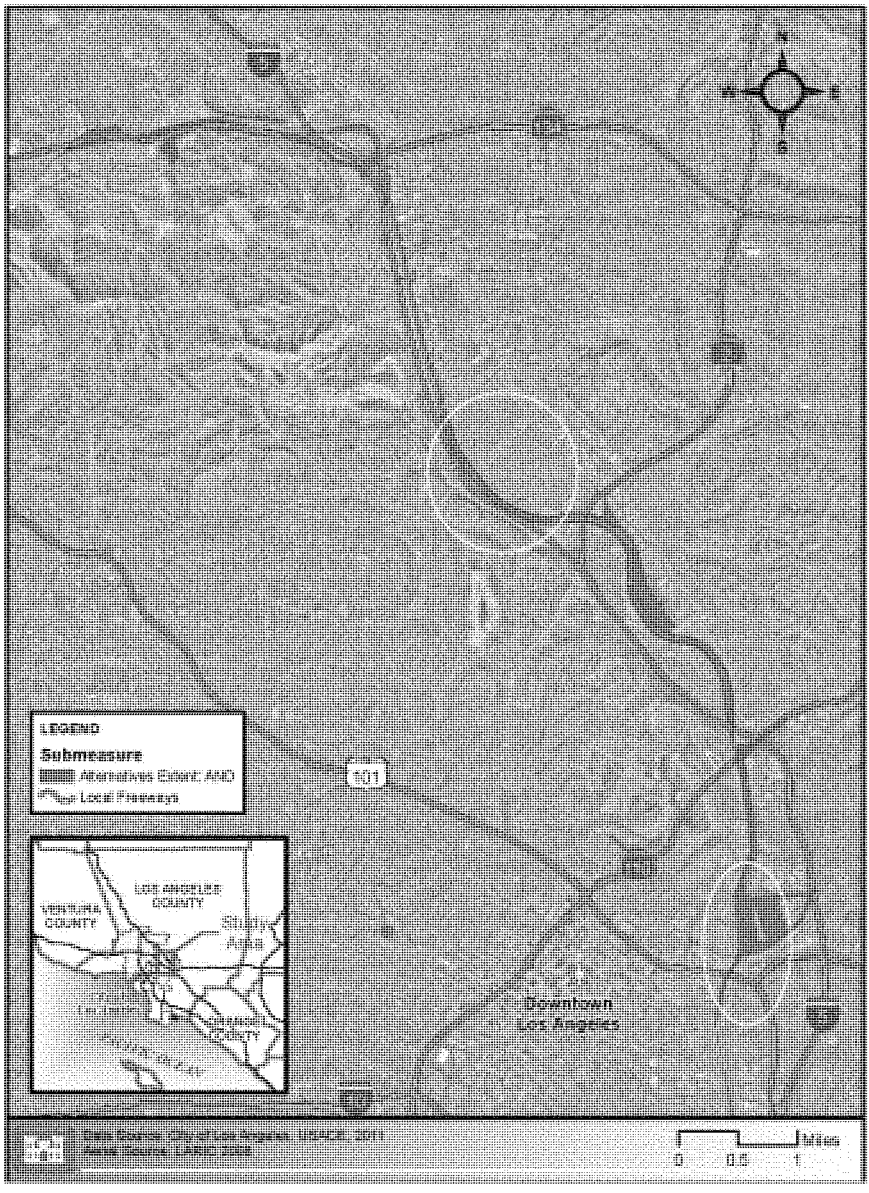


Figure 6-7 Alternative 16 AND footprint – Areas with Changes from Alternative 13 Circled in Yellow

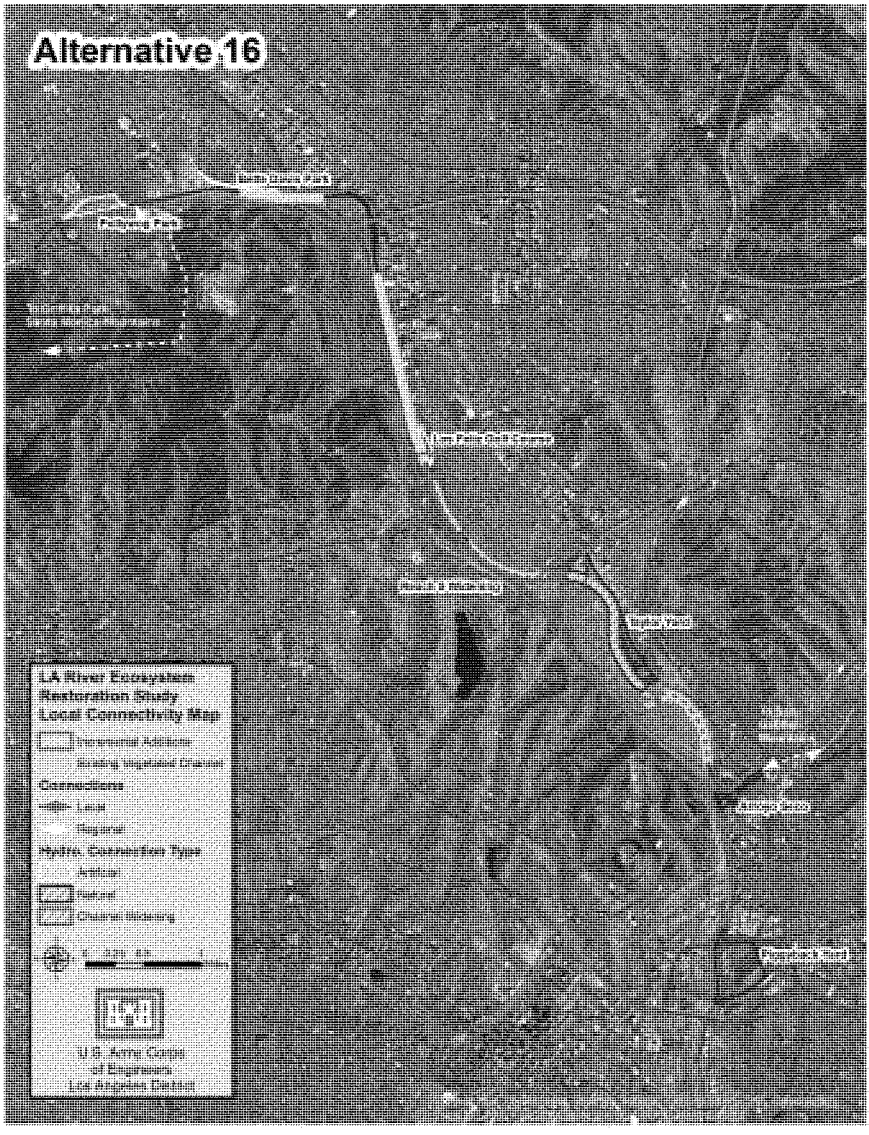


Figure 6-8 Alternative 16 Local Habitat and Hydrologic Connectivity

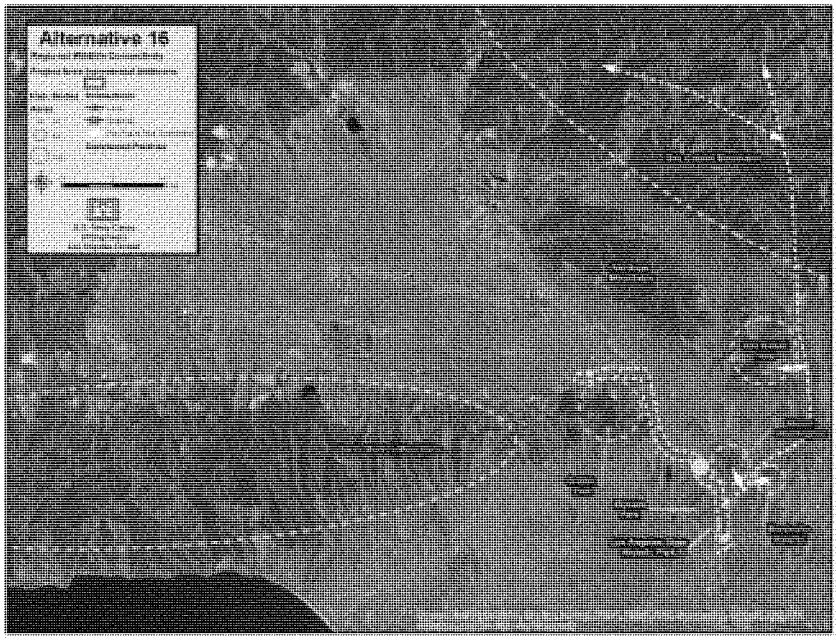


Figure 6-9 Alternative 16 Regional Habitat Connectivity Increases from Alternative 13 – Represented by Red Circled Area at the Downstream End of the Project

While the footprint is very similar to that of Alternative 13, the added measures in Reaches 5 and 8 provide incremental increases in benefits, connectivity benefits, including natural hydrologic and hydraulic functioning which reconnects the river, floodplain, and overbank areas, and improved local habitat connectivity for wildlife movement.

Alternative 16 increases natural hydrologic connectivity and local habitat connectivity but does not significantly increase regional connectivity over Alternative 13. Alternative 16 would remove a concrete wall and concrete in the channel bed at the LATC site. Direct natural hydrologic connection would allow for interaction between the river and historic floodplain. Concrete removal and expanded width for natural physical processes are directly linked. Restoring the hydrologic interaction between the river and the LATC site allows for removal of concrete in the bed of this reach that would otherwise be unacceptable from a flood risk standpoint. The interaction between the river and historic floodplain would increase sustainability and diversity within this resource scarce reach. With this removal of concrete, a natural hydrologic connection between the river and the site would be restored. The incremental modifications at LATC included in Alternative 16 would allow the site to function as a natural wetland area with a flow off channel, providing an area of low velocity. Lower velocity areas would allow for development of more structurally diverse habitat while maintaining a direct connection with the river. Restoration of the channel bed at LATC would provide an additional 41 acres of native fish habitat via establishment of natural channel geomorphic character and freshwater marsh.

The restored floodplain connection to the river in Alternative 16 would allow the large habitat node at LATC to support high populations of wildlife in Reach 8, which is currently completely built out and resource poor. The LATC habitat node would then serve as a source population for other nodes along the river and minimize the risk of local extinction in smaller nodes. The restored channel bed at LATC in also provides a habitat corridor that connects to other nodes in the study area. Wildlife could travel in and out of this node to other habitat nodes in the project area.

Alternative 16 additionally widens the river for a length of 1.6 miles in Reach 5. This widening allows for expansion of in-channel river habitat, which supports wildlife movement corridors. Restoration of a more natural in-channel geomorphic character, including riffle/pool complexes, would also support 25 acres of increased habitat for native fish.

In Alternative 16, local habitat connectivity would increase 39 percent within the study area over Alternative 13v, through restoration of a more natural hydrologic regime and habitat at the LATC site and its connection to Arroyo Seco via restored in-channel and channel bank habitat.

Alternative 20

Alternative 20 restores 719 acres of habitat along the 11 mile study reach. Below is a map showing the footprint of Alternative 20 (Figure 6-10). Alternative 20 adds the following benefits and incrementally meets objectives criteria above the level provided by Alternative 16 as follows:

Objective 1: Restore Valley Foothill Riparian Strand and Freshwater Marsh Habitat

- Reach 2 provides an added 10 acres of in channel riverine habitat via channel widening from a trapezoidal to vertical configuration (Freshwater marsh biological diversity objective 1a)
- Reach 3 provides an added 35 acres of in channel riverine habitat via removal of the concrete channel bed and bank in the tributary confluence of Verdugo Wash
- As in Alternative 13v, Reach7 restores a natural hydrologic connection between the river and the LA River State Historic Park via removal of the concrete bank between the river and the site.

Objective 2: Increase Habitat Connectivity

- 120 percent more connectedness (Rudd et al. 2002) within the Study Area over Alternative 16 via the restored nodal connections at Verdugo Wash and LA River State Historic Park (Figure 6-11).
- Increased regional habitat connectivity through Verdugo Wash to the Verdugo Hills and the San Gabriel Mountains
- Increased regional connectivity through the LA River State Historic Park to the Elysian Hills and upstream to Griffith Park and the Santa Monica Mountains (Figure 6-12)
- Reach 2 widens 0.6 miles of channel which supports a wider vegetated movement corridor for wildlife
- Channel bed restoration in Reaches 2 and 3 allow for creation of riffle/pool complexes which supports habitat and refugia for and movement of native fish species.

The added measures in Reaches 2, 3 and 7 provide additional connectivity benefits, including natural hydrologic and hydraulic connectivity between the river, floodplain, and overbank areas, and habitat connectivity for wildlife movement locally within the river system and to regional areas.

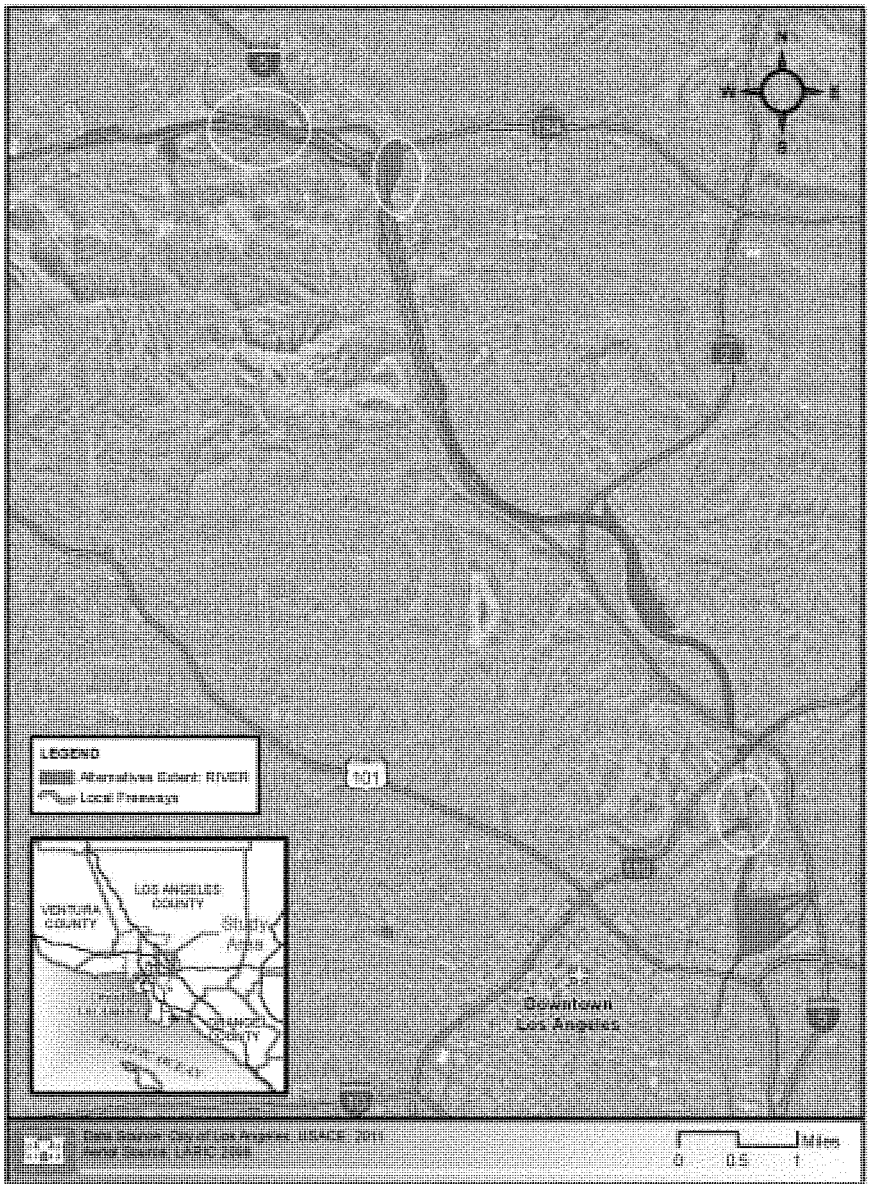


Figure 6-10 Alternative 20 Footprint Shows Areas with Changes from Alternative 16 in Yellow Circles

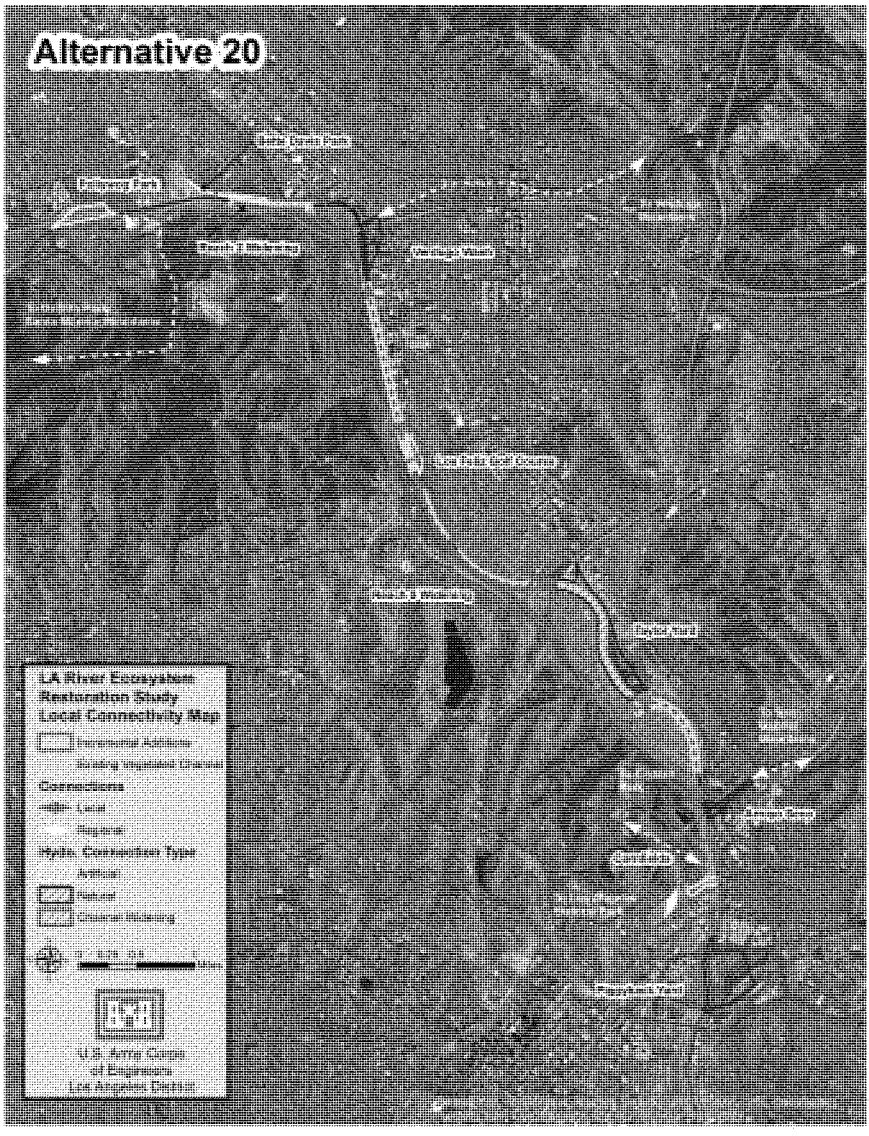


Figure 6-11 Alternative 20 Local Habitat and Hydrologic Connectivity Increase in Red Polygons

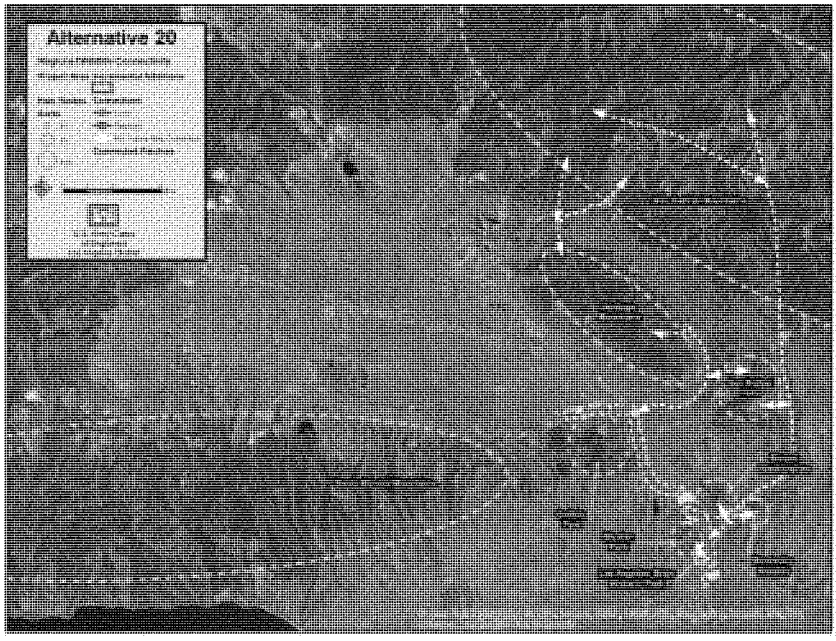


Figure 6-12 Alternative 20 Potential Regional Habitat Connectivity with Increase from 16 Shown by the Polygons

In addition to the features in Alternative 16, Alternative 20 restores a natural hydrologic connection between the river and the historic floodplain at the Verdugo Wash tributary, which increases local habitat connectivity within the study area as well as opportunities for widespread regional habitat connectivity. This alternative also restores an assisted hydrologic connection to the LA River State Historic Park (Cornfields) site, which provides additional opportunity for regional habitat connectivity, and widens the natural channel bed in Reach 2, which provides additional in-channel marsh and riparian habitat.

Alternative 20 would remove concrete and widen the confluence of the Verdugo Wash in Reach 3 to support a more natural hydrologic regime and reconnection of the tributary to the historic floodplain. This creates a third reach of the river with a large natural connection to the floodplain and restores a direct geomorphic connection between the River and the bed and banks of the Verdugo Wash. This reach is currently very constrained hydraulically. Opening up the confluence at this location provides a wide natural channel bed and confluence with potentially slower velocities providing an opportunity in the reach for nutrient cycling and refugia for native fish as they move up and down the river system.

Additionally, restoration of the channel bank at the LA River State Historic Park (Cornfields) provides an additional habitat connection within Reach 7 (as in Alternative 13v). Terracing the bank of the river at this location provides a habitat connection on the west bank of the river. Alternative 20 also widens the river for a length of 0.5 miles in Reach 2. This widening allows for expansion of in-channel river habitat

and a more natural geomorphic character, including riffle/pool complexes, which would support 5 acres of increased habitat for native fish.

Local connectivity would be improved through restoration of the Verdugo Wash confluence, which would provide an additional habitat node in the Study Area with connectivity to the Los Feliz Golf Course via existing habitat in the Glendale Narrows (Figure 6-11) and connectivity through the downstream reaches. The added restoration at the Cornfields site in Reach 7 provides a 10 acre riparian habitat node that decreases the distance between habitat nodes at Arroyo Seco and LATC in the resource poor downtown area (Figure 6-11). In Alternative 20, the restoration at Verdugo Wash and at Cornfields would increase local habitat connectivity 120 percent within the study area over Alternative 16.

Regional connectivity in Alternative 20 is improved over Alternative 16 through the restoration at the Verdugo Wash tributary, which provides opportunity for a future connection between the LA River and the Verdugo Mountains, a 26 square mile area serving as a stepping stone to the western San Gabriel Mountains (Figure 6-12). Urbanization has eliminated this habitat corridor, and without restoration of the confluence at Verdugo Wash, reconnection of the river to the Verdugo Mountains could not be realized. Additional habitat in the community of San Rafael Hills could also be incorporated into the movement corridor as a regional habitat node. Regional habitat connectivity is further improved by restoring connections between the river and the 575-acre habitat node at Elysian Park via restoration of the Cornfields site.

6.1.3 Additional Connectivity Comparison

As discussed in Section 6.6 below, many public comments received, as well as a comment from the project's Independent External Peer Review (IEPR) Panel, suggested that an additional analysis of connectivity benefits would assist with alternative comparison and selection. The following analysis has been added in response to those comments. The USACE used a framework suggested by the project's IEPR panel to better quantify the beneficial outputs of connectivity. Four different metrics were developed to further quantify different connectivity outputs. By evaluating hydrologic, local, and regional connectivity and combining the resultant output with the initial habitat model output, the USACE was able to more comprehensively compare the alternatives in the final array.

Local connectivity was evaluated based on the potential for wildlife to physically move between the river and areas restored by the project. The metric is based on the acreage of the restored sites and the ability of wildlife to access them. For the purpose of this evaluation, it was assumed that all types of wildlife must have access in order to be considered in the metric (i.e., mammals, reptiles, and amphibians, in addition to birds whose movements are not limited by barriers between the channel bottom and restored areas). Regional connectivity was evaluated based on the restored opportunities for wildlife to move out of the restored project area into adjacent, more distant significant habitat areas (now or in the future, after additional restoration occurs along river tributaries). This metric is based on the acreage of habitat area to which a given alternative connects. Areas considered include the Santa Monica Mountains (via Griffith Park) and Elysian Park, which constitute terrestrial connections, and potential future opportunities via tributaries to the San Gabriel Mountains (via Arroyo Seco) and the Verdugo Mountains (via Verdugo Wash), which constitute aquatic connections.

Hydrologic connectivity was evaluated based on the restored areas/floodplain that would be reconnected to the river via a more natural hydrologic regime. The total acreage of the sites with a natural hydrologic connection, as well as the number of sites with a natural hydrologic connection, was evaluated (giving two separate metrics). Parcels were considered hydrologically connected if the river is widened into a floodplain area, where the river can more naturally flood, meander, change shape, and interact with

adjacent sites. The floodplain is considered to be the area where floodwaters would be allowed to inundate.

For each metric, the values for each site (i.e., acres, count) were calculated and then summed across each alternative. In order to calculate the metric value, a Relative Value Index (RVI) was used, whereby the total for a given alternative was divided by the maximum possible value. In this way, the metric value is a simple proportion of the total possible, on a scale of 0 to 1 (1 being the maximum).

To obtain an overall connectivity metric, the metric values for each connectivity component were then summed, and an RVI calculated to determine a single, combined connectivity metric (Table 6-3). These combined metric values were then input into the economic analysis (CE/ICA) and weighted at varying levels using the Combined Habitat Assessment Protocol (CHAP) outputs. The original analysis only considered the CHAP analysis in the quantitative comparison and resulted in all four Final Array Plans included in the Draft IFR (10, 13, 16, and 20) being Best Buy Plans. In the revised analysis, two additional scenarios were evaluated that based the CE/ICA analysis on a Total Weighted Output Metric that included CHAP and connectivity benefits. The first scenario weighted the CHAP and Combined Connectivity equally. The second scenario weighted the CHAP at 75 percent and Combined Connectivity at 25 percent. These results were consistent in showing Alternative 13 as the first Best Buy Plan. After identification of the variation on Alternative 13, it was also analyzed according to the connectivity metrics, producing results very similar to Alternative 13.

Table 6-3 Connectivity Metrics

	RVI – Connectivity Metrics				Total	Connectivity Metric Value ***
	Local Connectivity	Regional Connectivity	Hydrologic Connectivity	Hydrologic Connectivity		
Alt 10	0.30	0.22	0.29	0.25	1.06	0.26
Alt 13	0.48	0.98	0.48	0.50	2.43	0.61
Alt 13v	0.51	0.98	0.48	0.50	2.46	0.62
Alt 16	0.86	0.98	0.88	0.75	3.46	0.87
Alt 20	1.00	1.00	1.00	1.00	4.00	1.00

6.1.4 Plan Recognition

While not a Federal plan, the Los Angeles River Revitalization Master Plan gathered the input of Federal, state, regional and local agencies and stakeholders. It was adopted by the Los Angeles City Council in 2007. The Corps was directed by WRDA 2007, as part of this study, to develop plans consistent with the goals of the Los Angeles River Revitalization Master Plan. Four of its major recommendations for ecosystem improvement are:

4.13) Create a continuous functional riparian corridor that provides habitat for birds, mammals, amphibians, reptiles, invertebrates, and fish within the channel bottom

4.14) Connect this corridor to other significant habitat and migration routes along the tributaries and into the mountains

4.15) Improve water quality and provide... [features and habitat] that would support desirable fish species...

4.16) Bio-engineer [or naturalize] the River's edge where feasible...

The study alternatives vary in their degree of responsiveness to the Plan. All alternatives include some restoration in all reaches of the river in the study area, supporting the establishing of a continuous river corridor. However, they vary in their responsiveness to connecting this corridor to other significant habitat and migration routes along the tributaries and into the mountains, providing aquatic habitat necessary to sustain fish, and naturalizing the river's edge.

6.1.5 Comparison by Objectives Conclusion

The primary NER objectives include restoring Valley Foothill Riparian strand and freshwater marsh habitat and increasing habitat connectivity. Figure 6-13 depicts the degree to which the final array of alternatives meets planning objectives for habitat restoration based on the CHAP analysis. Alternative 10 minimally meets the planning objectives while the larger alternatives provide incremental increases in NER outputs toward this objective. Table 6-4 compares nodal and regional habitat connectivity for each alternative. Alternative 13 provides the greatest percent incremental increase in habitat connectivity of the combinations in the Draft IFR, with Alternative 13v providing a slight increase above Alternative 13 with the change in Reach 7. Alternatives 16 and 20 provide additional increases in habitat connectivity.

Although quantifying connectivity showed more restoration output for each of the alternatives, the increase in cost between Alternative 13 and the next bigger best buy plan was substantial. Given the magnitude of the incremental costs relative to the incremental increase in benefits (after quantifying connectivity functions), there was not a sufficient basis to justify the selection of Alternative 16 or 20 as the NER Plan. However, as described in Section 6.2.3 below, additional cost analysis identified a more cost effective variation on Alternative 13 (Alternative 13v) that provides more benefits at lower cost than Alternative 13.

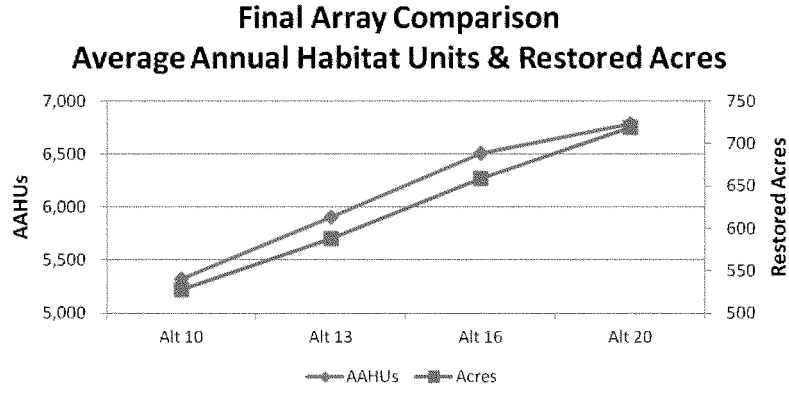


Figure 6-13 Final Array Comparison – AAHU's and restored acres

Table 6-4 Final Array Comparison by Objectives-Habitat Connections

Habitat Connections	Alternative 10	Alternative 13	Alternative 13v	Alternative 16	Alternative 20
Incremental / nodal increase between alternatives	Minor improvement	309% over Alt 10	33% over Alt 13	39% over Alt 13v	120% over Alt 16
Added Regional Connections	Santa Monica Mtns	Santa Monica & San Gabriel Mtns	Elysian Hills, Santa Monica & San Gabriel Mtns	Santa Monica & San Gabriel Mtns	Verdugo & Elysian Hills, Santa Monica & San Gabriel Mtns

6.2 FINAL ARRAY POLICY ISSUES, RISKS, AND CONSTRAINTS COMPARISON

During plan formulation, each measure and alternative was formulated to avoid constraints and minimize risk as much as was possible. An alternatives comparison by major project constraints for the final array is displayed in Table 6-5. Levee vegetation regulations will be followed either by request for variance or limitation. Where levee modifications occur, they will maintain existing levels of protection. Alternative 10 has the least amount of construction activity and modification of current conditions, which accounts for its having the fewest changes to current levee conditions. Alternatives 13, 13v, 16, and 20 have relatively more changes due to the increasing levels of habitat restoration. Percentages of real estate reflect the differences in construction activities relative to land area, with Alternative 20 having the lowest percentage and Alternative 10 having the highest. Not shown in the table is compliance with the constraint of avoiding urbanization and infrastructure wherever practicable. All alternatives would avoid urbanization and infrastructure wherever practicable; however, all alternatives would displace some industrial use. In addition, Alternatives 13v, 16, and 20 would require the relocation of segments of rail lines on trestles at grade to facilitate project construction (in Reach 7 for Alternatives 13v and 20, and in Reach 8 for Alternatives 16 and 20).

Table 6-5 Final Array Comparison by Key Constraint

Alternative	HTRW	Potential Levee Area (LAR#) Changes, and Variance Areas in Compliance with Levee Regulations	Percentage of Lands Relative to Project Cost
10 – ART	Sponsor response/remediation required at G1 and G2, potential remediation at LATC, and for San Fernando Valley groundwater plume	Reaches 1, 2, 4 and 5	83%
13 – ACE	Remediation similar to Alternative 10	Reaches 1, 2, 3, 4, 5, and 7	69%
16 – AND	Remediation similar to Alternative 10	Reaches 1, 2, 3, 4, 5, 7, and 8	47%
20 – RIVER	Remediation similar to Alternative 10	Reaches 1, 2, 3, 4, 5, and 8	46%
**Subsequent to Draft IFR, the 13v variation was compared for these constraints and has equivalent remediation and similar percentage of lands relative to project cost as 13. Potential levee area is in Reaches 1, 2, 3, 4, and 5*			

6.2.1 Flood Risk Management

A key constraint of the study was that existing levels of flood risk management will be maintained.

The study area includes a portion of the Los Angeles River that was altered and engineered as part of the LACDA Project. Any restoration alternatives had to take into account the continued functioning of the flood risk management system and avoid induced flooding. The existing river channel in this reach does not provide a high level of protection (with or without existing vegetation). The existing channel provides less than a 1 percent annual chance exceedance (ACE) (100-year) level of protection for most of the ARBOR reach. For this reason, an alternative located solely within the existing LACDA project right of

way was infeasible, as it would be likely to reduce conveyance capacity and/or be unsustainable and unable to meet restoration objectives given the high velocity flows carried by the system during storm events. Widening the channel at opportunity areas is thus critical to provide restoration benefits while maintaining existing levels of flood risk management. The inclusion of the Taylor Yard and LATC properties provided the only opportunities in the study area to substantially widen the channel and increase channel vegetation.

The addition of Taylor Yard, LA River State Historic Park (Cornfields), Verdugo Wash, Arroyo Seco, and LATC do not provide any additional flood risk reduction for larger floods, but may have an ecologically beneficial effect on the small to moderate size events that are contained within the channel. Unlike conventional hydraulics for the larger events where discharge is the dominant channel-forming parameter, vegetation dictates the channel forms during the small to moderate size events. Vegetation influences flow patterns and sediment settling on floodplains (Darby 1999, Larsen et al. 2007) as well as bedform changes, largely due to its effect on velocity.

The study analyzed impacts to the flood risk management function by looking at potential water surface elevation change. The study screened out any alternatives that adversely impacted the water surface elevation in a way that could not be addressed through design. Appendix E, Hydrology and Hydraulics, describes the hydraulic analyses conducted on the final array of alternatives. That analysis focused on changes to maximum velocity and associated changes to maximum water surface elevation. The alternatives were analyzed as compared to the existing conditions to determine the impacts on the flood risk management function of the channel. The results in the H&H Appendix are based on the limited hydraulic modeling that shows the alternatives are feasible without inducing flooding. Any minor increases in water surface elevations will be eliminated in the detailed design phase. These design refinements will not increase the costs of the recommended plan. If the water surface elevation for the with-project condition was significantly greater than that for the existing condition, then that restoration scenario was removed from further consideration.

All of the final alternatives can work hydraulically without inducing increased flooding. While the initial assessment identified that an increase in water surface elevation could occur at transition areas if no design refinements were made, the detailed design will ensure the maximum water surface elevations will not increase when compared to the existing conditions. Any change in water surface in the transition areas can and will be avoided through design refinements to the modifications to channel geometry and/or avoidance of introduction of vegetation and enforcing existing O&M requirements limiting vegetation growth in those areas. Characteristics of transition areas are either geometric (transitioning from trapezoidal to rectangular or from a widened section to a narrow section) or construction material (transitioning between soft-bottom and concrete). The exact refinements for avoidance will be further determined during the detailed design phase. The costs of these minor alterations have been included in the cost estimate for the project.

Under the analysis conducted during feasibility, the Engineering team also analyzed average velocities to determine channel function with respect to scour and sustainability of constructed restoration features. For widened areas, the flows need to be slowed sufficiently or sufficient protection need to be included to ensure channel erosion does not occur. Several areas exhibit average velocities in excess of 12 ft/s. In those areas, planting of vegetation as part of the restoration project is not recommended because vegetation may not withstand high velocities. For those areas with velocities greater than 8 ft/s, appropriate protection is included to avoid effects of scour and ensure channel function.

Concurrent with implementing the restoration project, the Corps would modify the current operations and maintenance (O&M) requirements of the LACDA project to accommodate and complement the ecosystem restoration project, which would be maintained by the City, while continuing to maintain the

channel for flood risk management. Constructed restoration features will be maintained by the City as restoration project sponsor, and the City will also conduct invasives management throughout the project footprint including the River and tributary bottom areas. There are no increased Corps flood risk management O&M requirements or costs as a result of the ecosystem restoration project when compared to the current O&M responsibilities. In addition, using the detailed hydrologic and hydraulic analysis the Corps will determine the extent to which the existing LACDA OMRRR for areas outside of the restoration features can be modified to accommodate native vegetation without negatively affecting design conditions.

During the detailed design phase, 2D unsteady flow numeric models, and possibly physical modeling, will be required to more accurately simulate the flow hydraulics for the project. This may result in adjustments to plan features, but should not change the overall habitat benefits and will not induce damages from the flood risk perspective.

As described above and in Section 3.4.1, the 1992 LACDA Review Feasibility Study showed that the LACDA channel and dam flood control system had a relatively low level of flood protection for a metropolitan area. Although the 1992 LACDA Review Feasibility Study resulted in Congressional authorization to upgrade flood risk management features for the Los Angeles River downstream of the Rio Hondo confluence to provide for the 0.8 ACE event (133 year), Congress did not authorize upgrades for the upper Los Angeles River including the ARBOR reach. Flood risk management upgrades within the study area were not found to be economically justified in the 1992 review. There are currently no proposals to study flood risk management improvements in the ARBOR reach. If a flood risk management study were to be undertaken in the future, by the Corps and/or non-Federal interests, the implementation of any of the restoration alternatives would not preclude potential flood risk management improvements. While some typical flood risk management measures (e.g., adding concrete or parapet walls at some locations) would likely be excluded due to inconsistency with the restoration alternatives, other FRM measures (e.g., diversions, detention, sheet pile,) could still be implemented. Any future flood risk management measures will need to take account of and be consistent with the ecosystem restoration project.

6.2.2 Existing Levee Systems

There are five existing levee systems that are within the study area. These levees are part of the existing LACDA project and are maintained by the Corps. The levees are identified based on their initials for the river name, Los Angeles River (LAR), and numbered. They are LAR-2, LAR-3, LAR-5, LAR-6, and LAR-7. Management of the vegetation on these levee systems, and any proposals for ecosystem restoration affecting these levee systems, must be compatible with the Corps vegetation management guidelines. There are several areas along these levee systems where the area directly behind the levee embankment has been filled in over time. For these areas, channel capacity is the main concern related to vegetation management. Appendix D (Geotechnical) contains information on the current condition of these levee systems as well as their location.

Corps vegetation management practices emphasize that levee embankments must be accessible for inspection, maintenance, and emergency activities. In addition, for any vegetation that is proposed or retained, it must be demonstrated that the vegetation does not pose an unacceptable risk. Restoration features in the final array of alternatives have been planned to be compatible with the Corps vegetation management guidelines allowing for forbs (native perennial grasses) grown on the levee embankment and other vegetation to be planted farther from the levee embankment. The riparian forbs on the levees are expected to occur in a relatively narrow band and be surrounded by more structurally diverse riparian vegetation in adjacent areas. Forbs provide habitat for small mammals, reptiles, birds and insects, and are an important part of the riparian community. Levees in each alternative that may be affected by

alternative measures along with the proposed vegetation that would be further assessed are indicated in the bulleted list below,

- **Alternative 10:** In Reaches 1 and 2, the proposed riparian corridor along the left and right overbanks includes riparian vegetation on or along the existing levee (LAR-7 and LAR-3). The proposed riparian corridors along the left bank of Reaches 4 and 5 include riparian vegetation on the existing levee berm and crown (LAR-6).

- **Alternative 13**: In Reaches 1 and 2, the proposed riparian corridor along the left and right overbanks includes riparian vegetation on or along the existing levee (LAR-7 and LAR-3). In Reach 3, the proposed riparian corridor along the left and right overbanks includes riparian vegetation on or along the existing levee (LAR-7 and LAR-6 on left, LAR-3 on right). The proposed riparian corridors along the left overbank of Reaches 4 and 5 include riparian vegetation on the existing levee berm and crown (LAR-6). The Reach 7 features include banks restructured to support vegetation on both sides of the channel (LAR-2 and LAR-5).

- **Alternative 13v**: In Reaches 1 and 2, the proposed riparian corridor along the left and right overbanks includes riparian vegetation on or along the existing levee (LAR-7 and LAR-3). In Reach 3, the proposed riparian corridor along the left and right overbanks includes riparian vegetation on or along the existing levee (LAR-7 and LAR-6 on left, LAR-3 on right). The proposed riparian corridors along the left overbank of Reaches 4 and 5 include riparian vegetation on the existing levee berm and crown (LAR-6).

- **Alternative 16**: In Reaches 1 and 2, the proposed riparian corridor along the left and right overbanks includes riparian vegetation on or along the existing levee (LAR-7 and LAR-3). In Reach 3, the proposed riparian corridor along the left and right overbanks includes riparian vegetation on or along the existing levee (LAR-7 and LAR-6 on left, LAR-3 on right).The proposed riparian corridors along the left overbank of Reaches 4 and 5 include riparian vegetation on the existing levee berm and crown (LAR-6). The Reach 5 features also include planted terracing on the left bank (with concrete erosion control) and overhanging vegetation on a vertical wall on the right bank (LAR-6). The Reach 7 features include banks restructured to support vegetation on both sides of the channel (LAR-2 and LAR-5). In Reach 8, the features include planted terracing on the right bank (LAR-2) and channel expansion and terracing on the left bank (LAR-5).

- **Alternative 20**: In Reaches 1 and 2, the proposed riparian corridor along the left and right overbanks includes riparian vegetation on or along the existing levee (LAR-7 and LAR-3). The Reach 2 proposed features also involve channel modifications that would include overhanging vegetation on a vertical wall on the right bank (LAR-3). The Reach 3 features include the widening of Verdugo Wash and planting on the left bank (LAR-7 and LAR-6) and planting of a riparian corridor along the right overbank, on or along the existing levee (LAR-3). The proposed riparian corridors along the left overbank of Reaches 4 and 5 include riparian vegetation on the existing levee berm and crown (LAR-6). The Reach 5 plan also calls for planted terracing on the left bank (with concrete erosion control) and overhanging vegetation on a vertical wall on the right bank (LAR-6). In Reach 8, the features include planted terracing on the right bank (LAR-2) and channel expansion and terracing on the left bank (LAR-5).

Wildlife is still expected to use the levee plantings as a movement corridor between the more diverse riparian habitat areas, which will provide habitat for small mammals, reptiles, and birds. By substituting riparian vegetation with riparian forbs on the levees, CHAP values in the final array would decrease

slightly for those areas. However the overall CHAP values and the ranking of the final array would not be significantly impacted as the decrease would be relative across all alternatives in the final array.

Construction of restoration features that modify levees would necessitate removal of existing vegetation on and adjacent to the existing levees being modified. Where vegetation removal on and adjacent to levees is necessary to accommodate construction, no additional engineering analysis of the existing vegetation is needed to confirm vegetation removal. Removal of invasive species will be undertaken to accomplish the ecosystem restoration project purpose. Where vegetation removal is not necessary to accommodate feature construction but vegetation may have a detrimental effect on safety, structural integrity, or accessibility of the constructed/modified levee features, an engineering analysis will be undertaken to determine whether the vegetation poses an unacceptable risk. Based on the engineering analysis, vegetation determined to pose an unacceptable risk to the constructed features shall be removed as part of project construction. Vegetation on or adjacent to levees modified by the restoration project that is not determined to pose a safety, structural integrity, or accessibility risk will be documented in a vegetation variance. Any required analysis will be accomplished during PED.

For levee embankments within the ARBOR reach, which is the project reach, that would not be modified as part of the ecosystem restoration project, these portions will continue to be operated and maintained as part of the LACDA project by the Corps.

6.2.3 HTRW

A study constraint was to avoid sites contaminated with HTRW to the extent practicable. The Corps' policy is for ecosystem restoration projects to avoid lands with hazardous, toxic and radioactive waste (HTRW) whenever practicable to do so. In most scenarios, avoidance of HTRW is possible. However, as described in this report and Appendix K, HTRW Survey Report Appendix, given the highly constrained river corridor and the historical industrial uses within it, HTRW contaminated lands and groundwater cannot be fully avoided in plan formulation while still providing a project responsive to the project objectives. The proposed project area for the action alternatives contains three major areas of known contamination, and one area with high potential for contamination of concern. The northern half of the river, including Reaches 1-6 in the Study Area, is underlain by a groundwater plume known as the San Fernando Valley Superfund Site, which is currently being remediated with oversight by EPA and LADPW. Furthermore, the Taylor Yard has two sites (G1 and G2) with known contamination resulting from its historical use as a railyard. In addition to these three sites, the LATC, another key site within the study area, is a railyard that can reasonably be anticipated to have some contaminated soils requiring remediation given the similarity of historical use at that site to Taylor Yard uses, although it has been paved for several decades. There are 19 other sites in various stages of remediation, adjacent to the alternative plan footprints, which were avoided by the alternatives, and these sites are considered to be low impact to a potential project. An exhaustive search for other appropriate real estate parcels was conducted, but no other parcels or groups of parcels of sufficient size to address study objectives and fully avoid HTRW impacted sites were identified. Although initial plans were developed that excluded the Taylor and LATC parcels, they did not meet the restoration objectives for restored habitat and habitat connectivity and were eliminated through the planning process.

Therefore, in order to meet project objectives, the project footprint for the action alternatives includes sites with known and suspected soil and groundwater contamination requiring response and remediation. There are known contaminated sites within the study area that cannot be avoided by the project. These include the San Fernando Valley Superfund Site, and Taylor Yard G1 and G2, which are considered high impact sites. In addition, contamination is possible at the LATC site based on historical uses, posing a potentially high impact to the project since the extent of this potential contamination is unknown. Localized groundwater contamination may also be encountered during construction. For the sites with soil

contamination, the City must undertake or otherwise ensure the remediation of the sites to the standards necessary to support the restoration project at 100 percent non-project cost, prior to construction at those sites. For the groundwater contamination that cannot be addressed prior to construction, the City will undertake necessary dewatering activities including treatment and disposal, at 100 percent non-project cost in areas with contaminated groundwater. The City of Los Angeles is aware of these requirements, and has accepted responsibility for delivering lands suitable for ecosystem restoration and addressing groundwater contamination during dewatering.

Although excluded from cost shared project costs, effort and costs of HTRW response and remediation have been considered in evaluating and comparing plans for implementation. Under all alternatives the non-Federal sponsor would remediate or ensure the remediation of soil contamination to the standard required for the restoration project prior to construction of restoration features at the affected sites. Because it is infeasible to remediate groundwater contamination prior to construction, the sponsor would be responsible at 100 percent non-project cost for addressing contaminated groundwater including treatment and disposal during dewatering activities.

The City understands its responsibility and has directly committed to undertaking or ensuring completion of the necessary remediation efforts on affected parcels and provide sites cleaned to the standard required to support the restoration project prior to project construction being undertaken on those sites, and its responsibility for addressing contaminated groundwater during dewatering, including treatment and disposal.

6.2.4 Real Estate

Corps policy provides that ecosystem restoration projects should not be composed primarily of land acquisition. To reflect that projects should be restoration focused, the Corps uses a target of 25 percent for land costs as a percentage of total project cost. The policy states,

Land acquisition in ecosystem restoration plans must be kept to a minimum. Project proposals that consist primarily of land acquisition are not appropriate. As a target, land value should not exceed 25 percent of total project costs. Projects with land costs exceeding this target level are not likely to be given a high priority for budgetary purposes (ER 1105-2-100, Appendix E, para. E-30f).

Real estate and potential relocation costs are known to be exceptionally high in the Los Angeles area. Initially, a conceptual alternative that restored the river to an area similar to its historic floodplain and removed the concrete channel within the study area was estimated to have real estate costs of approximately $7.6 billion, an excessive amount that did not include relocation costs or construction costs. Mindful that real estate costs would be high for any alternative that involved urban Los Angeles lands, the study examined lands already included in the LACDA project boundary, open space lands adjacent to the existing LACDA boundary, and other parcels that would support restoration goals such as habitat connectivity. Despite efforts to minimize land acquisition, real estate costs for the alternatives in the final array range from approximately 83 percent of total project cost for the smaller alternatives to approximately 45 percent for the largest alternatives. In recognition of the unusual nature of the real estate costs of the proposed alternatives and in commitment for the project, the City of Los Angeles proposed to waive reimbursement of real estate costs that exceed its statutorily required 35 percent share of total ecosystem restoration costs. The Assistant Secretary of the Army (Civil Works) has granted the request to waive reimbursement. The Corps and City would cost share the recreation feature costs 50-50, and other costs would be governed by the partnership agreement.

Additional discussion of real estate costs and cost share is presented in Chapter 7

6.3 COMPARISON BY NATIONAL OBJECTIVES AND THE FOUR ACCOUNTS

In the 1970 Flood Control Aet, Congress identified four equal national aeeounts for use in water resourees development planning. They are national economic development (NED); regional economic development (RED); environmental quality (EQ); and social well-being (OSE, other social effects). Policy in the 1970s regarded making contributions to only two of these, NED and EQ, as national objectives. Now only contributing to NED remains a national objective, as stated in the Principles and Guidelines.

> *The Federal objective of water and related land resources planning is to contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements.*

However, all four of these planning categories remain important considerations of water resource projects and the USACE is considering revising this in new guidelines. The four categories, known as the System of Accounts as suggested by the U.S. Water Resources Council, address long-term impacts and are defined in such a manner that each proposed plan can be easily compared to the No Action plan and other alternatives. Collectively, the four accounts are required to include all significant effects of a plan on the human environment.

Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary units. They are the direct net benefits that accrue in the planning area and the rest of the nation. Recommended ecosystem restoration measures do not need to exhibit net NED benefits, but will be based on non-monetary outputs compatible with the Principles and Guidelines selection criteria. Although alternatives may produce incidental NED benefits, for this study, the NED account addresses the recreation benefits with the national ecosystem restoration benefits shown in the EQ account providing the primary basis for comparison for the project purpose. Ecosystem restoration has become one of the primary missions of the Civil Works program. The NER plan is the option with the greatest net ecosystem restoration benefits. The NER objective is to contribute to the nation's ecosystems through restoration, with contributions measured by changes in the amounts and values of habitat. The four accounts used to compare the alternative plans have been modified to include the NED account, and the EQ, RED, and OSE accounts. The NED account comparison utilizes the two recreation plans formulated to complement Alternatives 13 and 20. The EQ account comparison includes Alternative 13v. The RED and OSE account comparisons use the analyses from the Draft IFR as used to preliminarily identify the NER plan and TSP in the Draft IFR. Updated RED analysis for the plans identified as the NER and the LPP and Recommended Plan in this Final IFR is provided in Section 7.

6.3.1 National Economic Development

National Economic Developments are accrued in the recreation plan. Benefits of recreation are summarized below. For both the Alternative 13 and the Alternative 20 recreation plan options, benefits exceed cost. Annual benefits, annual costs, net benefits, and the benefit-to-cost ratio (BCR) for each of the options are summarized in Table 6-6 below. Because the BCR for the proposed recreation features is above 1.0 for both options, the recreation features are economically justified. The Alternative 20 recreation plan option provides the greatest net benefits of the two options under evaluation. Alternative 13v is essentially the same as Alternative 13. For this project, the primary outputs are ecosystem restoration. The EQ (Environmental Quality) Account in Section 6.3.2 provides a discussion of those benefits.

Table 6-6 NED Benefits Summary (Price Level October 2014, Interest Rate FY15-3.375 Percent)

Alternative	Annual Benefits ($)	Annual Costs ($)	Net Benefits ($)	BCR
No Action	$0.00	$0.00	$0.00	0.00
Alternative 13v Recreation Plan Option	$2,479,000	$606,000	$1,873,000	4.09
Alternative 20 Recreation Plan Option	$3,510,000	$978,000	$2,532,000	3.59

6.3.2 Environmental Quality

The Planning Manual describes environmental quality as "favorable changes in the ecological, aesthetic, and cultural attributes of natural and cultural resources." Adverse effects within these categories can also be included in this assessment. Resource and use types that were assessed in this document (Chapter 5) include the following:

- Geology, Soils, Seismic Hazards, or Mineral Resources
- Air Quality
- Land Use
- Water Resources
- Biological Resources
- Cultural Resources
- Traffic and Circulation
- Noise
- Recreation and Public Access
- Aesthetics
- Public Health and Safety, including HTRW
- Utilities and Public Services
- Socioeconomics and Environmental Justice

Table 6-7 below summarizes the comparison of environmental quality between No Action and the final array of alternatives. Costs shown in the incremental costs were those used for the CE/ICA and based upon April 2013 price level with a FY 2013 interest rate of 3.75 percent.

Table 6-7 EQ Evaluation and Comparison Summary

Resource Area	No Action	10 (ART) ARBOR Riparian Transitions	13 (ACE) ARBOR Corridor Extension	Alternative 13v	16 (AND) ARBOR Narrows to Downtown	20 (RIVER) ARBOR Riparian Integration via Varied Ecological Reintroduction
Net gain in AAHU	0	5,321	5,902	5,989	6,509	6,782
Incremental Cost/AAHU (Q3FY13, 3.75% Interest Rate) % increase in AAHU versus no action	0	$3,259 93%	$6,651 104%	Incremental Cost in Chapter 7 106%	$29,253 114%	$46,827 (incremental costs is updated in Chapter 7) 119%
Geology, Seismology, Soils, and Minerals	No change.	Temporary, less than significant adverse impacts due to construction. Long term beneficial due to stabilization of soils from increased wetland and riparian vegetation over 251 acres.	Temporary, less than significant adverse impacts due to construction. Long term beneficial due to stabilization of soils from increased wetland and riparian vegetation over 271 acres.	Temporary, less than significant adverse impacts due to construction. Long term beneficial due to stabilization of soils from increased wetland and riparian vegetation over 283 acres.	Temporary, less than significant adverse inpacts due to construction. Long term beneficial due to stabilization of soils from increased wetland and riparian vegetation over 270 acres.	Temporary, less than significant adverse impacts due to construction. Long term beneficial due to stabilization of soils from increased wetland and riparian vegetation over 288 acres.
Air Quality	No change.	Temporary, less than significant adverse impacts from air quality threshold exceedances during construction under NEPA.	Temporary, less than significant adverse impacts from air quality threshold exceedances during construction under NEPA.	Temporary, less than significant adverse impacts from air quality threshold exceedances during construction under NEPA.	Temporary, less than significant adverse impacts from air quality threshold exceedances during construction under NEPA.	Temporary, less than significant adverse impacts from air quality threshold exceedances during construction under NEPA.
Land Use	No change.	Permanent, significant adverse impacts through conflict with land use designation in Reach 8.	Permanent, significant adverse impacts through conflict with land use designation in Reach 8.	Permanent, significant adverse impacts through conflict with land use designation in Reach 8.	Permanent, significant adverse impacts through conflict with land use designation in Reach 8.	Permanent, significant adverse impacts through conflict with land use designation in Reach 8 and Reach 3

Resource Area	No Action	10 (ART) ARBOR Riparian Transitions	13 (ACE) ARBOR Corridor Extension	Alternative 13v	16 (AND) ARBOR Narrows to Downtown	20 (RIVER) ARBOR Riparian Integration via Varied Ecological Reintroduction
Water Resources	Continued degradation.	Temporary, less than significant adverse impacts to water quality due to erosion. Long term beneficial impacts resulting from increase in riparian vegetation (251 acres) and wetland creation (16 acres).	Temporary, less than significant adverse impacts to water quality due to erosion. Long term beneficial impacts resulting from increase in riparian vegetation (271 acres) and wetland creation (39 acres).	Temporary, less than significant adverse impacts to water quality due to erosion. Long term beneficial impacts resulting from increase in riparian vegetation (271 acres) Increase with Alt 13v to 49 wetland acres	Temporary, less than significant adverse impacts to water quality due to erosion. Long term beneficial impacts resulting from increase in riparian vegetation (270 acres) and wetland creation (49 acres).	Temporary, less than significant adverse impacts to water quality due to erosion. Long term beneficial impacts resulting from increase in riparian vegetation (288 acres) and wetland creation (58 acres).
Biological Resources	Continued degradation.	Long term benefits to biological resources from creation of riparian vegetation (251), wetland creation (16), creation of one new side channel, and additional open water habitat (80 foot expansion).	Long term benefits to biological resources from creation of riparian vegetation (271), wetland creation (39), creation of 2 new side channels, and additional open water habitat (300 foot expansion).	Long term benefits to biological resources from creation of riparian vegetation (271), wetland creation (49), creation of 2 new side channels, and additional open water habitat (300 foot expansion). 13v would include connection to LASHP	Long term benefits to biological resources from creation of riparian vegetation (270), wetland creation (49), creation of 3 new side channels, additional open water habitat (500 foot expansion), and restoration of Arroyo Seco confluence.	Long benefits to biological resources from creation of riparian vegetation (288), wetland creation (58), creation of 3 new side channels, additional open water habitat (500), restoration of Arroyo Seco and Verdugo Wash confluences, and connection to LASHP.
Cultural Resources	No change.	Pending inplementation of the program laid out in the PA, no significant adverse effects are anticipated.	Pending implementation of the program laid out in the PA, no significant adverse effects are anticipated.	Pending implementation of the program laid out in the PA, no significant adverse effects are anticipated.	Pending implementation of the program laid out in the PA, no significant adverse effects are anticipated.	Pending implementation of the program laid out in the PA, no significant adverse effects are anticipated.

Resource Area	No Action	10 (ART) ARBOR Riparian Transitions	13 (ACE) ARBOR Corridor Extension	Alternative 13v	16 (AND) ARBOR Narrows to Downtown	20 (RIVER) ARBOR Riparian Integration via Varied Ecological Reintroduction
Traffic and Circulation	No change, continued degradation with population growth.	Temporary, less than significant adverse impacts from traffic congestion during construction.	Temporary, less than significant adverse impacts from traffic congestion during construction.	Temporary, less than significant adverse impacts from traffic congestion during construction.	Temporary, less than significant adverse impacts from traffic congestion during construction.	Temporary, less than significant adverse impacts from traffic congestion during construction.
Noise	No change, continued degradation with population growth.	Temporary increase during construction.	Temporary increase during construction.	Temporary increase during construction.	Temporary increase during construction.	Temporary increase during construction.
Recreation	No change	Minor and temporary adverse effects due to closures during construction. Long-term beneficial effects resulting from greater access and improved recreation features.	Minor and temporary adverse effects due to closures during construction. Long-term beneficial effects resulting from greater access and improved recreation features.	Minor and temporary adverse effects due to closures during construction. Long-term beneficial effects resulting from greater access and improved recreation features.	Minor and temporary adverse effects due to closures during construction. Long-term beneficial effects resulting from greater access and improved recreation features.	Minor and temporary adverse effects due to closures during construction. Long-term beneficial effects resulting from greater access and improved recreation features.
Aesthetics	Continued degraded condition	Minor and temporary effects from construction. Long-term beneficial effects from riparian revegetation, creation of native habitat, removal of invasive plants (338 acres).	Minor and temporary effects from construction. Long-term beneficial effects from riparian revegetation, removal of invasive plants (406 acres), creation of native habitat.	Minor and temporary effects from construction. Long-term beneficial effects from riparian revegetation, removal of invasive plants (406 acres), creation of native habitat.	Minor and temporary effects from construction. Long-term beneficial effects from riparian revegetation, creation of native habitat, removal of invasive plants (464 acres).	Minor and temporary effects from construction. Long-term beneficial effects from riparian revegetation, creation of native habitat, removal of invasive plants (499 acres).
Public Health and Safety, Including Hazardous, Toxic and Radioactive Waste	No change.	Impacts would be avoided by implementing safety standards and BMPs. HTRW remediation would occur where necessary prior to construction	Impacts would be avoided by implementing safety standards and BMPs. HTRW remediation would occur where necessary prior to construction	Impacts would be avoided by implementing safety standards and BMPs. HTRW remediation would occur where necessary prior to construction	Impacts would be avoided by implementing safety standards and BMPs. HTRW remediation would occur where necessary prior to construction	Impacts would be avoided by implementing safety standards and BMPs. HTRW remediation would occur where necessary prior to construction

Resource Area	No Action	10 (ART) ARBOR Riparian Transitions	13 (ACE) ARBOR Corridor Extension	Alternative 13v	16 (AND) ARBOR Narrows to Downtown	20 (RIVER) ARBOR Riparian Integration via Varied Ecological Reintroduction
Utilities and Public Services	No change.	Utility relocations would occur in Reaches 6 and 7.	Utility relocations would be the same as Alt 10.	Utility relocations would be the same as Alt 13.	Utility relocations would be the same as Alt 13 except in Reach 8, where more utilities would be relocated.	Utility relocations would be the same as Alt 16.
Socioeconomics and Environmental Justice	No change.	Potential minor temporary adverse effects from recreation closures. Temporary benefit to employment during construction. Long-term beneficial effects to low-income and minority populations from improved ecological condition, water quality, recreation access, aesthetics.	Potential minor temporary adverse effects from recreation closures. Temporary benefit to employment during construction. Long-term beneficial effects to low-income and minority populations from improved ecological condition, water quality, recreation access, aesthetics.	Potential minor temporary adverse effects from recreation closures. Temporary benefit to employment during construction. Long-term beneficial effects to low-income and minority populations from improved ecological condition, water quality, recreation access, aesthetics.	Potential minor temporary adverse effects from recreation closures. Temporary benefit to employment during construction. Long-term beneficial effects to low-income and minority populations from improved ecological condition, water quality, recreation access, aesthetics.	Potential minor temporary adverse effects from recreation closures. Temporary benefit to employment during construction. Long-term beneficial effects to low-income and minority populations from improved ecological condition, water quality, recreation access, aesthetics.

For most of the resource or use categories listed above, environmental effects arising from this project would be beneficial. However, significant, unavoidable adverse impacts have been identified under some resource categories. A summary of effects by alternative is as follows:

Alternative 10 (ART)

Long-term, beneficial impacts to water resources, biological resources, aesthetics, and recreation would occur under this alternative. In general, these beneficial effects would occur during operation and maintenance of the restored habitat, and are associated with increased wetland and riparian function, a higher ratio of plants to hardscape compared to existing conditions, and increased opportunities for bird watching and outdoor education.

Short-term, minimal to moderate adverse impacts to water resources, biological resources, aesthetics, recreation, transportation and circulation, and socioeconomics would occur under this alternative. Significant, unavoidable adverse impacts to land use would occur under this alternative. Significant land use impacts are associated with conflicts with the industrial and light industrial designation in Reach 8.

Alternative 13 (ACE) and Alternative 13v

Impacts under this alternative, both beneficial and adverse, would include those identified under Alternative 10. These impacts may be more extensive compared to Alternative 10 due to more extensive implementation of proposed restoration measures under this alternative. The significant, unavoidable adverse impacts to land use would be the same as in Alternative 10.

Alternative 16 (AND)

Impacts under this alternative, both beneficial and adverse, would include those identified under Alternatives 10 and 13. These impacts may be more extensive compared to Alternative 10 due to more extensive implementation of proposed restoration measures under this alternative. The significant, unavoidable adverse impacts to land use would be the same as in Alternative 10.

Alternative 20 (RIVER)

Impacts under this alternative, both beneficial and adverse, would include those identified under the previous alternatives. Impacts would likely be most extensive under this alternative since it would involve the most extensive implementation of proposed restoration measures. In addition to the significant adverse land use impacts in Alternative 10 in Reach 8, this alternative would also result in conflicts with the industrial land use designation in Reach 3, constituting a significant adverse impact.

6.3.3 Environmentally Preferable Alternative and Environmentally Superior Alternative

For NEPA, the environmentally preferable alternative is the alternative that will promote the national environmental policy as expressed in NEPA's Section 101. Ordinarily, this means the alternative that causes the least damage to the biological and physical environment; it also means the alternative which best protects, preserves, and enhances historic, cultural, and natural resources. NEPA requires that, when finalizing an EIS, the Record of Decision (ROD) specify the alternative that was considered to be environmentally preferable.

CEQA Guidelines in section 15126.6(e)(2) requires that an EIR identify an "environmentally superior alternative." The Guidelines go on to state that if the No Project Alternative is the environmentally superior alternative, then the EIR must also identify an environmentally sensitive alternative from among the build (or "action") alternatives.

Based on the following analysis and the information elsewhere in this IFR, Alternative 20 is the environmentally preferable alternative under NEPA and the environmentally superior alternative under CEQA.

The five action alternatives under consideration each have a combination of adverse and beneficial effects on the environment, although by far the overall effect of each action alternative is beneficial. With one exception, there are no instances where there is a significant adverse effect for one alternative and not for another; the same is true for less than significant effects and beneficial effects. (Construction scheduling assumptions made for Alternative 13v result in less than significant air quality impacts for that alternative, whereas the other action alternatives would potentially exceed Localized Significance Thresholds under CEQA.) In determining the environmentally superior/ environmentally preferable alternative for this project, alternatives were compared against one another in regards to the extent of impacts versus the extent of benefits.

The No Action alternative clearly has the least adverse effects during construction, since construction would not occur. However, there are also no beneficial effects in the long term for the No Action alternative.

As shown in Table 5-1, significant adverse effects (under NEPA) and significant and unavoidable impacts (under CEQA) to Land Use were identified for construction and operations for all five alternatives, and significant unavoidable impacts to Air Quality (exceedance of localized significance thresholds during construction) were identified under CEQA for all alternatives other than Alternative 13v. In the case of Land Use, all alternatives have significant adverse effects associated with inconsistency with industrial and light industrial land use designations and community plans in Reach 8. Alternative 20 has an additional significant adverse impact in Reach 3, where proposed restoration measures at Verdugo Wash are inconsistent with the industrial land use designation. In the case of Air Quality, the types of effects are the same across the alternatives, with the primary differences occurring in the magnitude of emissions of criteria pollutants during construction. Differences among alternatives were most noticeable for the following environmental elements: Biological Resources; Geology, Seismology, Soils, and Minerals; Water Resources; Recreation; Traffic and Circulation; and Socioeconomics and Environmental Justice.

In the cases of Biological Resources, Water Resources, and Recreation, Alt. 20 has greater beneficial effects than the other alternatives, due to the larger scale of the restoration effort and, thus, the greater benefits to water, species, and habitat, and greater recreational resources. For Geology, Seismology, Soils, and Minerals, there is a greater area of ground disturbance for Alternative 20 (and lesser for Alternatives 16, 13v, 13, and 10 in that order), though the effects for all five are less than significant. Traffic and Circulation effects are spread out for a longer period for Alternatives 16 and 20, than for 13v and 13, and finally for Alternative 10. Again, in all cases, the effects are less than significant. Socioeconomics and Environmental Justice impacts are again linked primarily to construction duration and are greatest for Alternatives 16 and 20, but again are less than significant for all alternatives.

Although Alternative 20 has the most extensive adverse impacts, the additional impacts are offset by the additional environmental benefits of having the greatest net gain in average annual habitat units, both in absolute terms and in percentage terms versus the No Action alternative. This, combined with the greater operational benefits in the key long-term biological and water resource elements, results in Alternative 20 being designated as the environmentally superior/environmentally preferable alternative. While there is a longer construction duration and larger work footprint for Alternative 20 than other alternatives, this is more than balanced by the gains in habitat units and other resources.

6.3.4 Regional Economic Development

RED impacts include, principally, changes in income and employment. There may be some overlap with the other accounts. Indirect and induced impacts are the focus of the RED account, and differences between it and NED are considered transfers from the rest of the nation. The study area for RED is the Los Angeles metropolitan area, which is home to 15.4 million people with the largest population and largest area in the United States. If this area were a country, it would have the 15th largest economy in the world, just below Australia and just above the Netherlands, Turkey, Sweden, Belgium, and Indonesia.

The following summarizes the RED assessment as reported in the Draft IFR. Updated numbers are reported in Chapter 7. These results were developed by the study team as reasonable factors, based upon available information, for developing a general estimate of potential redevelopment RED benefits associated with project alternatives. Ranking is in terms of employment, Gross Regional Product, and tax revenues. Additional detail pertaining to the RED is found in Appendix B Economics.

Table 6-8 provides the RED in three levels. Level 1 is impacts of construction of the project (both by the ecosystem restoration and the recreation components), Level 2 is impacts of redevelopment construction, and Level 3 shows impacts of long-term redevelopment.

Table 6-8 Assessment of Impacts from Construction (Price level April 2013)

Regional Economic Development From Construction					
Criteria		**10 (ART)**	**13 (ACE)**	**16 (AND)**	**20 (RIVER)**
Plan Description	**No Action**	**ARBOR Riparian Transitions**	**ARBOR Corridor Extension**	**ARBOR Narrows to Downtown**	**ARBOR Riparian Integration via Varied Ecological Reintroduction**
Ecosystem Construction Cumulative Impacts					
Jobs	0	913	1,986	6,491	9,001
Labor Income	$0	$52,560,000	$114,350,000	$373,823,000	$518,341,000
Sales	$0	$125,936,000	$273,986,000	$895,690,000	$1,241,959,000
GRP	$0	$73,445,000	$159,785,000	$522,357,000	$724,297,000
Recreation Construction Cumulative Impacts					
Jobs	0	74	74	74	74
Labor Income	$0	$4,998,000	$4,998,000	$4,998,000	$4,998,000
Value	$0	$12,958,000	$12,958,000	$12,958,000	$12,958,000
Output	$0	$7,265,000	$7,265,000	$7,265,000	$7,265,000
Redevelopment Construction Cumulative Impacts					
Jobs	0	1,226	1,281	1,281	5,087
Labor Income	$0	$80,981,000	$84,665,000	$84,665,000	$336,278,000
Value	$0	$111,132,000	$115,791,000	$115,791,000	$460,153,000
Output	$0	$185,630,000	$193,002,000	$193,002,000	$767,247,000
Redevelopment Long-term Economic Activity Cumulative Impacts					
Jobs	0	628	675	675	2,671
Labor Income	$0	$897,646,000	$964,851,000	$964,851,000	$3,815,989,000
Taxes – Local	$0	$5,386,000	$5,789,000	$5,789,000	$22,896,000

The alternatives are estimated to create between 2,200 to 14,100 construction related jobs over the period of analysis. Employment is anticipated to generate labor income ranging from $138 million to $860 million. Regional economic activity from construction is expected to increase by $260 million to nearly $1.5 billion with ecosystem restoration, recreation and redevelopment construction.

The long-term economic impacts of redevelopment are estimated to eventually create permanent employment of 630 to 2,700 jobs. This employment will have a greater impact to the region as these employment opportunities exist throughout the period of analysis. Total labor income from these employment opportunities is estimated to range from nearly $900 million to just under $4 billion depending upon alternative.

The cumulative effects of the construction/redevelopment components over the period of analysis will create between 2,800 to 16,800 jobs with incomes from over $1 billion to nearly $5 billion.

6.3.5 Other Social Effects Assessment

The OSE account describes the potential effects of project alternatives in areas that are not dealt with explicitly in the NER and RED accounts. The Principles and Guidelines state that the OSE, when included in USACE documents, should "display plan effects on social aspects such as community impacts, health and safety, displacement, energy conservation and others."

Social effects in a general sense refer to a concern for how the constituents of life that influence personal and group definitions of satisfaction, well-being, and happiness are affected by some condition or proposed intervention. Well-being is an ensemble concept composed of multiple dimensions. While economic factors are very important in characterizing well-being, there are many more factors which come into play. In particular the distribution of resources; the character and richness of personal and community associations; the social vulnerability and resilience of individuals, groups, and communities; and the ability to participate in systems of governance are all elements that help define well-being.

This OSE analysis describes the potential social effects of the alternatives under consideration. The OSE account explores the following categories of effects from the implementation of the alternatives considered; this is described in Appendix B, Economics, and summarized in the Table 6-9 below. In most cases it is not possible to differentiate between the social effects of the restoration alternatives. Appendix B Economics presents the OSE effects in much more detail.

- Displacement/Impacts to Population
- Public Health and Safety
- Displacement/Impacts to Minorities and Special Interest Groups
- Displacement/Impacts to Businesses
- Displacement/Impacts to Agriculture
- Displacement/Impacts to Recreational Areas
- Community Growth
- Project Impacts and Connectivity of the Community
- Community Well-being
- Environmental Health

1 **Table 6-9 Other Social Effects Assessment**

Criteria	No Action	10 (ART)	13 (ACE)	16 (AND)	20 (RIVER)
Displacement/Impacts to Population	No effects	No displacement to population	No displacement to population	No displacement to population	No displacement to population
Public Health and Safety	Same as existing condition	Improved community health through restored river and open space/recreation opportunities	Improved community health through restored river and open space/recreation opportunities	Improved community health through restored river and open space/recreation opportunities	Improved community health through restored river and open space/recreation opportunities
Displacement/Impacts to Minorities and Special Interest Groups	Same as existing condition	No displacements or relocations. Improved linkages to trails and neighborhood parks, increasing property values	No displacements or relocations. Improved linkages to trails and neighborhood parks, increasing property values	No displacements or relocations. Improved linkages to trails and neighborhood parks, increasing property values	No displacements or relocations. Improved linkages to trails and neighborhood parks, increasing property values
Displacement of Businesses	No impacts	Business displacement in Reach 8	Business displacement in Reach 8	Business displacement in Reach 8	Business displacement in Reaches 3, 7, and 8
Displacement/Impacts to Recreational Areas	No impacts	Temporary restriction to existing recreation areas during construction	Temporary restriction to existing recreation areas during construction	Temporary restriction to existing recreation areas during construction	Temporary restriction to existing recreation areas during construction
Community Growth	Continued as in the existing conditions	Ecosystem restoration measures are projected to revitalize commercial, industrial, and residential development in several areas	Ecosystem restoration measures are projected to revitalize commercial, industrial, and residential development in several areas	Ecosystem restoration measures are projected to revitalize commercial, industrial, and residential development in several areas	Ecosystem restoration measures are projected to revitalize commercial, industrial, and residential development in several areas
Project Impacts and Connectivity to the community	River would not be restored and not result in any improvement to existing conditions	Promote connectivity of the community by providing a common place for residents to recreate and interact and create a sense of community and belonging	Promote connectivity of the community by providing a common place for residents to recreate and interact and create a sense of community and belonging	Promote connectivity of the community by providing a common place for residents to recreate and interact and create a sense of community and belonging	Promote connectivity of the community by providing a common place for residents to recreate and interact and create a sense of community and belonging
Community Well Being	No changes	Restored River with recreation opportunities promotes well-being and livability of the community.	Restored River with recreation opportunities promotes well-being and livability of the community.	Restored River with recreation opportunities promotes well-being and livability of the community.	Restored River with recreation opportunities promotes well-being and livability of the community.
Environmental Health; aesthetics, stormwater runoff, energy savings, air quality	No changes	$4,216,800	$4,586,400	$4,536,000	$4,838,400

6.3.6 Principles and Guidelines

The Principles and Guidelines (U.S. Water Resources Council 1983) and the USACE Institute for Water Resources (IWR) Planning Manual (USACE 1996) present decision criteria for evaluation, comparison, and selection of measures. These are effectiveness, completeness, efficiency, and acceptability, as defined in Chapter 4. The discussion below addresses Alternatives 10, 13, 16 and 20. The assessment of these criteria for Alternative 13v is provided in Section 6.6.3 below.

Alt 10 ART

- *Effectiveness.* Alt 10 ART is judged to be minimally effective, in that while it meets the planning objectives overall and has restoration in all 8 reaches, it fails to meet the key target objective of reconnection to tributaries, and thereby does not realize those potential habitat benefits, nor does it provide opportunities for key regional connectivity to the San Gabriel or Verdugo Mountains.
- *Completeness.* Alt 10 ART is considered complete, though it is considered the less resilient than alternatives 16 AND or 20 RIVER and therefore is subject to higher risk of failure to realize the estimated habitat benefits over the period of analysis.
- *Efficiency.* Alt 10 ART is efficient. All components of the plan were judged to be cost effective and best buys in the CE/ICA.
- *Acceptability.* Alt 10 ART complies with applicable laws, regulations, and public policies, and any adverse effects would be mitigated per discussion provided in Chapter 5.

Alt 13 ACE

- *Effectiveness.* Alt 13 ACE is judged to be more effective than Alternative 10; it meets the planning objectives overall, including restoration in all 8 reaches, but also includes restoration of the tributary confluence at Arroyo Seco, which provides opportunity for key regional connectivity to the San Gabriel Mountains.
- *Completeness.* Alt 13 ACE is considered complete and is more resilient that Alternative 10
- *Efficiency.* Alt 13 ACE is efficient. All components of the plan were judged to be cost effective and best buys in the CE/ICA.
- *Acceptability.* Alt 13 ACE complies with applicable laws, regulations, and public policies and any adverse effects would be mitigated per discussion provided in Chapter 5.

Alt 16 AND

- *Effectiveness.* Alt 16 AND is judged to be more effective than Alternative 13. It meets the planning objectives, especially in terms of contiguous restoration within and across reaches. The widening at LATC reconnects the river to its historic floodplain with a natural hydrologic connection and provides connectivity for wildlife to a key habitat node within the project area.
- *Completeness.* Alt 16 AND is considered complete, more resilient than Alt 10 ART or Alt 13 ACE.
- *Efficiency.* Alt 16 AND is efficient. All components of the plan were judged to be cost effective any best buys in the CE/ICA. However, Alt 16 AND is substantially less efficient than Alt 13 ACE due to a significant increase in incremental cost per gain in output (HUs) compared to Alt 13 ACE.
- *Acceptability.* Alt 16 AND complies with applicable laws, regulations, and public policies, and any adverse effects would be mitigated per discussion provided in Chapter 5.

Alt 20 RIVER

- *Effectiveness.* Alt 20 RIVER is judged to be the most effective of the final alternatives. It maximizes contribution toward achievement of the planning objectives. Restoration at the

Verdugo Wash confluence provides additional habitat while maximizing opportunities for regional connectivity to the San Gabriel and Verdugo Mountains. Restoration at Cornfields provides additional habitat and opportunities for connectivity to the Elysian Hills. This alternative also maximizes the potential for near and long term RED and OSE benefits.

- *Completeness.* Alt 20 RIVER is considered complete. It would be resilient, and likely to achieve the estimated habitat benefits over the period of analysis.
- *Efficiency.* Alt 20 RIVER is efficient. All components of the plan were judged to be cost effective any best buys in the CE/ICA. It is the most expensive of the four final alternatives and is substantially less efficient than Alt 13 ACE due to a significantly higher incremental cost per gain in output (HUs).
- *Acceptability.* Alt 20 RIVER complies with applicable laws, regulations, and public policies and any adverse effects would be mitigated per discussion provided in Chapter 5.

6.4 FINAL ARRAY COST ESTIMATES IN DRAFT IFR

Following identification of the final array of alternatives for the Draft IFR, refinements were made to the cost estimates. An abbreviated cost risk analysis was also conducted. In a risk analysis, both risks and uncertainties pertaining to design and implementation of the project are considered and possible risks of future cost escalation considered. This risk analysis is included in Appendix C Cost Estimating, and applicable contingencies have been applied to the costs shown below in Table 6-10. These costs are shown as April 2013 price level as that is the time that they were last updated. These costs were the basis for plan formulation, evaluation and comparison used to identify the NER Plan. These are level 4 cost estimates per ER 1110-2-1302. Refinements to the costs for the Draft IFR final array resulted in minor changes to the total first costs and average annual costs. Economic evaluation confirmed that these impacts would not have had a material impact on the alternative comparison described in Chapter 4, or the selection of the final array of alternatives for the Draft IFR. Costs for the NER and LPP plans presented later in the report are expressed in October 2015 price levels and were refined based upon more detailed design and cost estimates.

Table 6-10 Draft Final Array Cost Information Ecosystem Restoration
(Price level April 2013, Interest Rate FY13-3.375 Percent)

	Alt 10	Alt 13	Alt 16	Alt 20
Construction Cost	$55,456,944	$120,312,641	$360,927,221	$506,743,287
PED/EDC	$5,466,398	$12,104,790	$39,106,569	$53,724,144
S&A	$3,278,181	$7,259,203	$23,452,081	$32,218,193
LERRDs	$310,581,116	$313,729,423	$380,442,863	$487,941,715
TOTAL FIRST COST	**$374,782,639**	**$453,406,057**	**$803,928,734**	**$1,080,627,339**
Interest During Construction	$8,525,508	$11,466,426	$49,902,201	$60,615,729
Total Investment Cost	$383,308,147	$464,872,483	$853,830,935	$1,141,243,068
Annualized Investment Cost	$15,975,233	$19,374,611	$35,585,332	$47,563,882
Annualized O&M	$579,141	$872,445	$2,257,215	$2,515,390
Total Annual Cost	$16,554,374	$20,247,056	$37,842,547	$50,079,272
AAHU	5,321	5,902	6,509	6,782

6.5 COMPARISON OF ALTERNATIVES TO SUPPORT TSP SELECTION AND DESIGNATION OF NER FOR DRAFT IFR

The final array of action alternatives in the Draft IFR provided a range of approaches for the project, from Alt 10 ART which minimizes cost but does not fully meet all target objectives, to Alt 20 RIVER, which provides the most extensive restoration actions to maximize NER, RED, and OSE benefits at higher costs. Comparisons of alternatives for impacts in chapter 5 and benefits in chapter 6 provide the following supported the selection of a TSP and designation of the NER plan in the Draft IFR.

6.5.1 Cost Effectiveness and Incremental Cost Analysis

The CE/ICA performed for the Draft IFR strongly supported the identification of Alternative 13 as the NER Plan. The following table summarizes the key cost and output metrics for the CE/ICA. As shown below, Alternative 10 provides 5,321 AAHUs at a total cost of $374 million and an annual cost of about $17 million. The AAC/AAHU is $3,111. Relative to Alternative 10, Alternative 13 provides an 11 percent increase in output at an incremental first cost of $79 million and an incremental average annual cost of $3.7 million (a 22 percent increase). The incremental AAC/AAHU is $6,365, which is about double the incremental AAC/AAHU for Alternative 10. Costs in table 6-11 are shown at April 2013 price level, per when it was last updated.

Table 6-11 Final Array CE/ICA Comparison Table (Price level April 2013)

	Alt 10	Alt 13	Alt 16	Alt 20
Total First Cost	$374,782,639	$453,406,057	$803,928,734	$1,080,627,338
Incremental First Cost	$374,782,639	$78,623,418	$350,522,677	$276,698,604
Incremental First Cost %		21%	77%	34%
AAHU	5,321	5,902	6,509	6,782
Incremental AAHU		581	607	273
Incremental AAHU %		11%	10%	4%
Total Cost/AAHU	$70,435	$76,822	$123,510	$159,338
Total Cost/AAHU % Increase		9%	61%	29%
Total First Cost/Restored Acre	$709,816	$771,099	$1,219,922	$1,502,959
TFC/Acre % Increase		9%	58%	23%
Total Annual Cost	$16,554,374	$20,247,056	$37,842,547	$50,079,272
Incremental Annual Cost	$16,554,374	$3,692,682	$17,595,491	$12,236,725
Incremental Annual Cost %		22%	87%	32%
AAC/AAHU	$3,111	$3,431	$5,814	$7,384
AAC/AAHU % Increase		10%	69%	27%
AAC/Acre	$31,353	$34,434	$57,424	$69,651
AAC/Acre % Increase		10%	67%	21%
Incremental AAC/AAHU	$3,111	$6,356	$28,988	$44,823
Incremental AAC/AAHU %		104%	356%	55%
Incremental AAC/AAHU vs. Alt 13	49%	100%	456%	705%
Multiple	0.5	1.0	4.6	7.1

There is a substantial increase in cost (both in total cost and percent increase in cost) associated with Alternative 16 relative to Alternative 13. While the percent increase in output for Alternative 16 of 10 percent is approximately the same as under Alternative 13 (relative to Alternative 10), the percent increase in costs are approximately 80 percent (vs. about 20 percent for Alternative 13). Therefore, the incremental AAC/AAHU for Alternative 16 is over four times higher than for Alternative 13. Similarly, Alternative 20 requires a significant increase in cost relative to output compared to Alternative 13. The incremental AAC/AAHU for Alternative 20 is about seven times higher than Alternative 13. The following two graphs display the substantial increases in cost and cost per output for Alternatives 16 and 20 relative to Alternative 13.

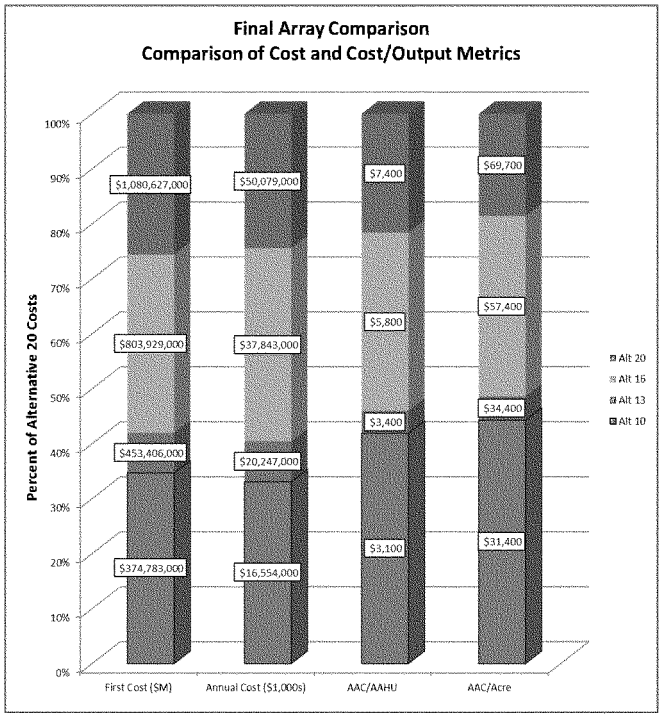


Figure 6-14 Final Array Comparison Cost and Cost/Output Metrics

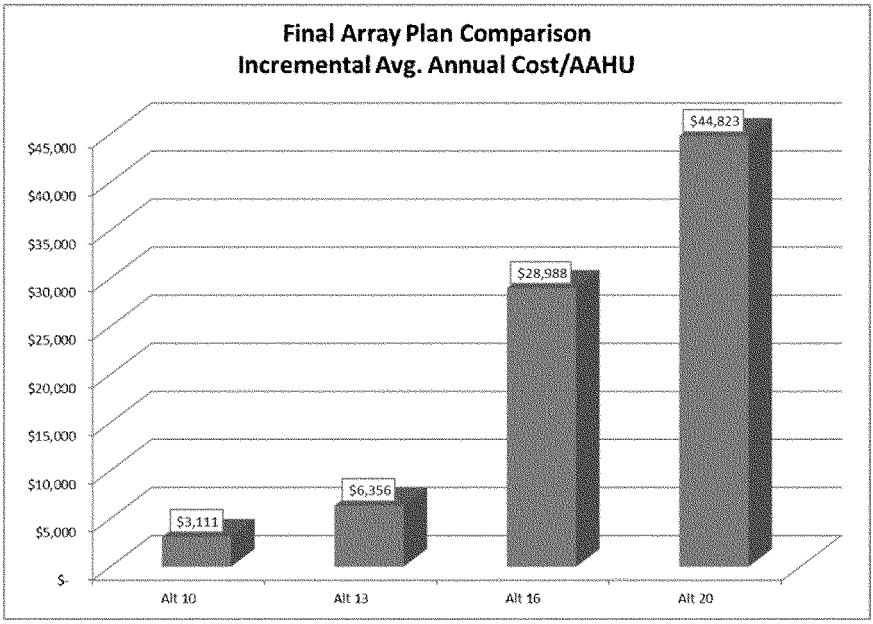


Figure 6-15 Final Array Plan Comparison Incremental Average Annual Cost/AAHU

Based upon these CE/ICA results, Alternative 13 was identified as the NER Plan. The following sections describe considerations other than the CE/ICA analysis considered in the selection of the tentatively selected plan, including completeness, effectiveness and acceptability, as well as the other Principles and Guidelines accounts.

6.5.2 Completeness, Effectiveness and Acceptability Criteria Comparison

Alternative 10 is complete, but less resilient than other alternatives, and only minimally effective as it does not provide key nodal connections to large tributary watersheds. Alternative 13 is incrementally more effective, and complete, as it is more resilient than Alternative 10. Alternative 16 is incrementally more complete and effective as it is more resilient than Alternatives 10 and 13. Alternative 20 is also incrementally more complete, and effective. All four alternatives are acceptable as they comply with applicable laws, regulations and public policies except as mitigated per the discussion in Chapter 5.

6.5.3 Effectiveness: Objective Analysis Summary

The alternatives were qualitatively analyzed for their ability to meet objectives, which is an important component of effectiveness. Alternative 10 minimally met the objectives with the incremental differences in 13, 16 and 20 increasing each larger alternative's capacity to meet each objective. For example, in restoring nodal habitat connectivity, Alternative 10 restores minimal connectivity within the reach where none existed before. Compared to Alternative 10, Alternative 13 significantly increases nodal connectivity by 309 percent. Increases in nodal connectivity for Alternatives 16 and 20 are incrementally

smaller (85 percent for Alternative 16 over Alternative 13 and 120 percent for Alternative 20 over Alternative 16). Alternative 13 adds restoration of a major tributary confluence and Alternative 20 adds a second major tributary. Each alternative adds increasing levels of naturalization of the riverbed and banks with Alternative 13 the first to add significant channel restoration in the centrally located Taylor Yard and Alternative 16 adding the naturalizing of the concrete bed (Reach 8).

6.5.4 Analysis using the Four Accounts

The final array of alternatives were also compared using the four accounts of National Economic Development (NED), Environmental Quality (EQ), Regional Economic Development (RED), and Other Social Effects (OSE). The EQ analysis shows similar results to that seen in the habitat evaluation with the highest incremental increases in benefits realized with Alternative 13. Benefits increase incrementally as the size of the alternative area increases. There are significant temporary adverse effects to environmental quality however, benefits increase after construction. RED benefits are significantly increased for each alternative. However, the largest increase in RED benefits occurs with the incremental change from Alternative 16 to Alternative 20. OSE benefits are similar and increasing with relative area.

6.5.5 Analysis by Constraints

There were several constraints considered in plan formulation, including avoidance of HTRW where practicable and sponsor remediation where avoidance is impracticable; avoidance of surrounding urbanization and infrastructure where practicable; sponsor provision of real estate; maintenance of existing levels of flood risk management; and avoidance of conflicts with existing engineering policies for flood risk management projects. The major constraints are compared in Section 6.2 above. All alternatives include similar requirements for use of sites currently known or suspected of having HTRW contamination with the inclusion of the two Taylor Yard sites in Reach 6, LATC in Reach 8 in addition to the SFVSS groundwater contamination within the study area. All alternatives have high real estate costs that required a policy exception. Existing levels of flood risk management are maintained with each alternative, and each alternative would avoid conflicts with existing engineering policies for flood risk management projects. All alternatives avoided surrounding urbanization and infrastructure where practicable, but all alternatives would displace some industrial uses and Alternatives 13v, 16, and 20 would all impact segments of active rail lines, requiring that these segments be trestled at grade.

6.5.6 Impact Analysis

The comparison of the benefits and impacts of each alternative shows that all alternatives will have similar environmental impacts in nearly all categories, with an increase in impacts as the alternatives increase in areal extent from Alternative 10 to 20. Each alternative has temporary impacts due to construction in all categories and similar beneficial cumulative impacts over the long-term. Alternative 20 would have more significant land use changes in Reach 3 adjacent to Verdugo Wash and in Reach 7 adjacent to the Los Angeles River State Historic Park. The impact analysis supports the choice of any of the four alternatives, however, the larger the alternative the higher the impacts, but with higher beneficial impacts in the long-term.

6.5.7 NER Plan Identification

Based on the comparative analysis above, the Draft IFR identified Alternative 13 as the Tentatively Selected Plan and NER Plan as it reasonably maximized net NER benefits. Alternative 13 reasonably maximizes outputs while passing tests of CE/ICA, reasonably met all planning objectives, reasonably avoids constraints (at least as well as other alternatives), provides significant ecosystem outputs, and is effective, efficient, complete, and acceptable. Therefore, it was identified as the NER Plan in the Draft IFR. The following section describes additional analysis and actions taken after the circulation of the

Draft IFR that resulted in identification of a variation on the previously identified NER plan and recommendation of a Locally Preferred Plan.

6.6 NATIONAL ECOSYSTEM RESTORATION (NER) PLAN AND LOCALLY PREFERRED PLAN (LPP)

The Los Angeles District (District) circulated the Draft IFR for a 45-day public review period beginning on September 20, 2013, and a public meeting was held on October 17, 2013. The Draft IFR identified Alternative 13 as the Tentatively Selected Plan and NER Plan as it reasonably maximizes net NER benefits. After consideration of public comments, IEPR panel comments, and further updates to cost to prepare this final IFR, the NER Plan was refined and a Locally Preferred Plan was approved for recommendation to Congress.

6.6.1 Public Review Comments

Review comments during the public comment period came from letters, emails, and participants at the Public Meeting. The District received and evaluated nearly 500 comments. Federal agencies including the U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, Department of Interior, the Urban Waters Federal Partnership, state and local agencies, non-governmental organizations, interest groups, elected officials, and private citizens provided comments. The public meeting included over 300 attendees, with close to unanimous support for Alternative 20. In addition, the District received over 8,000 petition signatures in support of Alternative 20. The comments can be reviewed in Appendix L and responses. Key comments related to the following topics:

- Scope of the recommended plan
- Acceptability and completeness of the plans
- Habitat and hydrologic connectivity benefits associated with the plans
- Model used to calculate benefits
- Environmental justice
- Union Pacific Rail Road Yard (LATC) relocation

6.6.2 Independent External Peer Review

Independent External Peer Review (IEPR) was conducted on the Draft IFR and Appendices. IEPR comments were addressed and responses provided in December 2013.

Overall, seventeen comments were identified and documented in the IEPR Report. Of the seventeen comments, one was identified as economics related; two were plan formulation related; six were hydrology or hydraulic related; one was hydrological and geotechnical related, two were cost engineering related, one was environmental related, one was related to hazardous, toxic and radioactive waste (HTRW) issues, one was environmental and hydrologic related, one was both environmental and cost engineering related, one was related to hydrology and hydraulics, environmental and cost engineering, and environmental issues. Four comments were identified as having high significance, eleven comments had medium significance, and two comments had low significance. All comments were responded to and resolved. Resolution of comments included clarifications and additions to this IFR and appendices where appropriate, along with commitments in some cases to undertake further analysis during PED. PED commitments are identified in the discussion of the Recommended Plan in Chapter 7 and relevant appendices.

The Addendum on the Public and Agency Comments provided one additional environmental-related technical concern of high significance. In the Addendum, the IEPR Panel recommended quantification of

connectivity outputs of proposed alternatives and reevaluation of Alternative 13 as the TSP after factoring in connectivity outputs as well as public review comments in support of Alternative 20. A framework suggested by the IEPR panel was applied to quantify the beneficial outputs of connectivity noted by public comments as not being fully captured in the alternatives analysis. By evaluating hydrologic, local, and regional connectivity and combining the resultant output with the initial habitat model output, USACE was able to more comprehensively compare the alternatives in the final array.

This additional analysis has been included above in Section 6.1.3. Quantifying connectivity benefits showed more restoration outputs for each of the alternatives, as well as for key features included in Alternatives 16 and 20 but not Alternative 13. Four different metrics were developed to further quantify different connectivity outputs. The individual metrics were then combined into a single connectivity metric. These combined metric values were then input into the economic analysis (CE/ICA) and weighted at varying levels along with the Combined Habitat Assessment Protocol (CHAP) outputs. The original analysis only considered the CHAP analysis in the quantitative comparison and resulted in all four Final Array Plans included in the Draft IFR (10, 13, 16, and 20) being Best Buy Plans. In the revised analysis, two additional scenarios were evaluated that based the CE/ICA analysis on a Total Weighted Output Metric that included CHAP and connectivity benefits. The first weighted the CHAP and Combined Connectivity equally, and the second weighted the CHAP at 75 percent and Combined Connectivity at 25 percent. These results were consistent in showing Alternative 13 as the first Best Buy Plan. After identification of the variation on Alternative 13 (13v), it was also analyzed according to the connectivity metrics, producing results very similar to Alternative 13. By capturing these additional benefits, this analysis showed that the incremental costs per output for larger scale plans were substantially lower, but still in excess of $100 million. Notwithstanding the incremental increase in benefits, based on the magnitude of this incremental increase in cost it was determined that the additional benefits of the larger plans were not worth the additional investment and did not materially affect the identification of the NER plan. The IEPR panel assessed the evaluation that factored in connectivity outputs, and was satisfied that the updated analysis confirmed the NER Plan identification.

6.6.3 Validation Process for the NER Plan and Identification of Refined NER

Following the public review period for the Draft IFR, the USACE performed further analysis that included a more detailed cost analysis using Mii software, real estate cost updates, and further modifications of contingencies based upon a cost and schedule risk analysis. Updates to real estate costs included completion of gross appraisal of the lands required for the project. Costs for the LATC site in Reach 8 increased substantially. Table 6-12 shows the total first costs as presented in the Draft IFR and as updated subsequent to the Draft IFR based on October 2014 price levels.

Table 6-12 Comparison of First Costs Draft IFR (April 2013) and Updated (October 2014)

	Alt 10	Alt 13	Alt 16	Alt 20
First Cost Draft IFR (April 2013 Price Level)	$374,782,639	$453,406,057	$803,928,734	$1,080,627,339
First Cost Updated (October 2014 Price Level)	$591,371,000	$707,800,000	$1,051,057,000	$1,309,332,000
Updated costs are derived from reach-based cost updates, due to rounding there is a minor difference between Alternative 13 and 20 as shown above and in the Total Project Cost Summary (TPCS). Alternatives 10 and 16 have not been *developed in Micro-Computer Aided Cost Estimating System (MCACES).*				

When developing the detailed cost estimates, the following design and cost assumptions were revisited for Reach 7: (1) to consider maintaining Baker Street in place, (2) to determine if the project could work around the proposed Water Wheel, and (3) to examine utilities. In conducting this review it was determined that costs for concrete removal and terracing associated with the Reach 7 Plan associated with Alternative 20 were higher than necessary. In addition the costs for the Reach 7 Plan associated with Alternative 13 required revisions to account for additional removal and hauling costs of concrete, and therefore increased.

Due to the changes in costs described above, an additional review of the project costs and benefits was completed. This analysis identified a more cost effective variation for Alternative 13 which included a change in Reach 7. The Alternative 13 variation in Reach 7, in addition to restoring the lower Arroyo Seco, restores 10 acres of freshwater marsh and provides a terraced connection from the river to the Los Angeles State Historic Park. This reach plan also daylights three streams while omitting the measure in Alternative 13 that implanted vegetated in channel banks. The Reach 7 substitution provides greater benefits than Alternative 13 at lower cost. When considered against the criteria in the Principles and Guidelines, the variation on Alternative 13 is effective, complete, efficient, and acceptable. It is slightly more effective and efficient than Alternative 13. With respect to the additional quantitative connectivity analysis, it is nearly identical to Alternative 13. Therefore, the updated cost analysis largely confirmed Alternative 13's selection as the NER plan, with the variation for Reach 7 as described. Alternative 13v is thus identified as the NER plan.

Table 6-12 provides the comparison of costs and benefits of Alternatives 13 and 13v. These costs are shown as FY 15 price level. Alternative 13v generally performs equivalently to Alt 13 in the categories analyzed above except with more cost effectiveness and greater benefits in Reach 7.

Table 6-13 Comparison of Alternative 13 and 13v (Price Level October 2014, 3.375 Percent Interest Rate)

	Alt 13	Alt 13v
Construction Cost	$147,851,000	$113,958,000
PED/EDC (14%)	$24,182,000	$15,954,120
S&A (9.5%)*	$16,856,000	$10,826,010
Lands & Damages (P.L. 91-646 included)	$350,474,000	$348,648,000
Utility/Facility Relocations	$168,437,000	$177,886,000
Total LERRDs*	$518,911,000	$526,534,000
TOTAL FIRST COST	$707,800,000	$667,272,130
AAHU	5,902	5,989
Annualized Investment Cost**	$31,147,128	$27,810,000
Annual O&M	$941,566	$951,887
Total Annual Cost	$32,088,695	$28,761,887
Total Annual Cost per AAHU	$5,438	4,802
Acres	588	598

** PED/EDC and Construction Management costs for Relocations are part of LERRD rather than Construction. Because provision and performance of LERRD required for the project is a non-Federal sponsor responsibility, these relocation-related PED/EDC and Construction Management costs are shown as separate line items in cost apportionment tables. The LERRD total in this table also includes Federal administrative costs, which are displayed separately in Chapter 7.*

** IDC is included via simple addition of individual reach-based IDC calculations.

6.6.4 Locally Preferred Plan Request

By letter dated April 10, 2014, the City of Los Angeles requested that Alternative 20 be the plan recommended to Congress for authorization. The basis for the sponsor's request for Alternative 20 included: the Administration's America's Great Outdoors and Urban Waters Federal Partnership initiatives; strong public, agency, and stakeholder support; Los Angeles Congressional delegation support; the USACE's acceptability criteria; redressing environmental injustice; the scarcity of Mediterranean-type habitat; and the ability of the plan to connect to opportunity areas highlighted in the City's LA River Revitalization Master Plan.

6.6.5 Locally Preferred Plan Details

Alternative 20 includes most of the restoration features of the other alternatives in the final array, and includes greater channel modifications and hydrologic connectivity. The most substantial additional features compared to the NER plan are restoration of the LATC site as part of the river in Reach 8 (also present in Alternative 16), restoration of the Verdugo Wash confluence in Reach 3, and channel bank modification and river bed widening in Reaches 2 and 5. The LATC feature, which in Alternative 13v restores a historic wash but connects to the river only through a culvert, would be physically reconnected to the river in Alternative 20. Hydrologic connection would be accomplished through removal of the concrete channel wall, removal of the approximately 0.7 miles of concrete riverbed, and restoration of freshwater marsh on the site. The confluence of the Verdugo Wash is restored by removing concrete in the channel and widening the channel opening, creating wetland and riparian habitat.

6.6.6 Approval to Recommend Locally Preferred Plan

By memorandum dated May 27, 2014, the Assistant Secretary of the Army (Civil Works) approved the Locally Preferred Plan request.

7 RECOMMENDED PLAN

As described in the previous section Alternative 13v is the NER Plan and Alternative 20 is the Locally Preferred Plan. The LPP, Alternative 20, is the Recommended Plan. Both plans include construction of restoration features in and along the river in specific locations as well as removal of non-native vegetation throughout the project area, including the River and lower tributary channel bottoms, particularly in the soft bottom channel areas. As previously stated in Chapter 4, the influence of restoration features extends beyond their immediate footprint to adjacent intermittent open water and perennial open water channel bottom areas, increasing their habitat and wildlife function. The project features make the entire channel more conducive to wildlife movement and provide new nodal and regional habitat connections as well as hydrologic connections.

Acres in the reach descriptions below are restored acreages in the soft bottom reaches as well as hard bottom open water areas both intermittently and perennially flowing. In-channel areas restored include over 146 acres of existing soft or natural bottom with mostly perennial flows and 91 acres of existing hard bottom channel with intermittent open water. In addition to the restoration provided by the NER Plan, Alternative 20 adds the LPP restores additional acres of soft bottom channel in Reaches 2 and 5 through widening the channel, and modifies removes the a portion of the hard bottom channel in Reach 8 as described in the reach by reach descriptions below, therefore, ultimately resulting in more soft bottom acres and fewer hard bottom acres than were included in existing conditions. Table 7-1 includes the approximate acreages in the project footprint by reach.

Table 7-1 Approximate Acres Restored By Reach

Reach	Alt 13v Acres	Alt 20 RIVER Acres
1	82	82
2	39	59
3	50	80
4	59	59
5	41	68
6	159	159
7	59	59
8	109	153
Total	598	719
The acreages provided in this table are based on conceptual drawings and GIS. The resolution of these estimates is at a feasibility level for planning purposes. The Real Estate Plan used individual parcel information based on County records for greater accuracy for future acquisition purposes.		

The features that make up the ecosystem restoration and recreation components of the NER Plan and LPP are described in Section 7.1. Section 7.2 includes description of plan implementation including apportionment of costs between the Federal government and non-Federal sponsor and allocation of costs among project purposes. It also describes Federal and non-Federal responsibilities for implementation.

7.1 ECOSYSTEM RESTORATION FEATURES OF THE NER AND LPP

The NER Plan, Alternative 13v, restores 598 acres of habitat throughout the 11 miles of study area. Table 7-1 includes the total approximate acres restored by reach. These acreages reflect newly restored acres as well as existing habitat and open water that will be improved. This plan includes restoration of valley foothill riparian and freshwater marsh habitat, daylighting of 15 streams (storm drains), creation of side channels in two locations, river widening in Reach 6, terracing in Reaches 6 and 7, and restoration of the lower Arroyo Seco tributary. Restoration measures were described in Chapter 4 Plan Formulation. The alternative is depicted on a map at the end of this chapter.

The LPP, Alternative 20 (RIVER), restores 719 acres of habitat throughout the 11 miles of study area. Table 7-1 includes the total approximate acres restored by reach. These acreages reflect newly restored acres as well as existing habitat and open water that will be improved. This plan includes restoration of valley foothill riparian and freshwater marsh habitat, daylighting of 13 streams (storm drains), creation of side channels in three locations, river widening and terracing in Reaches 2, 5, 6, 7 and 8, restoration at the Verdugo Wash confluence, and restoration of the lower Arroyo Seco tributary.

General measures related to vegetation and wildlife for both the NER and LPP, including invasives removal, are discussed in Sections 7.1.9 and 7.1.10.

7.1.1 Reach 1 Pollywog Park Area of Griffith Park

NER Plan

Approximately 82 acres would be restored in Reach 1 in the NER Plan. This reach plan would implement a habitat corridor with riparian planting on the overbanks of both sides of the River and other nearby locations. Overbanks are those areas adjacent to the river where overland flow in flood events could occur in a natural river environment. Areas of restoration include the left overbank across the River from the Headworks Study Site, the Pollywog Park area of Griffith Park, the open area directly downstream of Headworks on the right overbank, and the left overbank of Burbank Western Channel (tributary from the north/west). The riparian corridors will increase habitat and wildlife connectivity through the channel from Sennett Creek at the upstream end of the Headworks site on the right bank to the outlet at the downstream end of Pollywog Park on the left bank. Connections between these areas through the channel include a connection under SR-134 to the River and the open area restored on the overbank directly downstream of Headworks would be connected under Forest Lawn Drive on the same side of SR-134 with the Headworks Study site, and across the river with restored riparian habitat on the overbank of Burbank Western Channel The channel in this reach is concrete and often develops a vegetated mat with shallow open water flowing through it further enhancing these connections.

Restored habitat corridors would be planted with a riparian community of cottonwood/willow, sycamore, mugwort, mulefat, and scarlet monkeyflower with a buffer of sagebrush, buckwheat, and native herbaceous plants. It would include irrigation for establishment and water harvesting features to sustain plants, including micro-grading and/or swales to capture and infiltrate water. Water sources could include reclaimed water, harvesting of stormwater and street runoff (with small wetland features at the end of adjacent streets), and/or highway runoff. Where stormwater or street runoff is excessive during storm events, a connection to the River at the downstream edge of the park would allow it to overflow into the channel. Figure 7-1 includes a graphic depiction of the restoration at the downstream end of Pollywog Park. Establishment and drought management for this vegetation would utilize irrigation, either through flood irrigation (simulating a natural riparian regime) or drip irrigation, dependent upon the availability of water. There are no channel modifications within this reach. While there is a levee at the downstream end of this reach, any planting in that area will comply with all levee regulations. This set of measures in this reach subplan was the most incrementally cost effective and beneficial plan for all alternatives in the final

array. Stormwater harvesting of the types described for this reach will be used as appropriate in all reaches for restoration of riparian corridors.

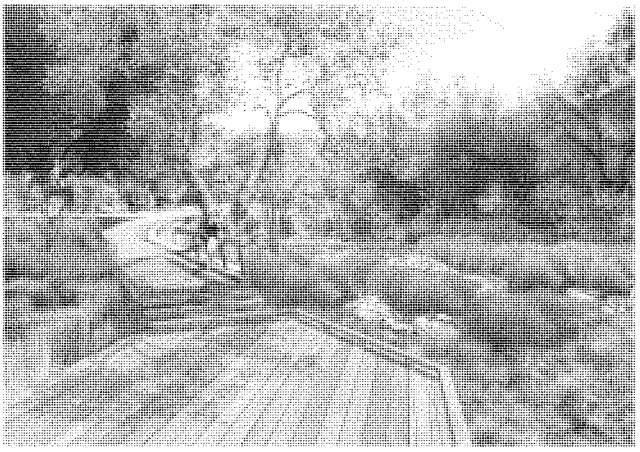


Figure 7-1 Graphic Depiction of the Restoration in Pollywog Park

LPP

For Reach 1, the restoration features in the LPP are the same as those described above for the NER plan.

7.1.2 Reach 2 Bette Davis Park Area of Griffith Park

NER Plan

The NER Plan restores approximately 39 acres in Reach 2. The NER Plan establishes riparian habitat corridors along the overbanks of both sides of the River as described for Reach 1. This includes restoration of riparian habitat in the Bette Davis Park area of Griffith Park on the left overbank and in the area between Zoo Drive and SR-134, with connections under the highway to a restored linear riparian planting along the River extending into Reach 3. The riparian corridor measure would include irrigation for establishment and water harvesting features similar to those described for Reach 1. There are no channel modifications within this reach. The channel is a soft bottom with mature riparian vegetation. Modifications to vegetation on or adjacent to levees will comply with levee regulations.

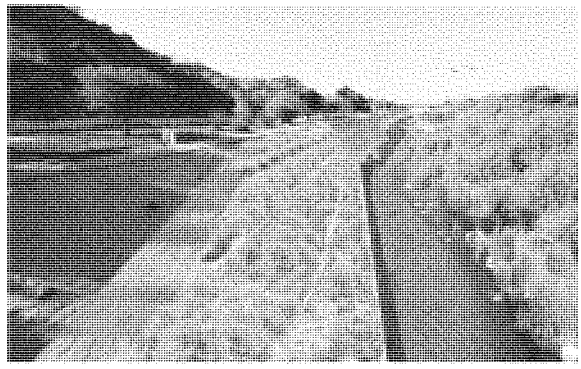


Figure 7-2 Graphic Rendering of the Vertical Banks

LPP

The LPP provides the restoration features included in the NER Plan. However, the LPP would add modification of the channel. In Reach 2, the right bank would be modified from trapezoidal to a vertical bank, creating 80 feet of additional soft bottom width in the channel with terraces transitioning from the existing trapezoidal bank configuration to the vertical bank and with overhanging vines on the new vertical bank. This feature provides an additional 20 acres of restoration along 0.6 miles of the existing soft bottom (Figure 7-2).

7.1.3 Reach 3 Ferraro Fields/Verdugo Wash area of Griffith Park

NER Plan

The area restored in this reach covers 50 acres. This reach sub-plan continues establishment of the riparian corridor along Zoo Drive on the right side of the River. It also daylights a stream currently confined in a large culvert just downstream of Ferraro Fields on the right bank in the Zoo Drive area and daylights two smaller streams on the left bank. In addition, using water diverted from the River, it creates a side channel that would flow along the west side of Ferraro Fields and reenter the River through the daylighted stream on the right bank. The side channel and daylighted stream will support a riparian fringe, open water and freshwater marsh. The two smaller streams daylighted on the left bank will also include riparian fringe with freshwater marsh at the confluence with the LA River. If it is not possible to design an efficient confluence, the connection to the river would remain gated. The riparian fringe measure would involve planting riparian communities described in Reach 1. It would include irrigation for establishment and water harvesting features similar to those described for Reach 1. In addition to the area along Zoo Drive, riparian areas would be located along the River's edge at Ferraro Fields and between the daylighted streams on the left overbank. There are no modifications to the channel itself, which has a hard or concrete bottom with intermittent open water and little developed vegetation. Levee protection will remain and levee vegetation policy will be followed. A graphic illustration of the side channel, its outlet and riparian corridor is shown in Figure 7-3.

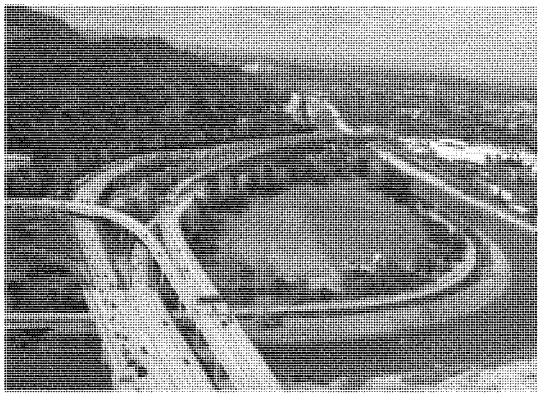


Figure 7-3 Graphic Rendering of the Ferraro Fields Area

LPP

The LPP provides the same restoration features as the NER Plan at Ferraro Fields on the west bank. However, the LPP would add substantial restoration at the Verdugo Wash confluence (Figure 7-4) on the east bank. While there would be no additional modifications to the main channel, the Verdugo Wash channel mouth would be widened and the left bank would be sloped back to the existing overbank elevation adding 30 acres of restoration but omitting the 2 daylighted streams on the east bank included in the NER Plan. Riparian vegetation would be used to stabilize the bank and a combined riparian and marsh community would be restored in the widened channel. Levee protection would be tied-into the bank, and other levee protection will remain. Levee vegetation policy will be followed. Design details for the confluence area will be determined during the detailed design phase of the study.

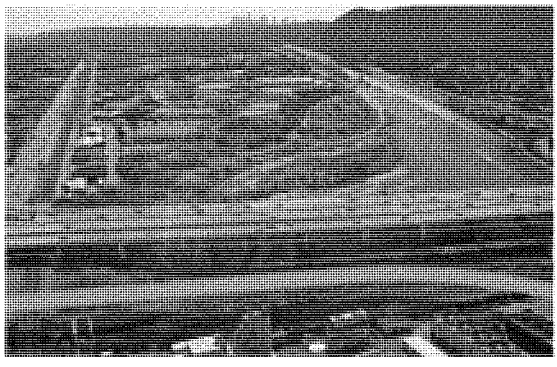


Figure 7-4 Graphic Rendering of the Verdugo Wash Area

7.1.4 Reach 4 Griffith Park

NER Plan

There are approximately 59 restored acres in this reach by the NER Plan. Restoration includes construction of a side channel at the edge of the Griffith Park Golf Course on the west. This is accomplished through a diversion of river flow into a side channel up to 10 feet deep with a riparian fringe through Griffith Park along the edge of Harding Golf Course. The side channel through Griffith Park would enter the park from the River under the I-5 Freeway through an existing tunnel (or farther upstream if necessary to facilitate diversion of flows) and exit the park to reenter the River downstream under I-5 through existing tunnels. A riparian fringe of trees and marsh vegetation would line the channel.

The Los Feliz Golf Course would be lowered, rebuilt, and allowed to flood (with no changes to the River channel levee walls) in order to establish a riparian habitat interspersed without changes to the golf course greens. Any necessary flood protection on the outer edge of the golf course will be included in the design. A graphic depiction of restored habitat at Los Feliz Golf Course is shown in Figure 7-5.

Restoration will include daylighting approximately eight small streams. The eight storm drains would be opened and naturalized as tributaries as far upstream as possible (at a minimum opening up the stream within the river right-of-way). Design of the channel and confluence would be similar to that described in Reach 3 daylighted streams.

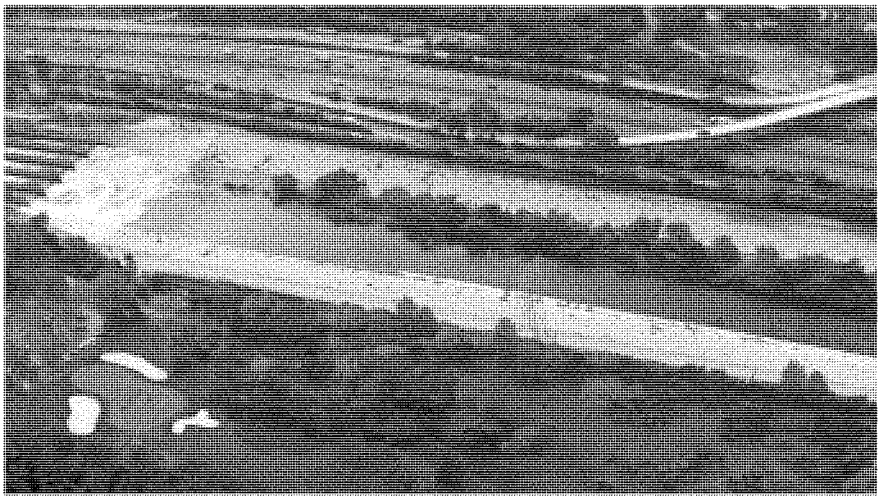


Figure 7-5 Graphic Depiction of Restoration at Los Feliz Golf Course

Lining the left river bank will be a riparian corridor implemented as continuously as possible within levee regulation requirements. The riparian corridor would involve planting a riparian strip of just herbaceous vegetation such as mugwort and scarlet monkeyflower with a buffer of and native herbaceous plants to comply with levee vegetation policies. It would include irrigation for establishment and the same water harvesting methods described for Reach 1 as appropriate for the site. There are no channel modifications within this reach, which is a soft natural bed with mature riparian vegetation developed on channel bars.

LPP

For Reach 4, the restoration features in the LPP are the same as those described above for the NER plan.

7.1.5 Reach 5 Riverside Drive

NER Plan

The area restored in this reach would cover approximately 41 acres. This reach will continue implementation of the habitat corridor restoration in a narrow strip along the east bank to avoid interference with the existing levee system (within current guidance for vegetation on levees), and restoration of one daylighted stream area with a riparian fringe and freshwater marsh at the downstream end of this reach on the east bank. Design of the daylighted stream would be similar to that described in Reach 3. The riparian corridor measure would involve planting riparian communities described in Reach 1 or in a levee area as described in Reach 4. It would include irrigation for establishment and water harvesting features similar to those described for Reach 1. There would be no channel modifications in this reach for the NER Plan. The channel is soft bottom with open water and mature riparian vegetation developed on channel bars.

LPP

In Reach 5, the LPP would include the same implementation of riparian habitat corridors and daylighting of the one stream with riparian fringe and freshwater marsh, but would also add substantial channel modifications. The right bank would be modified from a trapezoidal bank to a vertical bank. This would increase the width of the soft bottom river bed by over 100 feet for approximately 1.6 miles. The top of the bank in the widened area would be notched and planted with overhanging vines. The left bank would be modified with terraces planted with herbaceous vegetation and necessary erosion measures, which would consist of concrete-lined beds. The top of bank would be planted with riparian vegetation. At the downstream end of this reach, the river will also be widened on the left bank with appropriate erosion control measures in place. This would further increase the natural river bottom area. Restored area would cover approximately 27 additional acres above that in the NER Plan. All of these measures would comply with levee vegetation regulations.

7.1.6 Reach 6 Taylor Yard

NER Plan

The area restored in this reach would cover approximately 159 acres. Reach 6 includes riparian corridors and widening of the soft bottom river bed by approximately 300 feet and gradual riparian slope to the overbank elevation along the reach length approximately 1,000 feet. At the upstream end of the Bowtie parcel, a back water wetland would be developed at river level and there would be a small terraced area transitioning into the widening of Taylor Yard at the downstream end of the Bowtie parcel. Aquatic riverine habitat including freshwater marsh dominates the new river bed. The banks of the river upstream of Bowtie and downstream of Taylor Yard and on the west bank would be restructured to support overhanging vines and other implanted riparian vegetation. Restoration area would cover approximately 159 acres. Where west banks present a levee conditions around stormwater culverts, vegetation will comply with levee vegetation policies. Aquatic riverine habitat including freshwater marsh dominate the new river bed; the existing channel is a soft natural bottom with mature riparian vegetation developed on channel bars. A graphic depiction of the restored area is included in Figure 7-6.

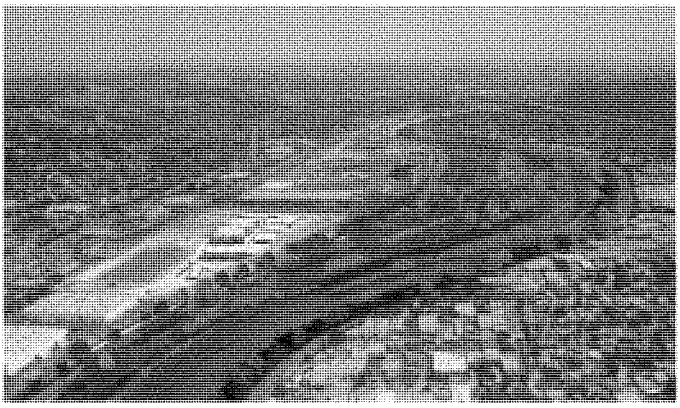


Figure 7-6 Graphic Depiction Restored Reach 6 including Taylor Yard

LPP

For Reach 6, the restoration features in the LPP are the same as those described above for the NER plan.

7.1.7 Reach 7 Arroyo Seco/Los Angeles River State Historic Park

NER Plan

In Reach 7, approximately 59 acres would be restored, with a key feature, the restoration of the Arroyo Seco confluence restored with riparian habitat. This ephemeral stream will have its banks and bed softened by removing concrete for approximately half a mile upstream and will be stabilized with erosion control elements to maintain the existing protection. At the confluence on the upstream edge of the River, a backwater riparian wetland would be established. The riparian corridor measure would involve planting riparian communities described in Reach 1. It would include irrigation for establishment and water harvesting features similar to those described for Reach 1. Figure 7-7 includes a graphic rendering depicting the restored section of the Arroyo Seco. At the downstream end of the reach on the right bank, the existing rail line would be put on a trestle at grade, and the right bank would be terraced and planted under the rail line connecting the main channel of the River with the Los Angeles State Historic Park. Approximately 10 acres of wetland would be restored within the Park and would gradually slope down to connect to the terraced bank (Figure 7-8). Three storm drains would be daylighted in this reach and designed as described in Reach 3. The River bottom in this reach is concrete with a low flow channel which contains most of the flow, although the channel bed is often wetted and has an algal mat.

Figure 7-7. Graphic Depiction of the Restored Arroyo Seco

LPP

Restoration features are the same as those described above for the NER Plan.

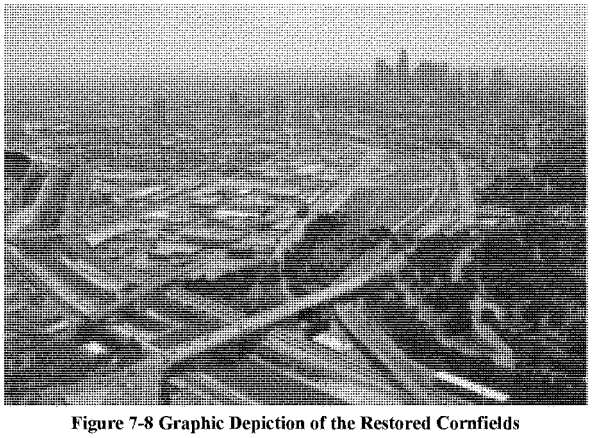


Figure 7-8 Graphic Depiction of the Restored Cornfields

7.1.8 Reach 8 LATC

NER Plan

In Reach 8, approximately 109 acres would be restored. The LATC site would be restored with riparian habitat, which would involve planting riparian communities in riparian corridors as described in Reach 1. It would include irrigation for establishment and water harvesting features similar to those described for Reach 1.Micro-grading would slope the site to restore the historical wash that once ran through this area. The restored historical wash would meander through the property and would be connected to the existing river channel through a wide culvert or designed confluence, if possible. The wash location will be determined by the USACE's hydrology and hydraulic analysis and would be located in the most

appropriate place. Riparian vegetation would be established within the site in and around the restored wash.

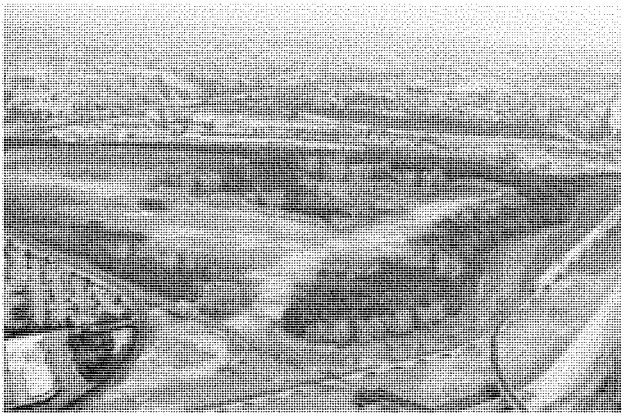


Figure 7-9. Graphic Depiction of the Restored LATC

There are no channel modifications within this reach as water entering the River from the historical wash would be routed through existing storm drains in the channel wall. The River channel in this reach is a concrete channel with intermittent flow.

LPP

In Reach 8, the LPP would include all the features of the NER with the additional features modifying the channel and adding to the restoration within LATC itself. Terracing would be created on the right bank upstream of LATC and on the left bank downstream of LATC. Riparian herbaceous vegetation would be planted in the terracing. The channel adjacent to LATC would also be changed from concrete to soft bottom to support freshwater marsh and aquatic habitat. The reach would also be widened. At the LATC site, marsh would extend approximately 500 feet into the property, with riparian area extending another 1,000 feet, gradually sloping up to existing bank elevations. The restoration of the historical wash would include riparian fringe and side channels. Additionally, river flows would be diverted out of the River into the LATC, creating a large wetland area as illustrated in Figure 7-9. A railroad trestle would be included with this alternative to allow the described restoration to occur and allow for the connection of the river channel and the adjacent restored areas increasing the river floodplain. These features would increase the restoration area by 44 acres above the NER Plan.

7.1.9 Vegetation

In addition to features described reach by reach above, plans would include these general measures related to vegetation. Such measures would depend on the detailed design and hydraulic analysis developed during the detailed phase, to ensure that they are not in conflict with flow conveyance requirements or other constraints on the project. Much of the proposed restoration areas are currently comprised of urban land uses, where concrete will be removed. Active planting and temporary irrigation will initially be required in these areas to begin establishing native vegetation. After storm events bring seed material from upstream and after active planting establishes a seed bank, passive restoration can be

implemented consisting mainly of invasives removal. Invasives species removal would occur throughout the project area for both the NER and LPP, both in constructed restoration features and River and tributary channel bottom.

Temporary irrigation will be used to establish restored vegetation in widened and overbank areas, after which vegetation is expected to be self-sustaining, requiring minimal O&M and relying on groundwater and surface flows to persist. Temporary irrigation will also be used to establish vegetation in the concrete channel walls and terraces. Detailed design will identify all water sources to support the proposed vegetation in the concrete channel walls, including surface flows and runoff that may be redirected to sustain this vegetation and avoid permanent irrigation. During extreme drought supplemental water may be used to protect the investment in the restored vegetation.

In widened areas, increased conveyance capacity will allow for varied substrates and a more natural hydrologic regime, high vegetative cover and structural diversity, and very limited and well-buried hard structures. It is expected that these widened areas will support high levels of heterogeneity. The active channel will have opportunity to migrate and change form and terraces and sediments will be redistributed with storm events. Initial grading during construction of widened areas will be heterogeneous and diverse topography will be created. The dynamic and episodic nature of the River flows will be accommodated in these areas, allowing the River to carve new channel configurations over time. Vegetation is expected to be denuded with natural higher flows and velocities, and be re-established naturally. Any grade stabilizers in these areas will be well buried perpendicular to flows, and not visible from the surface. Once initially planted and a seed bank established, passive recovery will be the method for re-vegetation after flood events. Such natural hydrologic functions would support riparian/aquatic interactions by providing habitat elements including shade over water, and stream nutrient and woody debris inputs.

The Corps plans to adopt maintenance practices that allow for ecosystem restoration while not significantly changing the current level of flood risk management provided by the channel. Vegetation within the channel has a significant impact on conveyance of the design flood within the ARBOR reach. If allowed to grow completely unchecked under the With-Project Conditions, such vegetation could eventually create an adverse condition with respect to flood risk. Therefore, during design, the Corps will further determine limits on vegetation volume and structure to ensure adequate channel conveyance.

In reaches where the Corps is proposing to construct a vertical wall to replace the trapezoidal side slopes, vegetation will be allowed to grow to the extent that it does not affect the conveyance of the channel. During the detailed design phase, the Corps will identify the methods for measurement to determine impacts on flow conveyance. It is anticipated that limitations to vegetation growth will be modest because of the increased conveyance caused by changing the wall to a vertical orientation.

7.1.10 Wildlife

In addition to features described reach by reach above, plans would include measures such as those listed below, or other opportunities, to maximize restoration potential for wildlife to the extent practicable. Such measures would depend on the detailed design and hydraulic analysis developed during the detailed design phase, to ensure that they are not in conflict with flow conveyance requirements or other constraints on the project.

In widened areas, restored river channels will be designed to support habitat for native fish including arroyo chub and Santa Ana sucker, and provide the necessary constituent elements including but not limited to water shaded by riparian vegetation, riffle/run/pool/glide sequences and refugia, in channel woody debris, gravel and cobble substrates. Some areas designated in restoration plans for open water

will also be designed to support these native fish by providing such features as including riffle/pool/glide sequences.

Vegetation and habitat elements in widened areas will also be restored with the goal to support a large number of territories for various riparian obligate birds, including least Bell's vireo, yellow warbler, and yellow breasted chat, stop over habitat for migrants, as well as habitat and refugia for amphibians, reptiles, and mammals, including larger carnivores such as coyote and possibly bobcat.

Local connectivity for these species will be improved by connecting restored widened patches in part via existing soft bottom reaches 2, 4, 5, and 6 and restored in-channel habitat in Reach 8. Regional connectivity would also be improved for larger mammals such as coyote and bobcat. It is expected that larger mammals may use the three existing equestrian tunnels in the project area (Reaches 1 and 4) to access the restored river near Griffith Park, and use restored vegetation and in-channel features to move through the project area and to disperse to greater regional habitat areas using tributary channels such as Arroyo Seco and Verdugo Wash.

Measures for wildlife access are described in Section 4.4.5, measures 3a-c, as measures retained for implementation where appropriate. Specific placement of these measures will, in some cases, utilize more detailed design information, as discussed below.

As part of the Corps' coordination with the USFWS under the FWCA, additional opportunities for restoration of habitat connectivity as part of the project, particularly within the River channel, along with design considerations for habitat opportunities, were identified. The Corps will further evaluate these measures during the design phase, as their implementation or placement is likely to require hydrologic and hydraulic modeling data and/or more detailed design. Prior to implementation of the measures identified, the Corps will assess whether supplemental analysis is needed to address new or different effects than those already assessed in this IFR.

In existing hard-bottom reaches 1, 3 and 7, which cannot be widened, opportunities for aquatic connectivity, to maximize restoration potential for aquatic wildlife, will be further evaluated during detailed design. These measures would create in-channel diversity and heterogeneity to support further passage of wildlife, including aquatic species such as native fish. Such measures may include 1) use of anchored boulders and a new meandering low flow channel in the existing concrete, 2) "speed bumps" perpendicular to flow that can trap sediment and allow small to moderate sized vegetation to grow, and 3) a new v-shaped low flow channel with varying widths and depths. Implementation of these measures would depend on the detailed design and hydraulic analysis developed during the detailed design phase, to ensure that they are not in conflict with flow conveyance requirements or other constraints on the project.

These measures would, in particular, improve connectivity for aquatic and terrestrial wildlife in Reach 3 from the Verdugo Wash confluence to the upstream edge of the soft bottom Reach 4, and in Reach 7 from the downstream edge of the soft bottom Reach 6 to Arroyo Seco. In addition, terrestrial wildlife may then more easily move from Griffith Park using the equestrian tunnel in Reach 4 upstream to Verdugo Wash or downstream to Arroyo Seco. Additional restoration of these tributaries outside the project area would facilitate further regional movement in the future. This restoration may be accomplished by other Federal, State, or local stakeholders.

Specific features for wildlife access will be considered during the detailed design stage, and would depend on the detailed design and hydraulic analysis developed during the detailed design phase, to ensure that they are not in conflict with flood damage reduction and flow conveyance requirements or

other constraints on the project. Movement for bobcats will be the standard for design of access, and such designs will be implemented wherever practicable.

Placement of wildlife access measures may include access in Reach 1 from Pollywog Park into the river channel, as practicable. In this area, wildlife access may be achieved through the creation of a slope along the currently vertical bank, as described in measure 3b in Section 4.4.5. Such a design would allow wildlife moving from Griffith Park into the river channel access to the restored Pollywog Park site, which is currently disconnected from the River by a vertical wall. Implementation of specific methods and location of access would be dependent on the detailed hydrologic and hydraulic modeling developed during the design phase.

Other design features specific to certain species may be incorporated in the detailed design phase and accommodated where practicable and appropriate. It is expected that while these features could potentially be installed artificially during restoration activities, many of these features will also evolve naturally over time as vegetation matures and natural hydrologic forces continue to shape the hydrologic regime of the widened areas. These features may include, but are not limited to, artificial nest cavities (which could be used by wood duck, barn owl, tree swallow, and western bluebird among other species), large hollow snags (used by swifts), and artificial steep sandy banks (used by northern rough-winged swallow and belted kingfisher).

Considerations for segregation of "spring fed waters" from surface water flows would also be made during the detailed design phase. This segregation would be considered to support refugia for fish, where groundwater would feed the refugia while surface flows might bypass such areas. Parameters required for engineering design would include groundwater levels as well as anticipated local fluctuations in groundwater conditions.

7.1.11 River Function and Sustainability

Per Civil Works Ecosystem Restoration Policy; "The intent of restoration is to partially or fully reestablish the attributes of a naturalistic, functioning, and self-regulating system." (ER 1165-2-501). While the study area is highly modified and occurs within the nation's second largest urban area with the largest population of any county in the country the NER and LPP both meet this intent.

As described in the water budget summary for the alternatives (Section 4.14.7), there is sufficient water available in the study area to support the proposed restoration project and alternatives. This is through a combination of surface water and rainfall runoff. Groundwater is also present in the soft bottom portions of the study area, such as Glendale Narrows. Treated effluent makes up a portion of the flows in the channel and that effluent is currently the primary source of water supporting wetland and riparian vegetation in many portions of the River. It is highly treated effluent that is tertiary treated and includes denitrifications thereby preventing eutrophication. The use of reclaimed water is frequent in the Western United States and there are effluent dominant streams supporting habitat in many parts of the Southwest.

The Study area includes the Glendale Narrows, which currently support some of the only remaining riparian and freshwater marsh habitat on the LA River. This area historically sustained the greatest natural surface flow on the river, a condition that still exists as the high water table prevented the paving of the Glendale Narrows in concrete. The existing habitat and perennial surface flow in the Narrows provides a base for restoration, connectivity, and expansion of riparian habitat, and maintains one of the most diverse assemblages of wildlife on the river today.

The existing pockets of habitat in the Glendale Narrows are a reference for the potential that can be achieved by the restoration proposed in this report. Although within a flood risk management channel and supported by effluent and groundwater, the Glendale Narrows includes functioning habitat that withstands flood flows. Riparian and wetland habitat proposed both within and adjacent to the channel is expected to achieve that same success.

7.1.12 Climate Change

The general consensus for climate change in the project area is that the region will experience longer droughts intermixed with less frequent but larger floods. Climate change effects on the project are mainly a consideration with respect to water availability and sustainability in drought conditions. A water budget was developed for the study. The proposed features are planned to be consistent with low water availability. In addition, the dominant water source is not directly affected by drought conditions. The dominant source of water during non-flood periods is effluent from the upstream treatment plants. There is also some runoff from the upstream watershed even during the dry periods. The water budget shows the water demand for the vegetation within the project area represents only a portion of the total released from the treatment plants. Since the non-Federal spousor is also the owuer of the main treatment plant, the Donald C. Tillman Water Treatmeut Plant, the non-Federal sponsor can and will eusure the delivery of water to sustain the vegetation into the future. Although drought conditions could increase desires to utilize effluent in other ways, the non-Federal sponsor is committed to ensuring adequate provision of water for this project. There are also other community interests in sustaining water in the proposed project area (e.g., passive recreation use).

Under existing conditions, larger flood events have au impact on the vegetation within the river. During larger flood events velocities can be relatively high and tear out some of the vegetation. However, based on previous events that tended to wash out the smaller vegetation, bend over the moderate size trees, and have little impact on the larger trees, the vegetation recovers relatively quickly on its own. Climate change indicates the larger events will be less frequent and allow for longer recovery times. This would not affect the long-term sustainability of the project or the design of the proposed features.

7.2 RECREATION PLANS

The objective of the recreation plan is to maintain and improve the quality and quantity of recreation amenities that complement the ecosystem restoration, especially in regard to promoting access and connectivity between both banks of the river and throughout the length of the reach. The recreation plans were developed through coordination with the non-Federal Sponsor to take advantage of existing recreation facilities, as well as proposed ecosystem restoration improvements, while complying with USACE policies and regulations pertinent to recreation improvements at ecosystem restoration projects. The recreation features will be designed and managed to avoid any negative impacts to the restoration areas. The recreation plans formulated to be consistent and compatible with the NER plan and the LPP includes the modification, upgrade, or creation of multi-use trails and related basic amenities (access points, wildlife viewpoints, parking lots, restrooms, and signage). The plans also include non-motorized multi-use bridges and smaller pedestrian bridges across tributaries or within large restored areas.

7.2.1 Recreation Plan Formulated for NER Plan

The recreation plan formulated for the NER recreation plan includes the following specific features:

- 5.89 miles of new unpaved non-motorized multi-use trail *(to include decomposed granite surface and trail signage)*
- 0.3 miles of new paved multi-use trail *(short extension of current southern end of LA River Bike Path)*
- 1 small bridge/crossing within Taylor Yard
- 1 medium bridge within LATC
- 2 paved parking lots, one at Taylor Yard and one at LATC *(each about 15,000 square feet)*
- 4 restrooms, one at Bette Davis Park, two at Taylor Yard, and one at LATC
- 1 pedestrian underpass at the south end of Taylor Yard
- 24 trail access points throughout the study area *(access points would include grading and planting, signage, stairs, benches, gating, and trash receptacles to provide quality trail access)*
- 6 wildlife viewing points throughout the study area *(viewpoints would include an elevated wood deck with railing, benches, interpretive signage, and trash receptacles to allow users to enjoy high quality viewsheds within the restored ARBOR reach)*
- 4 pedestrian underpasses along the river to support trail connectivity

Recreation features are displayed on a series of maps at the end of this chapter. Table 7-2, below, summarizes the two proposed bridges. Table 7-3 below, summarizes the proposed changes in trails. As shown in the table, the plan would result in a 41-percent increase in accessible trails and multi-use paths along the river. When including multi-use paths created by the ecosystem restoration plan, the total increase is 51.2 percent.

Table 7-2 Proposed Bridges, Recreation Plan Formulated for NER Plan

Length (ft)	Location	Description
150	Taylor Yard	1 pedestrian bridge within Taylor Yard over restoration area
250	LATC	Medium pedestrian bridge over restoration area within LATC

As shown in Table 7-3 below, 13.07 miles of existing trail would not be modified by the recreation plan. However, the recreation plan would upgrade 1.12 miles of existing trail to a fully-developed multi-use trail. There would also be 6.19 miles of new trail added in the study area, and conversion of 0.82 miles of currently inaccessible access road to multi-use trail.

The ecosystem restoration plan would upgrade 5.28 miles of existing trail, and convert 2.96 miles of currently inaccessible access road to multi-use trail. These changes would result in 29.44 miles of accessible trail and multi-use pathway.

At the current level of design, un-paved trails are assumed to be multiple-use, twelve feet wide, using a decomposed granite surface, and paved trails are assumed to be similar to the existing LA River Bike Path. Safety ramps will be part of project design and will be multi-use for maintenance, safety exits, and potential access by kayakers and canoeists.

Table 7-3 Proposed Trail Changes, Recreation Plan Formulated for NER Plan

Trail Type	Miles	% of Total With Project Miles
Existing Trail/Pathway Remaining As-Is	13.07	44.4%
Existing Trail/Pathway Upgraded per Recreation Plan	1.12	3.8%
New Paved and Unpaved Trail/Pathway per Recreation Plan	6.19	21.0%
Inaccessible access road converted to trail per Recreation Plan	0.82	2.8%
Existing Trail Upgraded per Ecosystem Restoration Plan	5.28	17.9%
Inaccessible access road converted to trail per Restoration Plan	2.96	10.1%
TOTAL	**29.44**	100.0%

7.2.2 Recreation Plan Formulated for LPP

The recreation plan formulated for the LPP utilizes the large land base of the LPP and includes the following specific features:

- 7.98 miles of new unpaved non-motorized multi-use trail (to include decomposed granite surface and trail signage)
- 1.26 miles of new paved multi-use trail (extension of current southern end of LA River Bike Path)
- 2 bridges spanning the LA River
- 1 smaller bridge/crossing within Taylor Yard
- 4 small/medium bridges within LATC
- 2 paved parking lots, one at Taylor Yard and one at LATC (each about 15,000 square feet)
- 4 restrooms, one at Bette Davis Park, two at Taylor Yard, and one at LATC
- 1 pedestrian underpass at the south end of Taylor Yard
- 28 trail access points throughout the study area (access points would include grading and planting, signage, stairs, benches, gating, and trash receptacles to provide quality trail access)
- 11 wildlife viewing points throughout the study area (viewpoints would include an elevated wood deck with railing, benches, interpretive signage, and trash receptacles to allow users to enjoy high quality viewsheds within the restored ARBOR reach)
- 6 pedestrian underpasses along the river to support trail connectivity

All of the features identified are eligible for Federal participation in cost sharing Recreation features are displayed on a series of maps at the end of this chapter. Table 7-4, below, summarizes the 7 proposed bridges. Shaded rows indicate bridges which were also included in the NER plan. Table 7-4, below, summarizes the proposed changes in trails. As shown in the table, the plan would result in a 58.1-percent increase in accessible trail and multi-use pathways. Including multi-use pathways created by the ecosystem restoration plan, the total increase in accessible trails and pathways would be 66.9 percent.

Table 7-4 Proposed Bridges, Recreation Plan Formulated for LPP

Length (ft)	Location	Description
450	Verdugo Wash	Spans the LA River on diagonal downstream of Verdugo Wash, connecting the Verdugo confluence to the LA River Bike Path
150	Taylor Yard	1 pedestrian bridge within Taylor Yard over restoration area
300	LATC	Spans the LA River at the upstream end of LATC
25	LATC	Small pedestrian bridge over restoration area in LATC
100	LATC	Medium pedestrian bridge over restoration area in LATC
250	LATC	Medium pedestrian bridge over restoration area in LATC
30	LATC	Small pedestrian bridge over restoration area in LATC

As shown in Table 7-5 below, 12.93 miles of existing trail would not be modified by the recreation plan. However, the recreation plan would upgrade 1.26 miles of existing trail to a fully-developed multi-use trail. There would also be 9.24 miles of new trail added in the study area, and conversion of 0.82 miles of currently inaccessible access road to multi-use trail.

The ecosystem restoration plan would upgrade 5.28 miles of existing trail, and convert 2.96 miles of currently inaccessible access road to multi-use trail. These changes would result in 32.49 miles of accessible trail and multi-use pathway.

At the current level of design, trails are assumed to be multiple-use, twelve feet wide, using a decomposed granite surface.

Table 7-5 Proposed Trail Changes, Recreation Plan Formulated for LPP

Trail Type	Miles	% of Total With Project Miles
Existing Trail/Pathway Remaining As-Is	12.93	39.8%
Existing Trail/Pathway Upgraded per Recreation Plan	1.26	3.9%
New Paved and Unpaved Trail/Pathway per Recreation Plan	9.24	28.4%
Inaccessible access road converted to trail per Recreation Plan	0.82	2.5%
Existing Trail Upgraded per Ecosystem Restoration Plan	5.28	16.3%
Inaccessible access road converted to trail per Restoration Plan	2.96	9.1%
TOTAL	**32.49**	100.0%

7.3 REGIONAL ECONOMIC DEVELOPMENT AND ECONOMIC IMPACTS SUMMARY COMPARISON

Table 7-6 presents the cumulative regional economic impacts from project implementation through the study's period of analysis for the NER and LPP alternatives. RED impacts associated with construction expenditures were developed using construction cost information updated following public review and reflect October 2015 price levels. RED impacts from redevelopment were not updated and reflect the values for Alternatives 13 and 20 as presented in Section 6.3.4 at April 2013 price levels. Because redevelopment effects are a function of the restoration plan components rather than their costs, no substantial changes in the redevelopment effects documented in Section 6.3.4 are expected for the NER and LPP alternatives. Redevelopment related RED impacts would be slightly higher if updated to reflect October 2015 price levels, as was done for construction related RED impacts, but this would not change the overall magnitude of estimated impacts or conclusions of the analysis.

Table 7-6 Cumulative RED & Economic Impacts of Ecosystem Restoration

Ecosystem Construction Cumulative Impacts (October 2015 PL)		
	NER	**LPP**
Jobs	4,781	11,430
Labor Income	$275,351,761	$658,227,256
Sales	$659,750,801	$1,577,131,584
GRP	$384,759,602	$919,766,251
Recreation Construction Cumulative Impacts		
Jobs	125	217
Labor Income	$8,455,129	$14,677,719
Value	$12,289,089	$21,333,299
Output	$21,920,484	$38,052,963
Redevelopment Construction Cumulative Impacts (April 2013)		
Jobs	1,281	5,087
Labor Income	$84,665,000	$336,278,000
Value	$115,791,000	$460,153,000
Output	$193,002,000	$767,247,000
Redevelopment Long-term Economic Activity Cumulative Impacts		
Jobs	675	2,671
Labor Income	$964,851,000	$3,815,989,000
Taxes – Local	$5,789,000	$22,896,000

The cumulative effects of the construction/redevelopment components over the period of analysis will create between 6,862 (NER Plan) to 19,405 (LPP) jobs generating labor income of $1.3 billion (NER Plan) to nearly $5 billion (LPP) as shown in Table 7-7.

Table 7-7 Employment and Income Cumulative Impacts

	NER	**LPP**
Jobs	6,862	19,405
Labor Income	$1,333,322,890	$4,825,171,975
Price level-See Table 7-6		

7.4 COST SUMMARY

The tables below summarizes the first costs of both the NER Plan and the LPP. These are shown as escalated to Fiscal Year 2016 price levels (October 2015). Data for this estimate is provided in Appendix C, the Cost Appendix. Following public review of the Draft Report and selection of the Recommended Plan a more detailed cost estimate was developed using the Corps MCACES version Mii software. A Total Project Cost Summary with refined contingency costs based upon a detailed cost and schedule risk analysis was also completed. These are Class 3 cost estimates per ER 1105-2-1302, and relocation costs include Class 4 cost estimates.

Table 7-8 First Cost Summary Table for the NER Plan including Recreation, Alternative 13v

Los Angeles River Ecosystem Restoration (Price Level October 2015)	
Construction Item	**Cost ($1,000)**
Lands and Damages (P.L. 91-646 Included)	$348,615
Utility/Facility Relocations	$181,305
Ecosystem Restoration	$114,637
Adaptive Management & Monitoring	$10,386
Recreation Facilities*	$8,556
Preconstruction Engineering and Design (PED)	$27,556
Construction Management (S&A)	$13,412
Total First Cost	**$704,467**

**Includes Costs for Recreation Plan formulated for the NER Plan*

Table 7-9 First Cost Summary Table of the LPP including Recreation, Alternative 20

Los Angeles River Ecosystem Restoration (Price Level October 2015)	
Construction Item	**Cost ($1,000)**
Lands and Damages (P.L. 91-646 Included)	$526,285
Utility/Facility Relocations	$228,562
Ecosystem Restoration	$450,233
Adaptive Management & Monitoring	$12,250
Recreation Facilities	$14,921
Preconstruction Engineering and Design (PED)	$85,135
Construction Management (S&A)	$39,222
Total First Cost	**$1,356,608**

**Includes Costs for Recreation Plan formulated for the LPP*

7.5 PLAN IMPLEMENTATION

This section presents the Federal and non-Federal responsibilities for implementing the recommended plan. This includes Federal and non-Federal project cost sharing requirements and the division of responsibilities between the Federal government and the non-Federal sponsor, the City of Los Angeles. It also lists the steps toward project approval, and a schedule of the major milestones for the design and construction of the tentatively recommended plan.

Cost Apportionment of the Recommended Plan

The following summarizes cost apportionment for the LPP, which is the Recommended Plan. The following guidance (ER 1105-2-100) specifically addresses cost sharing for LPPs.

- Projects may deviate from the National Ecosystem Restoration Plan if requested by the non-Federal sponsor and approved by ASA(CW).

- Plans requested by the non-Federal sponsor that deviate from these plans shall be identified as the Locally Preferred Plan (LPP).
- If the non-Federal sponsor prefers a plan more costly than the NER Plan, and the increased scope of the plan is not sufficient to warrant full Federal participation, ASA(CW) may grant an exception as long as the sponsor pays the difference in cost between those plans and the locally preferred plan.

As noted, the ASA (CW) has granted an exception to allow the recommendation of Alternative 20 as the LPP. As stated above, the Federal participation limit for LPPs is based upon the Federal share of the NER Plan, with the non-Federal sponsor paying for the non-Federal share of the NER Plan, as well as all of the incremental costs of the LPP over the cost of the NER Plan.

The non-Federal sponsor is responsible for providing 100% of lands, easements, rights of way, relocations, and disposal sites (LERRD) but has voluntarily offered to forgo reimbursement for the value of LERRD that exceed its statutory share (35%) of total ecosystem restoration costs. The ASA(CW) has approved this voluntary request. In addition, a non-standard cost sharing option is also presented in response to a request by the non-Federal sponsor. Selection of a cost sharing option for recommendation to Congress will be made subsequent to the circulation of this Final IFR and documented in the Chief of Engineers' Report.

Cost Sharing Option 1

Under this cost sharing option, the limit of Federal participation in cost sharing would be based upon the Federal share of the NER Plan according to standard cost sharing policy. Current guidance (ER 1105-2-100) describes cost sharing for ecosystem restoration projects as follows:

- The non-Federal share will be 35 percent of the project or separable element implementation costs (preconstruction, engineering and design, and construction), or total implementation costs of a multiple purpose project allocated to ecosystem restoration.
- Non-Federal sponsors shall provide 100 percent of LERRDs, and operation, maintenance, repair, rehabilitation, and replacement (OMRRR).
- The value of LERRD shall be included in the non-Federal 35 percent share. Where the LERRD exceeds the non-Federal sponsor's 35 percent share, the sponsor will be reimbursed for the value of LERRD which exceeds its 35 percent share.
- As noted previously, the non-Federal sponsor has volunteered to forgo reimbursement for the value of LERRDs which exceeds its 35 percent share of NER Plan costs. Since the value of LERRDs significantly exceeds this 35 percent threshold, the non-Federal sponsor's share of the ecosystem restoration component of the NER plan is equal to the value of all LERRDs (approximately $536.3 million, including PED and Construction Management relating to relocation), and the Federal share is equal to the remainder of the total project first cost (approximately $158 million). Costs for the recreation plan developed for the NER Plan would be shared equally between the Federal government and non-Federal sponsor. The following table (Table 7-10) summarizes costs apportionment for the NER Plan.
- As indicated in the notes to the following apportionment tables, PED and Construction Management costs relating to relocations are listed under the Non-Federal cost columns. This is because relocations are a component of LERRD, and provision and performance of LERRD required for the project is a non-Federal sponsor responsibility. PED and Construction Management costs are shown separately from other LERRD costs to distinguish these cost components from lands and damages and relocation construction costs. The Total Project Cost

Summary (TPCS) in Appendix C presents all PED and Construction Management Costs as a single line item and does not separate out those costs that relate to relocations.

- The following apportionment tables also show line items for Federal Administrative Costs. These costs represent Federal administration and review activities relating to the non-Federal sponsor's provision of LERRD for the project, and are therefore a cost shared component of the project and are not part of LERRD. The TPCS in Appendix C includes these costs under the category of Lands and Damages.

Table 7-10 Federal and Non-Federal Apportionment of Total Project First Cost of the NER Plan (October 2015 Price Level)

Item [1]	Federal Cost	Non-Federal Cost	Total Cost
Ecosystem Restoration			
PED[2]	$18,449,900	$7,865,500	$26,315,400
LERRDs	$0	$523,875,400	$523,875,400
Federal Admin. Cost [3]	$6,044,600	$0	$6,044,600
Ecosystem Restoration	$114,637,000	$0	$114,637,000
Adaptive Management & Monitoring	$10,386,000	$0	$10,386,000
Construction Management	$8,272,800	$4,583,100	$12,855,900
Subtotal	**$157,790,200 (23%)**	**$536,324,000 (77%)**	**$694,114,200 (100%)**
Recreation			
PED	$620,300	$620,300	$1,240,600
LERRDs	$0	$0	$0
Recreation Facilities	$4,278,000	$4,278,000	$8,556,000
Construction Management	$278,100	$278,100	$556,100
Subtotal	**$5,176,400 (50%)**	**$5,176,400 (50%)**	**$10,352,800 (100%)**
Total Project	**$162,967,000 (23%)**	**$541,500,400 (77%)**	**$704,467,000 (100%)**

(1) Based on October 2015 price level, 3.375% interest rate, and a 50-year period of analysis. Values may not add due to rounding. (2) Non-Federal PED and Construction Management Costs for Ecosystem Restoration are for Relocations and are therefore part of LERRD. (3) Federal Administrative Cost- Federal administrative costs of LERRD acquisition oversight.

For the LPP, the Federal share of ecosystem restoration costs under Option 1 is limited to the Federal share of ecosystem restoration costs for the NER Plan (or $157.79 million). The non-Federal sponsor is responsible for the remainder of total project first cost for ecosystem restoration features (approximately $1.18 billion). The following table (Table 7-11) summarizes cost sharing under Option 1; the effective non-Federal cost share under Option 1 is approximately 88 percent. Costs for the recreation plan developed for the LPP would be shared equally between the Federal government and the non-Federal sponsor.

Table 7-11 Federal and Non-Federal Apportionment of Total Project First Cost of the LPP (Option 1) (October 2015 Price Level)

Item [1]	Federal Cost	Non-Federal Cost	Total Cost
Ecosystem Restoration			
PED[2]	$68,253,700	$14,717,700	$82,971,500
LERRDs	$0	$748,652,000	$748,652,000
Federal Admin Costs [3]	$6,195,000	$0	$6,195,000
Ecosystem Restoration	$450,233,000	$0	$450,233,000
Adaptive Management & Monitoring	$12,250,000	$0	$12,250,000
Construction Management[2]	$30,597,300	$7,654,800	$38,252,100
Non-Federal Cash Contribution [4]	($409,738,800)	$409,738,800	$0
Subtotal	**$157,790,200 (12%)**	**$1,180,763,400 (88%)**	**$1,338,553,600 (100%)**
Recreation			
PED	$1,081,800	$1,081,800	$2,163,500
LERRDs	$0	$0	$0
Recreation Facilities	$7,460,500	$7,460,500	$14,921,000
Construction Management	$484,900	$484,900	$969,900
Subtotal	**$9,027,200 (50%)**	**$9,027,200 (50%)**	**$18,054,400 (100%)**
Total Project	**$166,817,400 (12%)**	**$1,189,790,600 (88%)**	**$1,356,608,000 (100%)**

1) Based on October 2015 price level, 3.375% interest rate, and a 50-year period of analysis. Values may nat add due to rounding. (2) Non-Federal PED and Construction Management Costs for Ecosystem Restoration are for Relocations and are therefore part of LERRD. (3) Federal Administrative Cost- Federal administrative costs of LERRD acquisition oversight. (4) Non-Federal sponsor cash contribution for LPP incremental cost. Federal share af LPP limited ta Federal share af the NER Plan. All LERRD is non-Federal cast with na reimbursement.

Cost Sharing Option 2

In a 27 May 2014 memorandum, the ASA (CW) specified the following regarding cost sharing for the LPP:

> *Having fully reviewed and taken into consideration the unique aspects of the project as detailed by the Los Angeles District, the concurrence by other Federal agencies in the plan, the city's willingness to limit the Federal government's exposure to real estate costs beyond 35 percent of project cost as approved in my August 8, 2013 memorandum, and the non-Federal sponsor's offer to share equally in the costs of the LPP, I have concluded there is substantial Federal interest in the LPP. Equal cost sharing of the LPP between the Federal government and the non-Federal sponsor, as requested by the City of Los Angeles, would total $540 million each. I have decided to permit the Corps to recommend equal cost sharing of the LPP plan.*
>
> *These decisions are subject to the Corps incorporating the information discussed above into the final decision documents and subject to the non-Federal sponsor's continued agreement to forgo reimbursement or credit for real estate which may exceed 35 percent of the LPP cost. All other requirements of local cooperation remain the same, including the non-Federal sponsor's requirement to operate, maintain, repair, replace, and rehabilitate (OMRRR) the project after construction...*

Based upon the above, the non-Federal sponsor's share under this option is equal to 50 percent of total project first cost, with the following adjustments:

1. The non-Federal sponsor's creditable LERRDs are limited to 35 percent of total project first cost for ecosystem restoration features.
2. Since the value of LERRDs for the LPP exceeds 35 percent of total project first cost for ecosystem restoration features, but only 35 percent is creditable, the non-Federal sponsor must also provide a 15 percent cash contribution to bring the sponsor's creditable share to 50 percent.
3. The non-Federal sponsor's request to forgo reimbursement for LERRDs in excess of 35 percent of total project first cost for ecosystem restoration features also applies to this cost sharing option.
4. In accordance with 3 above, the non-Federal sponsor must therefore contribute all LERRDs in excess of 35 percent of total project first cost for ecosystem restoration features, in addition to the 35 percent of LERRDs that is creditable and the required 15 percent cash contribution per 2 above.

The following table (Table 7-12) summarizes cost sharing under Option 2 based upon these provisions. Note that under this option, the non-Federal sponsor's effective share of total project first cost for ecosystem restoration features is approximately 73 percent (vs. 88 percent under Option 1).

Table 7-12 Federal and Non-Federal Apportionment of Total Project First Cost of the LPP (Option 2) (October 2015 Price Level)

Item [1]	Federal Cost	Non-Federal Cost	Total Cost
Ecosystem Restoration			
PED[2]	$68,253,700	$14,717,700	$82,971,500
Creditable LERRDs [4]	$0	$468,493,800	$468,493,800
Non-creditable LERRDs	$0	$280,158,300	$280,158,300
Federal Admin Costs [3]	$6,195,000	$0	$6,195,000
Ecosystem Restoration	$450,233,000	$0	$450,233,000
Adaptive Management & Monitoring	$12,250,000	$0	$12,250,000
Construction Management[2]	$30,597,300	$7,654,800	$38,252,100
Non-Federal Cash Contribution [5]	($200,783,000)	$200,783,000	$0
Subtotal	**$366,746,000 (27%)**	**$971,807,600 (73%)**	**$1,338,553,600 (100%)**
Recreation			
PED	$1,081,800	$1,081,800	$2,163,500
LERRDs	$0	$0	$0
Recreation Facilities	$7,460,500	$7,460,500	$14,921,000
Construction Management	$484,900	$484,900	$969,900
Subtotal	**$9,027,200 (50%)**	**$9,027,200 (50%)**	**$18,054,400 (100%)**
Total Project	**$375,773,200 (28%)**	**$980,834,800 (72%)**	**$1,356,608,000 (100%)**

1) Based an October 2015 price level, 3.375% interest rate, and a 50-year period of analysis. Values may not add due to rounding. (2) Non-Federal PED and Construction Management Costs for Ecosystem Restoration shown are for Relocations and are therefore part of LERRD. (3) Federal Admin Costs- Federal administrative costs of LERRD acquisition oversight. (4) Per ASA (CW) 27 May 2014, LERRD credit up to 35% of total project first cost. (5) Non-Federal cash contribution which brings non-federal creditable share to 50%.

Section 103 of the Water Resources Development Act of 1986, as amended, 33 U.S.C. 2213, sets out the standard requirements for cost sharing Corps water resources projects. Because Option 2 cost sharing deviates from these requirements, specific statutory language would be necessary in order to authorize Option 2 cost sharing, in addition to the Congressional authorization to carry out the Locally Preferred Plan.

7.5.1 Recommended Plan

Alternative 20 is the Recommended Plan. The table below displays the allocation of costs between Ecosystem Restoration and Recreation purposes. It also displays the annual benefits for both.

Table 7-13 Recommended Plan Cost Allocation (October 2015 Price Level)

Item [1]	Ecosystem Restoration		Recreation		Total Cost	
	Allocated Costs	Benefits	Allocated Costs	Benefits	Allocated Costs	Benefits
Investment Cost						
First Cost	$1,338,554,000		$18,054,000		$1,356,608,000	
Interest During Construction [2]	$57,911,000		$54,000		$57,965,000	
Total	$1,396,465,000		$18,108,100		$1,414,573,000	
Interest and Amortization	$58,201,000		$755,000		$58,956,000	
OMRRR [3]	$2,306,000		$223,000		$2,529,000	
Subtotal	$60,507,000		$978,000		$61,485,000	
Annual Benefits						
Non-Monetary (Ecosystem)		6782 AAHU's				6782 AAHU's
Monetary (Recreation)				$3,510,000		$3,510,000
Net Annual Recreation Benefits				$2,532,000		$2,532,000
Recreation Benefit-Cost Ratio				3.59		3.59

[1] Based on October 2015 price level, 3.375% interest rate, and a 50-year period of analysis. Values may not add due to rounding.
[2] IDC was calculated based on the start and end of construction for each contract in the MCACES TPCS. See Appendix C.
[3] Operation, Maintenance, Repair, Replacement, and Rehabilitation.

7.5.2 Operation and Maintenance Considerations.

Operation and maintenance (O&M) for specific reaches of the Los Angeles River as part of the LACDA are divided between the Corps and the Los Angeles County Department of Public Works (LACDPW). The ARBOR reach is maintained by the Corps. O&M of the current project includes maintenance of structures, vegetation control and subdrain cleaning. Vegetation maintenance from the concrete channel is recurring maintenance, and manholes are inspected and cleaned on a 3-year basis.

Operation, maintenance, repair, replacement, and rehabilitation activities (OMRRR) would occur after the project is constructed in order to keep project features functioning as designed. A detailed Operation and Maintenance Plan will be developed during implementation and will be coordinated with the current O&M plan for the existing flood risk management project. It is assumed that ongoing O&M of this restoration project will include the following activities:

Annual inspections and maintenance- Project features will be inspected to verify performance and identify damages or repair needs quarterly, and after major flood events. Clean up and minor repairs will also occur at least quarterly. Inspection would include evaluation of scour, sedimentation, and integrity of geotechnical structures.

Invasive Species Management- Periodic removal of invasive species will take place as needed. It will likely be required more frequently in the early stages of vegetation establishment and taper off as native vegetation matures. Invasives control will be carried out throughout the restoration project footprint, including the River and tributary channel bottom areas. Control of invasive vegetation is assumed to cost approximately $300,000 annually, and be completed each year for 5 years followed by once every 5 years. This is based on vegetation control that was conducted in the Glendale Narrows reach in the past several years.

Restored Vegetation- O&M costs for areas to be revegetated outside the river channel have been estimated as 1.5 percent of the initial construction cost annually. This cost will include maintenance of the temporary irrigation system infrastructure on an as- needed basis. Supplemental irrigation will also be provided during extreme drought. There is a limit to the size and amount of vegetation that will be allowed in the river since too much will affect the conveyance of flow. The amount of existing vegetation will be quantified during the annual inspections and a removal plan will be prepared and implemented, if necessary.

Additional maintenance, repair/and or replacement of project features was estimated by applying a percentage of initial construetion cost of items anticipated to require maiutenance over the life of the project, and listed in Appendix C Cost. The estimated annual O&M costs for the LPP is $2,306,000 for Restoration and $223,000 for Recreation.

LACDA O&M- USACE identified that a modification to the LACDA OMRRR plan would be needed to avoid contradictory maintenance requirements for the areas of restoration features. The LACDA OMRRR plan would thus be modified to accommodate the restoration project, with maintenance of the restoration project a City responsibility under the restoration OMRRR plan. The LACDA OMRRR manual would be modified to exclude constructed restoration features and would exclude invasives management throughout the restoratiou project footpriut. The Corps would continue to be responsible for maintaining all other aspects of the portions of the LACDA project that overlap with the restoration project footprint.

At the same time, the USACE would modify the LACDA OMRRR plan for the rest of the ARBOR reach to preserve the flood risk management function while complementing the restoration project. These modifications would allow some native vegetation to remain in the ARBOR reach outside of the constructed restoration features to the extent that design conveyance capacities would be met or would experience only minimal changes from the design conditions. Such OMRRR would be contingent on funding and would be anticipated to be phased in over time. These OMRRR modifications would be refined during detailed design of the restoration project with H&H data. OMRRR modifications would also account for levee vegetation requirements within the channel, either by limitation or variance.

Under this approach, if the District received funding to undertake OMRRR, the LACDA maintenance would be anticipated to selectively remove the larger trees but allow the smaller beudable vegetation to remain, in contrast to the vegetation-free desigu under the current OMRRR plan. OMRRR would be contiugent on fuuding and would be anticipated to be phased in over time. There is a limit to the size and amount of vegetation that will be allowed in the river since too much will affect the conveyance of flow. The amount of existing vegetation will be quantified during the annual inspections and a removal plan will be implemented when necessary.

This approach provides a route to a return to design or near-design conditions for LACDA within the ARBOR reach while facilitating and supporting the restoration features and goals. This course of action would have the least impact on environmental resources and would have the smallest effect on habitat benefits while having no more than a minimal impact on flow conveyance. The remainiug bendable vegetatiou would still provide the majority of the habitat benefits afforded by the curreut conditions.

With construction of the restoration project features, there may be some incidental flood risk management benefits from the proposed channel re-configurations in the Taylor Yard area due to widening the channel in that area. In the LATC area, where the channel would also be widened, there are no significant flood risk impacts because the channel already has greater than 100-yr level of protection. Within the lower reaches of the ARBOR (Reaches 6, 7, and 8), the OMRRR plan is expected to be able to allow some vegetation to establish and remain within the channel without reducing flood conveyance capacity from Design Conditions. With completion of the hydrology and hydraulics modeling during the design phase, the level of vegetation that could be maintained in the channel can be determined, consistent with or with only minimal changes to Design Conditions.

7.5.3 Detailed Design

Detailed design in PED will involve all technical elements and will be undertaken in accordance with applicable Corps regulations. This IFR and each technical appendix identify key design considerations and commitments where appropriate. Design considerations that were clarified during IEPR, coordination with other agencies, and/or the Corps review process include the following.

Detailed design will include detailed hydrologic and hydraulic analysis. The detailed hydrologic and hydraulic analysis would verify that there is no increase in flood risk compared to existing conditions, evaluate whether conveyance in the additional channel area is offset by the inclusion of vegetation, and further analyze incidental flood risk benefits. The detailed hydrologic and hydraulic analysis would also be used to determine to what extent some native vegetation in the channel outside the constructed restoration features could be maintained, as discussed in Sections 6.2.1 and 7.5.2. During PED, risk and uncertainty will be documented to ensure there are no adverse impacts to existing conditions.

Hydrologic and hydraulic modeling will include two-dimensional modeling and may include physical modeling to more accurately simulate the proposed alterations in and adjacent to the channel. Detailed modeling and design will involve actions identified in Section 6.2.1. In addition, perennial effluent base flow, channel forming discharge, and flow duration will be analyzed. The Corps will also clarify the hydrologic and hydraulic design of low flow channels and analyze the low flow channels in modified reaches. The detailed analysis will include design and evaluation of daylighted storm drains, with determination of effective and ineffective flow areas, verification and refinement of contraction/expansion coefficients for bridges; consideration of energy grade line, shear stress, and possibly stream power for determination of vegetation size, density, and extent; assessment of specific vegetation species and associated bending and/or breaking or washing out; and more detailed analysis of vegetation roughness using an appropriate tool such as ERDC's HYDROCAL. During PED, the Corps will also look for additional sources of existing data on groundwater-surface water interaction to incorporate into the water budget and evaluate possible segregation to support fish refugia.

As part of the detailed design phase, several additional stream gages may be recommended to be installed. These gages will be necessary to provide information to Corps personnel involved in flood risk management on real-time water levels within the river and to City personnel operating and maintaining the restoration and recreation features of the project. These gages would supplement the data from the four existing stream gages along the Los Angeles River that are maintained by LACDPW.

The PED analysis will also include sediment transport modeling and detailed analysis of scour and erosion. A detailed sediment management plan will be developed to protect against sedimentation and scour and further define sediment management required in O&M.

Geotechnical considerations, including levee policy compliance, appropriate erosion control measures, and investigation of HTRW and other contamination, will be further evaluated and addressed. Levee

vegetation policies will be followed, either by limitation or variance, as described in Section 6.2.2. Sampling, testing, and engineering in the areas of channel modifications will be conducted during PED, Further investigation of HTRW contamination will be undertaken by the non-Federal sponsor as identified in Sections 5.11.3 and 7.5.5 and Appendix K. Channel protection products wil be evaluated to ensure they meet Corps specifications and surpass all hydraulic, geotechnical, and structural criteria. As identified in Section 4.4.5, use of HPTRM or other soft methods to resist erosion will be fully evaluated using site specific data and engineering analysis before being incorporated into a final design and may require augmentation with more traditional channel protection measures.

As described in Sections 7.1.9 and 7.1.10 and the responses to the USFWS's CAR (provided in full in Appendix N and summarized in Section 8.7.1), more specific vegetation planting and management plans will be developed, and features for wildlife habitat and habitat connectivity will be refined, in PED. Such measures are dependent on the detailed design and hydraulic analysis as well as levee policies. As identified in Section 5.6, the Corps will ensure that appropriate cultural resource investigations occur early in PED for each reach of the project so that avoidance and impact minimization measures for cultural resources can be incorporated into the project design.

Detailed design drawings of all project features and multiple cross sections for each affected project reach will be developed in PED.

7.5.4 Monitoring and Adaptive Management

Monitoring and adaptive management conforms with the requirements of Section 2039 of WRDA 2007 and Corps implementation guidance (CECW-PB Memo 31 August 2009). The Corps and the non-Federal sponsor are responsible for carrying out the monitoring and adaptive management plan after construction of each project phase/component until ecological success criteria are met, but for no more than ten years. It is anticipated that the restored habitats can reasonably be expected to achieve success within five years for most or all project components. Upon the determination of the District Engineer that ecological success criteria have been met, cost-shared monitoring will be concluded, and in no case shall cost-shared monitoring extend beyond ten years after construction of each component. The monitoring and adaptive management plan has been developed to ensure the success of the recommended restoration plan in meeting project objectives and to provide a process to identify when any adaptive management actions are warranted during the monitoring period.

The Monitoring and Adaptive Management Plan (MAMP) is included in Appendix H-2. This MAMP describes the rationale for monitoring and adaptive management, monitoring parameters and methods, assessment of monitoring results, an adaptive management framework, decision-making triggers, the cost and duration of monitoring, and responsible parties.

Monitoring

An effective monitoring program is required to determine if the project outcomes are consistent with original project objectives. Monitoring must be closely integrated with the adaptive management components because it is the key to the evaluation of project objectives and adaptive management needs. The MAMP includes a monitoring plan that identifies performance measures along with desired outcomes and monitoring design in relation to specific objectives. Monitoring parameters for vegetation and native fish habitat are included.

Results of the monitoring will be assessed in comparison to project objectives and decision-making triggers to evaluate whether the project is functioning as planned and whether adaptive management actions are needed to achieve project objectives. The results of the monitoring will be provided to an

Adaptive Management Team (AMT) who will evaluate and compare data to project objectives and decision making triggers. The information generated by the monitoring plan will be used by the Corps and City in consultation with the other AMT members to guide decisions on adaptive management that may be needed to ensure that the ecosystem restoration project meets the success criteria. Final decisions on implementation of adaptive management actions are made by the Corps.

Adaptive Management

The primary incentive for implementing an adaptive management program is to increase the likelihood of achieving desired project outcomes given uncertainties. Adaptive management provides an organized, coherent, and documented process that suggests management actions in relation to measured project performance compared to desired project outcomes. The need for adaptive management actions will be based on assessment of monitoring results as compared to established decision-making triggers for vegetation and native fish habitat. Adaptive management actions may include such actions as temporary supplemental water drought conditions, addition of natural substrates, or re-grading. Details of the implementation of adaptive management are described in Appendix H-2.

Cost

The monitoring and adaptive management costs at October 2015 price levels total $12.25 million for the Recommended Plan and $10.4 million for the NER Plan including contingency. The plan includes cost shared monitoring and adaptive management actions during the first five years after construction of each project phase/component, or until success criteria are met, for no more than ten years.

7.5.5 Hazardous, Toxic and Radioactive Waste

As described in this report and Appendix K HTRW Survey Report, there are known and suspected contaminated sites within the study area that cannot be avoided by the project. These include the San Fernando Valley Superfund Site, and Taylor Yard G1 and G2 parcels, and LATC. Per ER 1105-2-100 and ER 1165-2-132, if sites cannot be avoided, studies or investigations undertaken by the sponsor may be cost shared, but the non-Federal sponsor has responsibility at 100 percent non-project cost for undertaking or ensuring remediation of any HTRW, both known and unknown, to provide sites compatible with the land use necessary for the restoration project. The City would undertake all appropriate inquiries prior to land acquisition and would adequately investigate City-owned lands. The City is responsible for ensuring that all lands provided for the project are remediated to the standards required for the ecosystem restoration project as determined by the local regulator and with input from USACE. The City must undertake the remediation or ensure the remediation is undertaken prior to providing such lands for construction of project features. Prior to providing a parcel for project construction, the City must ensure that it is either shown to be free of contamination through adequate site investigation or that it has been remediated to regulator and USACE satisfaction to the standards required for the ecosystem restoration project. Additionally, for groundwater contamination that is impracticable to remediate prior to project construction, the non-Federal sponsor will be responsible, at 100 percent non-project cost, for all treatment, handling and disposal of contaminated groundwater during dewatering. The City of Los Angeles is aware of these requirements, and has accepted responsibility for delivering lands suitable for ecosystem restoration and addressing groundwater contamination during dewatering.

7.5.6 Construction Phasing

Detailed construction schedules for both the NER and LPP are included in Appendix C, Cost. Both schedules assume construction sequencing to include multiple construction contracts. Construction of the NER Plan is assumed to span 10 years and the LPP a period of 15 years. Additional time is included in

the schedule for both design and acquisition of LERRD. The sequence of construction was modified from the Draft IFR to minimize air emissions and allow additional time for LERRD acquisition.

In an effort to reduce construction costs, sequencing of the earthwork operations for the HTRW remediation and grading to project design grades should be performed to eliminate double handling of soils and materials. This sequencing is proposed as follows and depicted in the conceptual and not to scale figure below. Sequencing is further discussed in Appendix K HTRW Survey Report.

1. Dewatering and subsequent contamination remediation prior to earthwork activities and prior to construction of the project would be needed to be performed. Continuation of dewatering would likely continue throughout construction of the project and monitoring and treatment would need to be performed by the non-Federal sponsor.
2. City responsibility: Removal of HTRW impacted soils would be performed by the non-Federal sponsor to the depth and grade required for restoration standards leaving in place the river channel and/or existing levee. If contaminants extend into channel or levee right of way, additional coordination with USACE would be needed to avoid flood risk management impacts during remediation.
3. City responsibility: The resulting excavation should not be filled beyond the design grades for the project landward of the channel.
4. Restoration Project construction: Modification of the channel and/or removal of the existing levee would be performed.
5. Restoration Project construction: Placement of fill to meet the desired grades at the channel would be made.
6. Restoration Project construction: Any planting and habitat efforts would be made.

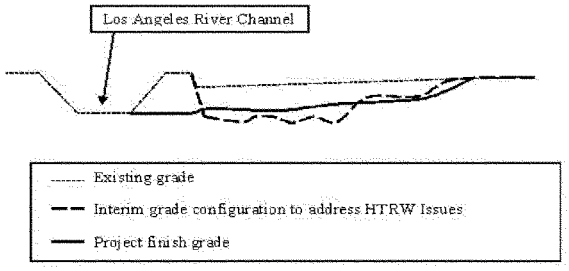


Figure 7-10 Conceptual earthwork sequencing

7.5.7 Environmental Operating Principles

The Corps of Engineers has reaffirmed its commitment to the environment by formalizing a set of "Environmental Operating Principles: applicable to all of its decision-making and programs. These principles foster unity of purpose on environmental issues, reflect a new tone and direction for dialog on environmental matters, and ensure that employees consider conservation, environmental preservation, and restoration in all Corps activities. The principles are described in Engineering Circular 1105-2-4040 "Planning Civil Work Projects under the Environmental Operating Principles," 1 May 2003.

The EOP are supported by the Los Angeles River Ecosystem Restoration Recommended Plan as follows.

1. Foster sustainability as a way of life throughout the organization.

The proposed project will foster sustainability as a way of life as it restore ecosystem function and will have associated beneficial effects of spurring redevelopment and contributing to improved public health and well being for the adjacent community.

Environmental sustainability, when applied to a water resource project must be designed to balance three major elements: environmental health, economic prosperity, and social well-being.

Environmental Health: The project complies with this environmental operating principle by first improving environmental health with restoration of habitat in and along 11 miles of the Los Angeles River. Hydrologic connections will be restored by widening the river in several places, opening up small streams that were once confined to storm drains, and restoring the confluence of two of the River's main tributaries.

Economic Prosperity: Second, restoration will contribute to future economic development by creating jobs during construction, increasing environmental education and recreational opportunities, and spurring future redevelopment in the area.

Social Well Being: In addition, the project will improve social well being by providing increased opportunities for the public to experience restored habitat in an urban setting, benefiting public health. In addition, the project increases open space and includes recreational features that assist in restoring community cohesion.

2. Proactively consider environmental consequences of all Corps activities and act accordingly.

The Corps has proactively considered environmental consequences of the proposed project, along with consequences and requirements of the existing flood risk management project whose footprint overlaps with the proposed project. The proposed project restores a portion of the aquatic and riparian ecosystem degraded over time by a cycle of development, flooding, and flood risk management efforts, including the LACDA flood risk management project constructed by the Corps and LACDPW during the twentieth century. The environmental consequences of the proposed project are largely beneficial, with positive benefits to biological, water, aesthetic, and other resources, and impacts to other resources have been avoided or minimized to the extent practicable. The project reestablishes habitat nodes and reconnects the river to its historic floodplain in key areas and widens the river within the existing right of way in others, restoring ecosystem functions lost or highly degraded during earlier periods of development and channelization. This reach is also the backbone of the river's connection to the nearby significant environmental areas of the Santa Monica Mountains, the Verdugo Hills, and the San Gabriel Mountains. This project will serve as a foundation for those reconnections. At the same time, the proposed project takes into account the need to preserve flood risk management levels provided by the existing project.

3. Create mutually supporting economic and environmentally sustainable solutions.

Seeking the balance between human development and natural systems is especially important in the arena of environmental restoration in urban areas. Improving measurements of success requires improvement of evaluation methods and finding ways to understand the value of what is achieved in both economic and environmental terms. The real costs of environmental degradation are not always recognized.

The ARBOR reach of the Los Angeles River is heavily urbanized. It is lined with highways, rail lines, and industrial and residential development. This urbanization was aided by channelization undertaken as part of flood risk management projects, including the construction of hardened levees and channel walls and concrete lining of the river bed as part of the Corps' and LACDPW's flood risk management project. Science and the public have begun to realize the value of riverine ecosystems to the health of the environment, as well as the economic and social well-being of the community. The proposed project for ecosystem restoration in this reach of the LA River is a strong example of a solution supporting the needs of the ecosystem within both the river and the region while maintaining flood risk management functions.

The project will provide significant regional economic development benefits. Construction of the project and anticipated redevelopment of river adjacent properties attributable to the restoration project are projected to support over 19,000 jobs and billions of dollars in labor income.

These restoration goals and economic and societal benefits would be achieved through sustainable ecosystem improvements that build upon existing remnants of a once vast mosaic of riparian and wetland habitats, and utilize groundwater and surface water resources that are still sufficient to support the proposed increase in restored acres.

4. Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the Corps, which may impact human and natural environments.

The values of environmental sustainability are incorporated into the Nation's laws and mandates to governmental and private actors. The statute that provides a basis for evaluation of environmental impacts is the National Environmental Policy Act of 1969 (NEPA). The planning framework found in the Water Resources Council's Principles and Guidelines (P&G) provides a guide for seeking sustainable solutions in civil works projects. Other standards include the Clean Water Act and the Clean Air Act.

The proposed project would restore a more sustainable ecosystem along the River in a reach that has been highly altered by human activities including activities of the Corps itself. The project incorporates a coordinated approach to the need for restoration while complying with environmental laws such as NEPA, the Clean Water Act, and the Clean Air Act.

5. Consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs.

As an ecosystem restoration study, the study gave restoration of functions of the natural environment foremost consideration during the development, evaluation, and comparison of alternatives. Habitat benefits or changes in value were calculated or forecasted for multiple points throughout the life of the project. Quantitative and qualitative benefits were based on not only the degree to which an alternative improved habitat value within the study area as a whole, but also on consideration of regional and watershed benefits associated with wildlife connectivity. The risks associated with achievement of restoration objectives will be addressed through implementation of the Monitoring and Adaptive Management Plan, which includes monitoring to evaluate ecological success and includes appropriate triggers for contingency actions.

6. Leverage scientific, economic, and social knowledge to understand the environmental context and effects of Corps actions in a collaborative manner.

The Corps must effectively utilize sources of expertise existing among other professional organizations, and other Federal, state and local entities to address problems of regional and national significance.

The Corps has utilized the scientific expertise within the agency as well as that of other Federal governmental entities, State and local governmental organizations, and private sector and non-profit-affiliated scientists in all phases of the study. Their efforts were included during the assessment phase and plan formulation phase and will be utilized in future phases to include the most up to date knowledge available in support of a more sustainable project.

7. Employ an open, transparent process that respects views of individuals and groups interested in Corps activities.

Throughout the study process, the Corps and the non-Federal sponsor have sought the views of individuals and groups on the best ways to restore the Los Angeles River ecosystem and its resources of significance to the region and Nation. The Corps has actively sought involvement of scientists, engineers, and other experts in academia, members of the private sector, public interest groups, and Federal, state, and local agencies, listening objectively to their input and concerns. For this study, the Corps and City incorporated public input through the scoping process and gathered public input during the public review of the Draft IFR including a public meeting. The Corps also participated in the development of the City's Revitalization Master Plan and participates in the EPA's Urban Waters Federal Partnership initiative for Los Angeles River watershed and Department of Interior's America's Great Outdoors on the Los Angeles River. We continue to provide information to keep the public informed on the study. The Corps recognizes its obligation to promote the interests of the Nation by continuously engaging the public and stakeholders throughout the project delivery process.

7.5.8 USACE Campaign Plan and Strategic Plan

The Corps' Campaign Plan Goal 2 to Transform Civil Works and the Sustainable Solutions to America's Water Resources Needs: Civil Works Strategic Plan 2014-2018 guided this effort. The team worked diligently and tirelessly with all segments of our partners and stakeholders. By following the Corps' 6-step plan formulation process as well as the extensive review process, the Corps is delivering an enduring and essential solution that meets the Nation's needs under Goal 2which seeks to "Deliver enduring and essential water resources solutions through collaboration with partners and stakeholders".

These Campaign Plan and Strategic Plan priorities are supported by the Recommended Plan through the following:

- The adaptive management plan incorporates measures to account for potential environmental/cultural changes.
- The O & M plan will provide assurance of engineering, economic, and environmental sustainability of project over 50-year economic life.
- The Recommended Plan has been peer reviewed and is supported by the Non-Federal sponsor and Resource Agencies.
- Employed an integrated, comprehensive systems – based approach by planning and designing project features as a system including up and downstream projects.
- Employed risk-based concepts in planning and conceptual design and will continue to do so in construction and O&M by acknowledging and planning for risk of flood flows, uncertainty in storm water discharges, and sizing of storm water features.
- Employed a continuous assessment of study policy issues through coordination with the South Pacific Division and Headquarters USACE, assessing and modifying organizational behavior as needed.
- Met design and construction standards by collaborating with Construction and Operations and applying lessons learned from other ecosystem projects into planning and alternative design. Examples include: use of storm water outfalls for water source, habitat established in low flow channel, and potential cost of debris removal, wetland designs, and cost estimates.

- Used a dynamic independent review process with Inter-District, Policy, Sponsor, and Agency Review throughout the study.
- Employed adaptive planning and engineering systems developing a Monitoring and Adaptive Management Plan cost shared for no more than 10 years after construction to allow for unexpected changes in system, and respond to necessary modifications of restoration following construction.
- Used a rationale for restoration alternatives focused on sustainability and applied ecological and engineering principles in design of alternatives to maximize functioning river and minimize future maintenance costs.
- Applied ecological and engineering principles in design of alternatives to place project features where appropriate ecologically, restore river functions, and maximize use of existing water sources.
- Considered the need for review and inspection of completed works by considering the needs of the existing flood risk management project and the future ecosystem restoration features.
- Effectively communicated risk using public involvement vehicles and discussions the non-Federal sponsor and with key stakeholders.
- Established public involvement early in the study process with regular meetings and study updates on the web and with the media.
- Manage and enhanced technical expertise and professionalism with an interdisciplinary team from the Corps, Federal and local agencies, the non-Federal sponsor, University and contractor personnel. Shared and learned from multiple disciplines within the Corps and from outside the Corps.

7.5.9 Division of Plan Responsibilities

The Water Resources Development Act (WRDA) of 1986 (Public Law 99-662) and various administrative policies have established the basis for the division of Federal and non-Federal responsibilities in the construction, maintenance, and operation of Federal water resource development projects accomplished under the direction of the Corps. Anticipated Federal and non-Federal responsibilities are described in this section. The final division of specific responsibilities will be formalized in the project partnership agreement (PPA).

Federal Responsibilities

For Option 1, the estimated Federal share of the total first cost of the project is not more than 65 percent of the costs of the NER plan, limited to costs of construction, and 50 percent of first costs related to recreation. The ASA (CW) waiver granting the non-Federal sponsor's request to forgo reimbursement for LERRDs in excess of its statutory share of total ecosystem restoration costs applies to this option. For Option 2, the estimated Federal share of the total first cost of the project is not more than 50 percent of total ecosystem restoration costs for the Locally Preferred Plan, limited to costs of construction, and 50 percent of first costs related to recreation. This option also requires the sponsor to forgo credit or reimbursement for LERRD in excess of 35 percent of total ecosystem restoration costs of the Locally Preferred Plan. First costs are typically all costs to implement the project inclusive of LERRD but do not include OMRRR costs or remediation of hazardous substances regulated by CERCLA. The Federal Government's responsibilities are anticipated to be:

a. Sharing the costs for Preconstruction, Engineering and Design (PED), including preparation of the Plans and Specifications, which is cost shared at the same percentage that applies to construction of the project.

b. Sharing the construction costs for the project in accordance with the cost sharing option recommended by the Chief of Engineers.

c. Administering contracts for construction and supervision of the project after authorization funding and receipt of non-Federal assurances.

Non-Federal Responsibilities

Federal implementation of the recommended project would be subject to the non-Federal sponsor agreeing to comply with applicable Federal laws and policies, including but not limited to:

For Option 1:

a. Provide a minimum of 35 percent of total ecosystem restoration costs of the National Ecosystem Restoration Plan as further specified below:
    1. Provide 35 percent of design costs allocated by the Government to ecosystem restoration in accordance with the terms of a design agreement entered into prior to commencement of design work for the ecosystem restoration features;
    2. Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the ecosystem restoration features;
    3. Provide, during construction, any additional funds necessary to make its total contribution of ecosystem restoration National Ecosystem Restoration Plan costs equal to 35 percent;
b. Provide, during construction, 100 percent of the costs of the total ecosystem restoration costs of the Locally Preferred Plan increment above the total ecosystem restoration costs of the National Ecosystem Restoration Plan;
c. Provide a minimum of 50 percent of total recreation costs of the Locally Preferred Plan as further specified below:
    1. Provide 35 percent of design costs allocated by the Government to recreation in accordance with the terms of a design agreement entered into prior to commencement of design work for the recreation features;
    2. Provide, during the first year of construction, any additional funds necessary to pay the full non-Federal share of design costs allocated by the Government to recreation.
    3. Provide, during construction, any additional funds necessary to make its total contribution for recreation equal to 50 percent of total recreation costs;
    4. Provide, during construction, 100 percent of excess recreation costs in the event that the Federal share of total recreation costs exceeds 10 percent of the Federal share of total ecosystem restoration costs;

For Option 2:

a. Provide a minimum of 50 percent of total ecosystem restoration costs of the Locally Preferred Plan as further specified below:
    1. Provide 35 percent of design costs allocated by the Government to ecosystem restoration in accordance with the terms of a design agreement entered into prior to commencement of design work for the ecosystem restoration features;
    2. Provide, during construction, a contribution of funds equal to 15 percent of total ecosystem restoration costs;
    3. Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated

material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the ecosystem restoration features;

4. Provide, during construction, any additional funds necessary to make its total contribution of ecosystem restoration costs equal to 50 percent;

b. Provide 50 percent of total recreation costs as further specified below:
   1. Provide 35 percent of design costs allocated by the Government to recreation in accordance with the terms of a design agreement entered into prior to commencement of design work for the recreation features;
   2. Provide, during the first year of construction, any additional funds necessary to pay the full non-Federal share of design costs allocated by the Government to recreation;
   3. Provide, during construction, any additional funds necessary to make its total contribution for recreation equal to 50 percent of total recreation costs;

c. Provide, during construction, 100 percent of the total recreation costs that exceed an amount equal to 10 percent of the Federal share of total ecosystem restoration costs;

For Both Options:

d. Shall not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefor, to meet any of the non-Federal obligations for the project unless the Federal agency providing the Federal portion of such funds verifies in writing that expenditure of such funds for such purpose is authorized;

e. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the outputs produced by the ecosystem restoration features, hinder operation and maintenance of the project, or interfere with the project's proper function;

f. Shall not use the ecosystem restoration features or lands, easements, and rights-of-way required for such features as a wetlands bank or mitigation credit for any other project;

g. Keep the recreation features, and access roads, parking areas, and other associated public use facilities, open and available to all on equal terms;

h. Comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. 4601-4655), and the Uniform Regulations contained in 49 Code of Federal Regulations Part 24, in acquiring lands, easements, and rights-of-way required for construction, operation, and maintenance of the project, including those necessary for relocations, the borrowing of materials, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;

i. For so long as the project remains authorized, operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, including any mitigation features, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government;

j. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;

k. Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, rehabilitation, and replacement of the project and any betterments, except for damages due to the fault or negligence of the United States or its contractors;

l. Keep and maintain books, records, documents, or other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, or other evidence are required, to the extent and in such detail as will properly reflect total project costs, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20;

m. Comply with all applicable Federal and state laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964 (42 U.S.C. 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; the Age Discrimination Act of 1975 (42 U.S.C. 6102); the Rehabilitation Act of 1973, as amended (29 U.S.C. 794) and Army Regulation 600 7 issued pursuant thereto; and 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (labor standards originally enacted as the Davis-Bacon Act, the Contract Work Hours and Safety Standards Act, and the Copeland Anti-Kickback Act);

n. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended (42 U.S.C. 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction;

o. Assume, as between the Federal Government and the non-Federal sponsor, complete financial responsibility for all necessary remediation and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project;

p. Agree, as between the Federal Government and the non-Federal sponsor, that the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, rehabilitate, and replace the project in a manner that will not cause liability to arise under CERCLA; and

q. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. 1962d-5b), and Section 103(j) of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2213(j)), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project or separable element.

7.5.10 Non-Federal Sponsor's Financial Capability

The non-Federal sponsor has committed to provide its share of total project costs, as well as all LERRD required for the project. The non-Federal sponsor has committed to perfroming all OMRRR required for the project. The non-Federal sponsor has also made a commitment to undertake all necessary response and remediation for CERCLA contaminants required for the Project, including providing lands free of soil contamination prior to construction of the Project features on those lands and handling groundwater contamination during construction activities.

7.5.11 Project Partnership Agreement

Prior to advertisement for the first construction contract, a Project Partnership Agreement will be required to be signed by the Federal Government and the City of Los Angeles, requiring formal assurances of local cooperation from the City. This agreement will be prepared and negotiated during the Plans and Specifications Phase.

7.5.12 Approval and Implementation

The necessary reviews and activities leading to approval and implementation of the tentatively recommended plan are listed below:

a. Environmental Impact Statement Filing – after circulation of this Final IFR for state and agency review, as well as public review, the District will file Final IFR together with the proposed report of the Chief of Engineers with EPA.

b. Environmental Impact Report Certification – The Final IFR will be circulated for public and agency review and comment a minimum of 10 days before consideration by the City of Los Angeles Board of Public Works. At a public hearing, the Board of Public Works will decide whether to recommend approval of the EIR and forward the document to the Los Angeles City Council for certification. If adopted, a Notice of Completion is filed with the City Clerk.

c. Chief of Engineers Approval – Chief of Engineers signs the report signifying approval of the project recommendation and submits the following to ASA (CW): the Chief of Engineers Report, the Final IFR, and the unsigned ROD.

d. ASA (CW) Approval – The Assistant Secretary of the Army for Civil Works will review the documents to determine the level of administration support for the Chief of Engineers recommendation. The ASA (CW) will formally submit the report to the Office of Management and Budget (OMB). OMB will review the recommendation to determine its relationship to the program of the President. OMB may clear the release of the report to Congress.

e. Project requires congressional approval for construction.

f. Funds could be provided, when appropriated in the budget, for preconstruction, engineering and design (PED), upon issuance of the Division Commander's public notice announcing the completion of the final report and pending project authorization for construction. Surveys, model studies, and detailed engineering and design for PED studies will be accomplished first and then plans and specifications will be completed, upon receipt of funds.

g. Construction would be performed with Federal and non-Federal funds, once the construction project was advertised and awarded.

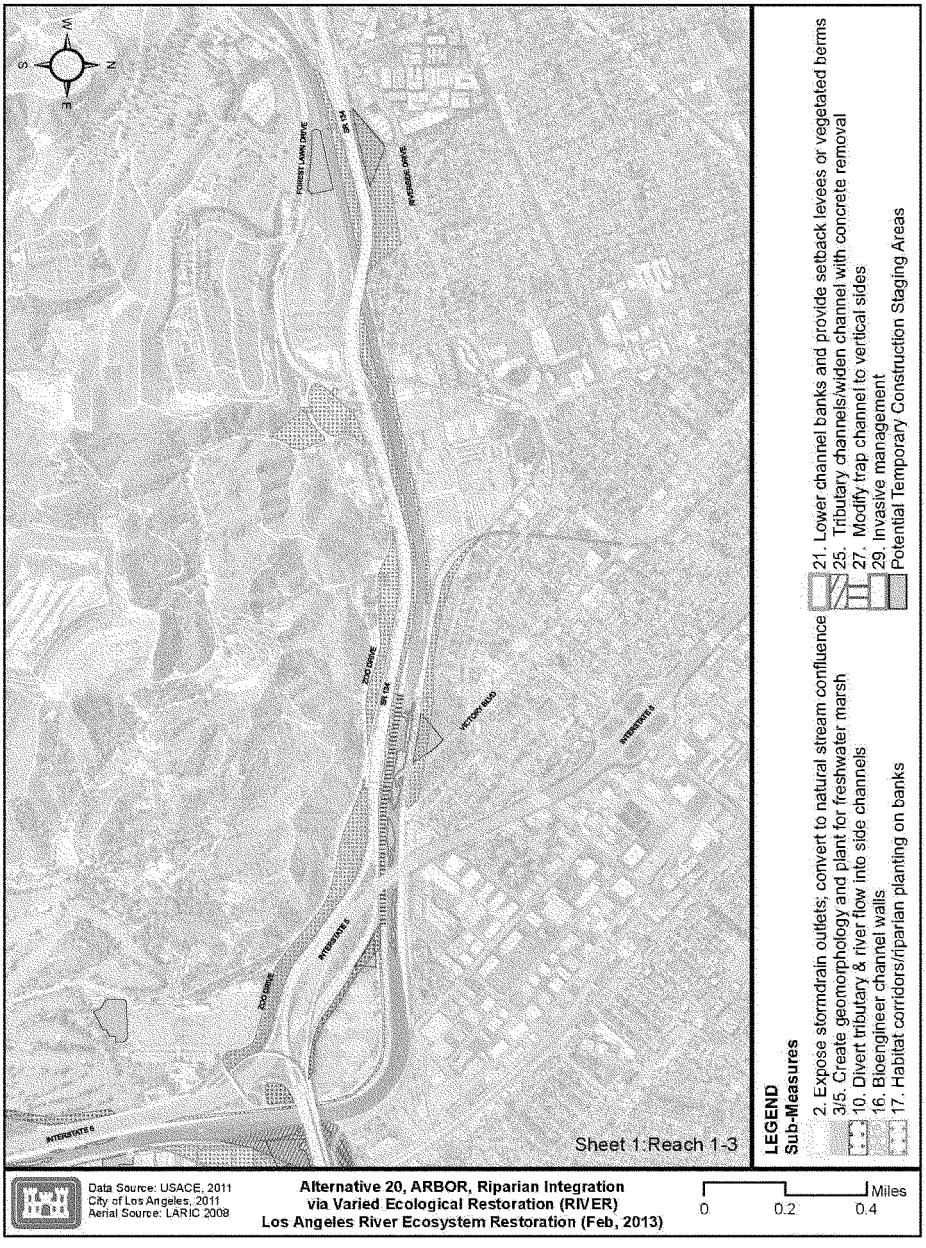
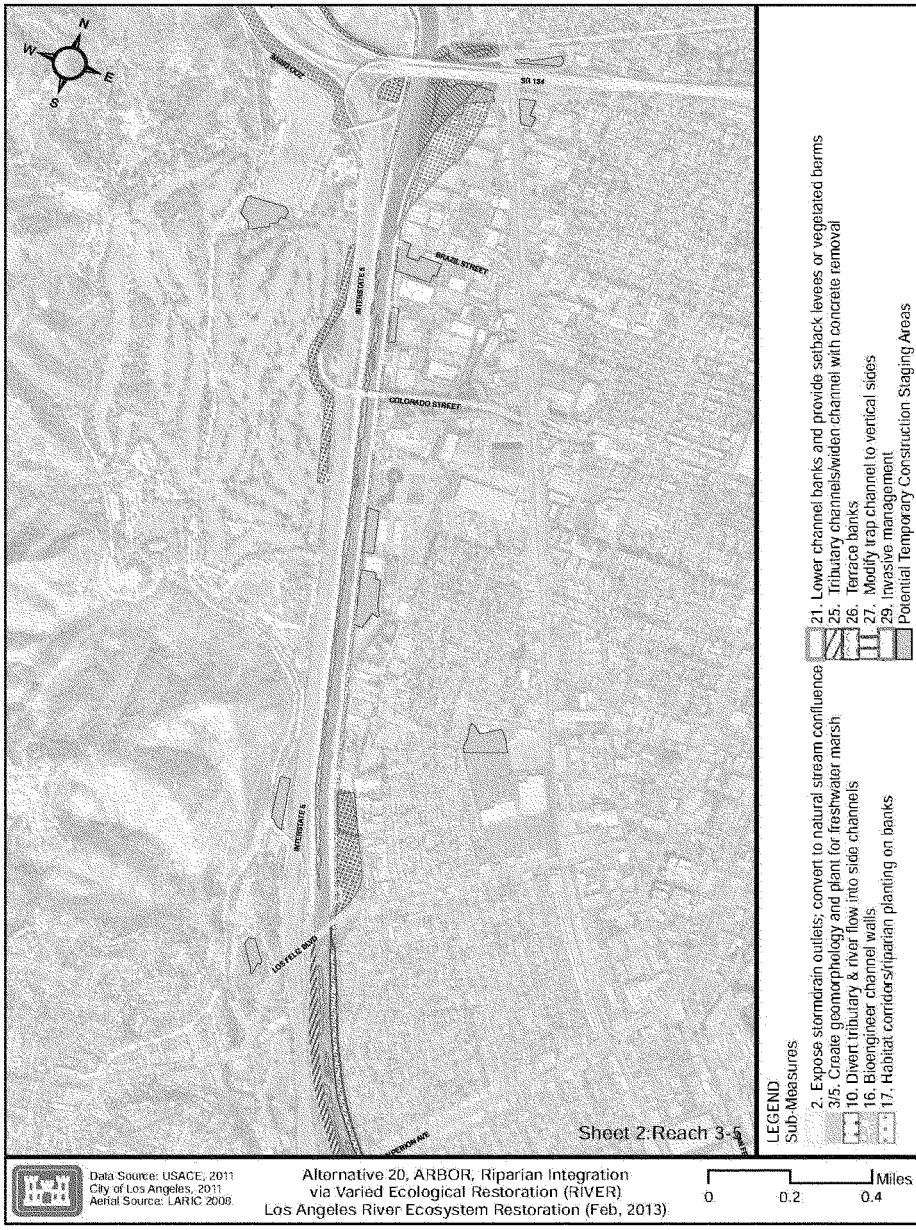


Figure 7-11 Map of the Recommended Plan



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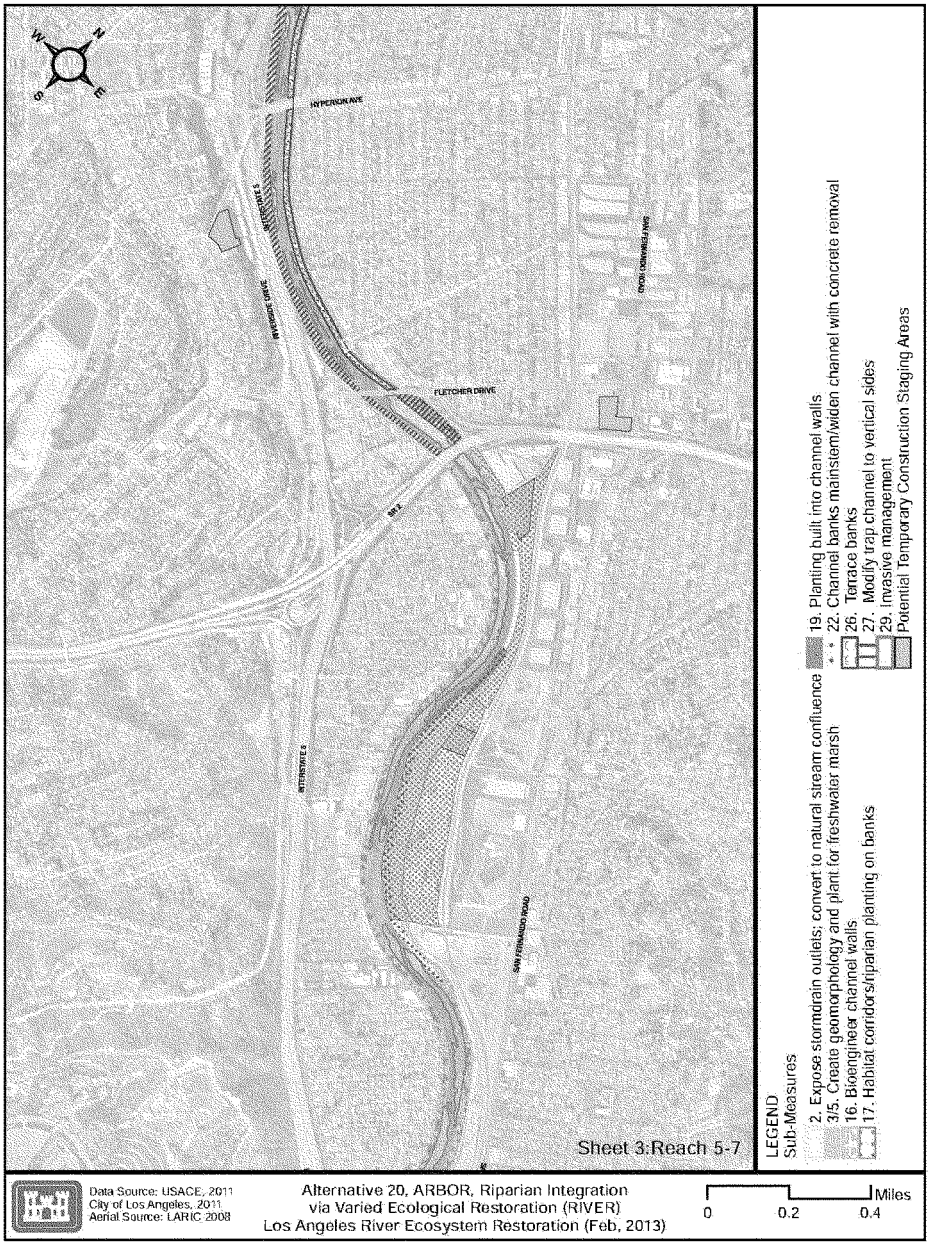

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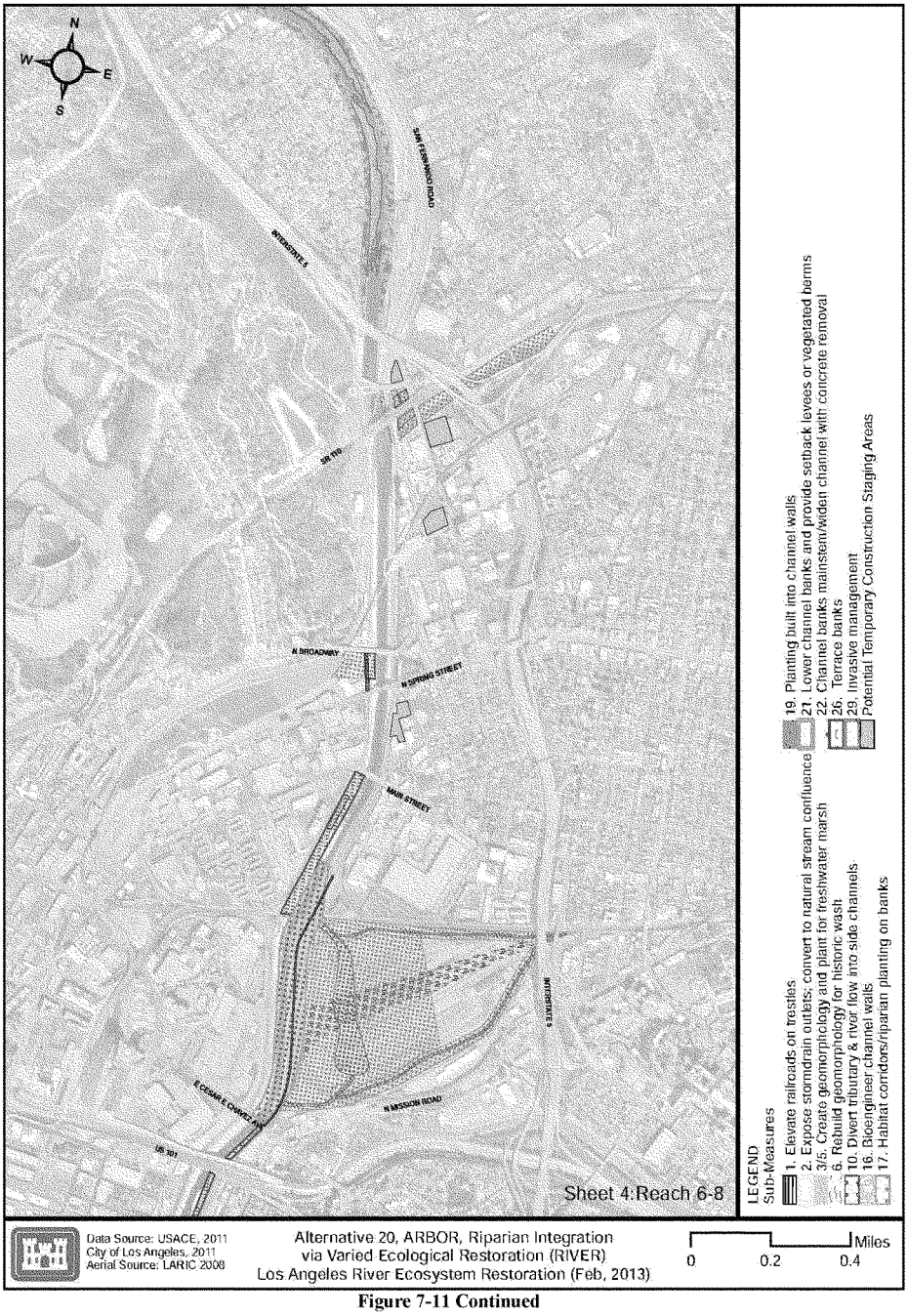

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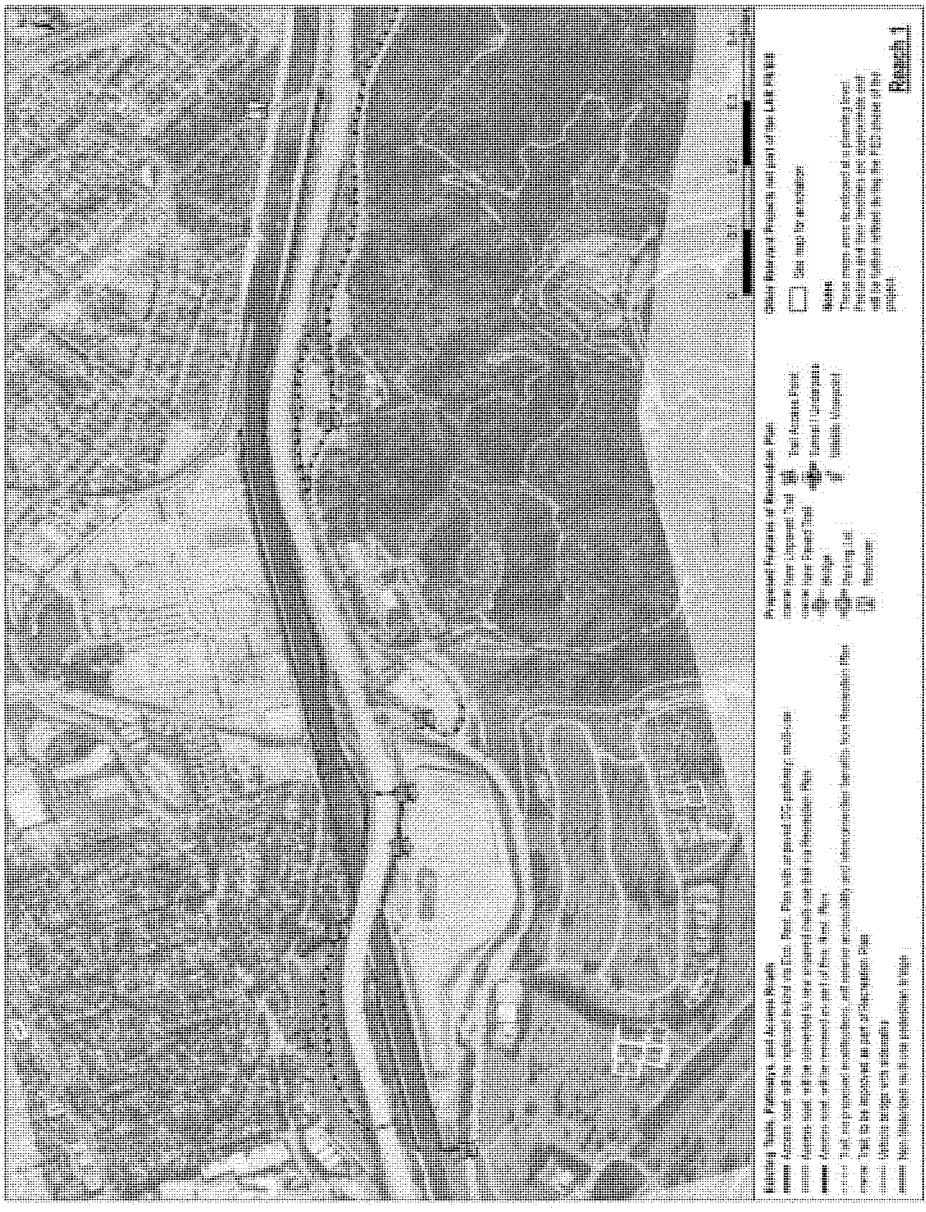
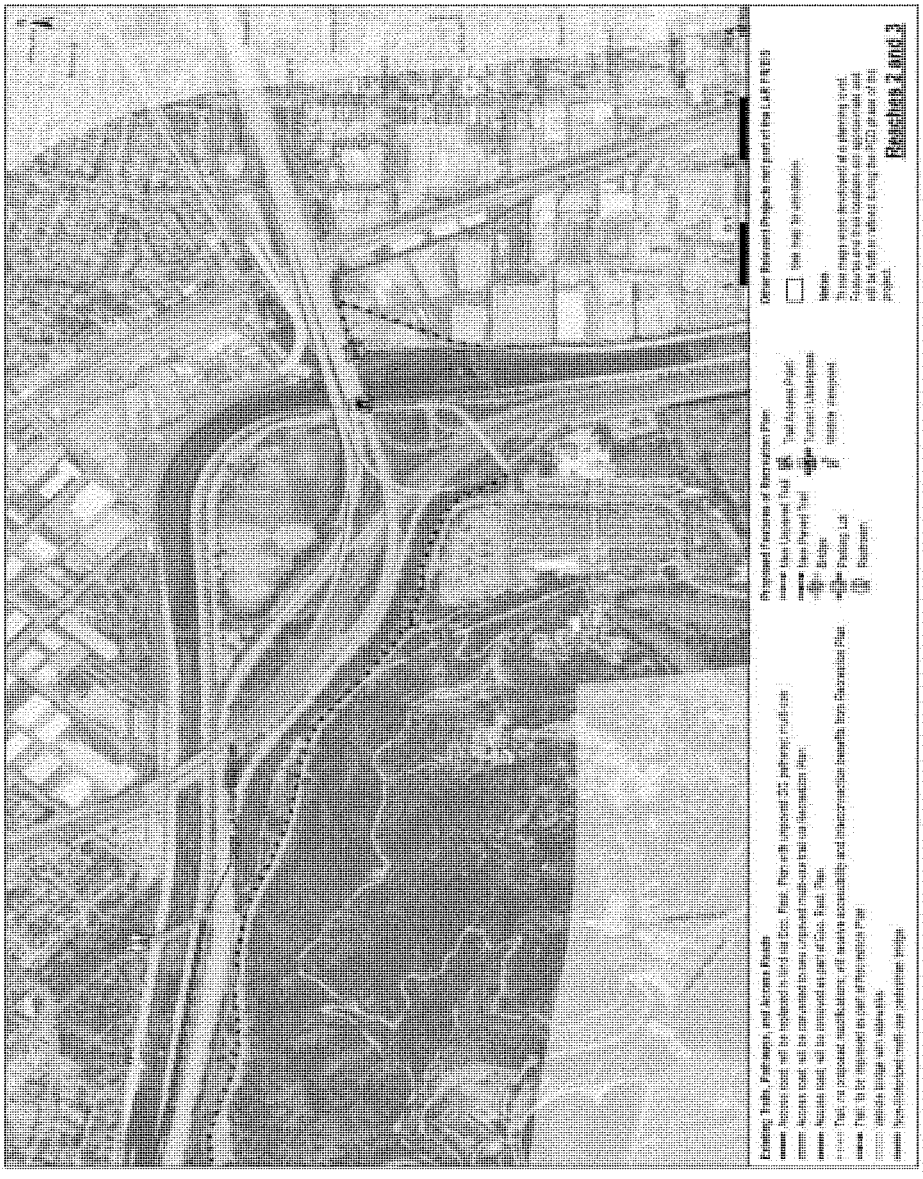


Figure 7-12 Map of the Recreation Plan



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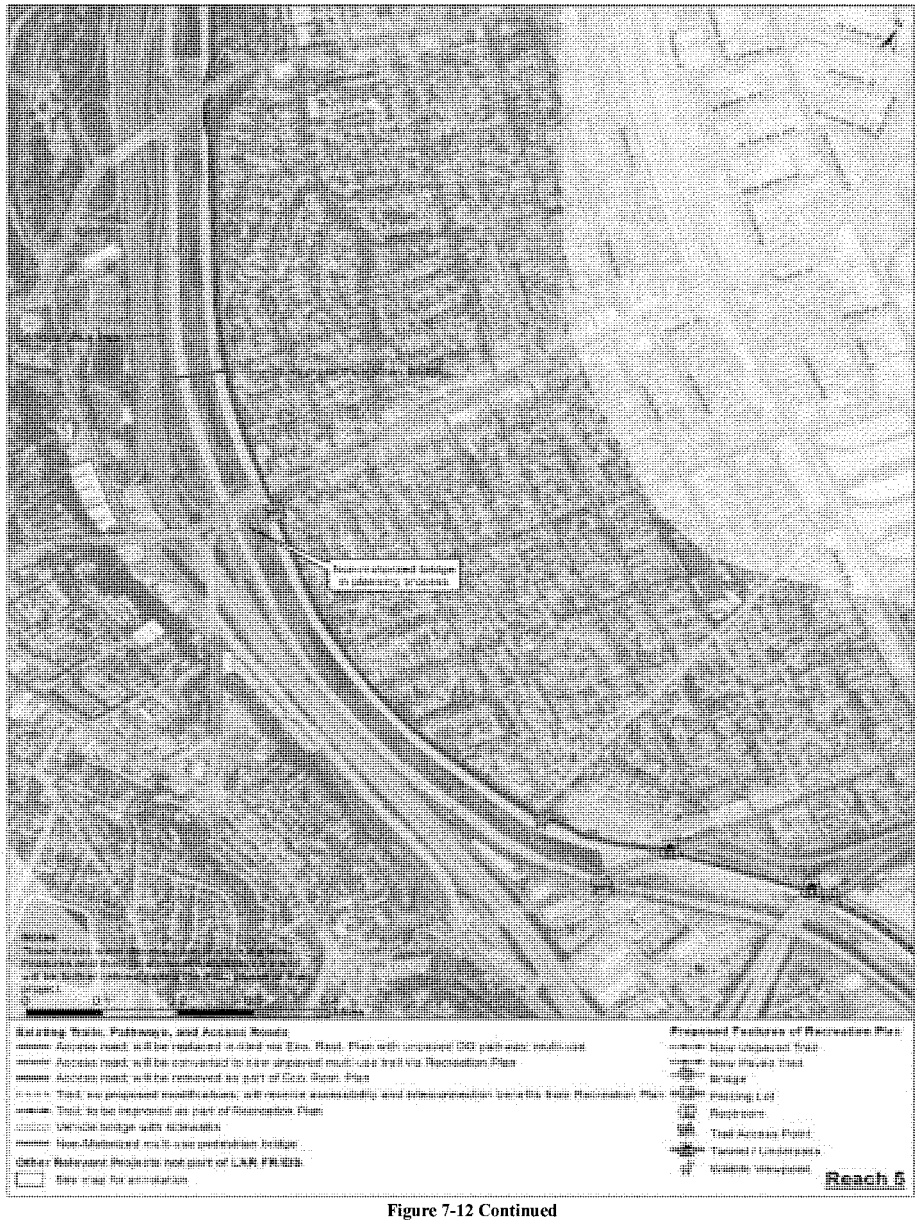

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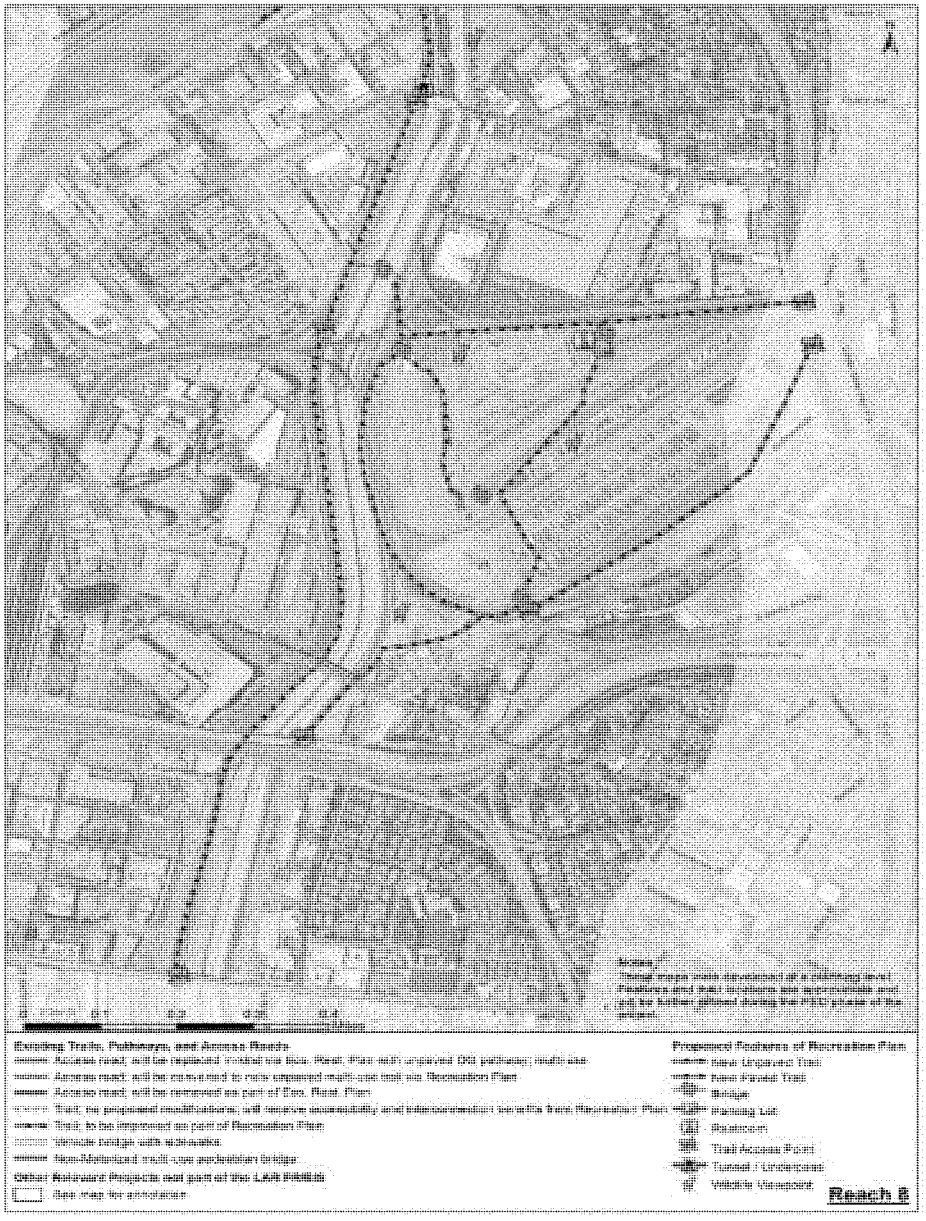

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8 PUBLIC INVOLVEMENT AND COLLABORATION

8.1 OVERVIEW AND HISTORY OF PUBLIC INVOLVEMENT

The development of the proposed restoration project has resulted from a systematic process of evaluating the River's existing conditions and any associated problems and opportunities, then identifying objectives to help solve the problems and measures for realizing those opportunities. Throughout this process, public involvement has been an essential and invaluable ingredient. Successful public involvement for this study began with the robust engagement process the City developed for the Los Angeles River Revitalization Master Plan (LARRMP). Beginning in 2005, the public engaged in the decision-making process at each step, including review of the Programmatic EIS/EIR for the LARRMP. Building off that process, this Study was able to engage the public and stakeholders in the development and review of this IFR. An overview of public involvement throughout this process is included in Table 8-1. Additional details regarding each of the steps of this process are provided in the sections below. In summary, over 40 meetings and outreach opportunities were held for this specific effort.

Table 8-1 History of Public Involvement

Document/Event	Timeframe	Public Involvement
Los Angeles River Revitalization Master Plan	2005-2007	During a 20-month period, a total of six sets of workshops were held to introduce the public to the LARRMP process and to solicit input for its development. A total of 17 workshops were held from San Fernando Valley to downtown Los Angeles. In addition, public briefings for professional organizations, briefings for Neighborhood Councils, press conferences, briefings for Congressional representatives, and a youth summit for several hundred high school students have taken place.
LARRMP Programmatic EIS/EIR	February 2007	The final series of public involvement workshops for the LARRMP were dedicated to updating the public about the Draft document and providing public hearings regarding the Programmatic EIS/EIR. Three workshops/public hearings were conducted in River-adjacent communities.
Los Angeles River Ecosystem Restoration Feasibility Study	2009-2012	A 3-day planning charrette was held in December of 2009 to introduce the Los Angeles River Restoration IFR and solicit feedback on the study area's problems and opportunities, objectives to address them, and measures that could be used to meet the objectives. Participants included staff from the USACE, County, City, resource and municipal agencies, and non-governmental organizations, as well as local community members and consultants. Meetings with agencies on the Habitat Evaluation Team, the Urban Waters Federal Partnership, Transportation Authorities, and other agencies were held to solicit input.
Los Angeles River Ecosystem Restoration Feasibility Report and Integrated EIS/EIR	2013	A 45-day review period was held from September 20 to November 18, 2013 to allow the public and agencies to review and submit comments on the Draft IFR.
River Update Meetings	2005-2013	Since 2007, a total of six meetings have been held for public information and to solicit public input. The meetings have provided status updates on the LARRMP as well as discussion on the development of the IFR.
City Council and Committee Meetings	2005-2014	USACE staff provided regular updates to the LA City Council and general public. The City Council of Los Angeles' Ad Hoc River Committee and its Arts, Parks, Health, Aging and River Committee held at least seven public meetings during the formulation of alternatives and Draft IFR public review period, and more than twenty meetings during the feasibility and scoping stage of the Study.
Public Briefings on the Draft LA River IFR	September 2013- January 2015	Since the release of the Draft LA River IFR in September of 2013, there have been more than ten public and focus group meetings to discuss the draft document and receive input on the alternatives and final IFR product.

8.2 LOS ANGELES RIVER REVITALIZATION MASTER PLAN

The community outreach process for the Los Angeles River Revitalization Master Plan needed to address a considerable geographic coverage area. In addition, it had to meet the challenge of attracting and involving potential new stakeholders, non-English-speaking stakeholders, and stakeholders who had not participated in or were not familiar with public involvement processes. Importantly, the outreach process sought to recognize past contributions and concerns from a broad range of existing leaders, community groups, and residents, thereby ensuring their ongoing participation and maximizing the continuity and historical framework of previous involvement.

The following objectives helped focus the outreach effort:

- Empower residents, businesses, and community leaders to participate in River-related decision- and policy-making processes that impact their lives and their livelihoods.
- Utilize an inclusive outreach strategy that maximizes input opportunities from existing project stakeholders while simultaneously working to identify and motivate new participants.
- Reinforce that community members are included in the decision-making process, and that their input is valued and incorporated.
- Create multiple opportunities for the generation of ideas and alternatives.
- Build trust in, and ultimately consensus around, the project by ensuring that stakeholders feel vested in the decision-making process.

The outreach strategy for this project was predicated on three critical factors:

- Increasing public awareness through an aggressive campaign that included a proactive outreach to both known and new stakeholders,
- A strong and creative media component, and
- Creating an atmosphere of celebration, uniqueness, and relevance at each of the community events.

Interest was expressed for returning the River to its natural state and habitat values as well as for recreation and enjoyment. The public also expressed interest in improving public access, creating more open/green space, dedicating space for athletics, beautifying the River with landscaping, preserving existing neighborhoods, finding socially conscious solutions to homelessness issues, and keeping the River and its environs clean and safe. Additionally, areas of interest such as arts/public art, community involvement/education, water quality, flood risk management, land use, and River management received significant feedback and comment.

As public input was collected, a consistent pattern of interest emerged that revealed a clear, primary concern for how the surrounding communities and general public will safely use the River for recreation and enjoyment. In particular, interest was expressed for improving public access, creating more open/green space, dedicating space for athletics, beautifying the River with landscaping, returning the River to its natural state, preserving existing neighborhoods, finding socially conscious solutions to homelessness issues, and keeping the River and its environs clean and safe. Additionally, areas of interest such as arts/public art, community involvement/education, water quality, flood risk management, habitat, land use, and River management received significant feedback and comment.

Methods used to communicate the planning efforts to the public included press conferences and coverage in the local, national, and global media as well as newsletters and other community notifications distributed on a regular basis.

In addition to the public outreach conducted as part of this IFR, outreach was conducted by the Alianza de los Pueblos del Rio, a collaborative organization funded by the Packard Foundation to concentrate

outreach efforts in the Latino community. The Alianza hosted three public workshops in August 2006, and involved organizations such as the Mujeres de la Tierra, the William C. Velasquez Institute, the Anahuak Youth Soccer Association, and the Center for Law in the Public Interest.

8.2.1 LARRMP Workshops

SERIES #1, Meetings 1 & 2
- Saturday, October 15, 2005; 10 a.m. – 12:30 p.m.

North Weddington Recreation Center, North Hollywood
- Saturday, October 22; 10 a.m. – 2 p.m.

Goodwill Work Source Center, Cypress Park

SERIES #2, Meetings 3, 4, & 5
- Saturday, January 21, 2006; 10 a.m. – 12:30 p.m.

Reseda High School, 18230 Kittredge Street, Reseda
- Tuesday, January 24, 2006; 6 p.m. – 8:30 p.m.

Exposition Park Intergenerational Community Center, 3890 S. Menlo Avenue, Los Angeles
- Saturday, January 28, 2006; 10 a.m. – 12:30 p.m.

Chevy Chase Recreation Center, 4165 Chevy Chase Drive, Los Angeles

SERIES #3, Meetings 6, 7, & 8
- Saturday, March 25; 10 a.m. – 12:30 p.m.

Birmingham High School in Van Nuys
- Tuesday, March 28; 6 p.m. – 8:30 p.m.

Glassell Park Elementary School in Los Angeles
- Wednesday, March 29; 6 p.m. – 8:30 p.m.

International Institute of Los Angeles

SERIES #4, Meetings 9, 10, & 11
- Saturday, June 24; 10 a.m. – 12:30 p.m.

Goodwill Work Source Center, 342 N. Fernando Road, Los Angeles
- Tuesday, June 27; 6 p.m. – 8:30 p.m.

Oakwood School, 11600 Magnolia Boulevard, North Hollywood
- Wednesday, June 28; 6 p.m. – 8:30 p.m.

Evergreen Recreation Center, 2839 E. 4th Street, Boyle Heights

SERIES #5, Meetings 12, 13, & 14
- Tuesday, September 26; 6 p.m. – 8:30 p.m.

The New Academy – Gymnasium, 21425 Cohassett Street, Canoga Park
- Wednesday, September 27; 6 p.m. – 8:30 p.m.

LADWP Headquarters – Auditorium, 111 N. Hope Street, Los Angeles
- Saturday, September 30; 10 a.m. – 12:30 p.m.

Chevy Chase Recreation Center, 4165 Chevy Chase Drive, Atwater Village

SERIES #6, Meetings 15, 16, 17, 18, 19, & 20
(Each location and date below included a separate Public Hearing on the Draft Programmatic EIS/EIR)
- Saturday, February 24, 2007; 10 am – 12:30 p.m.

Hollenbeck Middle School Auditorium, 2510 East 6th Street, Boyle Heights
- Tuesday, February 27, 2007; 6:30 – 9 p.m.

Canoga Park High School Auditorium, 6850 Topanga Canyon Boulevard, Canoga Park
- Wednesday, February 28, 2007; 6:30 – 9 p.m.

Metropolitan Water District Board Room, 700 N. Alameda Street, Los Angeles

8.3 LARRMP PROGRAMMATIC EIS/EIR

Three public workshops/public hearings were held in February 2007 for the Los Angeles River Revitalization Master Plan. This was the sixth and final series of meetings in the 20-month planning process. These meetings combined the presentation of the Los Angeles River Revitalization Draft Master Plan and Public Hearings with the Draft Programmatic EIS/EIR.

SERIES #6, Meetings 15, 16, 17, 18, 19, & 20
(Each location and date below included a separate Public Hearing on the Draft Programmatic EIS/EIR)

- Saturday, February 24, 2007; 10 am – 12:30 p.m.

Hollenbeck Middle School Auditorium, 2510 East 6th Street, Boyle Heights

- Tuesday, February 27, 2007; 6:30 – 9 p.m.

Canoga Park High School Auditorium, 6850 Topanga Canyon Boulevard, Canoga Park

- Wednesday, February 28, 2007; 6:30 – 9 p.m.

Metropolitan Water District Board Room, 700 N. Alameda Street, Los Angeles

8.4 LOS ANGELES RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY WORKSHOPS

At the outset of the USACE Study, it was clear that to fully integrate the input of the public and stakeholders for the Los Angeles River, it was necessary to design a workshop process that would best provide adequate background about the project and allow participants to effectively produce feasible restoration options. In this spirit, a 3-day charrette workshop was conducted in December 2009. A charrette is a focused process by which stakeholders engage in a collaborative brainstorming process to expedite the development of plans, alternatives, and/or management measures that address specific objectives. The purpose of the 3-day workshop was to receive input for the formulation of plans to restore ecosystem function to the highest level possible within the Los Angeles River, with an emphasis on ecosystem restoration for development of the NER plan. Specifically, the workshop sought to bring stakeholders together to:

- Identify new measures.
- Help validate study objectives for ecosystem restoration.
- Aid in the development of a list of alternatives to meet ecosystem restoration objectives.
- Provide conceptual representation of alternatives on maps.

The workshop series differed from previous workshops that were held during and subsequent to development of the LARRMP because it:

- Concentrated on approximately an 11- mile stretch of the Los Angeles River.
- Included a 6-hour field outing to critical locations within the study area during which specific problems and opportunities were discussed.
- Focused on ecosystem and habitat restoration as opposed to also emphasizing flood risk management, recreation, and/or adjacent development opportunities.
- Engaged the participants in organized brainstorming that developed long lists of problems and measures as well as personal vision statements.
- Grouped teams of experts in the disciplines of economics, biology, engineering, hydraulics, landscape architecture, geotechnical/soils engineering, planning, aud recreation. These teams were able to apply their expertise, along with the information gathered from the public and other stakeholders during the LARRMP outreach efforts, to the focused charrette process.

The charrette workshop consisted of presentations about the history and condition of the River to the attendees. The problems occurring within the study area, the opportunities existing for restoration, identification of study objectives, planning constraints and considerations, and the methodology for evaluating and selecting the final restoration plan were all presented to attendees. Participants were also taken on a field trip through the focused study area.

Participants included representatives from USACE, the City of Los Angeles as the non-Federal Sponsor, the USFWS, LADPW, the California Coastal Conservancy and the Mountains Recreation and Conservation Authority, Audubon, California State Parks, the City of Glendale, non-governmental agencies such as FoLAR, The River Project, the Los Angeles and San Gabriel Rivers Watershed Council, (renamed the Council for Watershed Health), and other stakeholders and experts having interest and knowledge about the Los Angeles River. A total of 68 participants attended the workshop for one or more of the 3 days.

Once the participants were familiarized with the project, the goals, and the constraints, they were divided into teams and given the task of identifying a variety of restoration measures that fulfilled the goals of the project. Teams were asked to brainstorm restoration alternatives, to imagine what the sites would ideally look like in 50 years, and to collate their ideas. A matrix was ultimately prepared that encompassed each of the distinct restoration alternatives. A series of weightings and rankings were applied to the matrix to identify the alternatives that were most feasible. Pairwise weighting provided the first culling, as pairs of alternatives were compared and one was selected over the other. This allowed for a reduction in alternatives that weren't substantially different from each other. Finally, the remaining alternatives were then ranked according to their completeness, effectiveness, efficiency, and acceptability.

Through this intensive charrette process, participants were able to accomplish the following:

- Identify study area problems related to ecosystem restoration.
- Validate study objectives to solve these problems.
- Aid in development of an alternatives matrix to meet ecosystem restoration objectives.
- Provide conceptual representation of alternatives on maps.

The highest ranked alternatives were then combined into groups of alternatives. This process provided the initial 19 alternatives utilized for plan formulation, as described above in Chapter 4. In March of 2012, the Corps and City met and held a workshop to discuss the array of alternatives. The final array of alternatives presented in this IFR was directly taken from the charrette process, and final selections were the result of the CHAP and CE/ICA process. The City and USACE also held Workshops on the LA River Study on focused topics:

- June 4, 2012: City Staff Workshop
- June 13, 2012: Public Stakeholder Workshop
- August 30, 2012: California High Speed Rail Coordination
- October 20, 2012: American Institute of Architects (AIA) and American Society of Landscape Architects (ASLA) Outreach Workshop and Charrette
- October 29-31, 2012: In-Progress Review I
- November 29, 2012: In-Progress Review II
- February 14, 2013: Briefing with Southern California Edison Staff

8.5 LOS ANGELES RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY AND INTEGRATED ENVIRONMENTAL IMPACT STATEMENT/REPORT

A Feasibility Scoping Meeting was held in November 2007. The Draft IFR was initially available to the public on September 13, 2013. Hard copies of the document and CD's were placed at more than eight libraries and agency offices for the 45-day public review period held from September 20, 2014 to November 18, 2013. A public hearing was held October 17, 2013 from 5:30-7:30 p.m. in the Atrium of the Los Angeles River Center and Gardens, located adjacent to the project's study area at 570 West Avenue 26, Los Angeles, CA 90065. Over 230 people attended the meeting, and over 500 individuals, agencies, elected officials and non-governmental organizations submitted comments, letters and petitions during the 45-day review period.

Other meetings and events were held by others during the 45-day review period, and are summarized below:

- Community LA River Rally in Support of Alternative 20: September 28, 2013
- LA River Revitalization Corporation's "Let's Talk River" Event: October 20, 2013

In addition, the City of Los Angeles and USACE visited Washington, D.C. for LA River Day on Capitol Hill to discuss the LA River Study and overall status October 28-29, 2013.

Comments from the public and agencies were received, evaluated, and responded to by the team. Appendix L documents comments and responses. During the public review period, the Corps received a total of 483 public review comment letters and emails, along with 8,494 signatures on multiple petitions in support of the ecosystem restoration project and specifically the Recommended Plan (Alternative 20). Key commenters include three Federal agencies, U.S. Senator Boxer, three members of Congress, four California state legislators, six state agencies, 13 local agencies, five City councilmembers, 17 key stakeholders, eight neighborhood councils and numerous individuals. The nature of the comments ranged in technical comments and questions to general support of the overall project. Table 8-2 provides a summary of comments.

This Final IFR is being circulated to the public and agencies for a 30-day review period.

1 **Table 8-2 Public Comment Summary**

Comment Category	Public Comments Summary	Primary Commenters	
Connectivity	▪ Connectivity benefits (wildlife movement and hydrologic) not captured in habitat evaluation or CE/ICA analysis. ➢ Benefits of connectivity qualitatively described, not quantitatively captured ➢ Since they were not represented in CE/ICA analysis, connectivity benefits and importance were undervalued when ranking alternatives. ▪ Restoration in Alternatives 16 and 20 provide a restored direct hydrologic connection between LATC site and the river. Alterative 13 does not. ➢ Lack of hydrologic connection between the river and LATC site does not allow for restoration of valuable fluvial processes and does not support wildlife movement to and from the large habitat node. ➢ Opportunity missed for inclusion of large habitat area in wildlife movement corridor. ▪ Decisions biased towards habitat acres, habitat units, and incremental costs; wildlife and hydrologic connectivity was not adequately considered in the decision making process. ▪ Decisions failed to consider connectivity to other Federal agency conservation areas critical to wildlife movement (i.e. SMMNRA, NPS Rim of the Valley Study, County SEA Programs). ➢ especially critical for large carnivores (bobcats, coyotes, mountain lions) ➢ evidence of use of movement corridors and current attempted use of the river	▪ Federal Agencies: ➢ USFWS ➢ USEPA ➢ DOI ▪ State/Regional Agencies: ➢ CA State Parks ➢ Santa Monica Mountains Conservancy ➢ Mountains Recreation and Conservation Authority ▪ Stakeholders: ➢ Friends of the LA River ➢ LA River Revitalization Corporation ➢ Sierra Club ➢ Trust for Public Land ➢ California Native Plant Society ➢ Arid Lands Institute ➢ National Wildlife Federation ➢ Audubon Society ➢ Arroyo Seco Foundation ➢ 6 Neighborhood Councils	
Other Incidental Environmental Benefits	▪ Water quality improvements ▪ Increased groundwater recharge ▪ Value of habitat scarcity in urban setting ▪ Value of restoring biodiversity ▪ Air quality improvements	▪ Federal Agencies: ➢ USEPA ▪ State/Regional Agencies: ➢ Regional Water Quality Control Board ➢ Santa Monica Mountains Conservancy Mountains Recreation and Conservation Authority	▪ Stakeholders: ➢ Friends of the LA River ➢ Council for Watershed Health ➢ Sierra Club ➢ Heal the Bay ➢ Audubon Society

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Public Support	▪ Public comments, and comments from Federal, State and local agencies, and political bodies, were received. ➢ 84% of individual public comments received expressed support of a large scale restoration project ➢ 3 petitions totaling 8494 petition signatures supported the project ➢ Remaining comments were technical in nature	▪ Federal Elected Officials: ➢ Senate Committee ➢ Congress members Becerra, Roybal-Allard, Schiff, Bass ▪ State Agencies: ➢ Santa Monica Mountains Conservancy ▪ State Elected Officials: ➢ California State Assembly ➢ State Senator de Leon	▪ Local Elected Officials: ➢ Mayor Garcetti ➢ former Councilman Ed Reyes ➢ Councilman Tom LaBonge ➢ Councilman Mitch O'Farrell ➢ City Council of Glendale ➢ General Public Individuals Petitions
Collaborative Perspective	▪ Alternative 13 stops short of developing "Return on Investment" that captures benefits for all Federal partners that have stake in LAR restoration. ▪ Alternative 20 provides opportunities to achieve goals and support missions of other Federal, State, and local agencies. ▪ Impact LAR Restoration Project has on a full docket of federally-engaged or funded projects cannot be overstated. ▪ Project aligns the billions of dollars of Federal investment that has been and is being invested into other aspects of the LA River and River-community revitalization.	▪ Federal Agencies: ➢ USFWS ➢ USEPA ➢ DOI ➢ Urban Waters Federal Partnership ▪ Federal Elected Officials: ➢ US Senate Committee on Environment and Public Works ➢ Congress members Becerra, Roybal-Allard, Schiff, Bass ▪ State/Regional Agencies: ➢ Regional Water Quality Control Board ➢ California State Parks Mountains Recreation and Conservation Authority	▪ State Elected Officials: ➢ California State Assembly ➢ Assembly Member Bloom ➢ State Senator de Leon ▪ Local Agencies: ➢ City of LA Dept of Planning ➢ City of LA Bureau of Sanitation ▪ Local Elected Officials: ➢ Mayor Garcetti ➢ former Councilmember Ed Reyes ➢ City Council of Glendale ▪ Stakeholders: ➢ LA River Revitalization Corporation ➢ Audubon Society ➢ Arroyo Seco Foundation

Reasonableness of Cost	▪ Additional outputs beyond what was in the CHAP (EQ, RED, OSE, NED) ▪ Study already reduced in scale to focus on a small segment of the river (32 miles reduced to 11 miles), therefore restoration is even more valuable. ▪ Options for more significant restoration within the study area (more concrete removal, plans including tunnels) were not carried forward to the Final Array. ▪ Location of the project ➢ Restoration within the highly urbanized L.A. environment will be more costly due to higher real estate costs. ➢ Restoration within this urban setting benefits not just the environment, but a very large and diverse population.	▪ Federal Agencies: ➢ Urban Waters Federal Partnership ▪ Federal Elected Officials: ➢ Senate Committee ▪ State Agencies: ➢ Santa Monica Mountains Conservancy ▪ State Elected Officials: ➢ State Senator Pavley ▪ Stakeholders: ➢ Council for Watershed Health ➢ Friends of the LA River	
Regional Economic Development	▪ One of the Principles & Guidelines 4 Accounts, which should be given consideration in plan selection. ▪ Includes regional income and employment benefits created by the project. ▪ Significantly greater regional economic development benefits for larger scale alternatives from: ➢ Project Construction expenditures ➢ Study Area redevelopment	▪ Federal Elected Officials: ➢ Senate Committee ➢ Congresswoman Roybal-Allard ▪ State Agency: ➢ Santa Monica Mountains Conservancy ▪ State Elected Officials: ➢ State Senator de Leon ▪ Local Agencies: ➢ City of LA Economic & Workforce Development Department	▪ Local Elected Officials: ➢ Mayor Garcetti ➢ former Councilman Ed Reyes ➢ Stakeholders: ➢ The City Project ➢ Council for Watershed Health ➢ LA River Revitalization Corporation

Other Social Effects/ Environmental Justice	▪ Other Social Effects are also one of the Principles & Guidelines 4 Accounts, which should be given consideration in plan selection. ▪ Project area has a large minority and lower income population. ▪ Larger scale alternatives will create greater benefits to this local population. ➢ Public access to enjoy the restored environment. ➢ Enhanced recreation opportunities. ➢ Access to local jobs created by project construction and local redevelopment. ➢ Enhanced local area aesthetics, public safety, public health benefits, and community cohesion.	▪ Federal Agencies: ➢ USFWS ➢ USEPA ▪ Federal Elected Officials: ➢ Senate Committee ➢ Congress members Becerra, Roybal-Allard, Schiff, Bass ▪ State/Regional Agencies: ➢ CA State Parks ➢ Santa Monica Mountains Conservancy ➢ Mountains Recreation and Conservation Authority ▪ State Elected Officials: ➢ State Senator de Leon	▪ Local Agencies: ➢ City of LA Economic & Workforce Development Dept. ▪ Elected Officials: ➢ Councilman Mitch O'Farrell ▪ Stakeholders: ➢ LA River Revitalization Corporation ➢ Trust for Public Land ➢ The City Project ➢ Audubon Society ➢ Arroyo Seco Foundation ➢ Neighborhood Council Alliance for River Communities ➢ Historic Highland Park Neighborhood Council
Recreation	▪ Recreation benefits are considered National Economic Development benefits – one of the Principles & Guidelines 4 Accounts, and should therefore be given consideration in plan selection. ▪ Larger scale restoration alternatives provide more locations and greater opportunities for development of compatible passive recreation features, as well as better connectivity to recreation features maintained by other agencies. ▪ Project Area has a large minority and lower income population, which has disproportionate lack of access to natural open space and recreation facilities. ▪ Recreation facilities also generate public health benefits.	▪ Federal Agencies: ➢ USFWS ➢ DOI ➢ Urban Waters Federal Partnership ▪ Federal Elected Officials: ➢ Congress members Becerra, Roybal-Allard, Schiff, Bass ▪ State/Regional Agencies: ➢ Regional Water Quality Control Board ➢ Santa Monica Mountains Conservancy ➢ Mountains Recreation and Conservation Authority	▪ Local Agencies: ➢ LA Unified School District ➢ City of LA Economic & Workforce Development Dept. ▪ Local Elected Officials: ➢ Councilman Mitch O'Farrell ▪ Stakeholders: ➢ LA River Revitalization Corporation ➢ Trust for Public Land ➢ Audubon Society ➢ Arroyo Seco Foundation

8.6 COLLABORATION AND OUTREACH EFFORTS

In addition to the public outreaeh described above, on behalf of the Study, the City and USACE engaged in numerous meetings to ensure ongoing dialogue with respect to the study.

The Study team was able to piggyback onto the City's River Update Meetings (RUMs), which are public workshops to discuss the status of activities and implementation of features related to the LARRMP. At RUM workshops, City and USACE staff also provided progress reports and gathered public feedback on the Draft IFR. This has provided valuable input during the study's plan formulation efforts.

Overall RUM topics include the following:

- The Los Angeles River Improvement Overlay District (Adopted by the City of Los Angeles on July 11, 2014)
- The North East Los Angeles Riverfront Collaborative and Vision Plan (2014)
- The Los Angeles River Memorandum of Understanding with the Los Angeles County Flood Control District, which establishes a joint City-County River Cooperation Committee (RCC), with the USACE at an advisory capacity (Executed in 2009); the RCC has met 11 times since 2009, and continues to hold regular public meetings (the first public meeting was held in 2011)
- The Los Angeles River Revitalization Corporation (Established in 2009)
- The Los Angeles River Foundation
- The status of River projects, grant applications, and achievements/awards

Since 2007, there have been a total of seven RUM meetings. The meetings are summarized online and include minutes and presentation materials for the following meeting dates:

- October 30, 2007
- April 30, 2008
- December 4, 2008
- July 28, 2009
- June 24, 2010
- February 10, 2011
- February 23, 2012
- October 17, 2013, (Joining RUM and Draft IFR Release Meeting)

The City of Los Angeles' Bureau of Engineering also briefed its Board of Public Works and Elected Offices over the course of the development of the IFR:

- June 2012: Coordination with Mayor's Office Staff and Study Briefing
- February 2013: Board of Public Works Study Briefing
- April 2013: Briefing to Mayor's Office Staff on Alternatives
- April 2013: Briefing Call and LA River Policy Conference for Congressional Staff
- June 2013: Mayor's Office attended the Alternative Formulation Briefing
- June 20, 2014: LA River Day, joint City-USACE public presentation to City Council

The Los Angeles River Watershed was one of seven pilot projects chosen in 2011 as part of the Urban Waters Federal Partnership (UWFP). As part of this effort, the City and USACE attended regular conferences and meetings to discuss how to work together and coordinate resources to help aid in the River revitalization effort. Specific meetings were held on the following dates:

- October 22, 2012: UWFP Briefing held in Washington, D.C.

- December 4, 2012: UWFP Meeting held in Los Angeles
- March 7, 2013: UWFP Meeting held in Los Angeles

USACE and City staff also participated in LA River stewardship opportunities, specifically the Friends of the Los Angeles Rivers' Annual River Clean-up, La Gran Limpieza, which celebrated its 25th year in 2014. This annual River event fosters stewardship among Corps and City staff that work on the River and the general public, who are all working together towards the same task of removing trash and beautifying the River.

USACE staff have attended and presented at several conferences over the past seven years, to both local and international groups, elected bodies, and academia, focusing their discussion on the LA River Ecosystem Restoration Feasibility Study.

8.7 AGENCY AND STAKEHOLDER COLLABORATION

Information regarding agency and stakeholder involvement, including any permitting completed, agreements reached, and restrictions that will apply during construction and/or operation, are included in this IFR.

The Corps and City consulted with the California State Historic Preservation Officer (SHPO) by telephone in June of 2013 regarding the level of effort for the EIS. The SHPO is satisfied with the use of existing information and a records and literature search to compare alternatives for the purposes of the EIS. The SHPO was provided an opportunity to review the Draft IFR including EIS, but did not provide comments. The Corps and SHPO determined that some cultural resource identification efforts and assessment of project effects will occur during the next phase of the study. The Corps, in consultation with the SHPO, has developed a Programmatic Agreement (PA) which lays out how the Corps will satisfy its requirements under Section 106 of the National Historic Preservation Act. The following agencies and groups have been invited to be concurring parties to the agreement: the City of Los Angeles, the California Department of Parks and Recreation, the Gabrieleno Band of Mission Indians, Fernandeno Tataviam Band of Mission Indians, Gabrielino Tongva Indians of California, Gabrielino –Tongva Tribe, Gabrielino Tongva Nation, Los Angeles City and County Native American Indian Commission, Ti'At Society/Inter-Tribal Council of Pima, and San Gabriel Band of Mission Indians.

The Corps and City are also coordinating with California State Parks due to land ownership and potential interests in the project area. The Corps met with California State Parks in August of 2014, to discuss the project and upcoming coordination efforts. The City is working with State Parks to secure real estate rights and interests needed to construct, operate and maintain restoration features on State Parks-owned land.

The Los Angeles District Ecosystem Planning Section has been coordinating with the USFWS regarding the Los Angeles River Ecosystem Restoration Study since the Planning Charettes that took place in December 2009. USFWS attended the Charettes and provided input on project measures through that forum. USFWS also contributed to the weighting of objectives during the early Plan Formulation process by providing input to an objectives comparison matrix. USFWS participated on the CHAP (Combined Habitat Assessment Protocols) Habitat Evaluation Team that took place in January 2010. The Habitat Team meetings solicited input on existing conditions, future without project conditions, and project alternatives. The input provided focused on existing species and habitat value, factors that degrade habitat value on the River, the viability of the measures and alternatives, and the habitat value that would be derived from these measures and alternatives. The Corps presented the preliminary final array of alternatives to resource agency contacts in September 2012.

The Corps further coordinated with USFWS during development of the Coordination Act Report (CAR) under the Fish and Wildlife Coordination Act (FWCA) from November 2013 to January 2015. The Corps met with USFWS regarding the CAR recommendations on September 29, 2014 and on October 30, 2014. Through this coordination on the CAR recommendations, the Corps committed to continued coordination with USFWS during the detailed design phase of the project. The Corps received the revised Final CAR in January 2015 and has responded to its recommendations in this Final IFR in Appendix N. A summary of the recommendations and responses is in Section 8.7.1.

The Corps will continue to work with USFWS as well as other resource agencies and wildlife experts during PED to refine project designs and incorporate the specificity needed to achieve restoration goals and including connectivity in the context of the project's complex constraints.

The Corps will develop detailed designs for the widened reaches (i.e. Verdugo Wash, Taylor Yard, LATC) during PED that consider the USFWS CAR recommendations, to ensure that restoration design in widened reaches mimics a more natural hydrologic regime and fluvial processes to the extent possible, allowing for channel migration and reworking of restored widened areas following flood events, while not compromising flood risk management. Additional H&H (hydrology and hydraulics) modeling will be conducted during the detailed design phase to inform design refinements that will provide for natural hydrologic functioning as well as ensuring flood damage reduction.. The Corps will work with USFWS to ensure that restored widened areas achieve the maximum level of ecological function, focusing on passive restoration, proper hydrologic regime, and a more natural geomorphic character. The Corps is committed to restoring the maximum ecological function and reducing stressors while meeting flood conveyance requirements.

The Corps will continue coordination with USFWS to identify restoration methodologies that may be appropriate in specific locations or circumstances, and specific habitat elements that may be required in restored areas to support target species, such as native fish (Santa Ana sucker, arroyo chub). Detailed designs will provide more specificity in terms of habitat, ecological, and hydrologic features to be created and restored based on the necessary habitat components for such recommended target species.

The Corps will continue to coordinate with USFWS during the development of detailed designs (PED) to ensure that the passive recreation features are compatible with restoration. The Corps will ensure that recreational use is compatible with the more in depth design of restoration features.

The Corps will continue to review conditions to determine if endangered species may be present, and coordinate or consult with USFWS as necessary through the design and construction of each project phase/feature. Endangered species surveys will be conducted during the detailed design phase and in the nesting season(s) immediately prior to construction within any potentially suitable areas to confirm presence or absence of federally and state listed threatened and endangered species. The Corps will continue to coordinate with the USFWS throughout the design and construction period, and consult under ESA if conditions change such that the Corps determines the project may affect the vireo or other listed species.

The Corps also received feedback and responded to comments from transportation agencies that have facilities in the Study's project area. The Corps will continue to address any agency concerns throughout the detailed design and construction phase to ensure that impacts to their operations are minimized before and after the project is complete.

8.7.1 CAR Recommendations and Responses Summary

The following highlights key points from the CAR recommendations provided by the USFWS under the FWCA, as well as key points from the Corps' response to these recommendations. The complete responses to the CAR recommendations are included in Appendix N.

RECOMMENDATIONS SUMMARY

- We generally suggest that the designs for proposed Project be developed with a stronger focus on principles of restoration of stream natural communities and processes.
- We expect that full or partial restoration also includes a self-sustaining component as essential to the definition of restoration, even in highly constrained project areas.
- We continue to stress the essential long-term importance of at least partial recovery of self-sustaining ecological functions for restoration projects. For example, this would mean evaluating whether proposed native vegetation in some planting areas would not only survive in the long-term without permanent irrigation, but would it also effectively reproduce and replace itself (or naturally succeed) both over time and following expected disturbances such as periodic flooding events.
- In part, the current proposed Project designs (all alternatives) appear substantially compromised by proposed recreational and aesthetic features, often at the expense of otherwise practicable ecological restoration potential.
- The current designs in many locations are also heavily compromised by the lack of channel widening; this is understandable given the consistent need to maintain channel flood flow capacity and the surrounding constraints.

RESPONSE TO SUMMARY:

- As the USFWS has noted, channel widening throughout all project reaches in order to restore ecological functions is constrained by the need to maintain the flow capacity requirements of the existing flood damage reduction project.
- The project restores native vegetation, wildlife habitat, and ecosystem functions within each reach at varying levels. Wherever possible with available lands, river widening has been included as a project measure to maximize restoration of natural hydrologic functions and support self-sustaining ecologic functions. Other areas rely on surface flows to support native vegetation on the overbank.
- Opportunities for additional connectivity have been identified in Reaches 1, 3, and 7. The Corps has committed to further evaluate these areas in the design phase, in partnership with USFWS, to ensure that opportunities for wildlife movement are provided throughout the project area.
- The proposed project would restore self-sustaining riverine and riparian functions in widened areas and provide opportunities for both aquatic and terrestrial wildlife foraging, shelter, and movement between widened areas in order to meet the Corps' criteria for ecosystem restoration.
- The Corps disagrees that the project is compromised by recreational and aesthetic features. As required by Corps policy, the project's Recreation Plan was developed after restoration features were planned and is designed to be compatible with restoration features.

RECOMMENDATION 1

- We promote the restoration and enhancement of fully functioning and self-sustaining ecosystems, where and to the extent practicable.
- The proposed Project has good basic goals and objectives in relation to general fish and wildlife resources, though they (combined with the Project description and figures) are currently too vague for us to assess the fundamental ecological functions and values of restoration and enhancement that would be implemented.
- Pursuant to the current Project goals and objectives (to the extent practicable), we suggest the Project designs be modified to more clearly focus on restoration of substantially more natural function of riverine and riparian natural communities in the Project, including designing in greater channel/aquatic and riparian area complexity and utilizing natural community compositions and substrates that support higher sensitive taxa richness. The current proposed designs and descriptions for restoration areas read more like landscaping plans than restoration plans.

RESPONSE 1:

- The objectives as currently defined are appropriate and reflective of the naturally occurring habitat that the project restoration is proposing to achieve. Objectives are described in Section 4.2 of the IFR, with measurable objectives criteria outlined in Section 4.2.2. The final array of alternatives meets these objectives' criteria based on Corps standards as described in Section 6.2, Tables 6-2 and 6-3.
- In the design phase, the next phase in the process, the Corps will elaborate on the current conceptual plans and further delineate the complexities of the proposed habitats.
- The Corps has proposed full functioning ecological restoration wherever it can be achieved, which because of the urban context of the study area, occurs primarily in widened areas of the river where properties containing historic floodplain adjacent to the river can be acquired. In planning these features, the Corps strived to use any available lands within and outside the river to provide opportunities for restoration of a more natural hydrologic regime that will support complex, self-sustaining native southern California river habitat.
- Reference sites to be considered for detailed design, particularly for design of habitat for Santa Ana sucker and least Bell's vireo, may include portions of the Santa Ana River which currently supports target habitats and populations of both species.
- The plans provided are at a conceptual level and contain planting plans and habitat configurations for the purposes of restoration; the plans are not appropriate for nor do they contain the specificity of landscape plans.
- The plans provided in the report are indicative of the planting to be implemented initially; however, over time, storm events will bring seed material from upstream, actively planted vegetation will establish a new seed bank in the soil, the restored natural hydrologic regime will develop dynamic braided channels will form, and areas denuded through scour or other disturbance are expected to naturally re-establish. Once these processes are reestablished, O&M consisting mainly of invasives removal can be implemented as necessary to support passive restoration in widened areas.
- Information regarding acreages of habitats created is provided in Table 6-7 of the IFR. Chapter 7 of the IFR describes the Recommended Plan and NER Plan in terms of features restored by reach.

RECOMMENDATION 2

- We recommend Alternative 20, with modifications (as noted below). Alternative 20 has the highest potential of the proposed alternatives to restore considerable ecological functions of the River. In order to perform any substantial riverine and riparian restoration or enhancement on the River (and maintain current flood flow capacities for flood risk management), the right-of-way (ROW) and floodplain currently utilized by the River will need to be re-widened in considerable River reaches (as noted in the 2013 EIS/EIR). Truly effective ecological restoration of the River (partial restoration) can only occur in areas of widened River ROW.
- We recommend substantive modification of any approved Project alternative to increase the focus of proposed Project resources on practicable levels of restoration of River hydrology and geomorphology. We expect that the current proposed designs (all proposed alternatives), if implemented, would result in improvements, but relatively small native fish and wildlife resource net gains and overall low ecological integrity and function for these species within Project restoration and enhancement areas, due to very important remaining stressors.
- We suggest that riverine and riparian ecological (partial) restoration be more clearly the primary goal within the specific River reaches to be widened. For instance, most widened floodplain areas should be designed for riparian scrub-woodland-forest communities relatively similar to those that existed historically in the Project reaches, including providing for cyclical and episodic succession of riparian natural community age classes over time following denudation events (floods).
- Restoration of widened floodplain areas should also be designed with the expectation of some channel form changes over time.

RESPONSE 2:

- Alternative 20 is the Locally Preferred Plan (LPP) and the Corps' recommended plan. The Corps agrees that it has the potential to restore considerable ecological functions of the River.

- As outlined in the feasibility study, aquatic ecosystem restoration is the primary goal and the driver for development of all alternatives.
- The Corps has proposed full functioning ecological restoration wherever it can be achieved, which because of the urban context of the study area, occurs primarily in widened areas of the river where properties containing historic floodplain adjacent to the river can be acquired.
- The Corps strived to use any available lands within and outside the river to provide opportunities for effective restoration of a more natural hydrologic regime that will support complex, self-sustaining native southern California river habitat while maintaining the necessary flood protection.
- The Corps' intent is that the stressors described will be addressed in widened areas, where increased flood capacity will allow for varied substrates and a more natural hydrologic regime, high vegetative cover and structural diversity of historically occurring riparian communities, and very limited and well-buried hard structures.
- In widened areas, it is expected that the active channel will migrate and change form and that sediments will be redistributed with storm events. Vegetation is expected to be denuded with natural episodic higher flows and velocities, and be re-established naturally.
- Given the constraints of this highly urbanized system, all stressors may not be entirely removed from the restored areas of the channel; however, high ecological

function and integrity sufficient to support these objectives can be achieved.

- Alternative 20 will provide large restored widened areas (such as Verdugo Wash, Taylor Yard, and the LATC site) to serve as riparian habitat patches with a more natural hydrologic regime. Vegetation and habitat elements in these widened areas will be restored with the goal to support a large number of territories for various riparian obligate birds, including least Bell's vireo, yellow warbler, and yellow breasted chat, stop over habitat for migrants, as well as habitat and refugia for amphibians, reptiles, and mammals, including larger carnivores such as coyote and possibly bobcat. River channels in widened areas will be designed to support habitat for Santa Ana sucker and arroyo chub.
- The Corps will develop detailed designs for the widened reaches during the PED phase that will carefully evaluate and consider USFWS recommendations. The Corps will continue to coordinate with USFWS during the PED phase and development of detailed designs to ensure that restoration in widened reaches achieves the maximum level of ecological function, focusing on passive restoration, a more natural hydrologic regime, and more natural geomorphic character. The Corps is committed to restoring the maximum ecological function while meeting flood conveyance requirements.

RECOMMENDATION 3

- Project recreation/access features involving hard structures should be limited to the outside periphery of widened/restored River stretches.
- The proposed construction of instream and floodplain hard structures that are out of context with naturally functioning systems (e.g., retaining walls, curbs, formal paved or heavily compacted or surfaced paths, boardwalks, grade control structures, etc.) should be minimized within restored areas in widened reaches (Kauffman et al. 1993).

RESPONSE 3:

- Recreation features are proposed for passive activities such as hiking, walking, and wildlife viewing where they will not conflict with the restored habitat. Widened areas supporting restoration of a more natural hydrologic regime such as Taylor Yard and LATC will support a limited length of dirt/gravel trails that will not impede hydrologic and ecologic functioning. Hard structures such as restrooms and parking lots will be limited to the outside edges of widened areas.
- The Recreation Analysis in Appendix B (Economics) of the IFR showed a restroom located in the middle of the LATC site. This restroom has been moved to the edge of the site in the Final IFR to be consistent with Corps policy. Section 4.16, Recreation Plan, of the IFR also has been revised to further emphasize that recreation features are designed after restoration features are planned, and per Corps policy must be compatible with the restoration function.

RECOMMENDATION 4

- We suggest that the potential ecological interactions between the riparian and aquatic ecosystems be reflected more fully in the Project restoration and flood damage reduction features proposed. We suggest minimization of instream flow-control hard structures and unburied hard stream bank slope protection in widened reaches, particularly along the riverine-

riparian interface.

- The hydrology designs for widened River reaches to be restored (such as Taylor Yard and Piggyback Yard) should accommodate, to the maximum extent practicable, the dynamic and episodic nature of surface low and high River flows and the fluvial processes that were natural to the River.
- Restoration designs should reflect and emulate the fact that the natural River channel and riparian zones were (historically) dynamic both spatially and temporally, and that episodic denudation flood flows are natural and necessary to riparian integrity (e.g., cycling of seral stages) in the Study Area.
- We suggest that the current proposed Project designs (even though an improvement over existing conditions) would retain many of the existing rather simplified ("naturalistic") features of the River in widened/restored areas.
- In areas where the River would be substantially widened, we suggest that Project designs should not intend to fully "lock" the low-flow channel in one place, but instead should allow for some limited amount of channel migration over time.
- Restored floodplain terrace ground surfaces should be well within the distances to groundwater that can be utilized naturally by the expected native riparian vegetation.

RESPONSE 4:

- We agree that the widened areas should be designed to support high levels of heterogeneity, and the existing plan provides for that. The active channel will be allowed to migrate and change form, and terraces and sediments will be redistributed with storm events. Initial grading during construction of widened areas will create diverse topography. The dynamic and episodic nature of the River flows will be accommodated in these areas, allowing the River to carve new channel configurations over time, creating the complexities of a natural river system. The Final IFR document includes these clarifications regarding provisions for natural hydrologic functioning.
- The Corps will continue to coordinate with USFWS during the development of detailed designs to ensure that restoration in widened reaches mimics a natural hydrologic regime and fluvial processes to the extent possible, allowing for channel migration and reworking of restored widened areas following flood events, while not compromising existing levels of flood protection. Flood damage reduction features are not proposed as part of this project.

RECOMMENDATION 5

- Within the Project portions of the River that would not be widened by the proposed Project, we suggest that ecological enhancement, native landscaping, recreation, buffer, and/or stream water shading be the stated goals for and focus of Project activities in most of these areas. While providing some ecological improvement, we suggest that these features be treated as ecological enhancement because the substantial constraints in these reaches preclude self-sustaining full or partial restoration of most of the important riverine or riparian ecological functions of the River.

RESPONSE 5:

- The project provides native vegetation, wildlife habitat, and ecosystem functions

within each reach at varying levels, within existing constraints. Each project feature is designed for restoration benefit. The Corps recognizes that in some cases the possible features are highly constrained by the need to maintain flood conveyance or to work within existing major infrastructure constraints such as freeways, railroad, and residential uses.

- The proposed project maximizes ecological restoration where it can be achieved, primarily in widened areas of the river where floodplain property adjacent to the river can be acquired. In other portions of the project area, the Corps has planned for construction of features that would improve value for wildlife in the vicinity and for connectivity between restored widened areas.
- The Corps disagrees that individual project features should be parsed out as restoration versus enhancement. While the definition of "restoration" as provided by USFWS is not achievable in every portion of the project area, the project as a whole meets the Corps' criteria for ecosystem restoration, in that all features collectively contribute to habitat and connectivity restoration and improvement throughout the project area.

RECOMMENDATION 6

- We suggest that the Project ecological guidelines and designs for restoration be based on typical restoration ecology science and terminology, and less on landscape architecture science and terminology.
- Baseline and post-Project implementation surveys/assessments for fish, amphibians, reptiles, and the associated parameters of potential habitats for target species should be performed in the Study Area.
- Water quality parameters of specific Project reaches should be evaluated and mapped as part of Project planning and implementation.
- Survey information should be used to inform basic Project design development (e.g., to provide functional habitats for specific native fish and aquatic wildlife species), as well as post-construction adaptive management decisions, and future restoration projects in the watershed.

RESPONSE 6:

- The Corps ecosystem restoration guidance and policy followed by this study is grounded in restoration science and terminology; recreation features are designed after restoration plans are in place, are designed to be compatible with restoration plans, and utilize standard landscape architecture principles.
- The MAMP included in Appendix H of the Final IFR includes restoration monitoring to evaluate the performance of restoration actions. As described in Section 5.5.4 of the Final IFR, pre-construction surveys would be performed for least Bell's vireo and for special status plant and wildlife species, and the Corps would continue to coordinate with the USFWS throughout the project design and construction period.
- Monitoring includes an inventory of wildlife species based on observations of wildlife and signs of usage, mapping of habitat, as well as inventory of habitat elements present within the project footprint.
- Monitoring of riparian, marsh, and fish habitat is outlined in the MAMP, which evaluates various habitat parameters. The water quality parameters suggested in

this recommendation will be monitored as part of the MAMP.
- Non-native plant species will also be removed as part of construction and managed as part of operation and maintenance of the project.

RECOMMENDATION 7

- The Project ecological restoration designs should provide higher priority to creating the natural parameters and conditions needed for the restoration of at least one specific native fish species, to the extent practicable, so as to both support their basic survival and to give them competitive advantages over exotic species that would likely continue to occupy the Study Area following Project implementation.

RESPONSE 7:

- The design drawings at the feasibility level are conceptual and will be revised and refined during the detailed design stage to include the necessary parameters that would support native fish habitat in widened areas and in overbank areas during the detailed design phase. In concrete reaches, where features are more limited by maintenance of flood capacity, designs will focus on providiug refugia and passage.
- Designs will focus on providing the hydrologic regime, substrates, and habitat elements required by arroyo chub and Santa Ana sucker.

RECOMMENDATION 8

- Considering the heavy constraints of the Study Area, some excellent opportunities exist for artificial enhancement measures, particularly where restoration is not practicable.
- Additionally, these types of features (e.g., large hollow snags, tall steep river banks) are not likely to otherwise develop in the short-term or over time in significant number/area within the Study Area due to the limited floodplain widths and modified hydrology in even the widest proposed restoration sites of the Project. The directed artificial measures suggested below would likely be substantially and quickly utilized by some uncommon or sensitive bird and bat species and could provide very attractive and important watchable wildlife opportunities along the River for residents and visitors.

RESPONSE 8:

- Iustallation of artificial habitat features as recommended could be considered in the detailed design stage in coordination with USFWS, as practicable in relation to meeting project objectives.

RECOMMENDATION 9

- If brown-headed cowbird parasitism levels are still likely to be problematic for sensitive birds potentially occurring within the Project area, then management of cowbird numbers should be performed by the Project for the life of the Project.

RESPONSE 9:

- General wildlife surveys are included as part of monitoring in the Monitoring and Adaptive Management Plan. If surveys document a large population of cowbirds in the project area and the presence of vireo, the Corps would inform the Adaptive Management Team member agencies, one or more of which may implement a program for removal separate from this project or identify an entity interested in doing so. If a removal program were to be proposed, the Corps and non-Federal sponsor would coordinate with the proponent and the agencies with jurisdiction over such removals to ensure compatibility of the program with the restoration project, including project operation and maintenance.

RECOMMENDATION 10

- We suggest that riparian and riverine native fish restoration designs within the Project's widened reaches include specific measures (where practicable) for development of: a) water shaded by riparian woody vegetation; b) sediment and leaf-fall inputs to aquatic areas; c) channels with steep native-soil stream banks and in-channel woody debris; d) substantial channel diversity including riffle-run-pool-glide sequences, point bars; e) back channel refugia that utilizes upwelling groundwater (low temperature water of higher quality) and provides protected waters during larger flood flow events; f) appropriate channel substrates, including sand, gravel and cobble; g) potential for some channel movement/meander over time in widened channel areas; h) minimal areas of wide ponded or open water; i) riparian hiding cover for native fish (e.g., herbaceous plants and woody shrubs providing overhanging vegetation on stream banks for hiding cover); and j) target fish species passage and appropriate water temperatures and oxygenation levels, including shading of water surfaces through native tree landscaping on the south side of non-widened channel reaches, where practicable and appropriate.
- Periodic artificial substrate import (e.g., sand and gravel) into the upper end of the Study Area during the Project life will likely be necessary to maintain some important fluvial processes and conditions for native fish through the Study Area.
- The Project should initiate an aquatic exotic species control program for the Study Area.

RESPONSE 10:

- Detailed designs will focus on providing the hydrologic regime, substrates, and vegetation required by arroyo chub and Santa Ana sucker. Detailed designs will also consider the incorporation of opportunities for aquatic and terrestrial passage in hard bottom reaches.
- Sediment import is included as a potential adaptive management action in the Monitoring and Adaptive Management Plan.
- Removal of non-native fish could be implemented by resource agencies or other interested entities separate from this project. If a removal program were to be proposed, the Corps and non-Federal sponsor would coordinate with the proponent and the resource agencies with jurisdiction over such removals to ensure compatibility of the program with the restoration project, including project operation and maintenance.

RECOMMENDATION 11

- Feral mammal populations should be controlled in Project restoration areas, as practicable and appropriate.

RESPONSE 11:

- General wildlife surveys are included as part of monitoring in the Monitoring and Adaptive Management Plan. If monitoring documents feral or nuisance mammals, the Corps would inform the Adaptive Management Team member agencies, one or more of which may implement a program for removal separate from this project or identify an entity interested in doing so. If a removal program were to be proposed, the Corps and non-Federal sponsor would coordinate with the proponent and the agencies with jurisdiction over such removals to ensure compatibility of the program with the restoration project, including project operation and maintenance.

RECOMMENDATION 12

- Project designs and objectives should include greater specificity regarding minimum levels of ecological functions and values to be created or enhanced.
- We suggest the use of appropriate umbrella species to help briefly outline/translate minimum ecological functions to be restored in meaningful ways, and for planning, design, and implementation purposes.
- As such, we suggest that the Project include restoration of specified minimum acreages of functional habitats in the long-term for typical restoration planning species for southern California riparian areas, including vireo, chat, and yellow warbler.

RESPONSE 12:

- The objectives as currently defined are appropriate and reflective of the naturally occurring habitat that the project restoration is proposing to achieve. Objectives are described in Section 4.2 of the IFR, with measurable objectives criteria outlined in Section 4.2.2. The final array of alternatives meet these objectives criteria based on Corps standards as described in Section 6.2, Tables 6-1 and 6-2.
- Detailed designs will provide more specificity in terms of habitat, ecological, and hydrologic features to be created and restored based on the necessary habitat components for such recommended target species.

RECOMMENDATION 13

- Any federally listed species occupying the Project footprint should be the subject of consultation under the Endangered Species Act, as appropriate. An unknown number of vireo likely occupy the Project direct activity footprint and would likely be positively affected by the beneficial aspects of the Project and temporarily adversely affected (through loss of habitat and function) by the action's construction activity of riparian vegetation clearing within seasonally occupied habitat in the River. As such, the action would likely warrant consultation. Appropriate surveys should be performed to determine occupation and usage areas.

RESPONSE 13:

- Section 5.5.1 of the IFR outlines that Section 7 of the ESA requires consultation with USFWS if the project would affect listed species. As documented in Section

10.1 of the IFR, the Corps determined that the proposed project would have no effect on federally listed threatened or endangered species.

- The recommended plan will avoid impacts to least Bell's vireo. Least Bell's vireo are not expected to be present in the study area and are not known to nest in the study area due to the marginal existing habitat.
- Protocol level surveys for least Bell's vireo would be performed during the detailed design phase and in the nesting season(s) immediately prior to construction of each feature within any potentially suitable areas to confirm presence or absence of this species within the study area. The Corps will continue to coordinate with the U.S. Fish and Wildlife Service and the California Department of Wildlife throughout the design and construction period, and would consult under the Endangered Species Act if conditions change such that the Corps determines the project may affect the vireo or other listed species.
- No other special status species, including the southwestern willow flycatcher and coastal California gnatcatcher, are expected to occur due to the degraded conditions within the study area and lack of suitable habitat.
- The Corps will continue to coordinate with the U.S. Fish and Wildlife Service and the California Department of Wildlife throughout the design and construction period.

RECOMMENDATION 14

- A table describing the various acreages of all of the existing conditions in the Project alternatives' direct activity footprints should be developed.

RESPONSE 14:

- Information regarding acreages of habitats created is provided in Table 6-7 of the IFR. Chapter 7 of the IFR describes the Recommended Plan and NER Plan in terms of features restored by reach. The Corps will continue to provide detailed restoration and habitat information during the PED (Pre-Construction Engineering & Design) phase as coordination with USFWS on detailed project features continues.

9 REMAINING REVIEWS, APPROVALS, IMPLEMENTATION, AND SCHEDULE

Section 7.5.12 describes the remaining reviews and approvals required for this report. The following major milestones are currently scheduled.

• Major Subordinate Command (MSC)Commander Endorsement	May 2015
• Civil Works Review Board (CWRB)	July 2015
• Final Report State and Agency Review	September-October 2015
• Chief of Engineers Report	December 2015
• CEQA Notice of Determination	January 2016
• Record of Decision	March 2016
• Assistant Secretary of the Army for Civil Works (ASA (CW)) Transmit to Congress	June 2016

9.1 PROJECT PARTNERSHIP AGREEMENT

Prior to advertisement for the construction contract, a Project Partnership Agreement (PPA) will be required to be signed by and between the Federal Government and the City of Los Angeles, requiring formal assurances of local cooperation from the City. This agreement will be prepared and negotiated during the PED (Plans and Specifications) Phase.

9.2 APPROVAL AND IMPLEMENTATION

The necessary reviews and activities leading to approval and implementation of the recommended plan are listed below:

a. Environmental Impact Statement Filing – the IFR, including Feasibility Report, FEIS/EIR, and appendices, along with the proposed report of the Chief of Engineers, will be circulated to state and Federal agencies as directed by HQUSACE for the 30-Day State and Agency review. The District will concurrently distribute the IFR to parties not included on the HQUSACE mailing list and file the IFR together with the proposed report of the Chief of Engineers with the EPA.

b. Chief of Engineers' Approval – the Chief of Engineers will sign the report signifying approval of the project recommendation and will submit the Chief of Engineers' Report, the IFR, and the unsigned ROD to the ASA(CW).

c. ASA(CW) Approval – The ASA(CW) will review the documents to determine the level of Administration support for the Chief of Engineers' recommendation. The ASA(CW) will formally submit the report to the Office of Management and Budget (OMB). OMB will review the recommendation to determine its relationship to the program of the President. OMB may clear the release of the Chief of Engineers' report to Congress.

d. The Recommended Plan requires congressional authorization for project construction.

e. Funds could be provided, when appropriated in the budget, for preconstruction, engineering and design (PED), upon the Division Commander's endorsement of the District Engineer's report and submittal to HQUSACE announcing the completion of the final report and pending project authorization for construction.

f. Surveys, model studies, and detailed engineering and design for PED studies will be accomplished first, and then plans and specifications will be completed, upon receipt of funds.

g. Construction would be performed with Federal and non-Federal funds in accordance with the PPA.

10 ENVIRONMENTAL COMPLIANCE

The status of the project's compliance with applicable Federal, State, and local environmental requirements is summarized below. Prior to initiation of construction, the project will be in compliance with all applicable laws, regulations, and Executive Orders.

10.1 FEDERAL LAWS, REGULATIONS, AND POLICIES

10.1.1 Clean Air Act of 1972, as amended (42 U.S.C. 7401, et seq.)

Section 5.2 and Appendix F of this IFR characterize the estimated air emissions associated with all action alternatives for both construction and operations. As fully documented in Appendix F, the estimated emissions for all action alternatives would not require a General Conformity Determination under the Clean Air Act. The project is in compliance with the Clean Air Act.

10.1.2 Clean Water Act of 1972, as amended (33 U.S.C. 1251, et seq.)

The potential effects of the proposed project on water quality have been evaluated and are discussed in Section 5.4. Those sections of the CWA most relevant to this project are described as follows:

Section 401 requires compliance with water quality standards. The Corps has applied to the Los Angeles RWQCB for Section 401 certification, pursuant to 33 CFR 336.1(a)(1). The Corps will continue to coordinate with the RWQCB throughout the remaining study, design and construction phases of this project. This IFR contains sufficient information regarding water quality effects, including consideration of the Section 404(b)(1) Guidelines, to meet the EIS content requirements of Section 404(r), should that exemption be invoked.

Section 404 addresses discharges of dredged or fill material to waters of the United States. The Corps does not issue itself permits for Corps Civil Works projects but must comply with the 404(b)(1) guidelines. A Section 404(b)(1) evaluation has been prepared and is found in Appendix M. With implementation of the avoidance and minimization measures listed therein, the proposed discharges of fill will be in compliance with Section 404 of the Clean Water Act.

10.1.3 Endangered Species Act of 1973, as amended (16 U.S.C. 1531, et seq.)

A list of threatened and endangered species that have the potential to occur in the study area was obtained from USFWS on April 29, 2012. Based on the analysis contained in this document, including Section 5.5.3, the Corps has determined that the project would have no effect on Federally listed threatened or endangered species, and therefore no consultation is required with USFWS or NMFS at this time. The project is in compliance with the Endangered Species Act.

Endangered species surveys will be conducted during the detailed design phase and in the nesting season(s) immediately prior to construction of each feature within any potentially suitable areas to confirm presence or absence of federally and state listed threatened and endangered species. The Corps will continue to coordinate with the USFWS throughout the design and construction period, and consult under ESA if future surveys conducted during PED or construction indicate that conditions have changed such that the Corps determines that listed species may be affected.

10.1.4 Executive Order 11988, Floodplain Management

The objective of this Executive Order is the avoidance, to the extent possible, of long-and short-term adverse effects associated with the occupancy and modification of the base floodplain (1 in 100 annual

event) and the avoidance of direct and indirect support of development in the base floodplain wherever there is a practicable alternative. Under the Order, the Corps is required to provide leadership and take aetion to:

a. Avoid development in the base flood plain unless it is the only practicable alternative;
b. Reduce the hazard and risk associated with floods;
c. Minimize the impact of floods on human safety, health and welfare; and
d. Restore and preserve the natural and beneficial values of the base flood plain.

The proposed project does not contribute to increased development in the floodplain and does not increase flood risk, but rather it restores "natural and beneficial values" and thus is in compliance with the executive order.

The Water Resources Council Floodplain Management Guidelines for implementation of EO 11988, as referenced in USACE ER 1165-2-26, require an eight-step process that agencies should carry out as part of their decision-making on projects that have potential impacts to or within the floodplain. The eight steps reflect the decision-making process required in Section 2(a) of the EO. The eight steps and project-specific responses to them are summarized below.

1. **Determine if a proposed action is in the base floodplain (that area which has a one percent or greater chance of flooding in any given year).** The proposed action is located within the Los Angeles River channel and immediate overbank areas and therefore is partially within the base floodplain.

2. **If the action is in the base flood plain, identify and evaluate practicable alternatives to the action or to location of the action in the base flood plain**. Chapter 4 of this document presents an analysis of alternatives. Practicable measures and alternatives were formulated, and potential impacts and benefits were evaluated in Chapter 5. As the primary objective of the project is aquatic ecosystem restoration, there are no practicable alternatives completely outside of the base floodplain that would achieve this objective.

3. **If the action must be in the flood plain, advise the general public in the affected area and obtain their views and comments**. Because the primary objective of the project is aquatic ecosystem restoration, the action must be in the flood plain. The proposed project has been fully coordinated with the general public, governmental agencies, organizations and interested stakeholders. As described in Chapter 8 of this document, public outreach on restoration concepts began in 2005 with a series of workshops aimed at soliciting input for the Los Angeles River Revitalization Master Plan. A three-day planning charette was held in December of 2009 to introduce the Los Angeles River Restoration study and solicit feedback on the study area's problems and opportunities, objectives to address them, and measures that could be used to meet the objectives. Participants included staff from the USACE, County, City, resource and municipal agencies, and non-governmental organizations, as well as local community members and consultants. The Draft IFR was released in September 2013, posted by EPA in the Federal Register on October 4, 2013, and a public meeting was held on October 17, 2013. Numerous comments were received on the Draft IFR, which have been included and responded to in this Final IFR (see Appendix L). In addition, a Coordination Act Report was received from the USFWS and is included in Appendix N, along with the Corps' responses to their recommendations.

4. **Identify beneficial and adverse impacts due to the action and any expected losses of natural and beneficial flood plain values. Where actions proposed to be located outside the base flood plain but will affect the base flood plain, impacts resulting from these actions should also be identified**. The anticipated impacts associated with the Recommended Plan are summarized in Chapters 5, 6 and 7 of this report. While construction of project features would result in mostly minor and temporary adverse impacts to the natural environment, the proposed restoration would result in a substantial and long-term increase in

habitat values, including an increase in the quantity and quality of riparian and aquatic habitat. The project will also result in a widening or expansion of the existing floodplain within the project footprint in certain reaches, restoring natural and beneficial floodplain functions which had been lost to development.

5. **If the action is likely to induce development in the base flood plain, determine if a practicable non-flood plain alternative for the development exists**. An evaluation of practicable measures and alternatives is presented in Chapter 4 of this report. The project will not induce development in the floodplain. There are no or very limited opportunities for additional development within the historic floodplain due to the existing "full buildout" condition along most of the study area. However, as identified in the Economic Appendix (Appendix B of this IFR) there are anticipated redevelopment opportunities within certain river-adjacent parcels, and river restoration may spur transition from industrial use to residential, retail or mixed-use zoning.

6. **As part of the planning process under the Principles and Guidelines, determine viable methods to minimize any adverse impacts of the action including any likely induced development for which there is no practicable alternative and methods to restore and preserve the natural and beneficial flood plain values. This should include reevaluation of the "no action" alternative**. For each resource analyzed in Chapter 5, wherever there is a potential for adverse impacts, appropriate Best Management Practices or other environmental commitments were identified and listed at the end of each section. As there is a net benefit to biological resources, no biological mitigation is required for the Recommended Plan. The project would not induce development in the flood plain. The project would restore natural and beneficial flood plain values by widening the river and flood plain within the project footprint without increasing flood risk to adjacent areas. Chapter 4 of this report summarizes the alternative identification, screening and selection process. The "no action" alternative was carried through the entire assessment and selection process.

7. **If the final determination is made that no practicable alternative exists to locating the action in the flood plain, advise the general public in the affected area of the findings**. The Draft IFR was released in September 2013, posted by EPA in the Federal Register on October 4, 2013, and a public meeting was held on October 17, 2013. Numerous comments were received on the Draft IFR, which have been included and responded to in this Final IFR (see Appendix L).

8. **Recommend the plan most responsive to the planning objectives established by the study and consistent with the requirements of the Executive Order**. The Recommended Plan is the most responsive to all of the study objectives described in Chapter 4, and it is consistent with the requirements of EO 11988.

10.1.5 Executive Order 11990, Protection of Wetlands

This Executive Order directs Federal agencies, in carrying out their responsibilities, to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands. Wetland vegetation within the study area would be disturbed during construction but much more wetland habitat would be established as a result of the proposed project; therefore the project is in compliance with the executive order.

10.1.6 Executive Order 12989, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations

This Executive Order states that Federal agencies are responsible for conducting their programs, policies, and activities that substantially affect human health of the environment in a manner that ensures that such programs, policies, and activities do not have the effect of excluding persons from participation in, denying persons the benefits of, or subjecting persons to discrimination under such programs, policies,

and activities because of their race, color, or national origin. The required analysis has been conducted, and impacts have been avoided to the extent possible. Significant impacts to environmental justice communities are not anticipated with the project. The project is in compliance with the Executive Order.

10.1.7 Farmland Protection Policy Act (7 U.S.C. 4201, et seq.)

There are no designated prime or unique farmlands within the study area; therefore there would be no adverse effects to farmland and the project is in compliance with this Act.

10.1.8 Fish and Wildlife Coordination Act of 1958, as amended (16 U.S.C. 661, et seq.)

Federal agencies undertaking water projects are required to fully consider recommendations made by the USFWS in the provided Coordination Act Report (CAR) or Planning Aid Letter associated with the project. USFWS and CDFW have had full participation in planning and evaluating the proposed project, and USFWS was funded to prepare a CAR.

The Corps coordinated with USFWS during development of the CAR from November 2013 to January 2015, in addition to the general coordination that occurred throughout the development and evaluation process. The Corps met with USFWS regarding the CAR recommendations on September 29, 2014 and on October 30, 2014. The Corps fully considered the CAR recommendations and committed to continued coordination with USFWS during the detailed design phase of the project. The Corps received the revised Final CAR on January 5, 2015. The CAR and the Corps' responses to the CAR's recommendations are included in this Final IFR in Appendix N. The project is in compliance with the Fish and Wildlife Coordination Act.

10.1.9 Migratory Bird Treaty Act of 1936, as amended (16 U.S.C. 703, et seq.)

The Migratory Bird Treaty Act implements various treaties and conventions between the United States, Canada, Japan, Mexico, and Russia, providing protection for migratory birds as defined in 16 U.S.C. 715j. Under the act, taking, killing or possessing migratory birds, their nests or eggs is prohibited. The proposed action is located primarily in a highly developed area, although some nesting habitat persists within the study area. To ensure that the project does not result in take of migratory birds, their eggs, or nests, to the maximum extent practicable vegetation clearing activities would not occur during the breeding season. If vegetation removal must occur during the breeding season, a qualified biologist would perform nesting bird surveys following established protocol prior to construction. If nests are detected during these surveys, a construction buffer would be delineated around the nest.

10.1.10 National Environmental Policy Act of 1969, as amended (42 U.S.C. 4321, et seq.)

NEPA applies to all Federal agencies and most of the activities they manage, regulate, or fund that affect the environment. This act requires full disclosure of the environmental effects, alternatives, potential mitigation, and environmental compliance procedures of proposed actions. NEPA requires the preparation of an appropriate document to ensure that Federal agencies accomplish the law's purposes. Full compliance with NEPA is achieved with the filing of the final EIS/EIR with USEPA and with the Corps' issuance of a Record of Decision.

10.1.11 CEQ Regulations for Implementing the Procedural Provision of NEPA (40 CFR Part 1500 et seq.)

The Council on Environmental Quality has prepared regulations for implementing NEPA, including those pertinent to NEPA and agency planning, preparation and distribution of an EIS, procedures for the open

comment period, resolution of environmentally unsatisfactory actions, agency responsibilities, and other requirements of NEPA. This document has been prepared in compliance with these regulations.

10.1.12 U.S. Army Corps of Engineers Procedures for Implementing NEPA (33 C.F.R., part 230, ER 200-2-2)

This regulation provides guidance for implementation of the procedural provisions of the National Environmental Policy Act (NEPA) for the Civil Works Program of the U.S. Army Corps of Engineers. It supplements Council on Environmental Quality (CEQ) regulations 40 CFR 1500-1508, in accordance with 40 CFR 1507.3, and is intended to be used in conjunction with the CEQ regulations. This regulation is applicable to all HQUSACE elements and all Field Operating Activities (FOAs) having responsibility for preparing and processing environmental documents in support of Civil Works functions. This IFR has been prepared in compliance with ER 200-2-2.

10.1.13 National Historic Preservation Act of 1966, as amended (54 U.S.C. 300101)

The impacts of Federal undertakings on cultural resources are formally assessed through a separate process mandated by the National Historic Preservation Act (NHPA) of 1966, as amended (54 U.S.C. Section 300101), and its implementing regulation, Protection of Historic Properties (36 CFR 800). Section 106 of the NHPA describes the process for identifying and evaluating historic properties, for assessing the effects of Federal actions on historic properties, and for consulting to avoid, reduce, or minimize adverse effects. Historic properties are cultural resources that are either "included in", or are eligible for inclusion in the National Register of Historic Places (NRHP). The Section 106 process does not require historic properties to be preserved but ensures that the decisions of Federal agencies concerning the treatment of these places result from meaningful consideration of cultural and historic values and the options available to protect the properties.

The USACE consulted with the SHPO staff by telephone in June of 2013 regarding the level of effort for the analysis in the IFR EIS/EIR. The SHPO has concurred with the use of existing information from the records and literature search. The Corps, in consultation with the SHPO, has developed a PA which lays out how the Corps will satisfy its requirements under Section 106 of the National Historic Preservation Act. The following agencies and groups have been invited to be concurring parties to the agreement: the City of Los Angeles, the California Department of Parks and Recreation, the Gabrieleno Band of Mission Indians, Fernandeno Tataviam Band of Mission Indians, Gabrielino Tongva Indians of California, Gabrielino –Tongva Tribe, Gabrielino Tongva Nation, Los Angeles City and County Native American Indian Commission, Ti'At Society/Inter-Tribal Council of Pima, and San Gabriel Band of Mission Indians.

10.1.14 Executive Order 13112 Invasive Species

This EO states that each Federal agency whose actions may affect the status of invasive species shall, to the extent practicable and permitted by law, use relevant programs and authorities to: (i) prevent the introduction of invasive species; (ii) detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner; (iii) monitor invasive species populations accurately and reliably; (iv) provide for restoration of native species and habitat conditions in ecosystems that have been invaded; (v) conduct research on invasive species and develop technologies to prevent introduction and provide for environmentally sound control of invasive species; and (vi) promote public education on invasive species and the means to address them. This project includes removal of invasive species and establishment of native habitat, and is therefore in compliance with this Executive Order.

10.2 STATE OF CALIFORNIA LAWS, REGULATIONS, AND POLICIES

10.2.1 California Clean Air Act

Section 5.2 of this document discusses the effects of the proposed project on the local and regional air quality. SCAQMD determines whether projeet emissions sources and emissions levels significantly affect air quality based on Federal Standards established by the U.S. EPA and State standards set by the California Air Resource Board.

Estimated operational emissions including maintenance and increased daily visitations for the proposed project would not exceed SCAQMD Regional Significance Thresholds and Localized Significance Thresholds. Estimated construction emissions for Alternative 20 would not exceed SCAQMD Regional Significance Thresholds. NOx emissions would exceed SCAQMD Localized Significance Thresholds during construction in 2022, 2023, and 2024. However, emissions reduction measures and other BMPs recommended by the SCAQMD would be implemented.

Total GHG emissions for construction and operations would not exceed the SCAQMD GHG threshold. Based on the above, construction and operation of either alternative would be in compliance with the California Clean Air Act.

10.2.2 California Endangered Species Act

This EIS/EIR has considered the potential effects to State-listed species and has determined that the project would have no effect on State-listed species. As a result, this project is in compliance with the California Endangered Species Act. The Corps will continue to coordinate with the CDFW throughout the design and construction period, and the non-Federal sponsor will coordinate and consult under CESA if future surveys conducted during PED or construction indicate that conditions have changed such that state-listed species would be affected.

10.2.3 Porter-Cologne Water Quality Control Act

The potential effects of the proposed project on water quality have been evaluated and are discussed in Section 5.4. This project expects to achieve full compliance with the Water Quality Control Act by achieving compliance with RWQCB certification mandates for Section 401.

10.2.4 California Fish and Game Codes 1600-1607

The California Department of Fish and Wildlife, under California Fish and Game Code Sections 1600 through 1607, regulates work that would substantially divert, obstruct, or change the natural flow of a river, stream, or lake; that would substantially change the bed, channel, or bank of a river, stream, or lake; or that would use material from a streambed. Under Section 1602, prior to construction, the City will enter into a Streambed Alteration Agreement (SAA) with the CDFW that will include conditions to ensure impacts on fish and wildlife or habitat are avoided, minimized. As this is an ecosystem restoration project, it is anticipated that no mitigation will be required.

11 RECOMMENDATIONS

I recommend that the selected plan for ecosystem restoration and recreation along the Los Angeles River within the corporate boundaries of the City of Los Angeles, California as described in this report be authorized as a Federal project, with such modifications thereof as in the discretion of the Commander, HQUSACE, may be advisable. I have given full consideration to all significant aspects of this recommendation in the overall public interest including environmental, social, and economic effects; and engineering feasibility. The recommended plan includes monitoring until ecological success criteria are met, for no more than 10 years, and adaptive management as described in this document. An Operations, Maintenance, Repair, Replacement, and Rehabilitation Plan will be developed following project implementation. The recommended plan is estimated to have a total first cost for ecosystem restoration and recreation of $1,356,608,000 (Program Year 2016 –Effective Price Level 1 Oct 2015).

The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and implementation funding. However, prior to transmittal to the Congress, the non-Federal sponsor, the States, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

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13 REFERENCES

Ackerman, D. 2003. Characterization of the Water Quality of the Los Angeles River. Bulletin of the Southern California Academy of Sciences. Funded by the City of Los Angeles, Los Angeles Regional Water Quality Control Board, and the Southern California Coastal Water Research Project.

American Association of State Highway and Transportation Officials. 2008. The Environmental Stewardship Practices in Construction and Maintenance Compendium. Prepared under the National Cooperative Highway Research Program as an effort of the AASHTO Standing Committee on Environment, with input from the Highway Subcommittees on Construction and Maintenance. Accessed September 2012 at http://environment.transportation.org.

Amtrak. 2012. Amtrak National Facts. Accessed September 2012 at http://www.amtrak.com/.

Arkle, J. C. and P. Armstrong. 2009. Exhumation of the Verdugo Mountains, Southern California; constraints from low-temperature thermochronology and geomorphic analysis. Geological Society of America Abstracts with Programs, vol. 41, no. 67 p. 300.

Ball, Joan E., Beche, Leah A., Mendez, Patina K., and Resh, Vincent H., Biodiversity in Mediterranean-climate streams of California, Hydrobiologia (2013) 719:187–213

Barkley, L.J. 1993. Mammals of the Los Angeles River Basin. *In:* Garrett, K.L. 1993. The Biota of the Los Angeles River. Natural History Museum of Los Angeles County Foundation for the California Department of Fish and Game. March.

Barrett, D.E. 1996. Traffic-Noise Impact Study for Least Bell's Vireo Habitat along California State Route 83. Transportation Research Record 1559.

Beier, P., D. Majka, and T. Bayless. 2006. Arizona Missing Linkages: Rincon-Santa Rita-Whetstone Linkage Design. Report to Arizona Game and Fish Department. School of Forestry, Northern Arizona University.

Bezy, R.L., C.A. Weber, and J.W. Wright. 1993. Reptiles and Amphibians of the Los Angeles River Basin. *In:* Garrett, K.L. 1993. The Biota of the Los Angeles River. Natural History Museum of Los Angeles County Foundation for the California Department of Fish and Game. March.

Brick, Tim. 2012. Flowing Waters, Fruitful Valley, A Brief History of Water Development in the Arroyo Seco. Accessed July 2012 at http://www.brickonline.com/Brief%20History.pdf.

Bittman, R., Kauffman, E., Keeler-Wolf, T., McGriff, D., and Salwasser, J., (2003). Climate and topography. *Atlas of the Biodiversity of California. California Department of Fish and Game. Sacramento, CA*

Bittman, R. (2003). Plants. In Atlas of the Biodiversity of California. California Department of Fish and Game. pp. 24-25.

Browning Ferris Industries of California, Inc. 2008. Solid Waste Facilities Permit: Sunshine Canyon City/County Landfill. Internet website: http://www.sunshinecanyonlandfill.com/home/regulatory/pdf/IssuedSunshineSWFP7-7-08-1.pdf. July 7, 2008.

Burbank Fire Department. 2011. Standards of Cover. Accessed May 2011 at http://burbankusa.com/modules/ShowDocument.aspx?documentid=10353.

Burbank Unified School District. 2010. District Facts 2010/2011. Accessed July 2012 at http://www.burbankusd.org/Modules/ShowDocument.aspx?documentid=2298.

Burbank Water and Power. 2011. 2010 Urban Water Management Plan. Accessed July 2012 at http://www.burbankwaterandpower.com/download/burbank-2010-UWMP.pdf.

Busch, Lawrence, P.E. 2012. Personal communication. Engineering Geologist, California Geological Survey, via email on 17 October.

Bureau of Reclamation. 2004. Natural Resources Group. Los Angeles River Physical and Biological Habitat Assessment. Prepared for the City of Los Angeles. April 2004.

California Air Resources Board (CARB). 2010a. California Ambient Air Quality Standards (CAAQS). Accessed August 2012 at http://www.arb.ca.gov/research/aaqs/aaqs2.pdf, updated 09/08/10.

California Air Resources Board (CARB). 2010b. Air Quality Data Statistics, California Air Resources Board. Access August 2012 at www.arb.ca.gov/adam/index.html.

California Air Resources Board (CARB). 2011. Air Quality (AQ) & Emissions, Standards and Area Designations. Accessed August 2012 at http://www.arb.ca.gov/desig/adm/adm.htm.

California Coastal Conservancy. 2002. Survey of Invasive Nonnative Plants, Primarily Arundo Donax, along the Los Angeles River and Tributaries. Prepared by Riparian Repairs. April 2002.

California Department of Conservation (CADC). 2012a. California Geological Survey – Alquist-Priolo Earthquake Fault Zones. Accessed September 2012 at http://www.conservation.ca.gov/CGS/rghm/ap/ Pages/Index.aspx.

California Department of Conservation. (CADC). 2012b. Seismic Hazards and Zonation Program. Accessed September 2012 at http://gmw.consrv.ca.gov/shmp/html/pdf_maps_so.html).

California Department of Fish and Game (CDFG). 1993. The Biota of the Los Angeles River. Prepared by the National History Museum of Los Angeles County Foundation and edited by Kimball L. Garrett.

California Department of Parks and Recreation (CDPR). 2005a. Rio De Los Angeles State Park (Taylor Yard), Preliminary General Plan and Final Environmental Impact Report. May 2005.

California Department of Parks and Recreation (CDPR). 2005b. Proposed Los Angeles State Historic Park (Cornfield Site). Preliminary General Plan and Draft Environmental Impact Report. State Clearinghouse #2003031096. March 2005.

California Department of Parks and Recreation (CDPR). 2005c. Los Angeles State Historic Park General Plan and Final Environmental Impact Report. Accessed September 2012 at http://www.parks.ca.gov/ ?page_id=25057.

California Department of Parks and Recreation (CDPR). 2012a. Rio De Los Angeles State Park. Accessed August 2012 at http://www.parks.ca.gov/?page_id=22277.

California Department of Parks and Recreation (CDPR). 2012b. Los Angeles State Historic Park. Accessed August 2012 at http://www.parks.ca.gov/?page_id=22272.

California Department of Toxic Substances Control (DTSC). 2012. Letter to Union Pacific Railroad approving Feasibility Study for Taylor Yard Site, including comments on Feasibility Study to be addressed in Remedial Action Workplan. August 8, 2012.

California Department of Transportation (Caltrans). 2011. 2011 Annual Average Daily Traffic. Accessed July 2012 at http://traffic-counts.dot.ca.gov/.

California Department of Transportation (Caltrans). 2012. I-5 North: Ventura Freeway (SR-134) to Magnolia Boulevard. Accessed August 2012 at http://i-5info.com/ventura-freeway-sr-134-to-magnolia-boulevard/.

California Department of Water Resources (DWR 4-12). 2004. California's Groundwater Bulletin 118, South Coast Hydrologic Region, San Fernando Valley Groundwater Basin.

California Department of Water Resources (DWR 4-11.4). 2004. California's Groundwater Bulletin 118, South Coast Hydrologic Region, Coastal Plains of Los Angeles Central Groundwater Basin.

California Energy Commission, 2012. Energy Consumption Data Management System: Energy Consumption by Entity. Accessed July 2012 at http://www.ecdms.energy.ca.gov/ elecbyutil.aspx.

California Geologic Survey (CGS). 2006. Map of Alquist-Priolo Earthquake Fault Zones. Accessed August 2012 at http://www.consrv.ca.gov/cgs/rghm/ap/index.htm.

California Governor's Office of Planning and Research (OPR). 1998. General Plan Guidelines. Appendix C, Noise Element Guidelines. Updated October 2003.

California High-Speed Rail Authority. 2012. California High-Speed Rail Project. Accessed September 2012 at http://www.cahighspeedrail.ca.gov/home.aspx.

California Native Plant Society (CNPS). 2012. CNPS Rare Plant Ranking System. Internet webpage located at http://www.cnps.org/cnps/rareplants/ranking.php. Accessed August 2012.

California Natural Diversity Database (CNDDB). 2012. Subscriber-limited access on-line database for Burbank, Hollywood, Pasadena, and Los Angeles topographic quadrangles.

California Public Utilities Commission. 2011. Telco Carrier Services Database. Accessed July 2012. http://www.cpuc.ca.gov/PUC/Telco/Consumer+Information/carrierlists.htm.

California Public Utilities Commission. 2012. 2012 California Gas Report. Prepared by the California Gas and Electric Utilities. Accessed July 2012 at http://www.socalgas.com/regulatory/ cgr.shtml.

California Environmental Quality Act (CEQA). 2006. Appendix G, Environmental Checklist Form. Accessed September 2012 at http://www.waterboards.ca.gov/laws regulations/docs/portercologne.pdf

California West Nile Virus Website. 2012. Latest West Nile Virus Activity in California. Accessed September 2012 at http://www.westnile.ca.gov/.

Camp Dresser & McKee Inc. 2011. Feasibility Study Taylor Yard Parcel G-2, Los Angeles, California. Prepared for Union Pacific Railroad. September 21, 2011.

Carothers, S.W. 1977. Importance, Preservation, and Management of Riparian Habitats: An Overview. *In:* Importance, Preservation and Management of Riparian Habitat: A Symposium, July 9, 1977. U.S. Forest Service General Technical Report RM-43, p. 2-4.

CH2M Hill, Inc. 2009. 2007 Report San Fernando Valley Superfund Sites Groundwater Monitoring Program, Los Angeles County, California. July 2009.

Chambers, J.P., H. Saurenman, R. Bronsdon, L. Sutherland, R. Waxler, K. Gilbert, and C. Talmadge. 2005. Highway Noise Levels in a Suburban Environment, Forum Acusticum 2005 Budapest, p1135-1140.

City of Burbank. 2010. City of Burbank: Keep Pace With Technology. Fact Sheet. Accessed August 2012 at http://www.ci.burbank.ca.us/Modules/ShowDocument.aspx?documentid=9636.

City of Burbank. 2012a. Burbank 2035: General Plan. Public Review Draft. Community Development Department, Planning and Transportation Division. Prepared by AECOM.

City of Burbank. 2012b. Burbank Bus. A Service of the City of Burbank. Maps and Schedules. Accessed September 2012 at http://www.burbankbus.org/index.aspx?page=866.

City of Burbank. 2012c. Parks and Recreation Facilities. Department of Park, Recreation, and Community Services. Accessed August 2012 at http://www.burbankca.gov/Modules/ ShowDocument.aspx?documentid=16145.

City of Burbank. 2013a. Wastewater Treatment Plant. Daily average effluent discharge data collected from the City of Burbank's Contractor; Bradley Davis, United Water Laboratory Manager. Data used by permission of the City of Burbank in an email received 3-25-2013. The City of Burbank and contractor United Water, do not necessarily support or endorse this report as presented, and have provided a gross estimate of daily average effluent discharge from the Burbank WRP to the Burbank Western Channel.

City of Burbank. 2013b. Burbank2035 General Plan. City of Burbank Community Development Department, Planning and Transportation Division. Prepared by AECOM, Sacramento, CA.

City of Burbank. 2013c. Burbank2035 General Plan Environmental Impact Report (EIR). City of Burbank Community Development Department, Planning and Transportation Division. Prepared by AECOM, Sacramento, CA.

City of Glendale. 1998. Circulation Element of the General Plan. Accessed July 2012 at http://www.ci.glendale.ca.us/planning/plangeneralplanelements.asp.

City of Glendale. 2007. City of Glendale General Plan. Noise Element of the General Plan. Prepared by City of Glendale Planning Department.

City of Glendale. 2012a. Glendale Beeline. Accessed July 2012 at http://www.glendalebeeline.com/.

City of Glendale. 2012b. Building Codes. Accessed September 2012 at http://www.ci.glendale.ca.us/gmc/index.aspx#bldg_ords.

City of Glendale. 2012c. Glendale Quality of Life Indicators: 9.2 Developed Parkland. Accessed August 2012 at http://www.ci.glendale.ca.us/planning/qol/indicators09/9_parks_open_space/developed_parkland.asp.

City of Glendale. 2012d. Parks, Historic Sites & Facilities. Department of Community Services and Parks. Accessed August 2012 at http://www.ci.glendale.ca.us/parks/facilities_parks_historic-sites.aspx.

City of Glendale. 2012e, as amended. General Plan. Accessed September 6 at http://www.ci.glendale.ca.us/ planning/plangeneralplanelements.asp. City of Glendale, California.

City of Glendale Department of Public Works. 2012. Public Works Department. Accessed July 2012 at http://www.ci.glendale.ca.us/public_works/about_public_works.aspx#Integrated_Waste_Management.

City of Glendale Redevelopment Agency. 1996. Redevelopment Plan for the San Fernando Road Corridor, an Addendum to the DreamWorks Animation Campus, Environmental Impact Report, June. Accessed September 2012 at http://www.ci.glendale.ca.us/fthb/pdf/FEIR_Addendum.pdf.

City of Los Angeles. 1996. Safety Element of the General Plan. Accessed September 2012 at http://cityplanning.lacity.org/cwd/gnlpln/saftyelt.pdf. November 1996.

City of Los Angeles. 1997. Transportation Element of the General Plan. Accessed August 2012 at http://planning.lacity.org/cwd/gnlpln/transelt/index.htm.

City of Los Angeles. 1998. Boyle Heights Community Plan, adopted November 10, Accessed September 2012 at http://cityplanning.lacity.org/complan/pdf/bhtcptxt.pdf.

City of Los Angeles. 1998. Department of City Planning. Noise Element of the Los Angeles City General Plan. Accessed July 2012 at http://cityplanning.lacity.org/cwd/gnlpln/noiseElt.pdf.

City of Los Angeles. 1999. Northeast Los Angeles Community Plan. Adopted June 15. Accessed March 2014 at http://cityplanning.lacity.org/complan/pdf/nlacptxt.pdf.

City of Los Angeles. 2002. City of Los Angeles Environmental Quality Guidelines. Adopted July 31, 2002. CF# 02-1507.

City of Los Angeles. 2003. Canyon Hills Project Draft Environmental Impact Report. Department of City Planning. Noise Impact Study Prepared by Arup Acoustics April 2003.

City of Los Angeles. 2005. Integrated Resources Plan, Draft Environmental Impact Report, SCH Number 2004071091, SCAG Number 120040466. November 2005.

City of Los Angeles. 2006. Integrated Resources Program Final Environmental Impact Report, June. Accessed September 2012 at http://www.lacitysan.org/irp/.

City of Los Angeles. 2006. L.A. CEQA Thresholds Guide. Your Resource for Preparing CEQA Analyses in Los Angeles.

City of Los Angeles. 2007. Programmatic Environmental Impact Report/Environmental Impact Statement for the Los Angeles River Revitalization Master Plan. Prepared by The City of Los Angeles, Department of Public Works, Bureau of Engineering and the U.S. Army Corps of Engineers, Los Angeles District, Planning Division, with technical assistance from Tetra Tech, Inc.

City of Los Angeles. 2009. 2009 Citywide Community Needs Assessment. Department of Recreation and Parks. Accessed July 2012 at www.laparks.org/planning/pdf/exeSum.pdf.

City of Los Angeles. 2009. Water Quality Compliance Master Plan, October. Accessed September 2012 at http://www.lastormwater.org/about-us/water-quality-compliance-master-plan/.

City of Los Angeles. 2011. Albion Dairy Park Project Mitigated Negative Declaration, June. Accessed September 2012 at http://albionparkproject.org/Albionpark/Update.html.

City of Los Angeles. 2011. Cornfield Arroyo Seco Specific Plan and Redevelopment Plan. Draft Environmental Impact Report.

City of Los Angeles. 2012. Cornfield-Arroyo Seco Specific Plan Draft Environmental Impact Report, August 6, Internet website: https://sites.google.com/site/cornfieldsla/index.

City of Los Angeles. 2012. Hollywood Community Plan Update, adopted June 19.

City of Los Angeles. 2012a, as amended. City of Los Angeles General Plan. Planning Department, 200 North Spring Street, 5th Floor, Los Angeles, California. Adopted 1996, 2001, and June 2012.

City of Los Angeles. 2012b. Official City of Los Angeles Municipal Code (LAMC). Sixth Edition. Compiled, Edited and Published Under the Direction of Carmen A. Trutanich, City Attorney. Accessed September 2012 at www.amlegal.com.

City of Los Angeles. 2012c. Camping Section: Camping Facilities. Department of Recreation and Parks. Accessed August 2012 at http://www.laparks.org/dos/camps/camps.htm.

City of Los Angeles. 2012d. Recreation & Parks: Park Sites. Department of Recreation and Parks. Web. Accessed August 2012 at http://www.laparks.org/dos/parks/parks.htm.

City of Los Angeles. 2012e. Recreation & Parks: Golf Courses. Department of Recreation and Parks. Accessed August 2012 at http://www.golf.lacity.org/courses.htm.

City of Los Angeles Bureau of Sanitation and Los Angeles Department of Water and Power (LADWP). 2006. City of Los Angeles Integrated Resources Plan: Planning for Wastewater, Recycled Water and Stormwater Management. December 2006.

City of Los Angeles Bureau of Sanitation. 2007. Construction and Demolition Recycling Guide. Internet website: www.lacitysan.org/solid_resources/pdfs/c&d_guide.pdf. August 2007

City of Los Angeles Bureau of Sanitation. 2012a. About Wastewater. Accessed July 2012 at http://www.lacitysan.org/wastewater/index.htm.

City of Los Angeles Bureau of Sanitation. 2012b. About Solid Resources. Accessed July 2012 at http://www.lacitysan.org/solid_resources/index.htm.

City of Los Angeles Bureau of Sanitation. 2012c. Answers to Frequently Asked Questions for CEQA Documents. Accessed July 2012 at http://www.lacitysan.org/solid_resources/index.htm.

City of Los Angeles Bureau of Sanitation 2012d. Solid Waste Integrated Resources Plan Brochure. Accessed August 2012 at http://www.zerowaste.lacity.org/about/brochure.html.

City of Los Angeles Bureau of Sanitation. 2012e. Facilities: Landfills, Mulching and Composting, and Transfer Station. Accessed July 2012 at http://www.lacitysan.org/srpcd/facilities.htm.

City of Los Angeles Department of Public Works (LADPW). 2005. Los Angeles County 1994-2005 Integrated Receiving Water Impacts Report, Final Report. August 2005.

City of Los Angeles Department of Public Works (LADPW). 2012a. Map of Los Angeles Major Interceptor/Relief Sewers. Accessed July 2012 at http://www.lasewers.org/sewers/map_bigger.htm.

City of Los Angeles Department of Public Works (LADPW). 2012b. Los Angeles-Glendale Water Reclamation Plant. Accessed July 2012 at http://www.lasewers.org/treatment_plants/la_glendale/index.htm.

City of Los Angeles Department of Public Works (LADPW). 2013. LA Sewers, Donald C. Tillman and Los Angeles Glendale Water Reclamation Plant, average daily effluent. Accessed March 2013 at http://www.san.lacity.org/lasewers/treatment_plants/tillman/new_construction/index.htm

City of Los Angeles Department of Water and Power (LADWP). 2004. Memorandum from Hampik Dekermenjian, CDM to William Van Wagoner, City of Los Angeles Department of Water and Power. Technical memorandum 3: Los Angeles River Flow Evaluation Phase 2 Biological Survey of the Fish of the Unlined Portion of the Los Angeles River. September 2004.

City of Los Angeles Stormwater Program. 2012. About the Los Angeles Storm Drain System. Accessed July 2012 at http://www.lacitysan.org/wpd/Siteorg/general/lastrmdrn.htm.

Cooper, Daniel S. 2013a. Memo RE: Nesting birds at Los Angeles River/Knox Ave. April 17. Performed for Paramount Pictures.

Cooper, Daniel S. 2013b. Memo RE: Nesting birds and sensitive-species surveys of sites along the Los Angeles River, Elysian Valley. May 16. Performed for Mountains Recreation and Conservation Authority.

Dahl, T.E. 1990. Wetlands Losses in the United States: 1780's to 1980's. Report to Congress. U.S. Fish and Wildlife Service. National Wetlands Inventory. St. Petersburg, FL.

Environmental Protection Agency (EPA). 2013. Superfund Site Overviews: San Fernando Valley (All Areas). Internet website:

http://yosemite.epa.gov/r9/sfund/r9sfdocw.nsf/BySite/San%20Fernando%20Valley%20(All%20Areas)?OpenDocument. Accessed May 23, 2013.

Executive Order 12898. 11 February 1994. Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations. Federal Register Vol. 59, No. 32, Presidential Documents. Accessed July 2012. http://www.epa.gov/fedrgstr/eo/eo12898.pdf.

Faber, P.A., E. Keller, A. Sands, and B.M. Massey. 1989. The ecology of riparian habitats of the Southern California coastal region; a community profile. U.S. Fish Wildl. Serv. Biol. Rep. 85(7.27). 152pp.

Federal Highway Administration (FHWA) (U.S. Department of Transportation, Federal Highway Administration). January 2006. Construction Noise Handbook. FHWA-HEP-06-015. Accessed September 2012 at http://www.fhwa.dot.gov/environment/noise/construction_noise/handbook/index.cfm

Friends of the Los Angeles River (FoLAR). 2008. State of the River 2: The Fish Study. Accessed September 2012 and March 2015 at http://ucanr.edu/blogs/Green/blogfiles/5222.pdf, September 2008

Friends of the Los Angeles River (FoLAR). 2012. PBY – The LATC: Context. Accessed July 2012 at http://piggybackyard.org/context/rail.

Fugate, Nick. 2012. California Energy Demand 2011 Revised Forecast: LADWP Planning Area Electricity Forecasts. California Energy Commission, Demand Analysis Office. Accessed July 2012 at http://www.energy.ca.gov/2012_energypolicy/documents/.

García, R., A. Rawson, M. Yellott, and C. Zaldaña. 2009 Healthy Parks, Schools and Communities for All: Park Development and Community Revitalization. Policy Report for The City Project. Accessed September 2012 at whttp://www.cityprojectca.org/publications/documents/PolicyReportHealthy ParksSchoolsCommunitiesforAllAB31.pdf.

Garrett, K.L. 1993. The Biota of the Los Angeles River. Natural History Museum of Los Angeles County Foundation for the California Department of Fish and Game. March.

Glendale Fire Department. 2012. Fire Operations. Accessed July 2012 at http://www.ci.glendale.ca.us/police/area_command.aspx.

Glendale Unified School District. 2012. General Information: Source of Community Pride. Accessed July 2012 at http://www.gusd.net/Page/48.

Greater Los Angeles County Vector Control District (GLACVCD). 2012a. About Us and Brochures and Publications. Accessed August 2012 at http://glacvcd.org.

Greater Los Angeles County Vector Control District (GLACVCD). 2012b. West Nile Virus Statistics. Accessed September 2012 at http://glacvcd.org/Contents/Vector-Services-Info/WestNileVirus Statistics.aspx.

GreenInfo Network. 2010. Park Poor, Income Poor, and People of Color. Figure presented by the City Project, Los Angeles, CA. Accessed September 2012 at http://www.mapsportal.org/thecityproject/socalmap/LosAngelesCounty.html#.

Gumprecht, B. 2001. *The Los Angeles River: It's Life, Death, and Possible Rebirth*. The Johns Hopkins University Press.

Hall, J., and J. Litton. 2008. LA Creek Freak: Fish in the Los Angeles River. http://lacreekfreak.wordpress.com/2008/10/28/fish-in-the-los-angeles-river/

Hall, W.H. 1888. Irrigation in California [Southern]: The Field, Water-Supply, and Works, Organization and Operation in San Diego, San Bernardino, and Los Angeles Counties. Sacramento. State Engineer of California. From Gumprecht 2001.

Hanski, I. and M. Gilpin. 1991. Metapopulation Dynamics: Brief History and Conceptual Domain. Biological Journal of the Linnean Society. Volume 42: 3-16.

Hanski, I. and C.D. Thomas. 1994. Metapopulation Dynamics and Conservation: A Spatially Explicit Model Applied to Butterflies. Biological Conservation. Volume 68, 167-180.

Harden, D. R. 1998. California Geology. Prentice Hall, Inc. Upper Saddle River, New Jersey.

Helping Communities Achieve a Sustainable Future. Accessed September 2012 at http://www.scag.ca.gov/rcp/ index.htm.

Hughes, D.E. Recollections, 29 November 1937, David Edward Hughes Papers. Water Resources Center Archives, University of California Berkeley. From Gumprecht 2001.

Iteris, Inc., Meyer Mohaddess Associates, Madrid Consulting Group, Banerjee Associated, Judith Steele, PhD, and Metcalfe Associates. 2007. Parking and Smart Growth Study. Prepared for SCAG and LADOT. Accessed September 2012 at http://ladot.lacity.org/studies_reports.htm. October 31, 2007.

Kauffman, E. (2003). Climate and topography. In Atlas of the Biodiversity of California. California Department of Fish and Game. pp. 12-15.

Krueper, D.J. 1993. Conservation priorities in naturally fragmented and human-altered riparian habitats of the arid West. USDA Forest Service. General Technical Report RM-43. Available online: www.birds.cornell.edu/pifcapemay/krueper.htm.

Krueper, D.J. 1995. Effects of Livestock Management on Southwestern riparian ecosystems. *In*: Desired future conditions for Southwestern riparian ecosystems: Bringing interests and concerns together. D.W. Shaw, and D.M. Finch, tech cords. Sept. 18-22, 1995; Albuquerque, NM. General Technical Report RM-GTR-272. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, 359 p.

Leadership Committee of Greater Los Angeles County Integrated Regional Water Management Plan. 2006. Greater Los Angeles County Region Integrated Regional Water Management Plan. Accessed July 2012 at http://www.ladpw.org/wmd/irwmp/index.cfm?fuseaction=documents.

Levick, L., J. Fonseca, D. Goodrich, M. Hernandez, D. Semmens, J. Stromberg, R. Leidy, M. Scianni, D. P. Guertin, M. Tluczek, and W. Kepner. 2008. The Ecological and Hydrological Significance of Ephemeral and Intermittent Streams in the Arid and Semi-arid American Southwest. U.S. Environmental Protection Agency and USDA/ARS Southwest Watershed Research Center, EPA/600/R-08/134, ARS/233046, 116 pp.

Linton, Joe. 2012. Sunnynook River Park Groundbreaking. LA Creek Freak Blog. Accessed August 2012 at http://lacreekfreak.wordpress.com/2012/07/25/sunnynook-river-park-groundbreaking/.

Lomar, D. L. 1970. Geology of the Elysian Park-Repetto Hills Area, Los Angeles County, California. Special Report 101. California Division of Mines and Geology.

Los Angeles Almanac. 2012. The Los Angeles Basin, A Huge Bowl of Sand. Accessed August 2012 at http://www.laalmanac.com/geography/ge08c.htm.

Los Angeles County Code. Chapter 12.08 Noise Control. Available online at http://search.municode.com/html/16274/_DATA/TITLE12/Chapter_12_08_NOISE_CONTROL.html, accessed September 2012.

Los Angeles County. 2006. Department of Public Works. Integrated Regional Water Management Plan, adopted December 13.

Los Angeles County. 1996. Los Angeles River Master Plan Report. Los Angeles Department of Public Works and National Park Service Rivers and Trails Program.

Los Angeles County. 2005. All-Hazard Mitigation Plan, Version 1.1. Prepared by Dimensions Unlimited, Inc. June 2005.

Los Angeles County Department of Public Works (LACDPW). 2006. Hydrology Manual. Appendix C, Soil type and runoff coefficient data. Water Conservation Division.

Los Angeles County Department of Regional Planning. 2004. Los Angeles County Airport Land Use Plan. Accessed August 2012 at http://planning.lacounty.gov//view/alup/. Adopted December 1991. Revised December 2004.

Los Angeles County Department of Water and Power (LACDPW). 1996. Los Angeles River Master Plan Report. Los Angeles Department of Public Works and National Park Service Rivers and Trails Program.

Los Angeles County Economic Development Corporation. February 2012. LAEDC 2012-2013 Economic Forecast and Industry Outlook. Accessed July 2012 at http://www.laedc.org/reports/.

Los Angeles County Fire Department. 2012. Swiftwater Rescue. Accessed August 2012 at http://fire.lacounty.gov/SpecialOps/TechOpsSwiftwaterRescue.asp.

Los Angeles County. 2012a. LA County MS4 Permit – TMDL Provisions for the Los Angeles River WMA. Staff Working Proposal 4/3/12.

Los Angeles County. 2012b. Chapter 8 Noise Element in: Revised Draft May 2012, Los Angeles County General Plan 2035.

Los Angeles Department of Building and Safety (LADBS). 2011. Accessed September 2011 at http://ladbs.org/ LADBSWeb/codes.jsf.

Los Angeles Department of Building and Safety (LADBS). 2012. Building Standards Code. Accessed September 2012 at http://ladbs.org/LADBSWeb/codes.jsf.

Los Angeles Department of Transportation (LADOT). 2009. Transportation Profile of the City of Los Angeles. Accessed July 2012 at http://ladot.lacity.org/pdf/PDF10.pdf.

Los Angeles Department of Transportation (LADOT). 2010. Traffic Volume Counts: Current Count Data. Accessed July 2012 at http://ladot.lacity.org/tf_hist_auto_counts.htm.

Los Angeles Department of Transportation (LADOT). 2012a. LADOT Transit Services and Maps DASH, Commuter Express, Cityride. Accessed July 2012 at http://www.ladottransit.com/.

Los Angeles Department of Transportation (LADOT). 2012b. Tips and Frequently Asked Questions: Parking. Accessed July 2012 at http://ladot.lacity.org/Parking.htm.

Los Angeles Department of Transportation (LADOT). 2012c. Bicycle Maps. Accessed July 2012 at http://www.bicyclela.org/maps_main.htm#downloadmaps.

Los Angeles Department of Water and Power (LADWP). 2011. 2010 Urban Water Management Plan. Accessed July 2012 at https://www.ladwp.com/ladwp/faces/ladwp/aboutus/a-water/.

Los Angeles Department of Water and Power (LADWP). 2012a. Power: Facts and Figures. Accessed July 2012 at https://www.ladwp.com/ladwp/faces/ladwp/aboutus/a-power/a-p-factandfigures?_adf.ctrl-state=2pp6qfh6d_4&_afrLoop=9506843629000.

Los Angeles Department of Water and Power (LADWP). 2012b. Our History: Water and Power Today. Accessed July 2012 at https://www.ladwp.com/ladwp/faces/ladwp/aboutus/a-whoweare/a-wwa-ourhistory?_adf.ctrl-state=2pp6qfh6d_17&_afrLoop=9234745926000.

Los Angeles Department of Water and Power (LADWP). 2012c. Water: Facts and Figures. Accessed July 2012 at https://www.ladwp.com/ladwp/faces/ladwp/aboutus/a-water/a-w-factandfigures?_adf.ctrl-state=cjn6j14yc_107&_afrLoop=81029495002000.

Los Angeles Department of Water and Power (LADWP). 2012d. Water Today. Accessed July 2012 at https://www.ladwp.com/ladwp/faces/ladwp/aboutus/a-water/a-w-pastandpresent/a-w-pp-

Los Angeles Department of Water and Power (LADWP). 2012e. Fiber Optics. Accessed July 2012 at https://ladwp.com/ladwp/faces/ladwp/partners/p-fiberoptics.

Los Angeles Fire Department (LAFD). 2012. Swift Water Rescue Team. Accessed August 2012 at http://lafd.org/apparatus/111-fire-a-rescue-resources/310-swift-water-rescue.

Los Angeles Police Department (LAPD). 2012. The Los Angeles Police Department: Then and Now. Accessed July 2012 at http://www.joinlapd.com/about.html.

Los Angeles Regional Water Quality Control Board, 2007. Total Maximum Daily Loads for Trash in the Los Angeles River Watershed. California Regional Water Quality Control Board, Los Angeles Region. August 9, 2007.

Los Angeles Regional Water Quality Control Board, 2003. Total Maximum Daily Loads for Nitrogen Compounds and Related Effects in the Los Angeles River and Tributaries. California Regional Water Quality Control Board, Los Angeles Region. July 10, 2003.

Los Angeles Regional Water Quality Control Board, 2007. Total Maximum Daily Loads for Metals in the Los Angeles River and Tributaries. California Regional Water Quality Control Board, Los Angeles Region. September 6, 2007.

Los Angeles Regional Water Quality Control Board, 2010. Total Maximum Daily Loads for Indicator Bacteria in the Los Angeles River Watershed. California Regional Water Quality Control Board, Los Angeles Region. July 9, 2010.

Los Angeles Regional Water Quality Control Board, 2010. Los Angeles River and Tributaries Metals TMDLs Final Implementation Plans. Accessed August 2012 http://www.waterboards.ca.gov/losangeles/board decisions/basin plan amendments/technical documents/bpa 59 2007-014 td .shtml

Los Angeles Regional Water Quality Control Board, 1994. Water Quality Control Plan – Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties, June 1994, as amended.

Los Angeles River Revitalization Corporation (LARRC). 2011a. Los Angeles River Guide: Fishing. Accessed August 2012 at http://thelariver.com/guide/.

Los Angeles River Revitalization Corporation (LARRC). 2011b. LA River Guide: Walking: Access and Cautions. Accessed August 2012 at http://thelariver.com/guide/walks/access-and-cautions/.

Los Angeles River Revitalization Corporation (LARRC). 2011c. Los Angeles River Guide: Walks. Accessed August 2012 at http://thelariver.com/guide/walks/.

Los Angeles River Revitalization Corporation (LARRC). 2011d. In the Works: A description of projects that are funded and under active development. Accessed September 2012 at http://lariverc0rp.org/.

Los Angeles Unified School District. 2012. Fingertip Facts 2011-2012. Accessed July 2012 at http://home.lausd.net/apps/pages/index.jsp?uREC_ID=170893&type=d.

LSA Associates, Inc. 2004. Final Wildlife Corridor Assessment Report Ventura State Route 118. Prepared for Caltrans District 7, Division of Environmental Planning.

Metropolitan Transit Authority (Metro). 2010. Congestion Management Program. Los Angeles County. Accessed July 2012 at http://www.metro.net/projects/congestion_mgmt_pgm/.

Metropolitan Transit Authority (Metro). 2012a. Metro: About Us. Accessed August 2012 at http://www.metro.net/. Los Angeles County.

Metropolitan Transit Authority (Metro). 2012b. Ridership Statistics. Los Angeles County. Accessed July 2012 at http://www.metro.net/news/ridership-statistics/.

Metropolitan Transit Authority (Metro). 2012c. Metro Gold Line Timetable and Map. Los Angeles County. Accessed August 2012 at http://www.metro.net/riding_metro/bus_overview/images/804.pdf.

Metropolitan Transit Authority (Metro). 2012d. Bike Metro: Cyclists' Guide: Metro Bike Map. Web. Accessed August 2012. http://www.metro.net/riding_metro/bikes/images/la_bike_map.pdf. Los Angeles County.

Moyle, Peter B., Inland Fishes of California, University of California Press, Berkeley, 2002.

Myers, N, R.A. Mittermeier, C.G. Mittermeier, C.G., G.A.B. da Fonseca, J. Kent. 1999. Biodiversity Hotspots for Conservation Priorities. Nature, 403. December

National Park Service, 2012. Rim of the Valley Corridor Special Resouces Study: Preliminary Findings and Alternative Concepts. Newsletter #3, Fall 2012. http://www.nps.gov/pwro/rimofthevalley/Newsletter3EnglishWEB.pdf

National Park Service. 1994. Report to Congress, Report on effects of aircraft overflights on the National Park System.

Natural Resources Conservation Service (NRCS). 2012. Soil Series. U.S. Department of Agriculture. Access July 2012 at https://soilseries.sc.egov.usda.gov/osdname.asp.

North East Trees. 2006. Arroyo Seco Watershed Management and Restoration Plan. Prepared by North East Trees for the Arroyo Seco Watershed Foundation.

Noss, R. F., R.L. Peters. 1995. Endangered Ecosystems: A Status Report on America's Vanishing Habitat and Wildlife. Defenders of Wildlife. Washington, DC

Oskin, M., K. Sieh, T. Rockwell., G. Miller, P. Guptill, M.Curtis, S. McArdle, and P. Elliot. 2000. Active parasitic folds on the Elysian Park anticline: Implications for seismic hazard in central Los Angeles, California. Geological Society of America Bulletin.

Professional Disc Golf Association (PDGA). 2012. Courses: Chavez Ridge DGC at Elysian. Accessed August 2012 at http://www.pdga.com/course_directory/course/chavez-ridge-dgc-at-elysian.

Public Policy Institute of California. June 2000. PPIC Statewide Survey: Special Survey on Californians and the Environment. PPIC in collaboration with The David and Lucile Packard Foundation. Accessed July 2012 at http://www.ppic.org/main/allpubs.asp.

Republic Services. 2012. Sunshine Canyon Landfill Fact Sheet. Accessed August 2012 at http://www.sunshinecanyonlandfill.com/home/pdf/FINAL_Fact_Sheet-1.pdf.

Santa Monica Mountains Conservancy and Mountains Recreation Conservation Authority. 2007. Your Parks. Accessed August 2012 at http://www.lamountains.com/parks.asp?parkid=20.

Santa Monica Mountains Conservancy. 1990. Preserving the critical link, a discussion of the wildlife corridor from the Santa Susana Mountains to the Santa Monica Mountains via Simi Hills.

Soil Conservation Service (SCS). 1980. Soil Survey of Los Angeles County California, West San Fernando Valley Area.

South Coast Air Quality Management District (SCAQMD). 2003. Final Localized Significant Threshold Methodology: Accessed September 2012 at http://www.aqmd.gov/ceqa/handbook/lst /Method_fina.pdf.

South Coast Air Quality Management District (SCAQMD). 2007. Air Quality Management Plan. Accessed August 2012 at www.aqmd.gov/aqmd/07aqmp/index.html.

South Coast Air Quality Management District (SCAQMD). 2010. Air Quality Historical Data, Historical Data by Year. Accessed August 2012 at https://www.aqmd.gov/gov/smog/historicaldata.htm.

Southern California Association of Governments (SCAG). 2008. Regional Comprehensive Plan.

Southern California Coastal Water Research Project (SCCWRP). 2007. Sources, Patterns and Mechanisms of Stormwater Pollutant Loading From Watersheds and Land Uses of the Greater Los Angeles Area, California, USA. Technical Report 510, March 2007.

Southern California Earthquake Data Center. 2012. Significant Earthquakes and Faults. Accessed August 2012 at www.data.scec.org/index.html.

Southern California Gas Company. 2012. Company Profile. Accessed July 2012 at http://www.socalgas.com/ about-us/company-info.shtml.

Southern California Regional Rail Authority (Metrolink). 2007. Multi-County Goods Movement Action Plan, Fact Sheet. Access September 2012 at http://www.metro.net/projects/mcgmap/.

Southern California Regional Rail Authority (Metrolink). 2012a. Metrolink: About Us. Accessed September 2012 at http://www.metrolinktrains.com/ agency/page/title/about.

Southern California Regional Rail Authority (Metrolink). 2012b. Measure R Project Tracker, I-5/SR 134 Flyover (Verdugo Wash), General Information. Accessed August 2012 at http://www.metro.net/projects/progress_tracker/bycity/glendale/.

State Water Resources Control Board (SWRCB). 2010a. Integrated Report, Clean Water Act Section 303(d) List/305(b) Report. Accessed August 2012 at http://www.waterboards.ca.gov/water_issues/ programs/tmdl/integrated2010.shtml.

State Water Resources Control Board (SWRCB). 2010b. Los Angeles River Watershed Bacteria Total Maximum Daily Load. Accessed August 2012 at http://www.waterboards.ca.gov/losangeles/board_decisions/ basin_plan_amendments/technical_documents/bpa_80_R10-007_td.shtml.

State Water Resources Control Board (SWRCB). 2010c. Los Angeles River and Tributaries Metals TMDLs Final Implementation Plans. Accessed August 2012 at: http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/bpa_59_2007-014_td.shtml

State Water Resources Control Board (SWRCB).1994. Los Angeles Region Water Quality Control Plan. Adopted by the Regional Board on June 13, 1994.

Stein, B. A., L. S. Kutner, and J. S. Adams, eds. 2000. Precious Heritage: The Status of Biodiversity in the United States. New York: Oxford University Press.

Swift, C.C. and J. Seigel. 1993. The Past and Present Freshwater Fish Fauna of the Los Angeles River, with particular reference to the area of Griffith Park. *In:* Garrett, K.L. 1993. The Biota of the Los Angeles River. Natural History Museum of Los Angeles County Foundation for the California Department of Fish and Game. March.

Tazik, David J., Evaluating Protocols to Quantify the Significance of Aquatic Ecosystems at Regional and National Scales: Proceedings of a Workshop, Cambridge, MA, 20-22 July 2011, ERDC TN-EMRRP-EBA-18, December 2012

Troyan, Vitaly B. 2003. Infrastructure Report Card for the City of Los Angeles. City of Los Angeles Bureau of Sanitation and Department of Public Works. January 2003.

Trust for Public Land. 2011. 2011 City Park Facts: Report #1 – Acres of Parkland by City and Agency. Published by the Center for City Park Excellence, The Trust for Public Land. Accessed August 2012. http://cloud.tpl.org/pubs/ccpe-city-park-facts-2011.pdf.

Upper Los Angeles River Area Watermaster (ULARA).2013. Website accessed March 2013 at http://ularawatermaster.ladwp.com/.

U.S. Army Corps of Engineers (USACE). 1991. Los Angeles County Drainage Area Final Feasibility Interim Report, Part I Hydrology Technical Report Base Conditions. Los Angeles District, December 1991.

U.S. Army Corps of Engineers (USACE). 1996. Planning Manual. Water Resources Support Center, Institute for Water Resources.

U.S. Army Corps of Engineers (USACE). 1999. Water Resources Policies and Authorities. Ecosystem Restoratipn Supporting Policy Information. Engineer Pamphlet 1165-2-502, 30 September 1999.

U.S. Army Corps of Engineers (USACE). 2009. Los Angeles River, Glendale Narrows Non-Native Vegetation Removal Project. Environmental Assessment prepared by US Army Corps of Engineers, Los Angeles District.

U.S. Army Corps of Engineers (USACE). 2012a. Los Angeles River Ecosystem Restoration Feasibility Study, Hydrology and Hydraulics AFB Appendix, Table 14: Frequency Discharges Used in HEC-RAS Models.

U.S. Army Corps of Engineers (USACE). 2012b. Los Angeles River Wildlife Habitat Assessment Baseline Condition Report. Prepared by the Northwest Habitat Institute. January 2012.

U.S. Census Bureau. 2010a. 2005 – 2009 American Community Survey. Census Tract Data. Accessed July 2012 at http://www.factfinder2.census.gov.

U.S. Census Bureau. 2010b. 2010 American Community Survey. 1-Yr Estimates. Accessed July 2012 at http://www.factfinder2.census.gov.

U.S. Census Bureau. 2011. 2010 Census Data by County, Form SF1. Accessed July 2012 at http://www.factfinder2.census.gov.

U.S. Census Bureau. 2012. 2008-2012 American Community Survey, Census Tract Data. Accessed March 2014 at http://factfinder2.census.gov.

U.S. Department of the Interior. 2011. America's Great Outdoors: Fifty-State Report. November.

U.S. Department of Transportation. 2012. Arroyo Seco Historic Parkway – Route 110. Federal Highway Administration. Accessed September 6 at http://byways.org/explore/byways/10246.

U.S. Environmental Protection Agency (USEPA). 1974. Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety. EPA Office of Noise Abatement and Control.

U.S. Environmental Protection Agency (USEPA). 2006. National Pollutant Discharge Elimination System. Accessed August 2012 at http://cfpub1.epa.gov/npdes/index.cfm.

U.S. Environmental Protection Agency (USEPA). 2010. Air Quality Planning and Standards, Technical Transfer Network. Accessed August 2012 at http://www.epa.gov/ttn/naaqs/standards/pb/s_pb_index.html.

U.S. Environmental Protection Agency (USEPA). 2010. National Ambient Air Quality Standards (NAAQS). Accessed August 2012 at http://www.epa.gov/.

U.S. Environmental Protection Agency (USEPA). EPA Takes Action to Strengthen Environmental and Public Health Protection for the L.A. River Basin. http://www.epa.gov/Region9/mediacenter/LA-river/index.html

U.S. Fish and Wildlife Service (USFWS). 1980. Ecological Services Manuals: ESM 101, 102 and 103. Division of Ecological Services, Washington, D.C. Fish and Wildlife Service. Department of the Interior.

U.S. Fish and Wildlife Service (USFWS). 2012a. Carlsbad Fish and Wildlife Office Species Status List. Internet website located at http://www.fws.gov/carlsbad/TEspecies.html. Accessed August 2012.

U.S. Fish and Wildlife Service (USFWS). 2012b. National Wetland Inventory (NWI). Accessed August 2012 at http://www.fws.gov/wetlands/.

U.S. Fish and Wildlife Service. 2014. Draft Recovery Plan for the Santa Ana sucker. U.S. Fish and Wildlife Service, Pacific Southwest Region, Sacramento, California. v + 61 pp.

U.S. Geologic Services (USGS). 2012a. Historic United States Earthquakes. Sorted by State. Accessed September 2012 at http://earthquake.usgs.gov/earthquakes/states/historical_state.php#california.

United States Code (USC). 2012. Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended. Pub. L. 91-646, 42 USC 4601. Accessed September 2012 at http://uscode.house.gov/download/pls/42C61.txt.

U.S Water Resources Council. 1983. Economic and Environmental Principles and Guidelines for Water and Land Related Resources Implementation Studies. 1983

University of Southern California. 2012. Green Visions Plan, General Information. Accessed September 2012 at http://greenvisions.usc.edu/about.html#watershed.

Wilbur Smith Associates. 2008. Multi-County Goods Movement Action Plan, Los Angeles County Action Plan. Accessed September 2012 at http://www.metro.net/projects/mcgmap/. April 2008.

Websites Used for References and Research:

http://www.mednscience.org/mediterranean_ecosystem_California

http://californiarangeland.ucdavis.edu/Mediterranean_Climate/

http://www.urbanwaters.gov/la/index.html

http://www.epa.gov/Region9/mediacenter/LA-river/index.html (Traditionally Navigable Waters in Institutional Recognition)

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Los Angeles District

Los Angeles River Ecosystem Restoration Feasibility Study

Final
Design Appendix

September 2015

LOS ANGELES RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY
DESIGN APPENDIX

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ATTACHMENTS

Attachment 1 Alternatives and Measures Matrix

Attachment 2 Utilities

Attachment 3 Final Array Maps

Attachment 4 Revised Cross-Sections

1. INTRODUCTION

The Los Angeles River Ecosystem Restoration Feasibility Study is evaluating ecosystem restoration opportunities on an 11.5-mile long reach of the Los Angeles River (River) located in southern California. This reach, named the Los Angeles River ARBOR (Area with Restoration Benefits and Opportunities for Revitalization) extends from the Headworks area[1] downstream to First Street in downtown Los Angeles. The ARBOR reach includes the Glendale Narrows—one of the few sections of the study area that does not have a hardened river bed—and contains several distinctive sites and connections including the Headworks, Pollywog Park, Bette Davis Park, the Burbank-Western Channel and Glendale River Walk, Griffith Park, Ferraro Fields, Verdugo Wash, Atwater Village, Taylor Yard and the Rio de Los Angeles State Park, the "Cornfields" (Los Angeles State Historic Park), Arroyo Seco, Elysian Park, "LATC" (also known as the "Los Angeles Transportation Center" as well as "Mission Yard"), and downtown Los Angeles.

This appendix documents the preliminary array of conceptual alternatives based on plan formulation efforts through 2013 and includes: reach alignments and geometries (Section 2), a summary of ecosystem restoration measures and alternatives (Section 3), review of preliminary design features (Section 4), the final array of alternative plans (Section 5), and utilities potentially affecting future implementation of the project features (Section 6).

The conceptual drawings presented in this appendix are adapted from the as-built design drawings. All elevations are based on the National Geodetic Vertical Datum (NGVD) of 1929, unless otherwise noted. Updated survey information will be required for the detailed design to be completed during the PED. Horizontal and vertical datum will be compliant with current Corps requirements for survey data.

[1] The "Headworks" is a site owned by the LA Department of Water and Power that was formerly used for groundwater infiltration using Los Angeles River water. The facility includes water diversion appurtenances, including a rubber dam that is no longer operated for diversion.

2. REACH ALIGNMENTS AND GEOMETRIES

The 11.5-mile study area ARBOR reach has been divided into eight distinct reaches, or sub-reaches. This section reviews the alignment and geometry for each of the eight sub-reaches within the project bounds. Alignment describes the length and location in relation to known landmarks/roads, and geometry describes the channel shape/geomorphology of each sub-reach. The eight sub-reaches are outlined on Figure 4.1, "Preliminary Design Cross-Section Locations by Sub-reach."

1. Pollywog Park/Headworks to the downstream edge of the concrete bed at the midpoint of Bette Davis Park (BDP)
2. Midpoint BDP to the upstream edge of Ferraro Fields
3. Ferraro Fields to Brazil Street
4. Brazil Street to Los Feliz Boulevard
5. Los Feliz Boulevard to the Glendale Freeway
6. Glendale Freeway to Interstate 5
7. Interstate 5 to Main Street
8. Main Street to 1st Street

2.1 Sub-Reaches

2.1.1 Pollywog Park/Headworks to the Downstream Edge of the Concrete Bed at the Midpoint of Bette Davis Park (BDP)

This sub-reach is approximately 1.5 miles in length and is located at the upstream boundary of the ARBOR reach. This reach connects the Headworks Ecosystem Restoration study area[2] with the area adjacent to Disney Studios in Burbank. Channel geometry in this reach is a rectangular reinforced concrete channel with dimensions typically 18 feet high and 130 feet wide. The Burbank-Western Channel enters the River just downstream of the Los Angeles Equestrian Center, at an approximate 45 degree angle. The geometry of the Burbank-Western Channel near the confluence is rectangular reinforced concrete with dimensions of 60 feet wide by 18 feet high.

[2] The Headworks Ecosystem Restoration Study is a separate, ongoing study being conducted in partnership with the Corps and the City of Los Angeles. It is authorized through utilization of the Los Angeles County Drainage Area (LACDA) Review flood control study, Senate Resolution approved 25 June 1969, as referenced in the Los Angeles River Watercourse Improvement, California, Reconnaissance Study, January 1993.

2.1.2 Midpoint BDP to Upstream Edge of Ferraro Fields

This sub-reach is approximately ¾ miles in length and extends from the midpoint of Bette Davis Park to the upstream location of Ferraro Fields just downstream the bridge crossing for Interstate 5. The channel geometry in this reach is a rectangular reinforced concrete channel with dimensions typically 18 feet high and 175 feet wide and is trapezoidal with a cobble bed and Derrick stone banks. The banks are toed-down with sheet pile and quarry run stone.

2.1.3 Ferraro Fields to Brazil Street

This sub-reach is approximately 1 mile in length and extends from the upstream edge of Ferraro Soccer Fields downstream to Brazil Street. The channel geometry is concrete rectangular reinforced channel 18 to 23 feet high and 180 to 380 feet wide. The Verdugo Wash confluences with the River on the left bank; the geometry of the confluence is a rectangular reinforced concrete channel. The Verdugo Wash channel bed contains deposits of sediment stabilized by vegetative growth, which spans 1,000 feet upstream of San Fernando Road.

2.1.4 Brazil Street to Los Feliz Boulevard

This sub-reach is approximately 1.75 miles in length and flows southerly from Brazil Street to the Los Feliz Boulevard Bridge. The channel geometry transitions from a rectangular reinforced concrete channel upstream of Brazil Street to an 18-foot high and 130- to 160-foot-wide trapezoidal channel with a cobble bed and grouted Derrick stone banks. The banks are toed-down with sheet pile and quarry run stone. The channel transitions back to a rectangular reinforced concrete channel at the downstream extent of the Los Feliz Boulevard Bridge. This section of the River has experienced sediment deposition which has subsequently formed bars and islands due to stabilization provided by tree/shrub root and vegetative cover establishment.

2.1.5 Los Feliz Boulevard to Glendale Freeway

This sub-reach is approximately 1.55 miles in length starting at the Los Feliz Boulevard Bridge and ending at the Glendale Freeway. A total of five bridges cross the channel within this sub-reach, as follows (in upstream to downstream order): Los Feliz Boulevard Bridge, Sunnynook pedestrian bridge, Hyperion Avenue Bridge, Fletcher Drive Bridge, and the Glendale Freeway (Hwy 2) Bridge. In general, the geometry of the channel between each bridge is trapezoidal and 18 feet high with a 130- to 160-foot-wide cobble bed. The channel banks are grouted riprap from Los Feliz Boulevard to Fletcher Drive, and transition to reinforced concrete from Fletcher Drive to the Glendale Freeway. The banks are toed-down with sheet pile quarry run stone. At each bridge crossing, the channel transitions to a downwardly-sloped concrete apron to create more advantageous flow conditions and to provide erosion protection. This section of the River has experienced sediment deposition which has subsequently formed bars and islands due to stabilization provided by tree/shrub root and vegetative cover establishment.

2.1.6 Glendale Freeway to I-5

This sub-reach is approximately 2.34 miles in length and extends from the Glendale Freeway Bridge to upstream of the crossing of the Interstate 5 Freeway. The geometry of the channel in between each bridge is trapezoidal with a cobble soft bottom and Derrick stone banks, and is 30 feet high and 190 to 215 feet wide. The banks are toed-down with sheet pile quarry run stone. This section of the river has experienced sediment deposition which has subsequently formed bars and islands due to stabilization provided by tree/shrub root and vegetative cover establishment. At each bridge crossing, the channel transitions to downwardly-sloped concrete apron to create more advantageous flow conditions and to provide erosion protection. The downstream geometry of the reach as it approaches the Interstate 5 Freeway transitions to a 170-foot-wide rectangular reinforced concrete channel. A 20-foot-wide low-flow channel begins within this transition and continues downstream.

2.1.7 I-5 to Main

This sub-reach is approximately one mile in length and begins at the Interstate 5 Bridge and ends downstream at the Main Street Bridge. The channel geometry is rectangular reinforced concrete channel that is 30 feet high and 150 to 190 feet wide with a 20-foot-wide low-flow channel in the bed. The Arroyo Seco confluences with the River at an approximate 60 degree angle on the left bank downstream of Highway 110. The geometry of the Arroyo Seco at the confluence is rectangular reinforced concrete channel 16 feet high and 66 feet wide, which transitions to trapezoidal reinforced concrete channel upstream. From upstream to downstream order, North Figueroa Street, Arroyo Seco Parkway, railway line, North Broadway, and North Spring Street all cross the channel within this reach.

2.1.8 Main to 1st Street

This sub-reach is approximately one mile in length and extends from the Main Street Bridge downstream to the First Street Bridge. The channel geometry is a trapezoidal reinforced concrete channel, 30 feet high and 170 to 200 feet wide. The bed has a low-flow channel throughout the reach.

3. ECOSYSTEM RESTORATION MEASURES AND PRELIMINARY ALTERNATIVES

Ecosystem restoration[3] measures were developed to meet the study objectives. The development and evaluation of measures and alternatives is described in the main report and is not repeated herein. A measure is "a feature or activity that can be implemented at a specific geographic site to address one or more planning objectives."[4] Alternatives are defined in the main report to be "a set of one or more management measures functioning together to address one or more planning objectives." The measures described below were first developed in a planning charette and further expanded and defined by the project team.

A matrix of alternatives and associated measures is provided as Attachment 1 to this document and is repeated in the Cost Appendix. This matrix includes these 19 preliminary alternatives across the top and the eight sub-reaches down the left. Measures and sub-measures that make up each of the alternatives, by reach, are shown within the matrix itself. Correlation of measures and the alternatives are designated with an "X." The measures listed on the matrix should be referred to in conjunction with Sections 3.1 and 3.2 below.

3.1 Ecosystem Restoration Measures

The ecosystem restoration measures identified consist of one or more actions or features in a particular location that are intended to solve specific problems or help achieve particular planning objectives. Measures are broken-out into six major categories as discussed in the six sub-headings immediately below. Under each of the six major categories are associated sub-measures; potential design components are described under each measure.

3.1.1 Adjacent or Off-Channel Modifications

Adjacent and off-channel modifications include restoration measures both immediately adjacent to and separated from the main river channel. Potential sub-measures include the following. *Note that the numbering is not sequential* because screening of the sub-measures has occurred, as explained in Chapter 3, "Formulation of Alternative Plans," of Volume 1 of the Integrated Feasibility Report.

(2) Restore riparian and marsh habitat by daylighting streams: Storm drains leading into the River would be modified with a transition structure that would divert low flows into a daylighted natural stream or wetland area where possible, especially where the rights-of -way are sufficient to do so. The wetlands or ponds created within the drainage area would provide habitat and water quality treatment. Existing storm drains would remain in place after modification to convey peak

[3] Within this appendix, references to restoration, creation, or improvement of "hydrology" and "geomorphology" are intended to refer to restoration, creation, or improvement of a more natural hydrologic regime and a more natural geomorphic character.

[4] USACE, 1996. IWR Report 96-R-21, Planning Manual.

storm flows. Design of the outlet and adjacent wetland is site-specific and depends on sizing, discharge, and available right-of-way.

Figure 3.1, displays the conceptual design of this sub-measure:

1. A low-flow diversion/high-flow bypass
2. A pipe diverting low flows from the splitter box to the wetland
3. A benched wetland area built into the wall or overbank area of the channel providing treatment capacity and added habitat value to the river corridor
4. A drainage pipe to be constructed from the base of the wetland to the channel wall
5. Existing storm drain line feeding into the low-flow splitter box up-gradient of the existing channel wall storm drain outlet

The low-flow diversion/high-flow bypass would allow the existing storm drain's nuisance flow and first flush pollutants to be diverted from the storm drain line to the wetland area for treatment and infiltration, and then returned back into the River. Contech's proprietary "StormGate Vault" or other approved, equivalent vault is recommended for the low-flow diversion/high-flow bypass as shown in Figure 3.2. A pipe with an approximate measurement of 24 inches would be used to divert low flows from the splitter box down-gradient to the wetland area. The wetland bench would be lined with a rock/soil filter for infiltration and then drained back through the sideslope of the channel. On top of the rock filter substrate would be additional topsoil and wetland vegetation planted according to the project biologist's recommendations, consistent with the plant palette seen in Table 3-1.

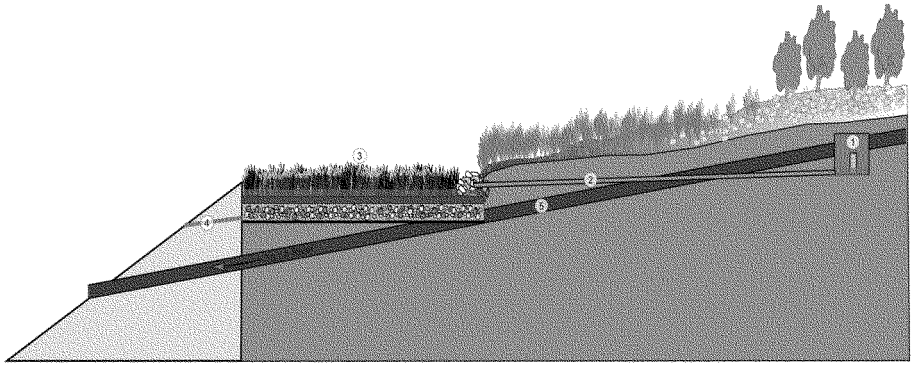

Figure 3.1 Daylight Streams

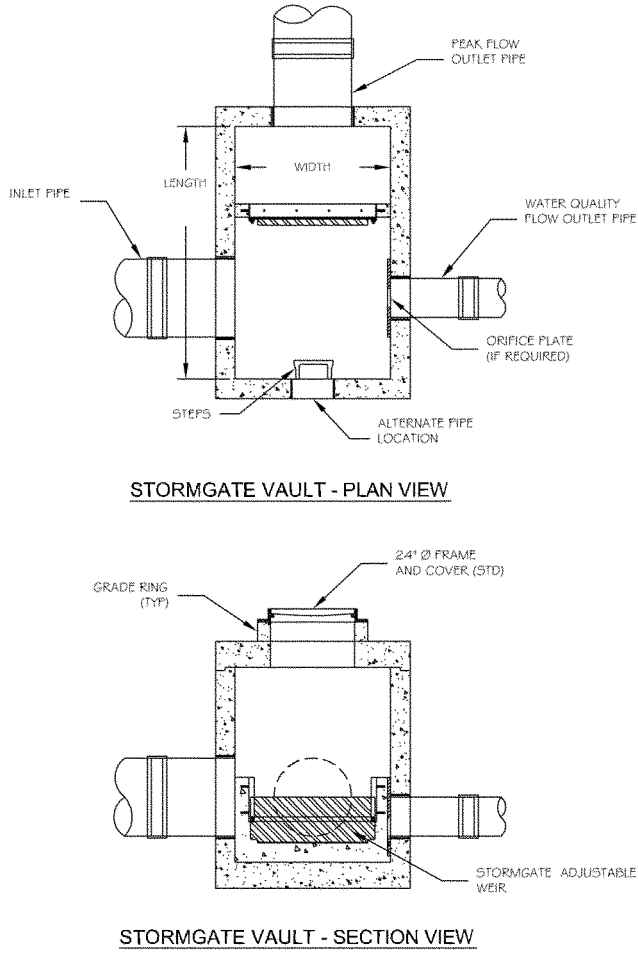

Figure 3.2 Storm Gate Vault High Flow Bypass

(3) Create geomorphology and plant for freshwater marsh in adjacent channel: This includes modification of the existing concrete channel to allow suitable conditions for restoration of freshwater marsh. Shallow water (< 6 feet) would be required for freshwater marsh, which would be interspersed with open water and riparian vegetation. Modifications to the channel include removal of concrete, excavation to create uneven bottom with pools and shallow zones, stabilization of the channel with boulders or weirs, and installation of wetland and riparian vegetation. The plant palette shown in Table 3-1, "Wetland Plant Palette," will be used to vegetate wetland restoration areas.

Existing reaches that include wetlands and pools/riffles will be prototypes for what can be created in remaining river reaches. Several variables including flow velocities and sheer stress will be used to help define areas within the project area that are suitable for freshwater marsh and riparian habitat restoration.

For this sub-measure, a series of grade control structures made of grouted stone are proposed. When more detailed hydraulic design occurs, modification to the preliminary design will take place to create site-specific pool/riffle and weir configurations.

Table 3-1 Wetland Plant Palette

Carex praegracilis	clustered field sedge
Cyperus odoratus	fragrant flatsedge
Eleocharis parishii	Parish's spikerush
Juncus effusus	common rush
Mimulus cardinalus	scarlet monkeyflower
Schoenoplectus californicus (Scirpus californicus)	California bulrush
Typha angustifolia	narrow leaved cattail
Typha latifolia	common cattail

(4) Grade adjacent areas to lower elevation for habitat, floodplain reconnection, and offline retention: This sub-measure includes the lowering of specific sites adjacent to the channel to allow for retention of water and habitat creation. It would include excavation to create basins or terraces that tie into the channel and adjacent topography. Identified sites would be terraced with a 3H:1V or more gradual slope, and be planted with emergent and riparian vegetation.

(5) Create geomorphology for open water adjacent to the channel: This sub-measure is similar to sub-measure 3 but will include deeper water or open-water deeper than 6 feet, which would be absent of vegetation growth. Modifications to the channel would include the removal of concrete and excavation as needed for channel bed equilibrium. To achieve this sub-measure, the channel bottom would include boulders to stabilize bed material and weirs to slow in-stream velocities.

(6) Rebuild geomorphology for historic wash: This sub-measure includes the restoration of the LATC (sub-reach 8) historic wash through the implementation of grading and excavation activities. Implementation of this sub-measure would require the removal of the existing industrial/railroad land use and associated contaminants.

Rebuilding the geomorphology of the historic wash would include creating channel banks with gradual (3H:1V or milder) slopes. Reshaping of the LATC area would incorporate the reshaping of the historic wash itself along with adjacent areas supportive of habitat restoration. Terraces for the planting and establishment of riparian and buffer vegetation would occur towards the perimeter of the site. A list of recommended riparian and buffer vegetation can be found in Table 3-2, "Riparian and Buffer/Transitional Plant Palette." Reshaping activities would extend from the River eastward to Interstate 5. Detailed site designs would be further developed during the final design phase of the study based upon more detailed hydraulic analysis.

Table 3-2 Riparian and Buffer/Transitional Plant Palette

Riparian	
Ambrosia psilostachya	western ragweed
Artemisia douglasiana	Mugwort
Baccharis salicifolia	Mulefat
Mimulus cardinalis	scarlet monkeyflower
Platanus racemosa	western sycamore
Populus fremontii	Fremont's cottonwood
Salix laevigata	red willow
Salix lasiolepis	Arroyo willow
Buffer/Transitional (minimal acreage)	
Artemisia californica	California sagebrush
Eriogonum fasciculatum	California buckwheat
Eschscholzia californica	California poppy
Helianthus annuus	Sunflower
Leymus condensatus	giant wild rye
Lotus scoparius	Deerweed
Malacothamnus fasciculatus	chaparral mallow
Malosma laurina	laurel sumac
Rhus integrifolia	lemonade berry
Salvia apiana	white sage

3.1.2 Attenuation

These measures include capture of flows from both the main channel and tributaries into surface and subsurface basins or channels. Potential sub-measures include the following:

(7) Create underground basins for attenuation of flood flows: This sub-measure consists of the construction of underground basins for attenuation of floodwaters and to provide temporary water supply for restoration. Six proposed locations include: Los Angeles Equestrian Center, Betty Davis Park, Ferraro Fields, Griffith Park, Bowtie Parcel, and LATC. Preliminary design considerations for this feature include potential use of Contech's Stormtank® (or approved equivalent) water storage modules developed for sub-surface storm water detention and infiltration systems. It was estimated that up to 3,100 acre feet of storage could be created with implementing all sites.

Installation would require excavation of the site followed by covering with geotextile and filling with crushed stone. Existing land uses would be returned to the site after construction. The system is design to exceed HS-25 weight-loading criteria, and could be utilized under parking lots, athletic fields, parks, etc. The estimated depth of the storage modules would be 10 to 12 feet.

An analysis of the basin's ability to store floodwaters was conducted based on frequency hydrographs found in the 1992 LACDA Study. The analysis showed that the storage capacity of the basins would only provide a minor amount of peak flow reduction before the storage volume is completely utilized. In addition, water stored in underground basins would be difficult to off-load for water conservation activities due to the associated piping requirements and the existing high depth of groundwater in the channel area. The estimated preliminary cost of implementing this measure is $1.3 billion or $4.7 million per acre. Due to the low effectiveness and high cost of this sub-measure, it was dropped from further consideration.

(8) Creation of attenuation basin with wetlands: This sub-measure includes slowing input of storm flows and restoration of wetlands by creating storage at appropriate confluences with the River. Wetland attenuation basins would be sized to capture runoff from the local area (not the main channel) and would include a basin surrounded by terraced slopes. The basin would slow down flows before entering the main stem of the river system and would provide seasonal wetland habitat. Preliminary design includes excavation of a basin that would have an impermeable layer of either geotextile or fine materials installed. The basin would then be planted with wetland vegetation. Average depth of the basin is assumed to be 3 feet with depths ranging to 10 feet.

(9) Diversion tunnels: This sub-measure consists of the construction of a culvert (tunnel) beginning at the Headworks and extending downstream to LATC to divert a minimum of 40,000 cfs from the channel during peak flow. The culvert would need to be designed to accommodate increasing flows from tributaries as it continues downstream. Preliminary costs were investigated for drilling four 24-foot-diameter tunnels to convey the discharge.

(10) Divert river and tributary flow into channels: This sub-measure includes diversion of either tributary or River flows into created channel or off-channel sites. Under this sub-measure, the installation of diversion structures and the grading and revegetation of the tributary or channel would be implemented. Further investigation would be required to design the site-specific diversions of water from the main channel at these sites.

This measure is currently proposed at seven sites within sub-reaches 1, 2, 3, 4, and 8. These include:

- Headworks area extending into Pollywog Park adjacent to the Burbank-Western Channel (1 site)
- Adjacent to Zoo Drive (2 sites)
- Adjacent to Ferraro Fields (1 site)
- Under the freeway and adjacent to the Wilson and Harding golf course (2 sites)
- LATC (1 site)

3.1.3 Wildlife Access

These measures provide access and crossings for wildlife between the River and adjacent landscape. They include bridges, under-crossings, and tunnels.

(12) Bridge undercrossings for wildlife: Under this sub-measure, bridge under-crossings would be modified by installing corridors, which would allow wildlife crossing.

(13) Wildlife bridges: Under this sub-measure, vegetated wildlife bridges would be installed at identified sites to allow wildlife to pass across the channel or other impediments.

(14) Wildlife access from river to bank: Under this sub-measure, the slopes of channels would be re-graded to 3H:1V or milder to improve the ability of wildlife to ingress/egress along channel slopes.

(15) Wildlife passage into river: Under this sub-measure, modifications to storm drains and culverts would be implemented to allow wildlife passage. Activities under this sub-measure would include the widening and daylighting of tunnels and culverts where possible.

3.1.4 Planting

These measures would restore vegetation at various locations throughout the study area through revegetation of wetland, riparian, and buffer zones including bioengineering of channel walls and plantings within the channel bed wherever possible.

(16) Restructure/vegetate concrete channel walls: This sub-measure includes modification of the channel walls to allow the growth of vegetation. It could be accomplished through notching or inclusion of other structural changes such as terracing to allow vegetation growth. Plantings in

or at the tops of channel walls would require, at a minimum, temporary irrigation during habitat establishment.

In order to stabilize planting and reduce erosion potential, turf reinforcement mats (TRM) or an acceptable geotextile fabric is proposed for the design of this measure. The fabric is reported to withstand velocities of up to 20 feet/second and shear stress of up to 15 pounds/square foot and can be planted with vegetation (grasses and low shrubs). These are the current manufacturer's claims, and further analysis during detailed design as well as potential physical modeling would need to take place. To that end, the product and others that are similar are being tested by the Corps' Engineer Research and Development Center (ERDC).

Detailed analyses of the Selected Plan will take place during final design phase (PED). Channel protection products will be evaluated to ensure they meet Corps specifications and surpass all hydraulic, geotechnical, and structural criteria. For the plans, Taylor Yard offers the only opportunity within the existing channel to employ High-Performance Turf Reinforcement Mats (HPTRMs), or alternate channel protection products. HPTRMs present higher uncertainties with respect to maintenance, repair, and/or replacement and may need to be augmented by more traditional channel protection measures. Features of the plans located adjacent or outside the existing channel offer greater opportunities for HPTRMs. We will follow Corps guidance and regulations and utilize existing information including any available testing results.

The plans call for the use of HPTRMs to resist the effect of erosion. This soft approach is highly compatible with the ecosystem restoration concept, but its inability to resist erosion in the same manner as a hard protection system such as concrete or grouted rock is obvious. At some level, a soft armored slope bank, which may be compatible with ecosystem restoration, will not be effective in resisting erosion. The ability of HPTRMs or other soft methods to resist erosion will need to be fully evaluated before they are incorporated in a final design. It is anticipated that site-specific data that includes results of subsurface investigation and engineering analysis will be necessary to complete this evaluation. As such, this work is anticipated to be completed during PED.

During PED, if it is determined that HPTRMs alone will not meet the Corps requirements, additional measures will be evaluated. These additional structural elements are likely to consist of hardened elements such as riprap, soil cement, sheet pile walls, secant walls, stone or other slope protection materials buried behind a soil slope that is soft armored with HPTRMs or other soft erosion protection methods. The remedial methods utilized must be integrated with the minimal grades and channel configurations required for hydraulic capacity.

(17) Habitat corridors/Riparian planting: Under this sub-measure, the creation of habitat corridors would include riparian vegetation planting on the riverbank and transitional vegetation on the overbank. Grading and modification of the top of the bank to tie created habitat into the adjacent river channel and proposed revegetation would occur. A list of recommended vegetation types for riparian and transitional zones can be found in Table 3-2.

(18) Establish/improve open water habitat over concrete areas: Currently, open water exists intermittently throughout the ARBOR reach albeit shallow with little habitat value. Using implementation actions included under sub-measures 3 and 5, modifications to create and/or

improve open water conditions would include the restoration of freshwater marsh (sub-measure 3), the removal of channel bottom concrete (sub-measures 3 and 5), excavation of the channel bottom and placement of boulders for channel bed stabilization and the creation of pool and riffle zone habitat (sub-measure 5), and the construction of weirs to slow in-stream velocities (sub-measure 5).

(19) Terrace concrete banks/planting built into channel walls: This would include modifications to the channel walls to allow growth of vegetation. Concrete walls would be modified to add structures able to support vegetation. This could include constructed terraced habitat or openings in the concrete where vegetation is installed. Terraced banks are proposed where channel walls are sloped and have suitable space. Dimensions of the planters would be approximately 12 feet wide and 3 to 4 feet deep, and would be filled with soil for planting vegetation.

3.1.5 Remove Concrete

Concrete removal measures include modification of the channel by removal of concrete and/or grouted stone. It implies that erosion control would take place with any concrete removal that occurs due to modifications to the channel bed, terracing of the banks, etc.

(21/22) Lower channel banks and widen: This sub-measure includes lowering the channel banks and providing setback levees to provide more capacity for habitat. The widened area would only convey peak flows when the water surface exceeded the elevation of the lowered channel banks. Sub-measures 21 and 22 were originally two separate measures but were combined during alternative formulation due to their similarity.

(23) Channel bed deepening: This sub-measure would consist of excavation of the channel bed to create more capacity for habitat. It would require the removal of the concrete invert and subsequent excavation of the channel bed and creation of a soft-bottom regime. The resulting channel would need to be stabilized either through the reduction of flow or reduction of the channel grade. This sub-measure is combined with sub-measure 3 in most cases, which includes modification of the channel to provide suitable conditions for freshwater marsh habitat.

(26) Terraces with earthen banks: This sub-measure consists of terracing the channel banks to provide step-like structures in place of current slopes. The terraced configuration would consist of planter-box type structures filled with soil to allow habitat planting. Terraces and the soil would need to be stabilized for flood flows and safety.

3.1.6 Reshape Channel

This measure is proposed in several sub-reaches of the study area. Reshaping of the channel would increase channel capacity and create geomorphic features that would support riverine habitat. This measure includes modification of the trapezoidal channel to vertical sides to increase channel capacity and cantilevering the top-of-bank surface over the channel walls to provide additional channel capacity.

(27) Modify trapezoidal channel to vertical, widening the channel: This sub-measure would remove the existing trapezoidal channel walls and widen the channel by constructing vertical

walls. To implement this measure, demolition and excavation of the existing trapezoidal channel banks would occur, and vertical walls with footings and toe protection would be constructed.

(28) Cantilever channel bank: This sub-measure includes the widening of the channel and construction of an overhanging, cantilevered top-of-bank section. Demolition and rebuilding of the channel and adjacent infrastructure would occur. The cantilevered bank sections would include overhanging walkways or promenades tied to hiking trails and adjacent streets while providing additional channel capacity underneath the overbank.

3.2 Preliminary Ecosystem Restoration Alternatives

The above measures and sub-measures, and a set of initial alternatives, were developed during charette workshops held December 2-4, 2009. Alternatives were subsequently evaluated and additional alternatives developed for a total of 19 preliminary alternatives, as shown in Table 3-3. Measures that make up each of the 19 alternatives are displayed in Attachment 3. This set of 19 alternatives was evaluated and different combinations of alternatives and reaches derived to develop the final array of alternatives described later in Section 5. Alternative formulation and evaluation is described in Section 4 of the IFR, and not repeated here.

It should be noted that implementation of some alternatives would be dependent on the diversion of flood flows from this reach of the river. That analysis is described in the main report and the descriptions in Section 4 assume that diversion would be in place, if required. However, the diversion tunnel and alternatives dependent on it were not cost effective and, therefore, none of the final alternatives found in Section 5 require a tunnel.

Table 3-3 Preliminary Array of 19 Alternatives

No.	Alternative	Description
0	No Action	Future Without-Project Conditions
1	Comprehensive A	Includes development of freshwater marsh, open water ponds, fish refugia, and riparian corridors, exposing storm drain outlets and converting to natural stream confluences, diversion of flow into side channels lined with habitat, underground basins and culverts to attenuate flow, bioengineering of channel walls, channel modification to increase width by terracing, channel widening, and/or modification of channel walls, connections to green streets, modification along tributary confluences to more natural habitat, and wildlife crossings.
2	Atwater to Cornfields (Developed by City)	Implements all of the above within the Atwater to Cornfields part of the reach.
3	Banks & Tributaries Only	Leaves the flood control channel bed primarily "as is" and restores floodplain by creating side channels in open areas along the river with freshwater marsh and riparian corridors and restoring tributary confluences. Includes modification of storm drain outlets and bank terracing.
4	Comprehensive B (developed based on measures with objectives scores over 3)	Includes most of measures included in Alt 1 Comprehensive A with fewer locations, less terracing and side channels, and omits elevating railroads on trestles, bioengineering walls, open water, and modifying trap channel to vertical.

No.	Alternative	Description
5	Los Feliz to Arroyo Seco (Developed by City)	Implements all measures within Los Feliz to Arroyo Seco reach.
6	Comprehensive C (developed by USACE)	Includes most of measures included in Alt 1 Comprehensive A with fewer locations and omits railroad elevation, bioengineering walls, open water, and modifying trap channel to vertical. Includes more terracing and storm drain modifications and different locations for wildlife crossings than Alt 4 Comprehensive B.
7	Channel Reshaping A (developed based on measures with objectives scoring over 5)	Focus is on channel reshaping and attenuation of flow – detention, bypass and widening. Using culverts and underground basins to attenuate flows, the channel is geomorphically changed to a wider, softer channel, naturalized storm drain outlets, and some restored riparian corridors.
8	Habitat Variation (Derived from Charette Team 1)	Maximizing habitat restoration for a species diversity, including fish, motivated formulation of alternative. Attenuation or reduction in flow is included in each reach as well as freshwater marsh, riparian and aquatic habitat measures.
9	Soft Bottom Channel & Associated Banks	This alternative focuses restoration in reaches that already have a soft riverbed. Where open areas are adjacent to the river, the river will be widened rather than terraced. Storm drains are converted to natural stream conflnences and restored with vegctation. Habitats include aquatic, freshwater marsh and riparian areas.
10	Channel Modifications with least structural and engineering impacts and public acceptability (based on scores for each measure under this criteria)	This alternative implements measures in locations with the least impact to infrastructure and engineering challenges, while still including measures in all reaches to attenuate flow, restore riparian and freshwater marsh habitat and tributary confluence restoration.
11	Habitat Connectivity (Derived from Charette Team 4)	This alternative focuses on bank to bank and upstream to downstream connections for wildlife, linkages to wildlife areas, channel widening and terracing.
12	Hydrologic Connection Improvements (Derived from Charette Team 3)	This alternative focuses on lowering grade for adjacent large open areas, improved hydrologic connections between the banks, storm drains and the river. It also intends to increase wildlife movement between the river and adjacent open areas.
13	Channel Reshaping B (Derived from Charette Team 6)	Using culverts to attenuate flows, the channel is geomorphically changed to a wider, softer channel, naturalized storm drain outlets, and restored riparian corridors. Includes bioengineering of channel walls, side channels and has more riparian and freshwater marsh replanting than Channel Reshaping A.
14	Channel Widening(Derived from Charette Team 5)	This alternative focuses on widening the channel. Attenuation is accomplished with culvert bypasses. Includes planting of freshwater marsh and riparian corridors.
15	Bypass with Bank and Tributary Confluence Restoration (Derived from Charette Team 2)	Reduces flow using culvert bypass to allow for terracing and channel bank softening. Improves freshwater marsh habitat in soft bottom area and adds riparian habitat to downstream locations on the river overbank. Emphasizes widening and restoration at tributary confluences.
16	Side Channels Only	Leaves the flood control channel bed and banks primarily "as is," and restores floodplain by creating side channels in open areas along the river with freshwater marsh and riparian corridors and restoring tributary confluences.
17	Opportunity area restoration with channel widening at tributaries (Derived from Charette Team 7)	Restores wetlands on the overbank and major tributaries at River Glen - Verdugo Wash confluence, Griffith Park, Bowtie/Taylor Yard, Arroyo Seco confluence, Burbank Western Channel, Cornfields (Los Angeles Historical Park) and the LATC (Mission

No.	Alternative	Description
		Yard). Widens the river at Verdugo, Arroyo Seco and Burbank Western Channel.
18	Opportunity area restoration to large open areas	Leaves flood control channel bed and banks "as is" and restores wetlands on the overbank and major tributaries at River Glen - Verdugo Wash confluence, Bowtie/Taylor Yard, Arroyo Seco confluence, and Cornfields (Los Angeles Historic Park).
19	Taylor Yard	Restores wetlands on the overbank and widens the river at this single key location on the river (includes the Bowtie parcel).

4. PRELIMINARY FEASIBILITY DESIGNS

Conceptual designs were developed for the measures described in Section 3 for the purpose of developing quantities and costs and comparing alternatives. They are not intended to be final designs, and only typical cross-sections were developed for this effort. Typical cross-sections were developed for each of the study sub-reaches; cross-section locations throughout the study area are shown in Figure 4.1. These cross-sections include major features found in each of the sections noted and include multiple measures, which may not be present in each alternative. Detailed design drawings were not developed for each project feature; rather, typical cross sections are included as well as mapping that is found in Attachment 3. Descriptions below include reference to the right and left bank. That reference assumes one is looking downstream.

During the formulation and analysis of alternatives it was assumed that the implementation of several of these would require tunnels to divert flood flows. The description of those alternatives and reaches that are assumed to require tunnels for implementation is described in the plan formulation section of the main feasibility report.

4.1 Assumptions and Limitations

Designs are based on preliminary, planning-level conceptual designs, and common engineering practices. The development of the preliminary designs took place prior to hydraulic and geotechnical design information. Design parameters for such things as velocities, shear stress, erosiveness, etc., were not provided at the time the preliminary designs were developed. Future design phases would be more integrated with the hydraulic analysis, geotechnical analysis, and vegetation requirements such that the concepts shown and discussed herein may be modified if necessary.

Several assumptions were developed during the preliminary design in order to complete the design and cost estimate. The riprap was conceptually sized in accordance with USACE's methodology and the TRM in accordance with the manufacturer's recommendation. Because of a lack of clear design parameters including the aforementioned hydraulic and geotechnical analyses, the designs and dimensions shown below are approximate in nature and are subject to reanalysis during the final design phase.

Turf Replacement Matting and Riprap Protection – The existing bank grouted rock or concrete slope protection would be removed and replaced by a 3H:1V combination of high performance TRM, or acceptable geotextile, and riprap system. A riprap layer was provided at the bottom river bank for higher flow velocity protection. In addition, the riprap extends an assumed 10 feet below the river invert for scour protection. This assumption was conservatively based on the existing toe protection, which in most cases is a 3-5 foot deep grouted section and sometimes includes a 10-15 foot deep sheet pile. Above the riprap, the river bank is lined with a high performance TRM to protect against erosion potential and to allow for acceptable vegetation growth.

Reinforced Concrete Retaining Wall – The existing bank grouted rock or concrete slope protection would be removed and replaced by a reinforced concrete retaining wall system. The 22-foot-high reinforced concrete wall was conceptually sized per the California Department of

Transportation's (Caltrans) Type 1 Retaining Wall specifications, having a 13-foot-wide footing. A horizontal layer of riprap with a 10-foot toe-down was assumed to provide erosion protection.

Terraced Banks and Riprap Protection – The existing bank grouted rock or concrete slope protection would be removed and replaced by a 3H:1V combination of terraces and riprap system. A riprap layer was provided at the bottom river bank for higher flow velocity protection. In addition, the riprap extends an assumed 10 feet below the river invert for scour protection. Above the riprap, the river bank would be protected by four reinforced concrete terraces anchored to the channel slope. The terraces would provide additional bank substrate for acceptable vegetation planting/establishment and would protect against potential erosion.

4.2 Cross-Sections

This section describes each cross-section illustrated in the preliminary design array. Typical cross-sections for measures included in the preliminary alternatives were developed to:

- Determine the feasibility of preliminary design measures
- Provide depictions of preliminary design measures
- Facilitate quantity and cost estimation

In addition, cross-sections representing revisions to the preliminary design array that were developed as part of the final array of alternatives described in Section 6, below, may be found in Attachment 4.

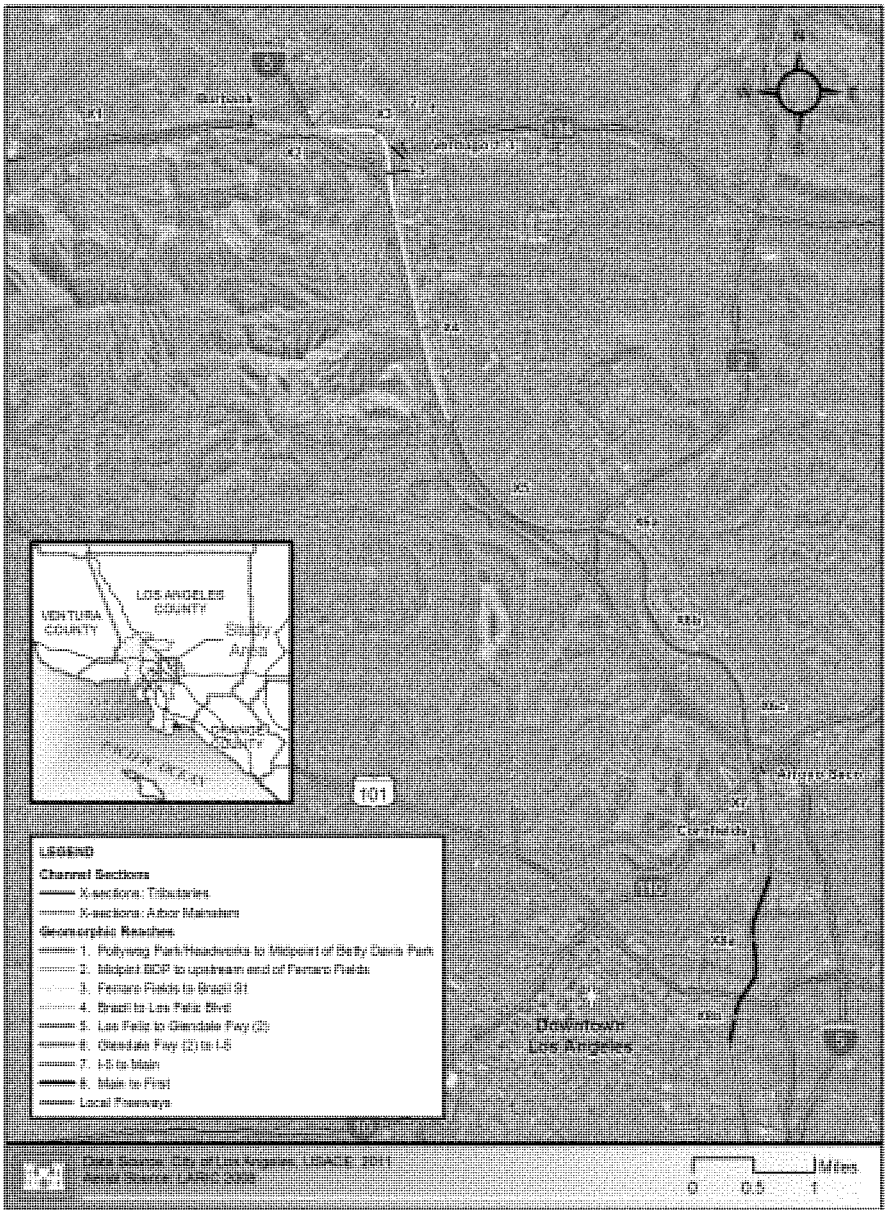

Figure 4.1 Preliminary Design Cross-Section Locations by Sub-reach

4.2.1 Cross-Section 1, Sub-Reach 1 - Pollywog Park/Headworks to Midpoint of Betty Davis Park

Existing Channel Features – The existing rectangular reinforced concrete channel is 130 feet wide and 18 feet high from the invert, with subdrain systems underneath the invert slab.

Preliminary Channel Design – As seen in Figure 4.2, "Cross-Section 1, Pollywog Park/Headworks to Midpoint of Betty Davis Park," the proposed design would widen the channel by 51 feet by replacing the existing vertical concrete retaining wall and footing with a combination of TRM and riprap on 3H:1V slopes on the left/north bank of the channel. The upper 3 feet of the right/south bank would be sloped 3H:1V, with the remaining portion of the wall and foundation protected in place. The existing concrete channel bottom would be replaced by a soft, "natural" substrate. A toedown structure with added bank protection would be constructed at the toe of the proposed left/north bank. Grade control structures would be constructed to reduce in-stream velocities and secure natural bed materials for meander and vegetation development. Impacts to the subdrain system and their mitigation will depend on additional modeling during detailed design, but it is likely that any concrete invert that is removed and replaced by an infiltrating substrate will no longer need the existing subdrain system.

Demolition and Excavation – Several areas of the reach would undergo demolition and excavation to implement the proposed design. The concrete channel bottom, the top 3 feet of the left/north bank retaining wall, and the right/south bank concrete retaining wall would be demolished. The remainder of the left/north bank retaining wall would be protected in place. Excavation of earthen material would occur behind the removed left/north bank retaining wall and behind the removed upper portion of the right/south bank retaining wall. In areas where grade control structures would be implemented, an additional 10 to 15 feet of earthen material would be excavated from the channel bed to accommodate construction of grouted riprap toedowns. Excavation at a depth of 3 to10 feet and a width of 20 feet would be conducted for the left/north bank toedown.

Compacted Fill and Maintenance Road – Compacted fill would be used to fill behind the left/north and right/south channel top of banks. The compacted fill would be used to create a 16-foot wide maintenance road. The maintenance road would be paved with asphalt-concrete that would meet the proposed channel's TRM and vegetated 3H:1V slope on the river, and compacted fill on the 3H:1V slope landward. Fencing would be constructed to separate areas of access from the maintenance road, on both the potentially private right-of-way, and the river.

Erosion Control – Erosion control matting, TRM, or approved equivalent geotextile mats would be used to stabilize, prevent channel scour, and to promote vegetation establishment on channel slopes.

Topsoil and Vegetation – Topsoil would aid in the recruitment and establishment of vegetation along the channel's riparian zone. Topsoil would be placed on the slopes of the maintenance road compacted fill and along the channel's 3H:1V slopes after TRM matting has been installed. Topsoil areas would be seeded and planted with native riparian vegetation as listed in Table 3-2.

Grade Control Structure – Grouted riprap grade control structures would be constructed every 500 feet along this reach of the channel. Grade control structures would reduce in-stream flow velocities and stabilize the channel's slope and earthen bed material. Grade control structures would be constructed in the channel bottom at a depth of 10 or 15 feet, have a 2H:1V slope on the upstream end and a 4H:1V slope on the downstream end, be 5 feet in width on top, and have a 2-foot-deep and 20-foot-wide low-flow centerline notch.

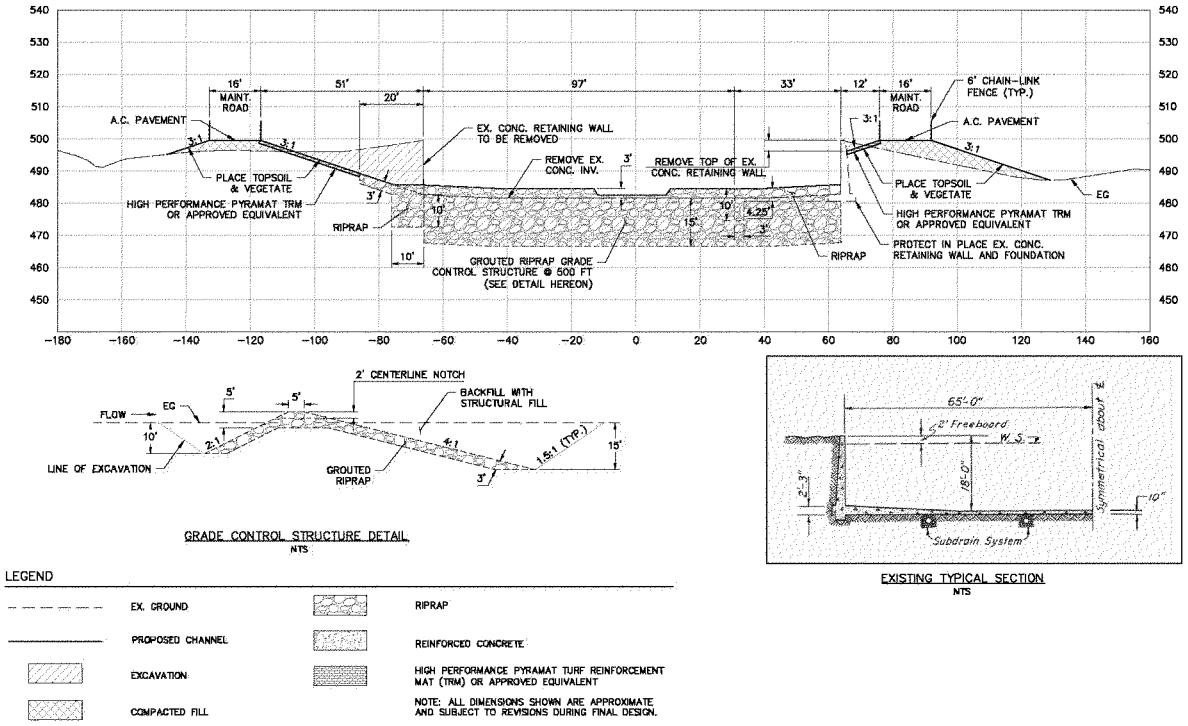

Figure 4.2 Cross-Section 1, Pollywog Park/Headworks to Midpoint of Betty Davis Park

4.2.2 Burbank-Western Channel Cross-Section, Sub-Reach 1 - Confluence at the Los Angeles River

Existing Channel Features – The existing rectangular reinforced concrete channel is 60 feet wide and 18 feet high from the invert.

Preliminary Channel Design – As seen in Figure 4.3, "Burbank-Western Channel Cross-Section," the proposed design would widen the left/north top of bank of the channel by 188 feet by removing the side channel tributary's right/south retaining wall. The proposed left/north bank would have an 8H:1V vegetated slope. A soft-bottom vegetated wetland would be constructed in the widened portion of the channel bottom. Two riprap toedowns would be constructed below the channel bottom and banks. The first riprap toedown would be located at the in-channel edge of the proposed wetland at a depth and width of 10 feet. The second riprap toedown, with additional bank protection, would extend landward from the toe of the proposed left/north bank at a depth of 3 to 10 feet and a width of 20 feet. A 16-foot-wide asphalt concrete maintenance road would be constructed on the proposed left/north top of bank.

Demolition and Excavation – The left/north concrete retaining wall would be demolished. The channel bottom would be excavated to a width of 60 feet; an 8H:1V channel bank would be excavated for an additional 88 feet to meet the existing ground above.

Compacted Fill and Maintenance Road – The existing ground at the left/north top of bank would be used as the base of the proposed 16-foot-wide asphalt concrete maintenance road. Fencing would be constructed to separate areas of access from the maintenance road, on both the potentially private right-of-way, and the river.

Wetlands – The wetlands would extend for a distance of 188 feet from the edge of the concrete channel bottom (where the retaining wall is to be removed) to the proposed right/west bank toe. The wetland area would spread channel flows and slow in-stream flow velocities, assist in treating pollutants, and create riverine wetland habitat for wildlife and aesthetics.

Erosion Control – Erosion control matting, such as TRM, would be used to stabilize, prevent channel scour, and to promote vegetation establishment on the left/north channel slope.

Topsoil and Vegetation – Topsoil would aid in the recruitment and establishment of vegetation along the channel's riparian zone. Topsoil would be placed on the left/north bank slope after TRM matting is installed. Topsoil would also be placed in the wetlands area. Topsoil areas would be seeded and planted with riparian vegetation on the banks and wetland vegetation in-channel per recommendations of the project biologist.

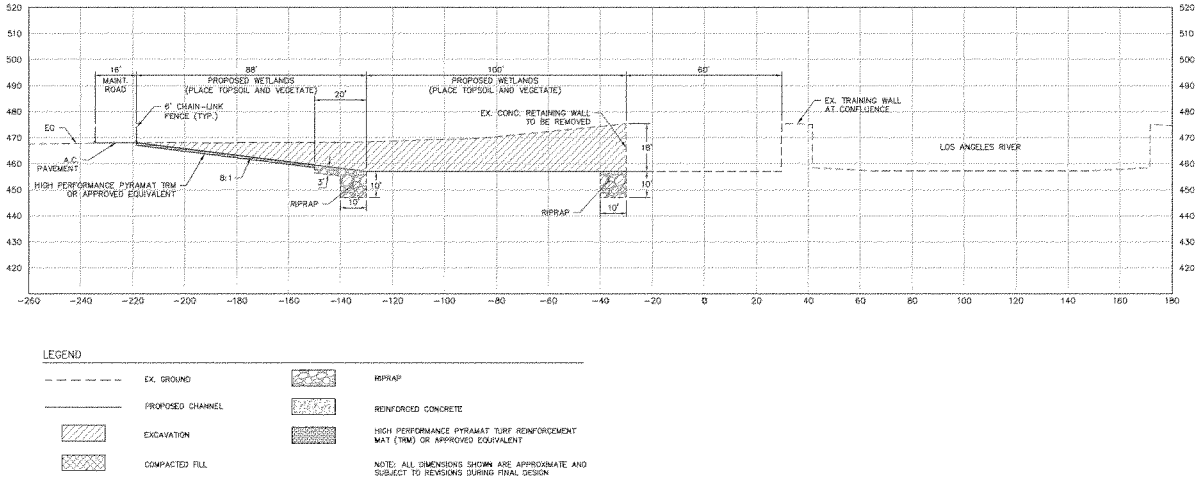

Figure 4.3 Burbank-Western Channel Cross-Section

4.2.3 Cross-Section 2, Sub-Reach 2 - Midpoint of Betty Davis Park to Upstream End of Ferraro Fields

Existing Channel Features – The existing trapezoidal reinforced concrete/grouted rock channel with cobblestone soft bottom is 300 feet wide from the top of bank and 16 feet above the invert.

Preliminary Channel Design – As seen in Figure 4.4, "Cross-Section 2, Midpoint Bette Davis Park to Upstream of Ferraro Fields," the proposed design would remove the existing grouted rock or concrete slope protection on both banks. The left/north bank would have a 3H:1V slope stabilized by erosion control matting and vegetation, and the top of bank would be widened by 10 feet. A toedown structure with added bank protection would be constructed at the toe of the proposed left/north bank. The toe of the right/south bank would be widened by 60 feet, where a 22-foot-high vertical retaining wall with subdrainage system would be constructed. The existing cobble bottom would be protected in place. Grade control structures would be constructed to reduce in-stream velocities and secure natural bed materials for meander and vegetation development.

Demolition and Excavation – Several areas of the reach would undergo excavation to implement the proposed design. The left/north bank's existing grouted riprap or concrete slope protection would be excavated to widen the channel by 10 feet. The right/south bank's existing grouted riprap or concrete slope protection would be excavated to widen the channel by 60 feet. Additional excavation would occur behind the proposed retaining wall, and would have a temporary slope of 1.5H:1V to meet the existing ground; excavation would allow temporary access for construction of the retaining wall. In areas where grade control structures would be implemented, an additional 10 to 15 feet of channel bottom would be excavated to accommodate construction of grouted riprap toedowns and retaining wall footings.

Compacted Fill and Maintenance Road – After construction of the retaining wall, compacted fill would be placed and compacted behind the right/south channel top of bank to create a 16-foot-wide paved asphalt-concrete maintenance road. Compacted fill would also be placed on the land of the maintenance road and sloped 3H:1V to meet the existing ground. The left/north top of bank maintenance road would use the existing ground as a base. Fencing would be constructed to separate areas of access from the maintenance road, on both the potentially private right-of-way, and the river.

Erosion Control – Erosion control matting, such as TRM, would be used to stabilize, prevent channel scour, and to promote vegetation establishment on channel slopes.

Topsoil and Vegetation – Topsoil would aid in the recruitment and establishment of vegetation along the channel's riparian zone. Topsoil would be placed over TRM on the right/south bank channel slope and the left/north bank maintenance road slope. Topsoil areas would be seeded and planted with native riparian vegetation per the project biologist's recommendations.

Grade Control Structure – Grouted riprap grade control structures would be placed every 500 feet along this reach of the channel. Grade control structures would reduce in-stream flow velocities and stabilize the channel's slope and earthen bed material. Grade control structures would be constructed in the channel bottom at a depth of 10 or 15 feet, have a 2H:1V slope on the upstream end and a 4H:1V slope on the downstream end, be 5 feet in width on top, and have a 2-foot-deep and 20-foot-wide low-flow centerline notch.

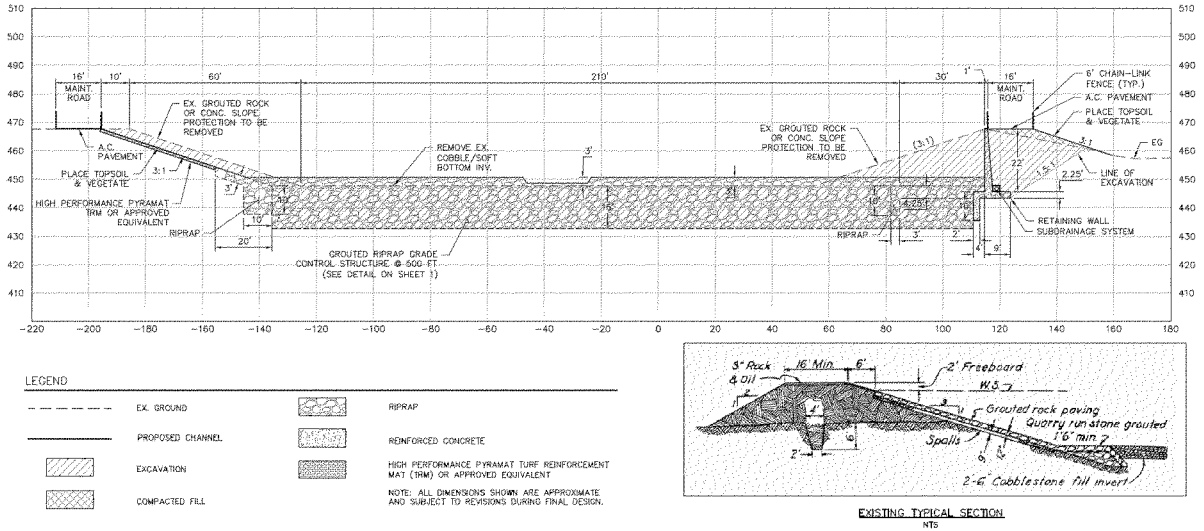

Figure 4.4 Cross-Section 2, Midpoint Bette Davis Park to Upstream of Ferraro Fields

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4.2.4 Cross-Section 3, Sub-Reach 3 - Ferraro Fields to Brazil Street

Existing Channel Features – The existing trapezoidal reinforced concrete/grouted rock paving channel with concrete bottom, and 3H:1V slopes, is 280 feet wide from the top of bank, and approximately 21 feet high from the invert.

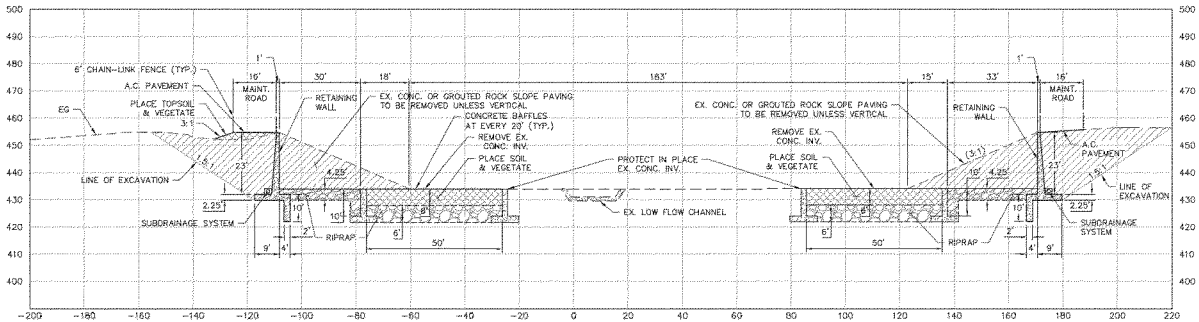
Preliminary Channel Design – As seen in Figure 4.5, "Cross-Section 3, Ferraro Fields to Brazil Street," the proposed design would construct two 23-foot-high retaining walls associated subdrain systems on the left/east and right/west banks of the channel. Riprap toedowns would be placed at the toe of the retaining walls. Two concrete reinforced planter boxes (naturalized channel) on the left/north and right/south banks would be constructed at the edge of the toedown and extend 50 feet towards the centerline of the channel. Two 16-foot-wide asphalt concrete maintenance roads would be constructed on the top of the channel's banks. The existing low-flow channel and concrete bottom would be protected in place except where removal is needed for construction of the walls and concrete planter boxes.

Demolition and Excavation – Several areas of the reach would undergo demolition and excavation to implement the proposed design. The right/west bank and the left/east bank existing trapezoidal grouted riprap or concrete paved slope protection would be demolished; 74 feet of the concrete channel bottom would be demolished for construction of the naturalized channel. Excavation would widen the channel bottom by 48 feet on both banks and would occur behind the proposed location of the retaining walls and would have a temporary slope of 1.5H:1V to meet the existing ground; excavation would allow temporary access for construction of the walls. The proposed toedown locations would be excavated to a depth of 4.25 to 10 feet and a width of 30 and 33 feet at the toe of the left/east and right/west retaining walls respectively. The naturalized channel and concrete footing locations would be excavated to a depth of 12 feet and a width of 50 feet at the edge of the toedowns towards the center of the channel.

Compacted Fill and Maintenance Road – After construction of the retaining walls, compacted fill would be placed and compacted behind the left/north and right/south channel's retaining walls. The fill would be placed to accommodate a 16-foot-wide paved asphalt-concrete maintenance road on both banks. The land compacted fill on the right/south bank maintenance road would be sloped 3H:1V to meet the existing ground. Fencing would be constructed to separate areas of access from the maintenance road, on both the potentially private right-of-way, and the river.

Planter Boxes (Naturalized Channel) – Naturalized channel would be constructed at the edge of the retaining wall toedowns and would extend 50 feet into the center of the channel at a depth of 12 feet. The surface of the naturalized channel would be flush to the existing channel concrete bottom. The bottom 6 feet of the naturalized channel would be filled with riprap. The top 6 feet of the planter boxes would be filled with soil and secured with concrete baffles at 20-foot intervals to prevent scour/erosion. They would also include drainage holes to help route drainage water from upper boxes to lower boxes.

Topsoil and Vegetation – Topsoil would aid in the recruitment and establishment of vegetation along the channel's riparian zone. Topsoil would be placed on the right/south bank of the maintenance road and the two sections of naturalized channel. Topsoil areas would be seeded and planted with transitional zone vegetation on the top of the maintenance road and riparian/wetland vegetation in the channel as recommended by the project biologist.



LEGEND

- EX. GROUND
- PROPOSED CHANNEL
- EXCAVATION
- COMPACTED FILL
- RIPRAP
- REINFORCED CONCRETE
- HIGH PERFORMANCE PYRAMAT TURF REINFORCEMENT MAT (TRM) OR APPROVED EQUIVALENT

NOTE: ALL DIMENSIONS SHOWN ARE APPROXIMATE AND SUBJECT TO REVISIONS DURING FINAL DESIGN.

Figure 4.5 Cross-Section 3, Ferraro Fields to Brazil Street

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4.2.5 Verdugo Wash Cross-Section 1, Sub-Reach 3 - Upstream of the Los Angeles River Confluence

Existing Channel Features – The existing rectangular reinforced concrete channel is 110 feet wide and 28 feet high from the invert.

Preliminary Channel Design – As seen in Figure 4.6, "Verdugo Wash Cross-Section 1, Upstream of Los Angeles River Confluence," the proposed design would widen the left/south top of bank of the channel by 389 feet, and construct a 119-foot-wide 3H:1V benched/terraced vegetated slope. The benching/terracing would provide access for maintenance of the vegetated slope as well as break up the flow path downslope by providing cross drainage. The proposed widened section of the channel would be soft bottom. Two riprap toedowns would be constructed below the channel bottom at the respective banks. The first riprap toedown would be located at the edge of the proposed widened portion of the channel at a depth and width of 10 feet. The second riprap toedown, which would include bank protection along the base of the proposed left/east bank, would be at a depth of 3 to 10 feet and a width of 20 feet. A 16-foot-wide asphalt concrete maintenance road would be constructed on the proposed left/east top of bank.

Demolition and Excavation – The left/south concrete retaining wall would be demolished. The channel bottom would be excavated to a width of 270 feet; a 3H:1V terraced/benched channel bank would be excavated for an additional 135 feet to meet the existing ground above. Excavation for riprap toedowns would occur at the toe of the proposed left/south bank and at the edge of where the widened and existing concrete channel bottoms would meet, at a depth of 3 to 10 feet.

Compacted Fill and Maintenance Road – The existing ground at the left/east top of bank would be used for the base of the proposed 16-foot-wide asphalt concrete maintenance road. Fencing would be constructed to separate areas of access from the maintenance road, on both the potentially private right-of-way, and the river.

Erosion Control – Erosion control matting, such as TRM, or approved equivalent, would be used to stabilize, prevent channel scour, and to promote vegetation establishment on the left/south channel slope.

Topsoil and Vegetation – Topsoil would aid in the recruitment and establishment of vegetation along the channel's riparian zone. Topsoil would be placed on the left/south bank and after TRM matting is installed. Topsoil areas would be seeded and planted with recommended vegetation.

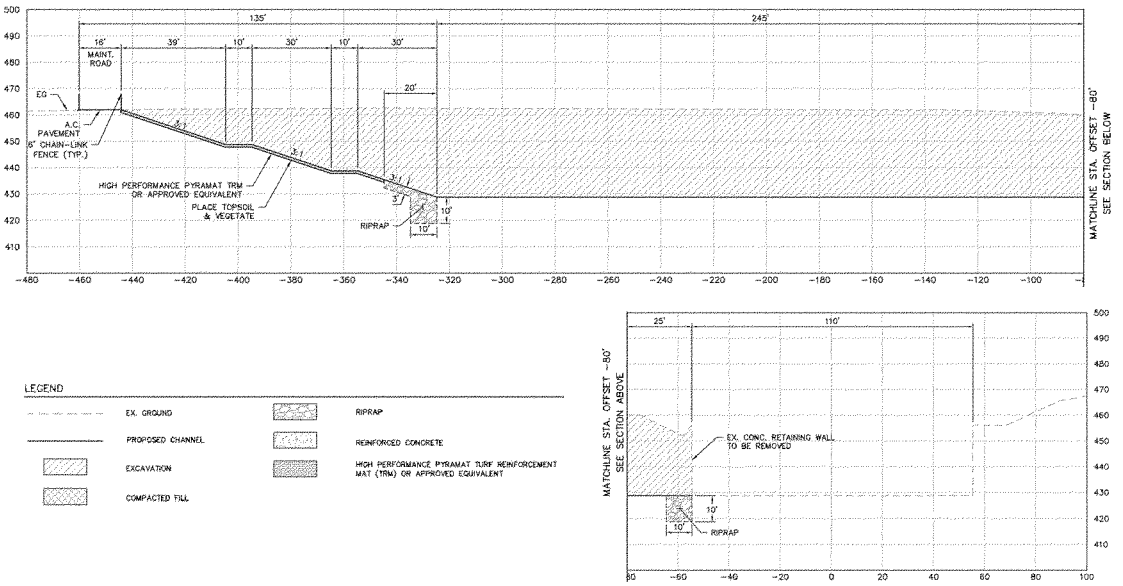

Figure 4.6 Verdugo Wash Cross-Section 1, Upstream of Los Angeles River Confluence

4.2.6 Verdugo Wash Cross-Section 2, Sub-Reach 3 - Upstream of Los Angeles River Confluence

Existing Channel Features – The existing rectangular reinforced concrete channel is 90 feet wide and 24 feet high from the invert.

Preliminary Channel Design – As seen in Figure 4.7 and Figure 4.8, "Verdugo Wash Cross-Section 2, Upstream of Los Angeles River Confluence," the proposed design would widen the left/south top of bank of the channel by 647 feet, and construct a 129-foot-wide 3H:1V benched/terraced vegetated slope. Benching on the slope would be 10 feet wide and occur at 30 and 70 feet from the toe. The benching/terracing would provide access for maintenance of the vegetated slope as well as break up the flow path downslope by providing cross drainage. The proposed widened section of the channel would be soft bottom. Two riprap toedowns would be constructed below the channel bottom at the respective banks. The first riprap toedown would be located at the edge of the proposed widened portion of the channel at a depth and width of 10 feet. The second riprap toedown, which would include bank protection along the base of the proposed left/south bank, would be at a depth of 3 to 10 feet and a width of 20 feet. A 16-foot-wide asphalt concrete maintenance road would be constructed on the proposed left/east top of bank.

Demolition and Excavation – The left/east concrete retaining wall would be demolished. The channel bottom would be excavated to a width of 534 feet; a 3H:1V terraced/benched channel bank would be excavated for an additional 113 feet to meet the existing ground above. Excavation for riprap toedowns would occur at the toe of the proposed left/east bank and at the edge of where the widened and existing concrete channel bottoms would meet, at a depth of 3 to 10 feet.

Compacted Fill and Maintenance Road – The existing ground at the left/south top of bank would be used as the base of the proposed 16-foot-wide asphalt concrete maintenance road. Fencing would be constructed to separate areas of access from the maintenance road, on both the potentially private right-of-way, and the river.

Erosion Control – Erosion control matting, such as TRM, or approved equivalent, would be used to stabilize, prevent channel scour, and to promote vegetation establishment on the left/south channel slope.

Topsoil and Vegetation – Topsoil would aid in the recruitment and establishment of vegetation along the channel's riparian zone. Topsoil would be placed on the left/south bank after TRM matting is installed. Topsoil areas would be seeded and planted with riparian vegetation per recommendation of the project biologist.

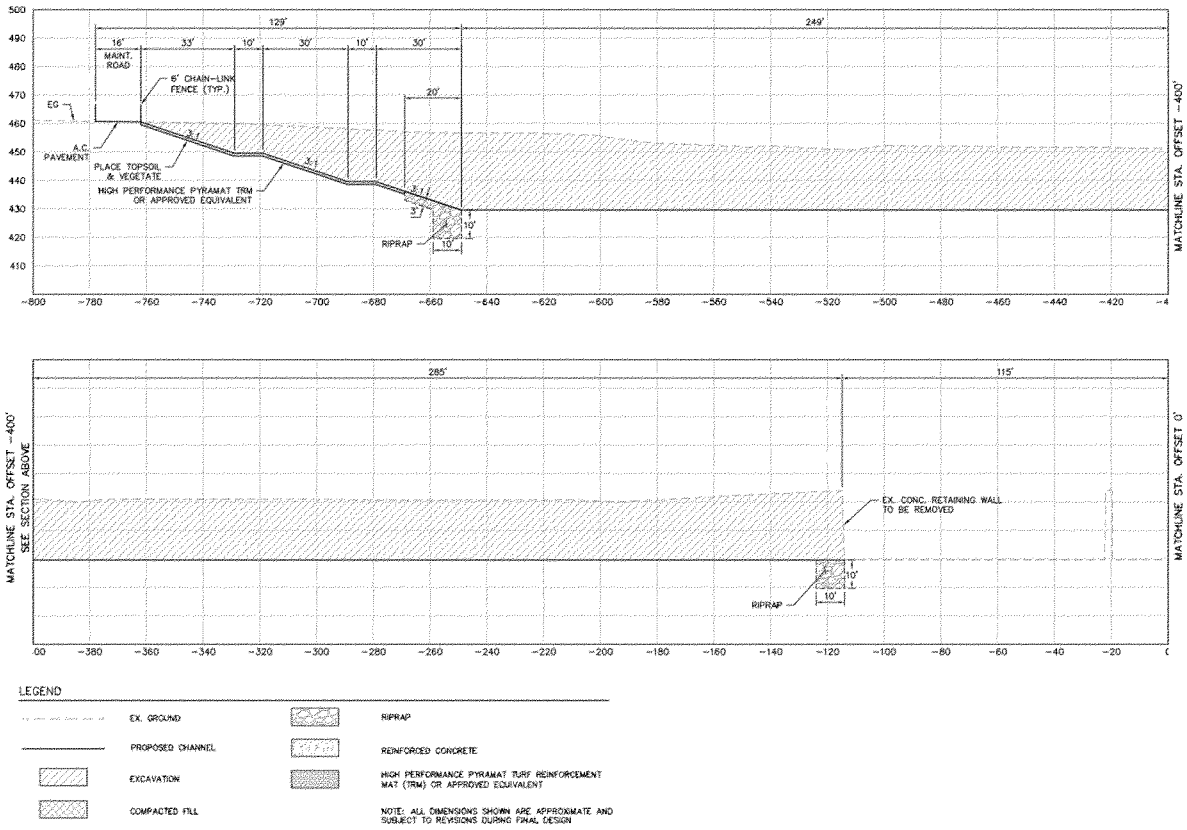

Figure 4.7 Verdugo Wash Cross-Section 2, Upstream of Los Angeles River Confluence

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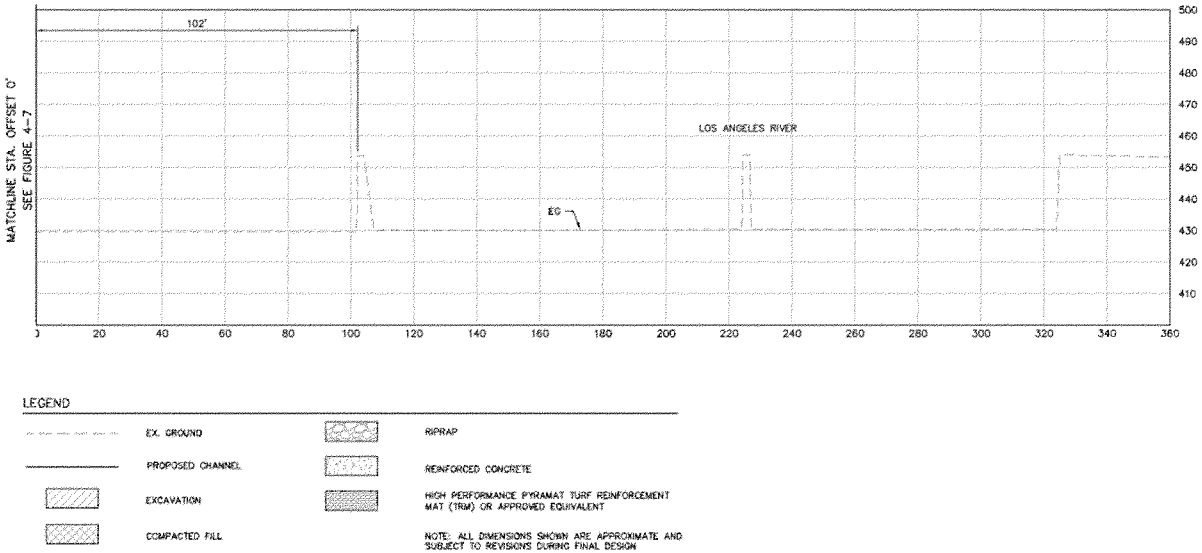

Figure 4.8 Verdugo Was Cross-Section 2 (cont'd), Upstream of Los Angeles River Confluence

4.2.7 Verdugo Wash Cross-Section 3, Sub-Reach 3 - Los Angeles River Confluence

Existing Channel Features – The existing rectangular reinforced concrete channel is at the confluence of Verdugo Wash and the Los Angeles River. The width of the existing channel is 389 feet wide and 25 feet high from the invert.

Preliminary Channel Design – As seen in Figure 4.9 and Figure 4.10, "Verdugo Wash Cross-Section 3, Upstream of Los Angeles River Confluence," the proposed design would widen the left/east top of bank of the channel confluence by 628 feet, and construct a 113-foot-wide 3H:1V benched/terraced vegetated slope. Benching on the slope would be 10 feet wide and occur at 30 and 70 feet from the toe. The benching/terracing would provide access for maintenance of the vegetated slope as well as break up the flow path downslope by providing cross drainage. The proposed widened section of the channel would be soft bottom. Two riprap toedowns would be constructed below the channel bottom respective banks. The first riprap toedown would be located at the edge of the proposed widened portion of the channel at a depth and width of 10 feet. The second riprap toedown, which would include bank protection along the base of the proposed left/east bank, would be at a depth of 3 to 10 feet and a width of 20 feet. A 16-foot-wide asphalt concrete maintenance road would be constructed on the proposed left/east top of bank.

Demolition and Excavation – The left/east concrete retaining wall would be demolished. The channel bottom would be excavated to a width of 515 feet; a 3H:1V terraced/benched channel bank would be excavated for an additional 103 feet to meet the existing ground above. Excavation for riprap toedowns would occur at the toe of the proposed left/east bank and at the edge of where the widened and existing concrete channel bottoms would meet, at a depth of 3 to 10 feet.

Compacted Fill and Maintenance Road – The existing ground at the left/east top of bank would be used as the base of the proposed 16-foot-wide asphalt concrete maintenance road. Fencing would be constructed to separate areas of access from the maintenance road, on both the potentially private right-of-way, and the river.

Erosion Control – Erosion control matting, such as TRM would be used to stabilize, prevent channel scour, and to promote vegetation establishment on the left/east channel slope.

Topsoil and Vegetation – Topsoil would aid in the recruitment and establishment of vegetation along the channel's riparian zone. Topsoil would be placed on the left/east bank after TRM matting is installed. Topsoil areas would be seeded and planted with riparian vegetation per recommendation of the project biologist.

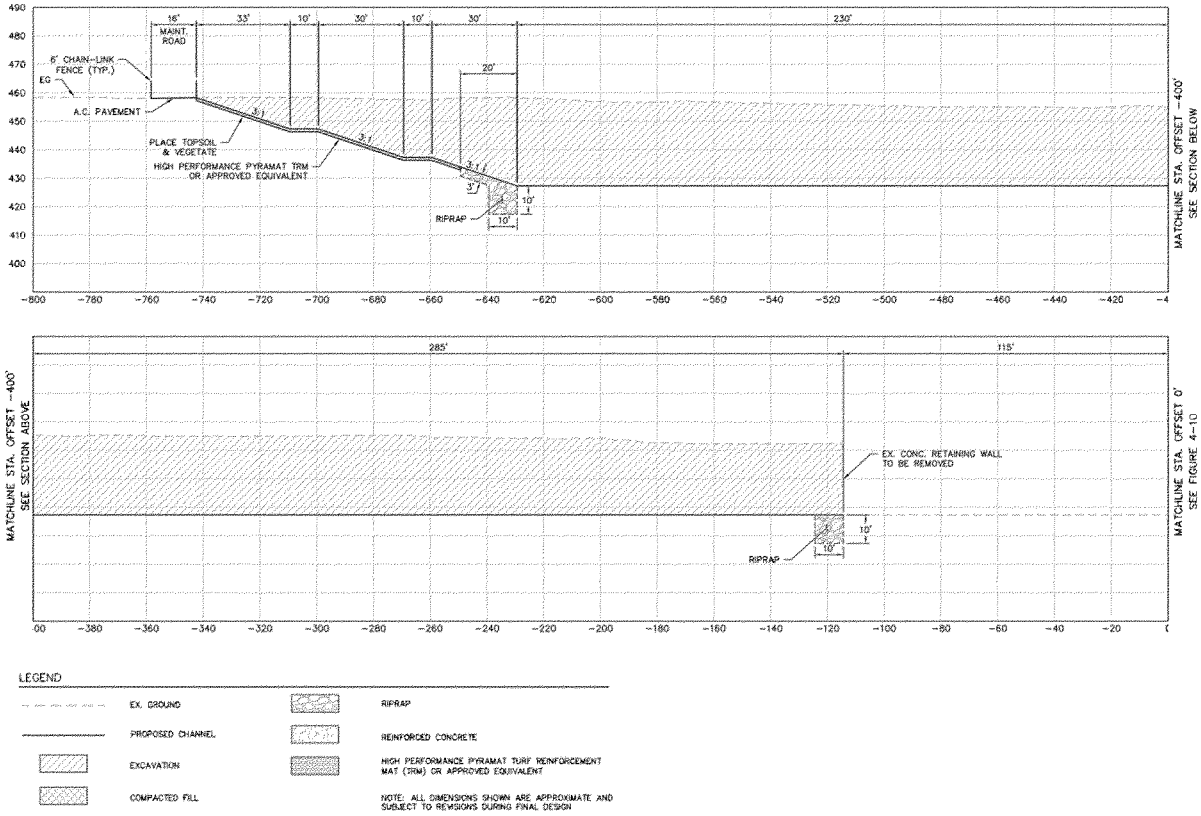

Figure 4.9 Verdugo Wash Cross-Section 3, Upstream of Los Angeles River Confluence

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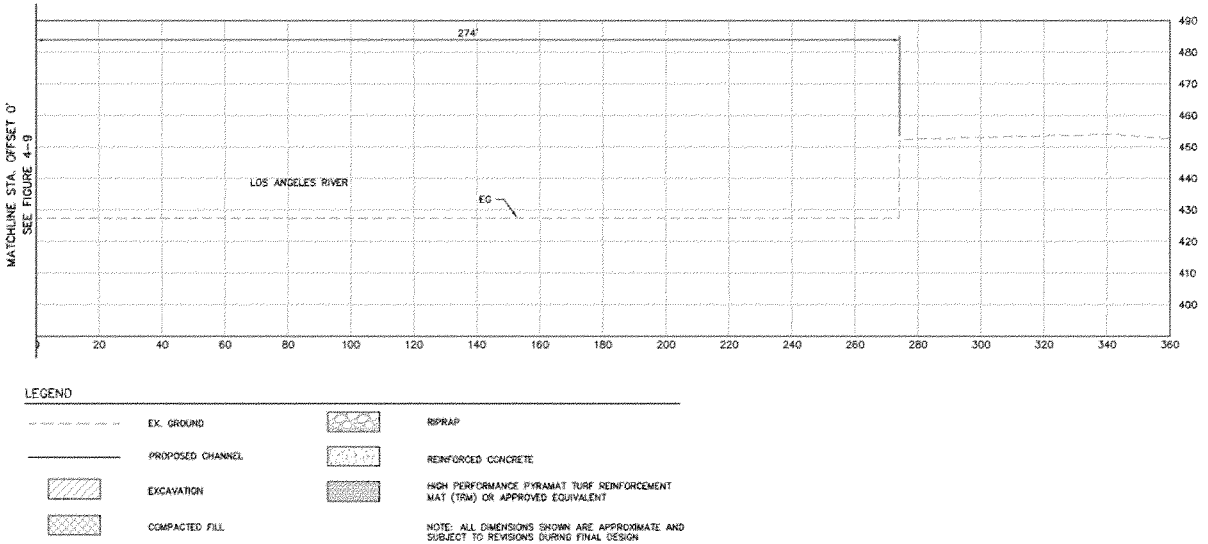

Figure 4.10 Verdugo Wash Cross-Section 3 (cont'd), Upstream of Los Angeles River Confluence

650

4.2.8 Cross-Section 4, Sub-Reach 4 - Brazil to Los Feliz Boulevard

Existing Channel Features – The existing trapezoidal channel within the sub-reach varies from grouted rock to concrete paved channel, is 324 feet wide from the top of bank, and 22 feet high from the invert.

Preliminary Channel Design – As seen in Figure 4.11, "Cross-Section 4, Brazil to Los Feliz," the proposed design would construct four concrete terraced planters in the left/east and right/west banks of the channel. Toedowns with bank protection would be constructed at the toe of the proposed channel banks. A 16-foot-wide asphalt concrete maintenance road would be constructed on both sides of the channel. Grade control structures would be constructed to reduce in-stream velocities and secure natural bed materials for meander and vegetation development.

Demolition and Excavation – Several areas of the reach would undergo demolition and excavation to implement the proposed design. The left/east and right/west banks' grouted rock or slope paving would be demolished. Excavation of earthen material for four concrete terraced planters at a depth of 4 to 8.75 feet and a width of 12.5 feet would occur on the channel slopes. Excavation would also occur at a depth of 3 to 10 feet at the toe of both banks for proposed toedowns with bank protection. In areas where grade control structures would be implemented, 10 to 15 feet of earthen material would be excavated from the channel bed to accommodate construction of grouted riprap toedowns.

Compacted Fill and Maintenance Road – Compacted fill would be placed behind the right/west and left/east channel top of banks to create 16-foot wide maintenance roads on both sides of the channel. The asphalt concrete maintenance roads would meet the proposed channel's top of bank on the river and would have a slope of 3H:1V on the landward. Fencing would be constructed to separate areas of access from the maintenance road, on both the potentially private right-of-way, and the river.

Terraced Vegetated Planters – After demolition and excavation, terraced planters would be constructed in the slopes of the existing channel. Planter dimensions would be 4 to 8.75 feet in height and 12.5 feet in width. The terraces would be spaced along the channel wall so that the top of the lowest meets the bottom of the next. The bottom would be flush with the top of the highest point of the grade control structure. Each planter would have a 1-foot-thick concrete bottom and 1.5-foot-thick concrete walls. Concrete baffles would be placed every 20 feet along the terraces to prevent erosion/scour. Terraces would be seeded and planted with native riparian vegetation per the project biologist's recommendation. The planter boxes would also include drainage holes to help route drainage water from upper boxes to lower boxes.

Topsoil and Vegetation – Topsoil would aid in the recruitment and establishment of vegetation along the channel's riparian zone. Topsoil would be placed on the slopes of the maintenance road compacted fill and in the concrete terraced planters. Topsoil areas would be seeded and planted with native riparian vegetation per the project biologist's recommendations.

Grade Control Structure – Grouted riprap grade control structures would be placed every 500 feet along this reach of the channel. Grade control structures would reduce in-stream flow velocities and stabilize the channel's slope and earthen bed material. Grade control structures would be constructed in the channel bottom at a depth of 10 or 15 feet, have a 2H:1V slope on the upstream end and a 4H:1V slope on the downstream end, be 5 feet in width on top, and have a 2-foot-deep and 20-foot-wide low-flow centerline notch.

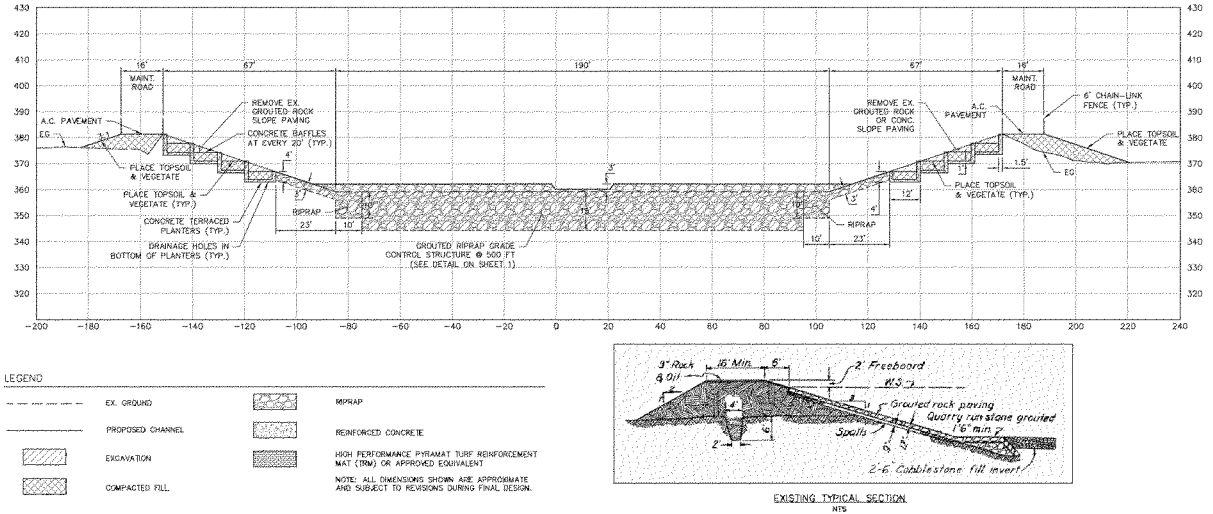

Figure 4.11 Cross-Section 4, Brazil to Los Feliz

653

4.2.9 Cross-Section 5, Sub-Reach 5 - Los Feliz Boulevard to Glendale Freeway

Existing Channel Features – The existing trapezoidal channel within the sub-reach varies from grouted rock to concrete paved channel, is 310 feet wide from the top of bank and 20 feet high from the invert.

Preliminary Channel Design – As seen in Figure 4.12, " Cross-Section 5, Los Feliz Boulevard to Glendale Freeway," the proposed design would construct four concrete terraced planters in the left/east bank of the channel slope. The right/west bank of the trapezoidal bank would be replaced by a 22-foot-high vertical retaining wall with subdrainage under the footing, which would meet the existing top of bank. Two riprap toedowns would be constructed below the channel bottom and bank. The first riprap toedown would be constructed on the right/west bank and the second that would include bank protection, would be located on the left/east bank. Two 16-foot-wide asphalt concrete maintenance roads would be constructed on the land of the retaining walls on the top of bank. The existing cobble/soft bottom would be protected in place and expanded 27 feet towards the proposed right/west bank of the channel.

Demolition and Excavation – Several areas of the reach would undergo demolition and excavation to implement the proposed design. The left/east and right/west banks' grouted rock or slope paving would be demolished. Excavation of earthen material for four concrete terraced planters with dimensions of 4 to 8.75 feet deep and 12.5 feet wide would occur along the left/east bank. Excavation on the right/west bank would widen the channel by 60 feet. Toedown excavation would occur at a depth of 3 to 10 feet and 27 and 33 feet wide at the toe of the left/east bank, which would include bank protection at the base of the channel, and right/west bank, respectively. Excavation for the footing of the retaining wall would range from 4 to 12 feet deep and be 13 feet wide. Excavation would also occur behind the location of the proposed retaining wall, and would have a temporary slope of 1.5H:1V to meet the existing ground; excavation would allow temporary access for construction of the walls.

Compacted Fill and Maintenance Road – Compacted fill would be placed behind the left/east and right/west channel top of banks. The compacted fill would be used to create a 16-foot-wide asphalt concrete maintenance road on both sides of the channel, which would meet the proposed channel's top of bank on the river, and would have a slope of 3H:1V on the landward. Fencing would be constructed to separate areas of access from the maintenance road, on both the potentially private right-of-way, and the river.

Terraced Vegetated Planters – After demolition and excavation, terraced planters would be constructed in the slopes of the existing channel. Planter dimensions would be 4 to 8.75 feet in height and 12.5 feet in width. The terraces would be spaced along the channel wall so that the top of the lowest meets the bottom of the next. The bottom would be flush with the top of the highest point of the grade control structure. Each planter would have a 1-foot-thick concrete bottom and 1.5-foot-thick concrete walls. Concrete baffles would be placed every 20 feet along the terraces to prevent erosion/scour. The planter boxes would also include drainage holes to help route drainage water from upper boxes to lower boxes. Terraces would be seeded and planted with native riparian vegetation per the project biologist's recommendation.

Topsoil and Vegetation – Topsoil would aid in the recruitment and establishment of vegetation along the channel's riparian zone. Topsoil would be placed on the slopes of the maintenance road's compacted fill 3H:1V slopes and in the concrete terraced planters on the left/east bank. Topsoil areas would be seeded and planted with native riparian vegetation per the project biologist's recommendations.

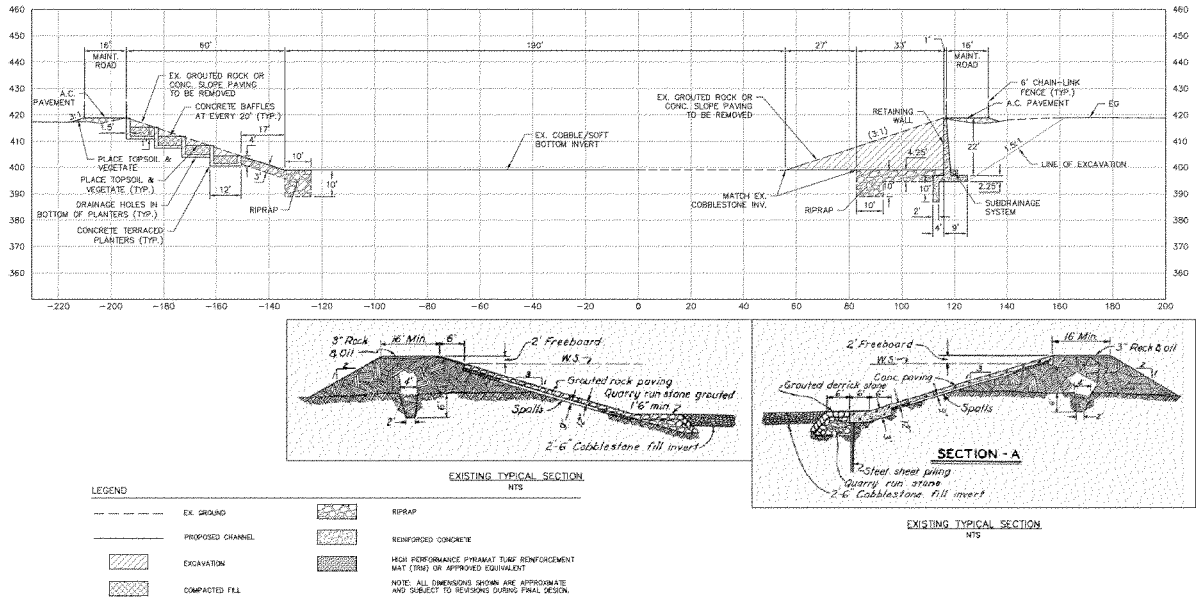

Figure 4.12 Cross-Section 5, Los Feliz Boulevard to Glendale Freeway

4.2.10 Cross-Section 6a, Sub-Reach 6 - Glendale Freeway to Interstate 5

Existing Channel Features – The existing trapezoidal channel within the sub-reach varies from grouted rock to concrete paved, is 365 feet wide from the top of bank, and approximately 22 feet high from the invert.

Preliminary Channel Design – As seen in Figure 4.13, "Cross-Section 6a, Glendale Freeway to Interstate 5," the proposed design would replace the existing trapezoidal channel's grouted rock or concrete paved 3H:1V slopes with TRM, topsoil, and vegetation on the left/east bank and right/west bank. Riprap toedowns with bank protection would be placed at the toe of both banks of the channel. Two 16-foot-wide asphalt concrete maintenance roads would be constructed on the channel's left/east and right/west top of banks. The existing cobble/soft bottom would be protected in place.

Demolition and Excavation – The left/east bank and the right/west bank grouted rock or slope paving would be demolished. Excavation for the left/east bank and the right/west bank toedowns and bank protection would start at the channel toe, and extend 20 feet towards the landward at a depth of 3 to 10 feet below the existing cobble/soft bottom and channel banks.

Compacted Fill and Maintenance Road – Compacted fill would be used to fill behind the left/east and right/west channel top of banks to form the subsurface of the proposed 16-foot-wide maintenance road. Fencing would be constructed to separate areas of access from the maintenance road, on both the potentially private right-of-way, and the river.

Erosion Control – Erosion control matting, such as TRM, would be used to stabilize, prevent channel scour, and to promote vegetation establishment on channel slopes.

Topsoil and Vegetation – Topsoil would aid in the recruitment and establishment of vegetation along the channel's riparian zone. Topsoil would be placed on the 3H:1V channel slopes after TRM matting has been installed. Topsoil areas would be seeded and planted with native riparian vegetation per the project biologist's recommendations.

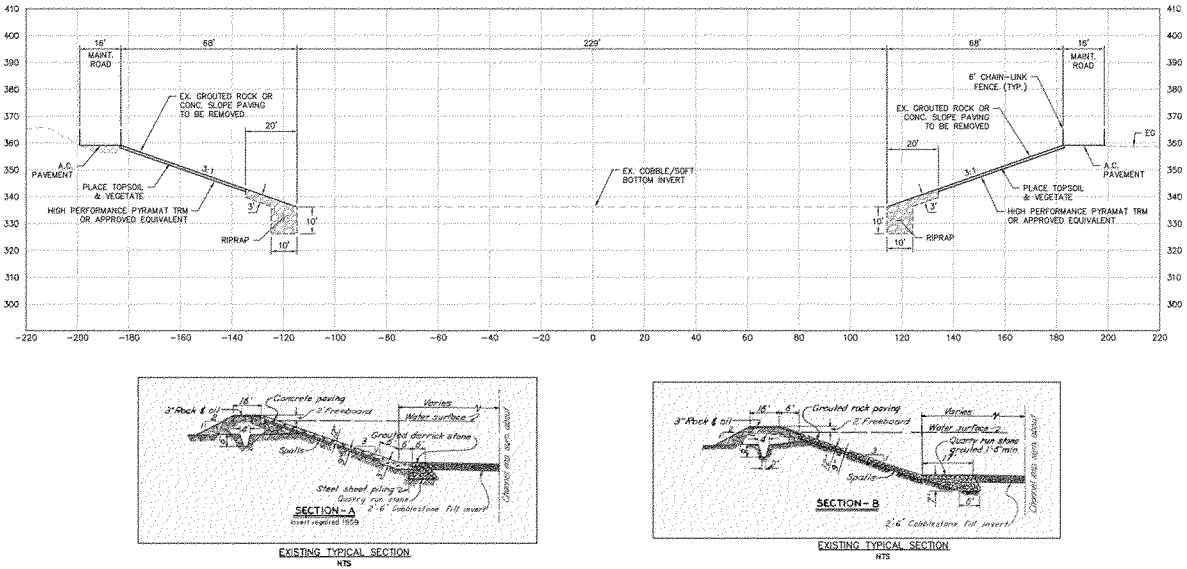

Figure 4.13 Cross-Section 6a, Glendale Freeway to Interstate 5

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4.2.11 Cross-Section 6b, Sub-Reach 6 - Glendale Freeway to Interstate 5

Existing Channel Features – The existing trapezoidal channel within the sub-reach varies from grouted rock to concrete paved channel, is 365 feet wide from the top of bank, and approximately 22 feet high from the invert. The existing channel bottom is cobble/soft bottom.

Preliminary Channel Design – As seen in Figure 4.14, "Cross-Section 6b, Glendale Freeway to Interstate 5," the proposed design would replace the existing channel's grouted rock or concrete paved 3H:1V slopes with TRM, topsoil, and vegetation on the left/east bank and the widened right/west bank. The left/east top of bank would be widened by approximately 316 feet to create acreage for the construction of wetlands. Three riprap toedowns with slope protection would be constructed: one at the toe of the right/west bank, one at the toe of the proposed wetlands (existing left/east bank), and the third at the toe of the widened left/east bank. Maintenance roads would be constructed on both sides of the channel's top of banks. The existing cobble/soft bottom would be protected in place.

Demolition and Excavation – The right/west bank and left/east bank grouted rock or slope paving would be demolished. Excavation would also occur as needed to widen the left/east overbank area by approximately 316 feet and to an elevation of approximately 6 feet above the existing channel invert. The new left/east bank would be excavated at a 3H:1V slope and meet the existing ground at the top of bank. Excavation for the three toedowns would be approximately 20 feet wide and at a depth of 3 to 10 feet below the adjacent ground surface elevation.

Compacted Fill and Maintenance Road – Two 16-foot-wide asphalt concrete maintenance roads would be constructed on the left/east and right/west channel top of banks. Compacted fill would be used to fill behind the right/west channel top of bank to form the subsurface for the road. Fencing would be constructed to separate areas of access from the maintenance road, on both the potentially private right-of-way, and the river.

Wetlands – The construction of wetlands would start 20 feet landward from the existing channel left/east bank toe, terraced to an elevation of 6 feet above the invert. The wetlands would extend for a distance of approximately 316 feet to the proposed left/east bank toe. The 6-foot-high terraced wetland area would receive channel flow conveyed throughout the site that would assist in treating pollutants and creating riverine wetland habitat.

Erosion Control – Erosion control matting, such as TRM, would be used to stabilize, prevent channel scour, and to promote vegetation establishment on channel slopes.

Topsoil and Vegetation – Topsoil would aid in the recruitment and establishment of vegetation along the channel's riparian zone. Topsoil would be placed on the right/west bank and the left/east bank's 3H:1V channel slopes after TRM matting is installed. Topsoil would also be placed in the proposed wetlands area. Topsoil areas would be seeded and planted with native riparian vegetation per the project biologist's recommendations.

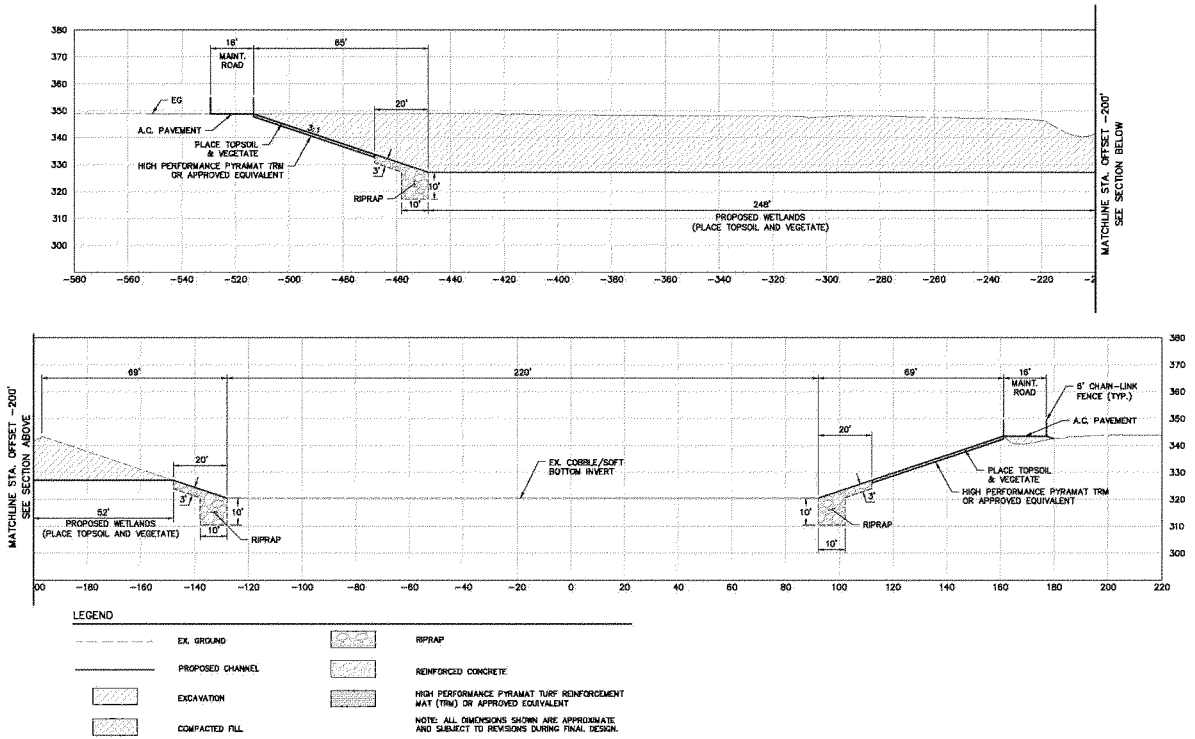

Figure 4.14 Cross-Section 6b, Glendale Freeway to Interstate 5

600

4.2.12 Cross-Section 6c, Sub-Reach 6 - Glendale Freeway to Interstate 5

Existing Channel Features – The existing trapezoidal channel within the sub-reach varies from grouted rock to concrete paved channel, is 380 feet wide from the top of bank and approximately 26 feet high from the invert. The existing channel bottom is cobble/soft bottom.

Preliminary Channel Design – As seen in Figure 4.15, "Cross-Section 6c, Glendale Freeway to Interstate 5," the proposed design would replace the existing trapezoidal channel's grouted rock or concrete paved 3H:1V slopes with erosion control matting and vegetation on the left/east bank and right/west bank. Riprap toedowns with bank protection would be placed at the toe of both banks in the channel, and extend 20 feet landward. Asphalt concrete maintenance roads would be constructed on both sides of the channel at the top of bank. The existing cobble/soft bottom would be protected in place.

Demolition and Excavation – The left/east bank and right/west bank grouted rock or slope paving would be demolished. Excavation for the left/east bank and the right/west bank toedowns would start at the channel toe and extend 20 feet landward, at a depth of 3 to 10 feet below the existing cobble/soft bottom and the channel banks.

Compacted Fill and Maintenance Road – Compacted fill would be used to fill behind the left/east and right/west channel top of banks to form the subsurface of the proposed 16-foot-wide maintenance roads. The fill would meet the top of bank on the river, and have a slope of 3H:1V to meet the existing ground. Fencing would be constructed to separate areas of access from the maintenance road, on both the potentially private right-of-way, and the river.

Erosion Control – Erosion control matting, such as TRM, would be used to stabilize, prevent channel scour, and to promote vegetation establishment on the channel's 3H:1V slopes.

Topsoil and Vegetation – Topsoil would aid in the recruitment and establishment of vegetation along the channel's riparian zone. Topsoil would be placed on the left/east and right/west banks' 3H:1V channel slopes after TRM matting is installed. Topsoil without TRM matting would be placed on the 3H:1V maintenance road slopes. Topsoil areas would be seeded and planted with vegetation per the project biologist's recommendations.

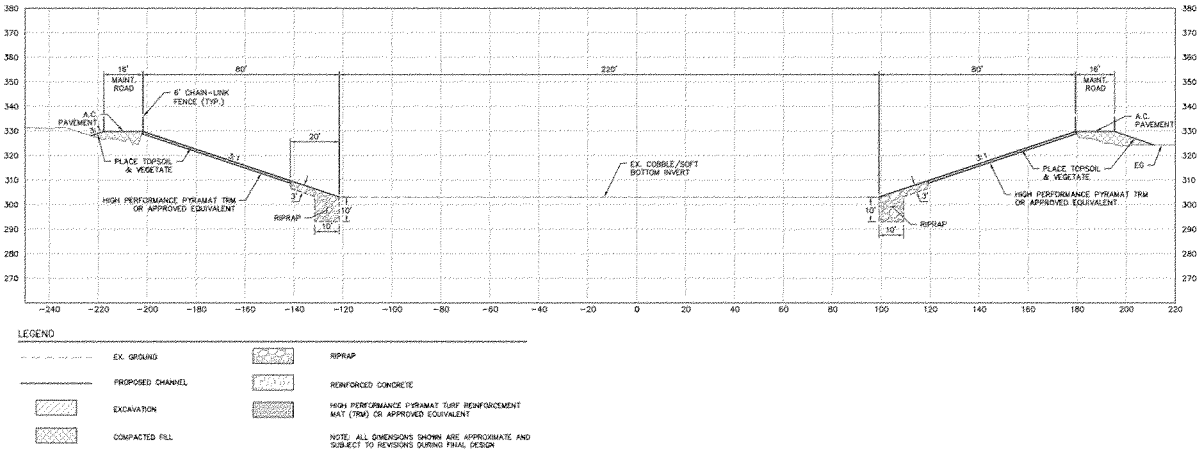

Figure 4.15 Cross-Section 6c, Glendale Freeway to Interstate 5

662

4.2.13 Cross-Section 7, Sub-Reach 7 - Interstate 5 to Main

Existing Channel Features – The existing trapezoidal reinforced concrete channel with concrete bottom is 264 feet wide from the top of bank and approximately 26 feet high from the invert.

Preliminary Channel Design – As seen in Figure 4.16, "Cross-Section 7, Interstate 5 to Main Street," the proposed design would widen the bottom of the channel by 52 feet and construct a 29-foot-high retaining wall with subdrainage at the footings and invert slab on the left/east and right/west banks. Reinforced cantilevered platforms would be constructed on the top of the proposed retaining walls and would extend 25 feet over the channel. Reinforced concrete piers would be located on the in-channel edge of the platform and spaced 25 feet apart for support. Concrete-reinforced, naturalized planter boxes that would replace portions of the concrete invert would be constructed adjacent to the footings at both banks and extend 50 feet towards the center of the channel. A 16-foot-wide asphalt concrete maintenance road would be constructed on the retaining wall and on the top of both banks. The low-flow channel and portion of the concrete-lined invert that would remain following construction would be protected in place.

Demolition and Excavation – Several areas of the reach would undergo demolition and excavation to implement the proposed design. The left/east and right/west banks' existing concrete slope protection would be demolished. A 31-foot stretch of reinforced concrete channel bottom starting at the existing toe and extending towards the channel centerline would be demolished. Excavation would widen the channel bottom by 52 feet on both banks, changing the channel wall morphology from trapezoidal to vertical. Retaining wall and pier footing locations at depths of 4.25 to 10 feet and a width of 42 feet would be excavated. Naturalized channel locations would be excavated at a depth of 12 feet and width of 50 feet towards the channel centerline. Excavation would occur behind the locations of the proposed retaining walls and would have a temporary slope of 1.5H:1V to meet the existing ground. Excavation would allow temporary access for construction of the retaining walls.

Compacted Fill and Maintenance Road – After construction of the retaining walls, compacted fill would be placed behind the left/east and right/west channels' retaining walls. The fill would be placed to accommodate a 16-foot-wide paved asphalt-concrete maintenance road on both banks. The river side elevation of the maintenance roads would meet the top of the proposed retaining walls on both banks. The land side of the left/east bank maintenance road would be sloped 3H:1V to meet the existing ground using compacted fill. Fencing would be constructed to separate areas of access from the maintenance road and the platform on both the potentially private right-of-way and the river.

Planter Boxes (Naturalized Channel) – Naturalized channel would be constructed at the edge of the retaining wall toedowns, and would extend 50 feet towards the center of the channel at a depth of 12 feet. The surface of the naturalized channel would be flush with the invert. The bottom 6 feet of the channel would be filled with riprap and the top 6 feet with soil. The soil would be secured with concrete baffles spaced 20 feet apart to help prevent scour/erosion. The naturalized channel would be seeded and planted with native riparian vegetation per the project biologist's recommendation.

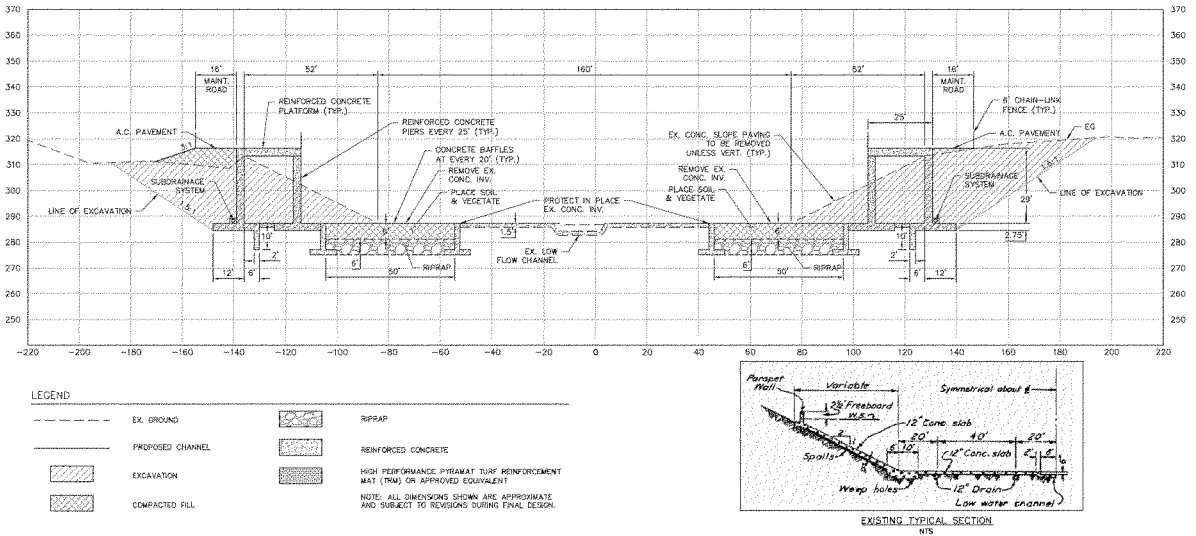

Figure 4.16 Cross-Section 7, Interstate 5 to Main Street

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4.2.14 Arroyo Seco Cross-Section, Sub-Reach 7 – Arroyo Seco Confluence

Existing Channel Features – The existing rectangular reinforced concrete channel with concrete bottom is 66 feet wide from the top of bank and approximately 24 feet high from the invert.

Preliminary Channel Design – As seen in Figure 4.17, "Arroyo Seco Cross-Section," the proposed design would remove 4 feet and 24 feet off the top of the existing left/south and right/north retaining walls respectively. The channel bottom would be widened by 10 feet on both banks. Both sides of the channel would be additionally widened to accommodate 3H:1V vegetated banks; the left/south bank would be widened by 60 feet, 12 feet above the invert, and the right/north bank widened by 62 feet, 6 feet above the invert. The existing concrete bottom would be protected in place. An asphalt concrete maintenance road would be constructed on both sides of the channel top of bank. Fencing would be constructed to separate areas of access from the maintenance road, on both the potentially private right-of-way, and the river.

Demolition and Excavation – Demolition of the tops of the retaining walls would occur on both sides of the channel; the top 4 feet of the left/south retaining wall and the top 24 feet of the right/north retaining wall would be demolished. From the new height of the retaining walls, both sides of the channel would be excavated and benched 10 feet landward; trapezoidal banks with a slope of 3H:1V would be excavated and extend from the benches for 60 feet on the left/south bank and 62 feet on the right/north bank. In addition, the left/south bank would be excavated and leveled for the construction of a 16-foot-wide asphalt concrete maintenance road.

Maintenance Road – The proposed channel design would construct two 16-foot-wide asphalt concrete maintenance roads on the left/south and the right/north banks of the channel. Fencing would be constructed to separate areas of access from the maintenance road, on both the potentially private right-of-way, and the river.

Erosion Control – Erosion control matting, such as TRM, or approved equivalent, would be used to stabilize, prevent channel scour, and to promote vegetation establishment on channel's 3H:1V slopes.

Topsoil and Vegetation – Topsoil would aid in the recruitment and establishment of vegetation along the channel's riparian zone. Topsoil would be placed on the left/south and right/north banks' 3H:1V channel slopes, after TRM matting is installed. Topsoil areas would be seeded and planted with native riparian vegetation per the project biologist's recommendations.

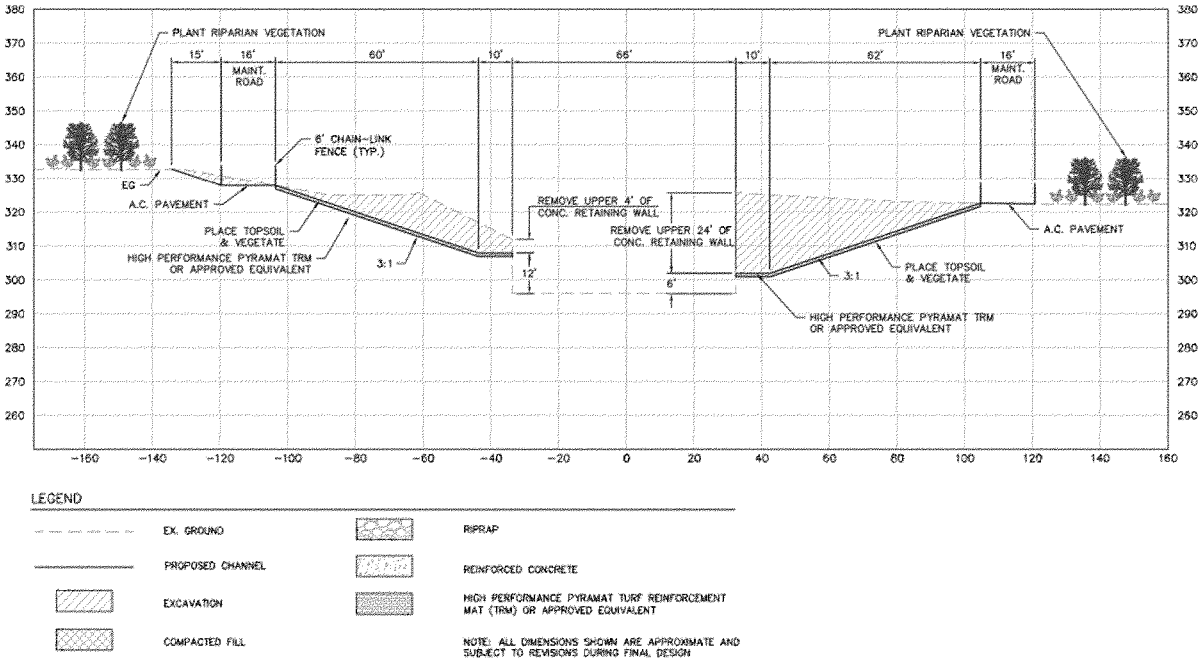

Figure 4.17 Arroyo Seco Cross-Section

4.2.15 Cornfields Cross-Section, Sub-Reach 7, Cornfields Hydrologic Connection

Existing Channel Features – The preliminary design is proposing to hydrologically connect the upstream portion of the Cornfields site with the Los Angeles River; currently, there is no existing channel at the site.

Preliminary Channel Design – As seen in Figure 4.18, "Cornfields Cross-Section," the proposed design would create a 379-foot-wide channel with a 51-foot-wide low-flow channel near center. The left/north and right/south banks of the channel would have 3H:1V slopes with a benched point on either bank. The channel bottom and slopes would be covered with an impermeable liner and vegetated. An asphalt concrete maintenance road would be constructed on both sides of the channel top of bank. A 6-foot chain link fence would be constructed on both shoulders of the maintenance road to seclude trespassers from the road and the channel.

Demolition and Excavation – No major demolition would occur in the proposed channel area. Excavation in the main channel would occur at an average depth of 7 to 8 feet and a width of 325 feet. Within the main channel, excavation of the 51-foot-wide proposed low-flow channel would occur at a depth of 14 feet and width of 15 feet, with 18-foot-wide 3H:1V slopes on either. Excavation of the left/north bank would be 25 feet wide and right/south bank 29 feet wide; approximately halfway up the banks 3H:1V slopes, a 10-foot-wide terraced/benched area would be excavated.

Maintenance Road – The proposed channel design would construct two 16-foot-wide asphalt concrete maintenance roads on the right/south and the left/north banks of the channel. Fencing would be constructed to separate areas of access from the maintenance road, on both the potentially private right-of-way, and the river.

Impermeable Liner and Vegetation – Depending on the level of residual contamination of the soil, an impermeable liner would be used to cover the surface of the channel bottom and slopes. The impermeable liner would prevent the interaction between surface and groundwater and the potential for contamination. Impermeable liners would be seeded and planted with native riparian vegetation and wetland vegetation per the project biologist's recommendations. (Costs for the liner have been included in the subsequent cost estimate.)

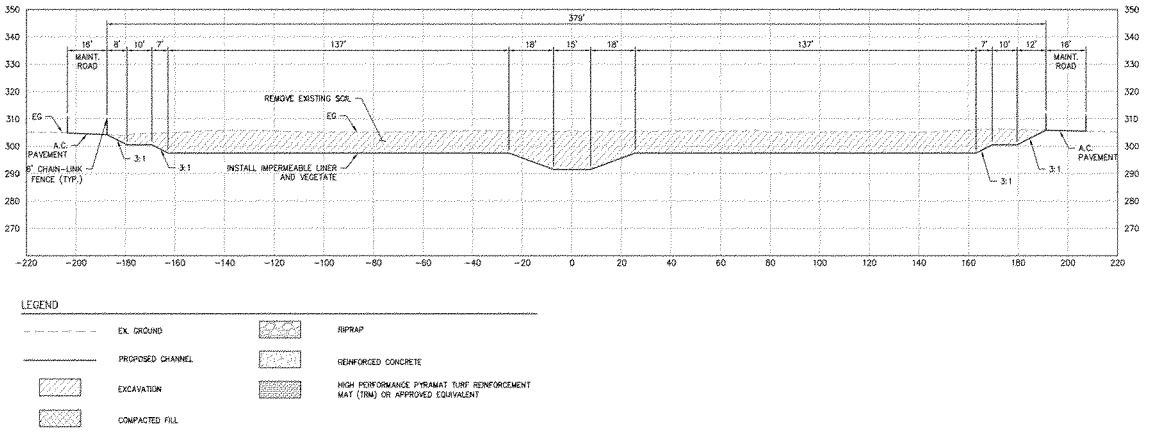

Figure 4.18 Cornfields Cross-Section

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4.2.16 Cross-Section 8a, Sub-Reach 8 - Main to First

Existing Channel Features – The existing trapezoidal reinforced concrete channel is 237 feet wide from the top of bank and approximately 22 feet high from the invert. The existing channel bottom is cobble/soft bottom.

Preliminary Channel Design – As seen in Figure 4.19, "Cross-Section 8a, Main to First Street," the proposed design would widen the left/east overbank area by298 feet to create acreage for the construction of wetlands. Due to the widening of the left/east bank and channel bottom, the existing railroad would be impacted; the railroad would need to be elevated on a trestle above the proposed wetland area. Construction of the trestle would avoid realignment of the current railway and would provide hydrologic connection and flow supportive of wetland habitat proposed to the west and east of the railway line. The existing channel's right/west bank concrete paved 3H:1V slopes would be replaced with three concrete terraced planters with riprap toedowns for bank protection. A 16-foot-wide asphalt concrete maintenance road would be constructed at the top of both the right/west and left/east banks. The existing concrete channel bottom would be replaced by soft "natural" substrate. Grade control structures would be constructed to reduce in-stream velocities and secure natural bed materials for meander and vegetation development.

Demolition and Excavation – The right/west bank and left/east bank slope paving would be demolished. Demolition would also occur as needed to widen the left/east top of bank by approximately 200 feet. The existing left/east bank would be excavated to a height of 2 feet above the existing invert for 200 feet landward. At 200 feet, the toe of the new right/west bank would begin with a 3H:1V slope to the top of bank and existing ground. Excavation on the right/west top of bank would be conducted to shape and level the area for the proposed maintenance road. Riprap toedowns with bank protection at the channel toes would be excavated to a depth of 3 to 10 feet below the channel bottom and banks, and a width of 20 feet on the left/east bank to 30 feet on the right/west bank. Excavation on the east of the grade control structure at a depth of 10 feet and width of 10 feet would be used for a grade control structure toedown.

Compacted Fill and Maintenance Road – A 16-foot-wide asphalt concrete maintenance road is proposed to be constructed on the left/east and right/west channel top of bank. Fencing would be constructed to separate areas of access from the maintenance road, on both the potentially private right-of-way, and the river.

Wetlands – The construction of wetlands would start on the eastern edge and top of the proposed grade control structure, 2 feet above the invert. The wetlands would extend for a distance of 200 feet landward to the proposed left/east bank toedown. The wetland area would receive channel flow conveyed throughout the site that would assist in treating pollutants and creating riverine wetland habitat.

Erosion Control – Erosion control matting, such as TRM, would be used to stabilize, prevent channel scour, and to promote vegetation establishment on channel slopes above the proposed riprap toedown bank protection structures.

Topsoil and Vegetation – Topsoil would aid in the recruitment and establishment of vegetation along the channel's riparian zone. Topsoil would be placed on the left/east bank and the right/west bank 3H:1V channel slopes after TRM matting is installed. Topsoil without TRM matting would be placed in the wetlands area. Topsoil areas would be seeded and planted with native riparian vegetation and wetland vegetation per the project biologist's recommendations.

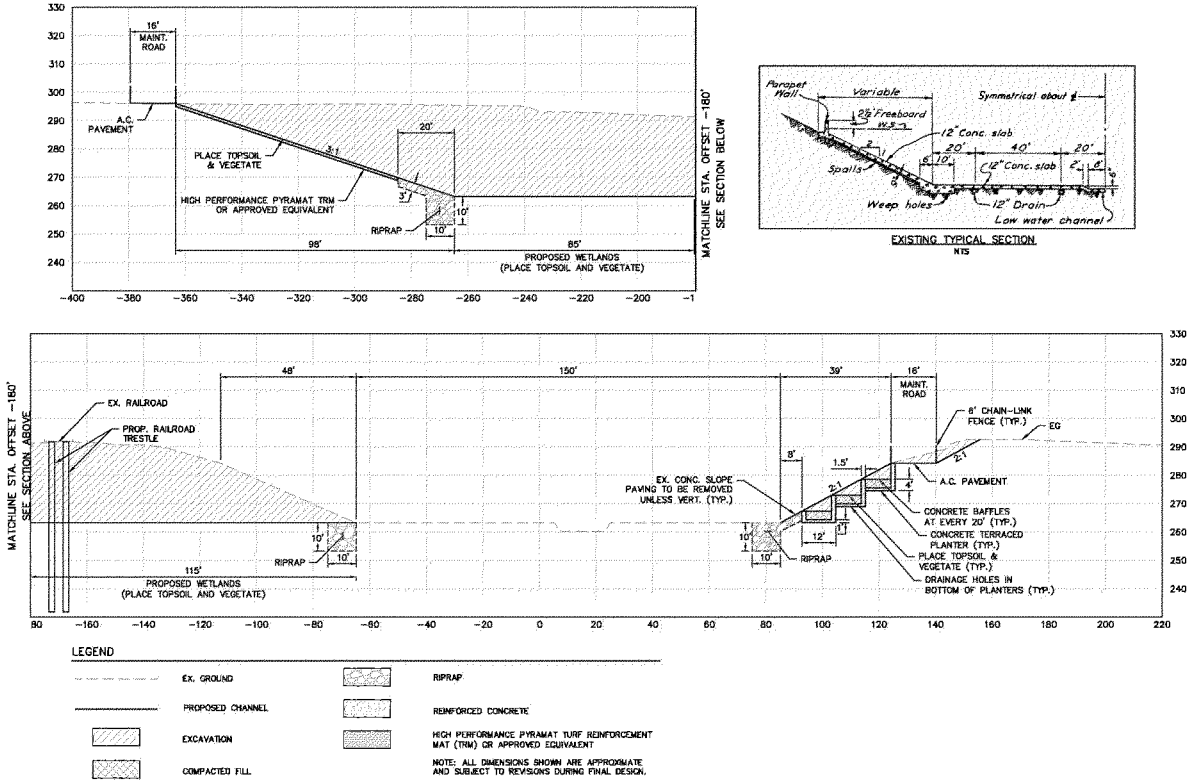

Figure 4.19 Cross-Section 8a, Main to First Street

4.2.17 Cross-Section 8b, Sub-Reach 8 - Main to First

Existing Channel Features – The existing trapezoidal channel within the sub-reach varies from grouted rock to concrete paved channel, is 264 feet wide from the top of bank, and 26 feet high from the invert.

Preliminary Channel Design – As seen in Figure 4.20, "Cross-Section 8b, Main to First Street," the proposed design would construct four concrete terraced planters in the 3H:1V left/east bank. The right/west channel bottom would be widened by 52 feet. A 29-foot-high retaining wall with a subdrain system at the footings and invert slab would be constructed at the new toe. Reinforced cantilevered platforms would be constructed on the top of the proposed retaining wall and would extend 25 feet over the channel. Reinforced concrete piers located on the in-channel edge of the platforms would be spaced 25 feet apart for platform support. Two concrete-reinforced, naturalized planter boxes that would replace portions of the concrete invert sections of would be constructed in the channel bottom on the left/east and right/west banks of the channel. A riprap toedown with bank protection would be constructed at the toe of the left/east bank. A 16-foot-wide asphalt concrete maintenance road would be constructed on both sides of the channel's top of bank. After construction of project features, the remaining existing low-flow channel and concrete bottom would be protected in place.

Demolition and Excavation – Several areas of the reach would undergo demolition and excavation to implement the proposed design. The left/east and right/west bank slope paving and approximately 100 feet of the channel bottom would be demolished. Excavation of earthen material for four concrete terraced planters at a depth of 4 to 8.75 feet and a width of 12.5 feet would occur in the channel's left/east bank slope. Excavation on the right/west bank would widen the channel bottom by 52 feet, changing the channel morphology from trapezoidal to vertical. Excavation to construct retaining wall and pier footings would be at a depth of 2.75 to 10 feet and a width of 42 feet. Excavation to construct naturalized planter boxes at the edge of right/west bank pier support footings and the left/east bank toedown would be 12 feet deep and extend 50 feet towards the channel centerline. Excavation would also occur behind the proposed retaining wall, and would have a temporary slope of 1.5H:1V to meet the existing ground; excavation would allow temporary access for construction of the retaining wall.

Maintenance Road – The asphalt concrete maintenance roads would meet the proposed channel's top of bank on the river and would have a slope of 3H:1V on the landward. Fencing would be constructed to separate areas of access from the maintenance road, on both the potentially private right-of-way, and the river.

Terraced Vegetated Planters – After demolition and excavation, terraced planters would be constructed in the slopes of the existing channel. Planter dimensions would be 4 to 8.75 feet in height and 12.5 feet in width. The terraces would be spaced along the channel wall so that the top of the lowest meets the bottom of the next. The bottom would be flush with the top of the highest point of the grade control structure. Each planter would have a 1-foot-thick concrete bottom and 1.5-foot-thick concrete walls. Concrete baffles would be placed every 20 feet along the terraces to prevent erosion/scour. Terraces would be seeded and planted with native riparian vegetation per the project biologist's recommendation.

Planter Boxes (Naturalized Channel) – Naturalized channel would be constructed at the edge of the retaining wall toedown on the right/west bank and on the left/east bank, extending 50 feet into the center of the channel at a depth of 12 feet. The surface of the boxes would be flush to the invert. The bottom 6 feet of the channel would be filled with riprap, and the top 6 feet with soil. The soil would be secured with concrete baffles spaced 20 feet apart to prevent scour/erosion.

Topsoil and Vegetation – Topsoil would aid in the recruitment and establishment of vegetation along the channel's riparian zone and bottom. Topsoil would be placed in the concrete terraced planters and the naturalized channel. Topsoil areas would be seeded and planted with native wetland/riparian vegetation per the project biologist's recommendations.

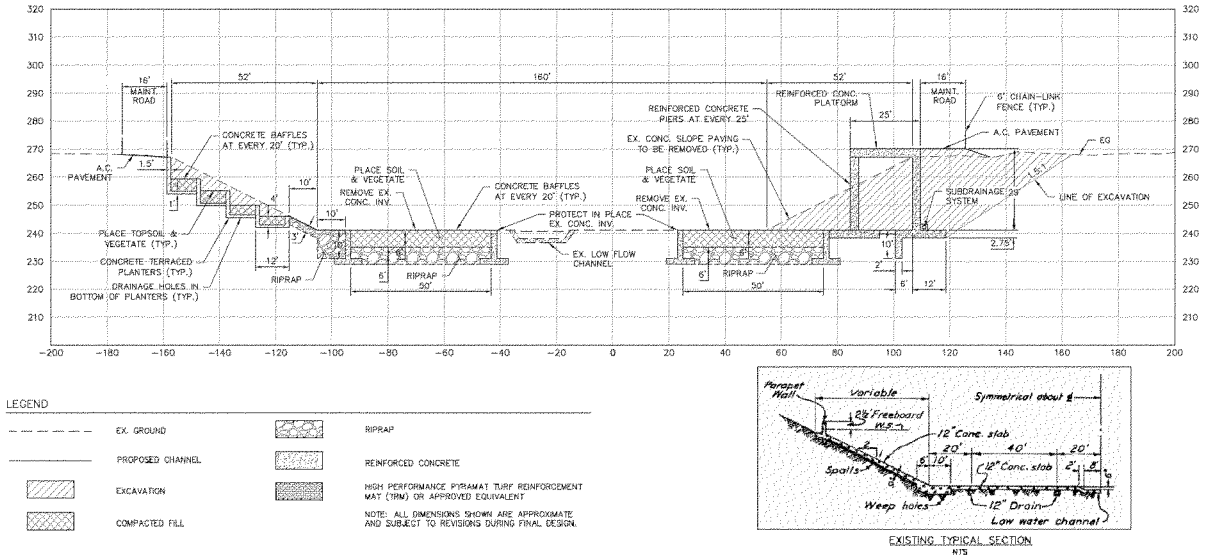

Figure 4.20 Cross-Section 8b, Main to First Street

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5. FINAL ARRAY OF ALTERNATIVES

Five alternatives were selected for further analysis. These include: 10-ARBOR Riparian Transitions, 13-ARBOR Corridor Extension, 16-ARBOR Narrows to Downtown, and 20-ARBOR Riparian Integration via Varied Ecological Reintroduction. These are also referred to by the following acronyms:

- Alternative 10-ART
- Alternative 13-ACE
- Alternative 13v
- Alternative 16-AND
- Alternative 20-RIVER

The final array of alternatives was developed by combining separate, independent sub-reaches from the preliminary 19 alternatives that optimized habitat benefits compared to costs. Table 5-1, below, includes an overview of each. The right hand column indicates which reaches from the preliminary 19 alternatives make up each of the final four alternatives. So, for example, Alternative 10-ART represents the design configuration of Reaches 1 and 2 from Preliminary Alternative 11, the design configuration of Reach 3 from Alternative 17, the design configuration of Reaches 4 and 5 from Alternative 16, and so on.

Formulation and analysis of the alternatives is described in the main report and not repeated herein.

5.1 Maps and Revised Cross-Sections

Mapping and revised cross-sections are provided in Attachments 3 and 4 in order to depict the final array of alternatives. Mapping includes the aerial extent of each project feature with the study area displayed on four 11"x17" maps from upstream to downstream.

The preliminary set of typical cross-sections was developed to aid in development of quantities and costs and, therefore, include more features than are included in the final array. Consequently, several modified cross-sections included in Attachment 4 depict only the structural measures that make up the final array. All are subject to additional modifications based on further analysis that could change the dimensions of foundations and retaining walls, for example, during detailed design. Typical cross-sections focus on the main river channel and do not generally include features beyond the main channel such as riparian corridors or channels.

Table 5-1 Final Array of Alternatives Summarized

Name	Description	Reaches (R) & Alternatives (A)
10 ARBOR Riparian Transitions (ART)	Focuses on areas upstream and downstream of existing soft-bottomed Glendale Narrows; includes all sub-reaches but limited restoration in sub-reaches 3, 4 and 5.	R1A11 R2A11 R3A17 R4 A16 R5A16 R6A14 R7A09 R8A15
13 ARBOR Corridor Extension (ACE)	Includes all 8 river sub-reaches, with channels in key locations and treatments into Downtown LA, but not at the Cornfield/LA State Historic Park	R1A11 R2A11 R3A16 R4A16 R5A16 R6A13 R7A12 R8A15
13v	Includes all 8 river sub-reaches. It includes the same reach sub-plans as Alternative 13 except in Reach 7, where it includes the sub-plan from Alternative 20.	R1A11 R2A11 R3A16 R4A16 R5A16 R6A13 R7A16 R8A15
16 ARBOR Narrows to Downtown (AND)	Includes all river sub-reaches and sub-reaches 1-4 are similar to the smaller two alternatives. Sub-reach 5 includes channel widening and terracing, includes restoration of Arroyo Seco and LATC.	R1A11 R2A11 R3A16 R4A16 R5A5 R6A13 R7A12 R8A3
20 ARBOR Riparian Integration via Varied Ecological Reintroduction (RIVER)	Most extensive, includes measures in all 8 sub-reaches with channel widening at Verdugo Wash, Arroyo Seco, Cornfield/LA State Historic Park, and LATC	R1A11 R2A13 R3A18 R4A16 R5A5 R6A13 R7A16 R8A3

5.2 Alternative Reach Descriptions

A summary of restoration activities for Alternatives 10, 13, 16, and 20 is listed below by sub-reach.

5.2.1 Alternative 10 ARBOR Riparian Transitions (ART)

In the ARBOR Riparian Transitions or ART plan, reaches would be restored to increase connections between upstream and downstream riparian areas and restore lost riparian strands on the overbank. This alternative restores a total of 528 acres, and each reach is described below. In addition to removal of invasives species throughout the ARBOR reach, this alternative includes the following specific restoration features.

Reach 1 Pollywog Park Area of Griffith Park

The Reach 1 sub-plan for all alternatives in the final array would implement a habitat corridor with riparian planting on the overbanks of both sides of the River and other nearby locations. Overbanks are those areas adjacent to the river where overland flow in flood events could occur in a natural river environment. Areas of restoration include the left overbank across the River from the Headworks Study Site, the Pollywog Park area of Griffith Park, the open area directly downstream of Headworks on the right overbank, and the left overbank of Burbank Western Channel (tributary from the north/west).

Riparian corridor restoration would involve planting a riparian community of cottonwood/willow, sycamore, mugwort, mulefat, and scarlet monkeyflower with a buffer of sagebrush, buckwheat, and native herbaceous plants. It would include irrigation for establishment and water harvesting features to sustain plants, including micro-grading and/or swales to capture and infiltrate water. Water sources could include reclaimed water, harvesting of stormwater and street runoff (with small wetland features at the end of adjacent streets), and/or highway runoff. Where stormwater or street runoff is excessive during storm events, a connection to the River would allow it to overflow into the channel. Establishment and drought management for this vegetation would utilize irrigation, either through flood irrigation (simulating a natural riparian regime) or drip irrigation, dependent upon the availability of water. In Pollywog Park, the water from an existing storm drain will spread/meander into the park, and during big storms may then flow back into the river at the downstream end through an existing culvert. There would be no substantial channel modifications within this reach. While there is a levee at the downstream end of this reach, any planting in that area would comply with all levee regulations.

Reach 2 Bette Davis Park Area of Griffith Park

This reach sub-plan continues establishment of habitat corridors/riparian planting along the overbanks of both sides of the River. This includes restoration of riparian habitat in the Bette Davis Park area of Griffith Park on the left bank and the area between Zoo Drive and SR-134, with connections under the highway to a restored linear riparian planting along the River extending into Reach 3. There would be no channel modifications within this reach. Modifications to levees would comply with levee regulations.

Reach 3 Ferraro Fields/Verdugo Wash Area of Griffith Park

This reach sub-plan continues establishment of the riparian corridor along Zoo Drive on the right side of the River. It also daylights a stream currently confined in a large culvert just downstream of Ferraro Fields on the right bank in the Zoo Drive area and daylights two smaller streams on the left bank. Depending upon the length of the daylighted stream, it would be planted with riparian vegetation and end at the confluence with the River in a small freshwater marsh. If it is not possible to design an efficient confluence, the connection to the River would remain gated. Freshwater marsh vegetation would include clustered field sedge, fragrant flatsedge, Parish's spikerush and common rush, scarlet monkey flower, California bulrush, narrow leaved cattail, and common cattail. There would be no modifications to the channel itself. Levee protection would remain.

Reach 4 Griffith Park

This reach sub-plan would restore approximately riparian and wetland habitat by establishing a riparian corridor on the left overbank of the River, daylighting eight streams, creating a side channel diverting river flows through the Griffith Park (Harding) Golf Course on the right bank, and lowering the Los Feliz Golf Course on the left bank to allow seasonal flooding through existing culverts.

The riparian corridor on the left overbank would be implemented as continuously as possible within the requirements of levee regulations. There would be no channel modifications within this reach. The side stream through Griffith Park would enter the park from the River under the I-5 Freeway (or farther upstream if necessary) and exit the park to reenter the River downstream under the I-5 as well. A riparian fringe of trees and marsh vegetation would line the new side channel. The Los Feliz Golf Course would be lowered, rebuilt, and allowed to seasonally flood (with no changes to the River channel walls) in order to establish a riparian habitat interspersed with the golf course greens.

The eight streams currently encased in culverts would be opened and naturalized as tributaries as far upstream as possible (at a minimum opening up the stream within the River right-of-way). Depending upon the length of the daylighted stream, it would be planted with riparian vegetation and end at the confluence with the River in a small freshwater marsh. If it is not possible to design an efficient confluence, the connection to the River would remain gated.

Reach 5 Riverside Drive

This reach sub-plan would continue implementation of the habitat corridor restoration in a narrow strip along the left overbank to avoid interference with the existing levee system (in compliance with current USACE guidance for vegetation on levees) and would daylight and restore one stream currently encased in a culvert with a riparian fringe and freshwater marsh. The stream would be opened and naturalized as far upstream as possible (at a minimum, this would open up a confluence within the River right-of-way). Depending upon the length of the daylighted stream, it would be planted with riparian vegetation and end at the confluence with the River in a small freshwater marsh. If it is not possible to design an efficient confluence due to

the levee, the connection to the river would remain gated. Examples can be found in Los Angeles at North Atwater Park.

Reach 6 Taylor Yard

Restoration measures in this reach sub-plan include increasing riparian habitat within the Bowtie site and at Taylor Yard. This would include widening the channel bed on the left side of the River by a minimum of 80 feet and connecting this new channel bed to the existing level of the overbank with a sloped bank vegetated with riparian plants. The length of this widening would extend through the beginning of the bend in the Bowtie site downstream for 700 feet through the G-2 Taylor Yard parcel and beyond, for a maximum of about 1,000 feet. Widening would include removal of concrete and excavation followed by reconstruction of the channel structure to stabilize the bank using grade control, rock walls with toe-ins (an extension of the wall below the bed), and/or geotextiles, and would provide for a gradual, undulating four-to-one (4:1) slope up to current grade. There is limited terracing at the downstream end of the Bowtie site as it transitions into the widened Taylor Yard. In the widened area, the riparian area on the overbank would be similar to that described for Reach 1 and the bank would be vegetated with plants that would survive seasonal inundation and would lay down in flood events.

At the upstream end of the Bowtie site, the channel banks would be lowered in an approximate 100-foot-wide by 600-foot-long riparian area by creating a setback in the channel wall with a terrace planted with riparian and marsh habitat. The terrace would be 10 feet above the channel invert transitioning from upstream and downstream ends. The left overbank along the Bowtie site would be planted with a riparian corridor, irrigated for establishment, and water harvested from stormwater drainages.

Reach 7 Arroyo Seco/Los Angeles State Historic Park

This reach sub-plan would daylight three streams currently confined in storm drains/culverts. One is just upstream of Arroyo Seco on the opposite bank (right bank), and the others are downstream of Arroyo Seco. The second is on the right bank upstream of Los Angeles State Historic Park, and the third is on the left bank. Both streams on the right bank connect to the hills in Elysian Park. A freshwater marsh would be located in the daylighted area outside of the mainstem of the River channel. The streams would be opened and naturalized as tributaries as far upstream as possible (at a minimum opening up the stream within the River right-of-way). Depending on the length of the daylighted stream, it would be planted with riparian vegetation and end at the confluence with the River in a small freshwater marsh. If it is not possible to design an efficient confluence, the connection to the River would remain gated. There would be no modifications to the channel itself.

Reach 8 LATC

In this Reach 8 sub-plan, the LATC site would be restored with riparian habitat. Micro-grading would slope the site to restore the historical wash that once ran through this area. The restored historical wash would meander through the property and would be connected to the existing River channel through a wide culvert or designed confluence, if possible. The wash location

would be determined by the USACE's hydrology and hydraulic analysis and would be located in the most appropriate place. This reach sub-plan also establishes riparian habitat within the site.

There would be no channel modifications within this reach as water entering the River from the historical wash would be routed through existing storm drains in the channel wall.

5.2.2 Alternative 13 ARBOR Corridor Extension (ACE)

ARBOR Corridor Extension (ACE) Alternative 13 restores a total of 588 acres.

Reach 1 Pollywog Park Area of Griffith Park

This reach sub-plan is the same as described for Alternative 10.

Reach 2 Bette Davis Park Area of Griffith Park

This reach sub-plan is the same as described for Alternative 10.

Reach 3 Ferraro Fields/Verdugo Wash area of Griffith Park

This reach sub-plan includes the three daylighted streams from the reach sub-plan for Alternative 10. In addition, using water diverted from the River, it creates a side channel that would flow along the west side of Ferraro Fields and reenter the River through the daylighted stream on the right bank. The side channel would support a riparian fringe, and open water and freshwater marsh would be located in the daylighted area outside of the mainstem of the River channel. This reach sub-plan continues and expands the riparian corridor from the reach plan for Alternative 10. Riparian areas would be located on the right overbank along Zoo Drive, along the River's edge at Ferraro Fields, and between the daylighted streams on the left overbank. There would be no modifications to the channel itself. Levee protection would remain and levee vegetation policy would be followed.

Reach 4 Griffith Park

This reach sub-plan is the same as described for Alternative 10.

Reach 5 Riverside Drive

This reach sub-plan is the same as described for Alternative 10.

Reach 6 Taylor Yard

The Reach 6 sub-plan in Alternative 13 restores riparian corridors and widens the soft bottom bed of the River by over 300 feet with additional slope back to the overbank elevation along the reach for a length of approximately 1,000 feet. At the upstream end of the reach, a back water wetland would be developed at river level, and there would be a small terraced area at the downstream end of the Bowtie parcel to facilitate the transition into the widened area at Taylor Yard. Aquatic riverine habitats including freshwater marsh would dominate the new river bed. The banks of the River, upstream of the Bowtie backwater wetland and downstream of Taylor

Yard on the left bank and the entirety of the right bank, would be restructured to support overhanging vines and other vegetation.

Reach 7 Arroyo Seco/Los Angeles River State Historic Park

In this Reach 7 sub-plan, the Arroyo Seco tributary would be restored with riparian habitat. This stream would have its banks and bed softened by removing concrete for approximately one-half mile upstream and planting riparian vegetation on its banks. It would be stabilized with erosion control elements to maintain the existing protection. At the confluence on the upstream edge of the River, a backwater riparian wetland would be established. Within the River channel itself, the banks would be restructured to support vegetation on the banks.

Reach 8 LATC

This reach sub-plan is the same as for Alternative 10.

5.2.3 Alternative 13v

Alternative 13v restores a total of 598 acres and is a variation of Alternative 13. It includes the same reach sub-plans as Alternative 13 except in Reach 7, where it includes the sub-plan from Alternative 20.

Reach 1 Pollywog Park Area of Griffith Park

This reach sub-plan is the same as described for Alternative 10..

Reach 2 Bette Davis Park Area of Griffith Park

This reach sub-plan is the same as described for Alternative 10.

Reach 3 Ferraro Fields/Verdugo Wash area of Griffith Park

This reach sub-plan is the same as described for Alternative 13.

Reach 4 Griffith Park

This reach sub-plan is the same as described for Alternative 10.

Reach 5 Riverside Drive

This reach sub-plan is the same as described for Alternative 10.

Reach 6 Taylor Yard

This reach sub-plan is the same as described for Alternative 13.

Reach 7 Arroyo Seco/Los Angeles River State Historic Park

This Reach 7 sub-plan includes the three daylighted streams restored in the Alternative 10 sub-plan and the restoration of the Arroyo Seco tributary included in the Alternative 13 sub-plan. In addition, this Reach 7 sub-plan restores freshwater marsh at the Los Angeles State Historic Park and terraces the adjacent right River bank to include riparian vegetation and connect the marsh area to the river. To facilitate the terracing, the existing rail road track would be trestled at grade. This reach sub-plan is the same as for Alternative 20.

Reach 8 LATC

This reach sub-plan is the same as for Alternative 10.

5.2.4 Alternative 16 ARBOR Narrows to Downtown (AND)

ARBOR Narrows to Downtown Alternative 16 (AND), would include restoration of a total of 659 acres. Specific restoration features in each reach are described below.

Reach 1 Pollywog Park Area of Griffith Park

This reach sub-plan is the same as described for Alternative 10.

Reach 2 Bette Davis Park Area of Griffith Park

This reach sub-plan is the same as described for Alternative 10.

Reach 3 Ferraro Fields/Verdugo Wash Area of Griffith Park

This reach sub-plan is the same as described for Alternative 13.

Reach 4 Griffith Park

This reach sub-plan is the same as described for Alternative 10.

Reach 5 Riverside Drive

In Reach 5, the right bank would be modified from a trapezoidal bank to a vertical bank. This would increase the width of the soft bottom bed of the River by over 100 feet. The top of the bank would be notched and planted with overhanging vines. The left bank would be modified from trapezoidal to terraced and planted with riparian herbaceous vegetation and would include any necessary erosion measures, which would consist of concrete-lined beds. The land side of the bank would be planted with riparian herbaceous vegetation. At the downstream end of this reach, the River will also be widened on the left bank with appropriate erosion control measures in place. This would further increase the natural river bottom area. The daylighed stream in the sub-plan for Alternatives 10 and 13 is also included in this reach sub-plan. All of these measures would comply with levee vegetation regulations.

Reach 6 Taylor Yard

This reach sub-plan is the same as for Alternative 13.

Reach 7 Arroyo Seco/Los Angeles River State Historic Park

This reach sub-plan is the same as for Alternative 13. However, after more detailed cost analysis, it was concluded that this reach sub-plan was not cost effective compared to the sub-plan in Alternatives 13v and 20.

Reach 8 LATC

In this sub-plan, Reach 8 would be modified with terracing on the right bank upstream of LATC and on the left bank downstream of LATC. This terracing would be planted with riparian vegetation. The channel would be modified from concrete to soft bottom to support aquatic habitat including freshwater marsh, and the reach would be widened. The marsh would extend into the LATC site 500 feet, with riparian area extending another 1,000 feet into the LATC site, gradually sloping up to existing bank elevations. The historic wash would be restored through the property with a riparian fringe as well as other side channels, and flows would be diverted out of the River into the LATC site, creating a large wetland area. A railroad trestle would be included with this alternative to allow the connection of the River channel and the adjacent restored areas.

5.2.5 Alternative 20 ARBOR Riparian Integration via Varied Ecological Reintroduction (RIVER)

Riparian Integration via Varied Ecological Reintroduction (RIVER) Alternative 20 would include restoration of a total of 719 acres. Restoration features within each reach are described below.

Reach 1 Pollywog Park Area of Griffith Park

This reach sub-plan is the same as described for Alternative 10.

Reach 2 Bette Davis Park Area of Griffith Park

The reach sub-plan for this alternative includes the habitat corridors/riparian planting included in the reach sub-plan for Alternative 10. In addition, this alternative modifies the right bank of the channel from trapezoidal to a vertical bank with overhanging vines, creating 80 feet of additional soft bottom width in the channel.

Reach 3 Ferraro Fields/Verdugo Wash area of Griffith Park

This reach sub-plan would include the riparian corridor along the right bank, the side channel and one of the daylighted streams included in the reach sub-plan for Alternative 13, and it would also restore the Verdugo Wash confluence. The side channel would be established on the west side (right bank) at Ferraro Fields with water diverted from the River. The stream currently confined in a large culvert just downstream of Ferraro Fields in the Zoo Drive area would be daylighted. The side channel would support a riparian fringe. The daylighted stream would include a riparian fringe with freshwater marsh at the confluence. Riparian areas are located on the right bank along Zoo Drive and on the River's edge at Ferraro Fields. These features would

not modify the channel. In the Verdugo Wash confluence, the channel mouth will be widened, and the left bank of the wash would be sloped back to the existing overbank elevation. One potential design would use riparian vegetation to stabilize the south bank and a combined riparian and marsh community in the widened channel. Riparian habitat will be planted along the overbank of the widened Verdugo Wash. Levee protection would be tied in to the bank, and other levee protection will remain. Levee vegetation policy will be followed. Details for the confluence area will be determined during the detailed design phase.

Reach 4 Griffith Park

This reach sub-plan is the same as described for Alternative 10, 13, 13v, and 16.

Reach 5 Riverside Drive

This reach sub-plan is the same as described for Alternative 16.

Reach 6 Taylor Yard

This reach sub-plan is the same as described for Alternative 13, 13v, and 16.

Reach 7 Arroyo Seco/Los Angeles State Historic Park

This reach sub-plan is the same as described for Alternative 13v.

Reach 8 LATC

This reach sub-plan is the same as for Alternative 16.

5.3 Policy Issues, Risks and Constraints

During plan formulation, each measure and alternative was formulated to avoid constraints and minimize risk as much as was possible. However, several policy issues, risks, and constraints apply to all of the alternatives and will require further consideration during design. Each are summarized below and also included in the main feasibility report and relevant technical appendices.

5.3.1 Flood Risk Management

A key constraint of the study was that existing levels of flood risk management will be maintained.

The study area includes a portion of the Los Angeles River that was altered and engineered as part of the LACDA Project. Any restoration alternatives had to take into account the continued functioning of the flood risk management system and avoid induced flooding. The existing river channel in this reach does not provide a high level of protection (with or without existing vegetation). The existing channel provides less than a 1 percent annual chance exceedance (ACE) (100-year) level of protection for most of the ARBOR reach. For this reason, an alternative located solely within the existing LACDA project right of way was infeasible, as it would be likely to reduce conveyance capacity and/or be unsustainable and unable to meet restoration objectives given the high velocity flows carried by the system during storm events. Widening the channel at opportunity areas is thus critical to provide restoration benefits while maintaining existing levels of flood risk management. The inclusion of the Taylor Yard and LATC properties provided the only opportunities in the study area to substantially widen the channel and increase channel vegetation.

The addition of Taylor Yard, LA River State Historic Park (Cornfields), Verdugo Wash, Arroyo Seco, and LATC do not provide any additional flood risk reduction for larger floods, but may have an ecologically beneficial effect on the small to moderate size events that are contained within the channel. Unlike conventional hydraulics for the larger events where discharge is the dominant channel-forming parameter, vegetation dictates the channel forms during the small to moderate size events. Vegetation influences flow patterns and sediment settling on floodplains (Darby 1999, Larsen et al. 2007) as well as bedform changes, largely due to its effect on velocity.

The study analyzed impacts to the flood risk management function by looking at potential water surface elevation change. The study screened out any alternatives that adversely impacted the water surface elevation in a way that could not be addressed through design. Appendix E, Hydrology and Hydraulics, describes the hydraulic analyses conducted on the final array of alternatives. That analysis focused on changes to maximum velocity and associated changes to maximum water surface elevation. The alternatives were analyzed as compared to the existing conditions to determine the impacts on the flood risk management function of the channel. The results in the H&H Appendix are based on the limited hydraulic modeling that shows the alternatives are feasible without inducing flooding. Any minor increases in water surface elevations will be eliminated in the detailed design phase. These design refinements will not increase the costs of the recommended plan. If the water surface elevation for the with-project condition was significantly greater than that for the existing condition, then that restoration scenario was removed from further consideration.

All of the final alternatives can work hydraulically without inducing increased flooding. While the initial assessment identified that an increase in water surface elevation could occur at transition areas if no design refinements were made, the detailed design will ensure the maximum water surface elevations will not increase when compared to the existing conditions. Any change in water surface in the transition areas can and will be avoided through design refinements to the modifications to channel geometry and/or avoidance of introduction of vegetation and enforcing existing O&M requirements limiting vegetation growth in those areas. Characteristics of transition areas are either geometric (transitioning from trapezoidal to rectangular or from a widened section to a narrow section) or construction material (transitioning between soft-bottom and concrete). The exact refinements for avoidance will be further determined during the detailed design phase. The costs of these minor alterations have been included in the cost estimate for the project.

Under the analysis conducted during feasibility, the Engineering team also analyzed average velocities to determine channel function with respect to scour and sustainability of constructed restoration features. For widened areas, the flows need to be slowed sufficiently or sufficient protection need to be included to ensure channel erosion does not occur. Several areas exhibit average velocities in excess of 12 ft/s. In those areas, planting of vegetation as part of the restoration project is not recommended because vegetation may not withstand high velocities. For those areas with velocities greater than 8 ft/s, appropriate protection is included to avoid effects of scour and ensure channel function.

During the detailed design phase, 2D unsteady flow numeric models, and possibly physical modeling, will be required to more accurately simulate the flow hydraulics for the project. This may result in adjustments to plan features, but should not change the overall habitat benefits and will not induce damages from the flood risk perspective.

5.3.2 Existing Levee Systems

There are five existing levee systems that are within the study area. These levees are part of the existing LACDA project and are maintained by the Corps. The levees are identified based on their initials for the river name, Los Angeles River (LAR), and numbered. They are LAR-2, LAR-3, LAR-5, LAR-6, and LAR-7. Management of the vegetation on these levee systems, and any proposals for ecosystem restoration affecting these levee systems, must be compatible with the Corps vegetation management guidelines. There are several areas along these levee systems where the area directly behind the levee embankment has been filled in over time. For these areas, channel capacity is the main concern related to vegetation management. Appendix D (Geotechnical) contains information on the current condition of these levee systems as well as their location.

Corps vegetation management practices emphasize that levee embankments must be accessible for inspection, maintenance, and emergency activities. In addition, for any vegetation that is proposed or retained, it must be demonstrated that the vegetation does not pose an unacceptable risk. Restoration features in the final array of alternatives have been planned to be compatible with the Corps vegetation management guidelines allowing for forbs (native perennial grasses) grown on the levee embankment and other vegetation to be planted farther from the levee embankment. The riparian forbs on the levees are expected to occur in a relatively narrow band and be surrounded by more structurally diverse riparian vegetation in adjacent areas. Forbs

provide habitat for small mammals, reptiles, birds and insects, and are an important part of the riparian community. Levees in each alternative that may be affected by alternative measures along with the proposed vegetation that would be further assessed are indicated in the bulleted list below,

- **Alternative 10**: In Reaches 1 and 2, the proposed riparian corridor along the left and right overbanks includes riparian vegetation on or along the existing levee (LAR-7 and LAR-3). The proposed riparian corridors along the left bank of Reaches 4 and 5 include riparian vegetation on the existing levee berm and crown (LAR-6).

- **Alternative 13**: In Reaches 1 and 2, the proposed riparian corridor along the left and right overbanks includes riparian vegetation on or along the existing levee (LAR-7 and LAR-3). In Reach 3, the proposed riparian corridor along the left and right overbanks includes riparian vegetation on or along the existing levee (LAR-7 and LAR-6 on left, LAR-3 on right). The proposed riparian corridors along the left overbank of Reaches 4 and 5 include riparian vegetation on the existing levee berm and crown (LAR-6). The Reach 7 features include banks restructured to support vegetation on both sides of the channel (LAR-2 and LAR-5).

- **Alternative 13v**: In Reaches 1 and 2, the proposed riparian corridor along the left and right overbanks includes riparian vegetation on or along the existing levee (LAR-7 and LAR-3). In Reach 3, the proposed riparian corridor along the left and right overbanks includes riparian vegetation on or along the existing levee (LAR-7 and LAR-6 on left, LAR-3 on right). The proposed riparian corridors along the left overbank of Reaches 4 and 5 include riparian vegetation on the existing levee berm and crown (LAR-6).

- **Alternative 16**: In Reaches 1 and 2, the proposed riparian corridor along the left and right overbanks includes riparian vegetation on or along the existing levee (LAR-7 and LAR-3). In Reach 3, the proposed riparian corridor along the left and right overbanks includes riparian vegetation on or along the existing levee (LAR-7 and LAR-6 on left, LAR-3 on right).The proposed riparian corridors along the left overbank of Reaches 4 and 5 include riparian vegetation on the existing levee berm and crown (LAR-6). The Reach 5 features also include planted terracing on the left bank (with concrete erosion control) and overhanging vegetation on a vertical wall on the right bank (LAR-6). The Reach 7 features include banks restructured to support vegetation on both sides of the channel (LAR-2 and LAR-5). In Reach 8, the features include planted terracing on the right bank (LAR-2) and channel expansion and terracing on the left bank (LAR-5).

- **Alternative 20**: In Reaches 1 and 2, the proposed riparian corridor along the left and right overbanks includes riparian vegetation on or along the existing levee (LAR-7 and LAR-3). The Reach 2 proposed features also involve channel modifications that would include overhanging vegetation on a vertical wall on the right bank (LAR-3). The Reach 3 features include the widening of Verdugo Wash and planting on the left bank (LAR-7 and LAR-6) and planting of a riparian corridor along the right overbank, on or along the existing levee (LAR-3). The proposed riparian corridors along the left overbank of Reaches 4 and 5 include riparian vegetation on the existing levee berm and crown (LAR-

6). The Reach 5 plan also calls for planted terracing on the left bank (with concrete erosion control) and overhanging vegetation on a vertical wall on the right bank (LAR-6). In Reach 8, the features include planted terracing on the right bank (LAR-2) and channel expansion and terracing on the left bank (LAR-5).

Wildlife is still expected to use the levee plantings as a movement corridor between the more diverse riparian habitat areas, which will provide habitat for small mammals, reptiles, and birds. By substituting riparian vegetation with riparian forbs on the levees, CHAP values in the final array would decrease slightly for those areas. However the overall CHAP values and the ranking of the final array would not be significantly impacted as the decrease would be relative across all alternatives in the final array.

Construction of restoration features that modify levees would necessitate removal of existing vegetation on and adjacent to the existing levees being modified. Where vegetation removal on and adjacent to levees is necessary to accommodate construction, no additional engineering analysis of the existing vegetation is needed to confirm vegetation removal. Removal of invasive species will be undertaken to accomplish the ecosystem restoration project purpose. Where vegetation removal is not necessary to accommodate feature construction but vegetation may have a detrimental effect on safety, structural integrity, or accessibility of the constructed/modified levee features, an engineering analysis will be undertaken to determine whether the vegetation poses an unacceptable risk. Based on the engineering analysis, vegetation determined to pose an unacceptable risk to the constructed features shall be removed as part of project construction. Vegetation on or adjacent to levees modified by the restoration project that is not determined to pose a safety, structural integrity, or accessibility risk will be documented in a vegetation variance. Any required analysis will be accomplished during PED.

For levee embankments within the ARBOR reach, which is the project reach, that would not be modified as part of the ecosystem restoration project, these portions will continue to be operated and maintained as part of the LACDA project by the Corps.

5.3.3 HTRW

A study constraint was to avoid sites contaminated with HTRW to the extent practicable. If sites cannot be avoided, the cost of HTRW investigations is cost-shared, but the non-Federal sponsor has responsibility at 100 percent non-project cost for undertaking or otherwise ensuring remediation of any known or unknown HTRW to provide sites compatible with the land use necessary for the restoration project. As described in this report and Appendix K HTRW Survey Report Appendix, there are known contaminated sites within the study area that cannot be avoided by the project. These include the San Fernando Valley Superfund Site, and Taylor Yard G1 and G2, which are considered high impact sites. In addition, contamination is possible at the LATC site based on historical uses, posing a potentially high impact to the project since the extent of this potential contamination is unknown. Localized groundwater contamination may also be encountered during construction. Under all alternatives the non-Federal sponsor would remediate or ensure the remediation of soil contamination to the standard required for the restoration project prior to construction of restoration features at the affected sites. Because it is infeasible to remediate groundwater contamination prior to construction, the sponsor would be responsible at 100 percent non-

project cost for addressing contaminated groundwater including treatment and disposal during dewatering activities. The sponsor understands its responsibility and has directly committed to undertaking or ensuring the necessary HTRW remediation to facilitate the project, including providing sites to be cleaned to be compatible with the restoration land use necessary and addressing groundwater contamination during dewatering activities.

5.4 Modified NER Plan

Following public review, further analysis was performed that included a more detailed cost analysis using Mii software, real estate cost updates, and further modified contingencies based upon a full cost risk summary analysis. This analysis identified a more cost effective variation on Alternative 13 (referred to throughout the IFR and Appendices as "Alternative 13v") that is identical to Alternative 13 except for Reach 7, where it includes the reach plan included in Alternative 20 that provides 10 acres of marsh and a connection to the Los Angeles State Historic Park. As described in the IFR, the previously identified NER plan has been modified to include the substitution of the Reach 7 plan on the basis of the analysis referenced above; Alternative 13v is the NER plan. Because the analysis in this Appendix included analysis of all of the components of Alternative 13v, no separate or additional analysis is necessary. For the assessment of Alternative 13v for Reaches 1-6 and 8, see the Alternative 13 analysis included in this Appendix. For the assessment of Alternative 13v for Reach 7, see the Alternative 20 analysis included in this Appendix.

Alternative 20 is the Recommended Plan in the IFR.

6. UTILITIES

The main Integrated Feasibility Report describes the identification of the NER Plan and Locally Preferred Plan. That plan identification is not being repeated here. For purposes of evaluating potential utility relocation needs the NER and LPP were reviewed. Alternative 13v is the NER Plan and Alternative 20 the Locally Preferred Plan.

A desktop survey was conducted comparing the footprint of the NER and LPP with known utilities to inform relocation cost estimates. This included review of data available on the City of Los Angeles Department of Public Works, "Navigate LA" GIS website http://navigatela.lacity.org/index01.cfm. It should be recognized that the data base utilized may not contain all existing utilities and their locations. However, it is assumed that the data utilized is adequate for the current level of study. Unless otherwise noted the assumptions apply to both the NER and LPP. All water, sewer and power lines referenced below are indicated in the available information to be owned and operated by LADWP.

Reach 1 - Pollywog Park/Headworks to Midpoint of Bette Davis Park

Reaches 1 and 2 are comprised entirely of riparian corridors. It is assumed that riparian corridors will not affect utilities, and potential impacts can be avoided and designed around during PED.

Reach 2- Midpoint Bette Davis Park to Upstream end Ferraro Fields

The right bank of the channel is being converted from trapezoid to vertical in Alternative 20. There are power lines along the top of bank and storm water outfalls along the bank. It is assumed that the power lines do not require relocation and can be worked around (protect in place). Storm water outfalls will be modified with the channel, but may require relocations.

Reach 3- Ferraro Fields- to Brazil Street

There is a 48" concrete sewer line that bisecting the area where a side channel is proposed along the right bank in Ferraro Fields. The nearest manhole indicates that this is only 9ft below ground where the two intersect. Recommend that the side channel design will protect this in place, as designed during PED.

Reach 3- Verdugo Wash. Two sewer lines are indicated as crossing the under the river channel in siphons. One is a 21" VCP and the other 48" concrete pipe. Both appear to be 20' below the channel and deep enough to protect in place. There are also several lines in the areas to be widened that appear to service that area. These would need to be removed for construction and abandoned as the buildings that they service would be removed. These are local service lines to structures, not public utility lines, and no relocation has been identified. (This only applies to Alternative 20.)

Reach 4- Brazil Street to Los Feliz Boulevard

There is a 10" VCP indicated within Griffith Park Golf Course near the planned side channel. This could be designed around and avoided during construction.

Reach 5- Los Feliz Boulevard to Glendale Freeway

Immediately upstream of Glendale Freeway there are an abandoned 48" concrete pipe, and a 36" VCP in a siphon. Manhole data indicates that the siphon is between 22-37 feet deep as is crosses the channel. Modifications to the bank line should be able to avoid these, and protect in place if necessary. The river channel is not being excavated in this reach.

Reach 6- Glendale Freeway to I-5 Freeway

There are 2 lines crossing the channel near the north end of Taylor Yard. One is listed as a 24" CIP (abandoned), and a 15" VCP marked as inactive. Should be able to protect both in place.

Upstream of I-5 there is a 48" RCP crossing under the river in a siphon, nearest manholes indicate a depth of 22+ feet. No impact.

Power Lines- Lines that cross Taylor Yard will be relocated to the perimeter to avoid impacts.

Reach 7- I-5 Freeway to Main Street

Arroyo Seco- Sewer and water lines cross the channel at the San Fernando Road Bridge. These can be avoided and protected in place.

Railroad- The rail line on the right bank of the river channel near the Los Angeles State Historic Park (Cornfields) will be placed upon a trestle. It is assumed that the construction will be conducted in a manner to minimize closure or delays.

Power Lines- There are power lines along the right bank and two towers in the section proposed for terraces and trestle. These will be moved for construction.

There are several utilites along Baker Street that would require relocation if the street is removed for restoration. However based on USACE response to Metro the street will remain in place so that they can access the Gold Line maintenance facility. In addition the proposed waterwheel will likely be constructed in the next two years. Refinements are being made to the design to avoid impacting the street or waterwheel, utilities impacts will also be avoided.

Reach 8- Main Street to First Street (Alternative 20 only)

LATC

Two sewer lines including a 24" VCP (West alignment) and a 54" concrete pipe (East alignment) cross LATC parallel to the existing railroad tracks. On average, the West Alignment is 16.5 feet above the invert of the LAR and 202 feet from the centerline. The West alignment varies from 8 feet to 42 feet away from the centerline of the UPRR. In some locations, the West alignment intersects the alignment of the UPRR. On average, the East Alignment is 6.2 feet above the invert of the LAR and 312 feet from the centerline. The East Alignment varies from 65 feet to 198 feet away from the centerline of the UPRR. In some locations, the East Alignment intersects the alignment of the UPRR.

Sewer- Both sewer lines will be relocated across the river in a siphon, extended downstream along the right bank, then cross back under the channel in a siphon to their original alignment.

Electric towers- There are 3 electrical towers along the east bank (approximately 2,100 ft). To allow for channel modifications it is assumed that these lines will be moved to the west side of the river.

Railroad - Railroad lines running parallel to left bank of the channel will be placed upon trestles for implementation of the project. It is assumed that the construction will be conducted in a manner to minimize closure or delays.

6.1 Summary of Utility Relocation Assumptions

The table below summarizes the assumed relocations that will be required for implementation of the project. Other known utilities will not be impacted or will be protected in place.

Table 6-1. Summary of Utility Relocation Assumptions

NER (ALT 13v)	LPP (ALT 20)
Reach 6- LADWP Power lines, ~4,800 feet and 6 towers relocated around the Taylor Yard parcel being restored.	Reach 6- LADWP Power lines, ~4,800 feet (6 towers) relocated around the Taylor Yard parcel being restored.
Reach 7- Railroad, approximately 500 ft placed on trestle.	Reach 7- Railroad, approximately 500 ft placed on trestle.
Reach 7- LADWP Power lines, ~500 feet (2 towers) relocated to allow construction on the right bank.	Reach 7- LADWP Power lines, ~500 feet (2 towers) relocated to allow construction on the right bank.
	Reach 8- Relocate two LADWP sewer lines (24"VCP and 54" Concrete) sewer lines crossing LATC. Each approximately 2,200 ft length.
	Reach 8- LADWP power lines, ~2,100 ft. (5 towers) on the left bank at LATC, relocate across river.
	Reach 8- Railroad, approximately 1,500 ft placed on trestle.

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Attachment 1 – Alternatives Matrix

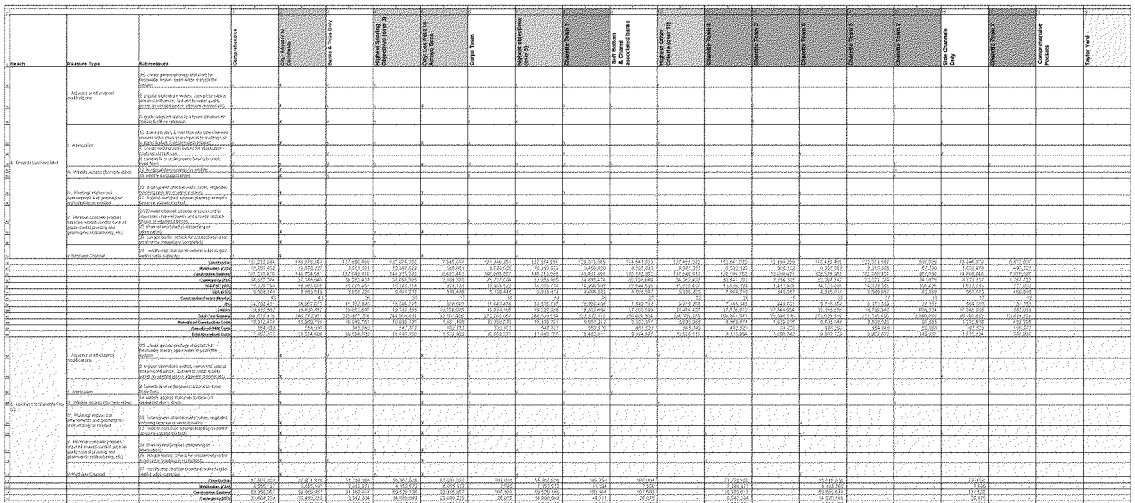
September 2014

LOS ANGELES RIVER COST ESTIMATE
ALTERNATIVES MATRIX

X: Indicates that the measure is included in the alternative

Y: Preliminary area included cut-outs or basins.

LOS ANGELES RIVER COST ESTIMATE
ALTERNATIVES MATRIX



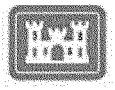
X: Indicates that the measure is included in the alternative.

y: Preliminary array included culverts or basins.

LOS ANGELES RIVER COST ESTIMATE
ALTERNATIVES MATRIX

X: Indicates that this measure is included in the alternative

Y: Preliminary since included cul-de-sacs or basins.



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Attachment 2 - Utilities

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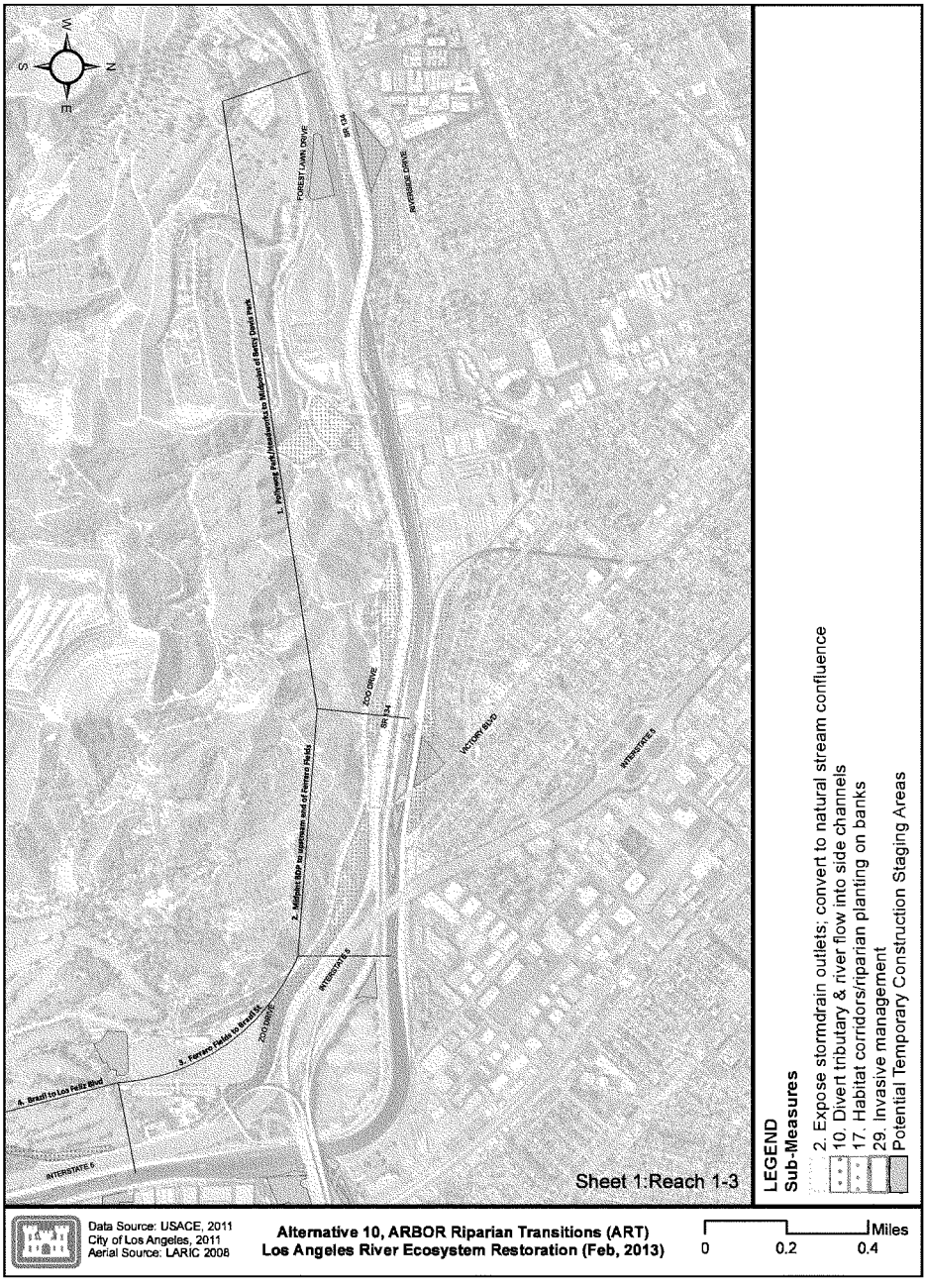
Attachment 3 – Final Array Maps

September 2014


W
S
N
E
FOREST LAWN DRIVE
SR 134
RIVERSIDE DRIVE
1. Potential Realignments to Midpoint of Sepulveda Basin
ZOO DRIVE
SR 134
2. Midpoint SDP to upstream end of Ferrero Fields
VICTORY BLVD
INTERSTATE 5
INTERSTATE 5
3. Ferrero Fields to Brazil St
ZOO DRIVE
4. Brazil to Los Feliz Blvd
INTERSTATE 5
Sheet 1 Reach 1-3
LEGEND
Sub-Measures
2. Expose stormdrain outlets; convert to natural stream confluence
10. Divert tributary & river flow into side channels
17. Habitat corridors/riparian planting on banks
29. Invasive management
Potential Temporary Construction Staging Areas
Data Source: USACE, 2011
City of Los Angeles, 2011
Aerial Source: LARIC 2008
Alternative 10, ARBOR Riparian Transitions (ART)
Los Angeles River Ecosystem Restoration (Feb, 2013)
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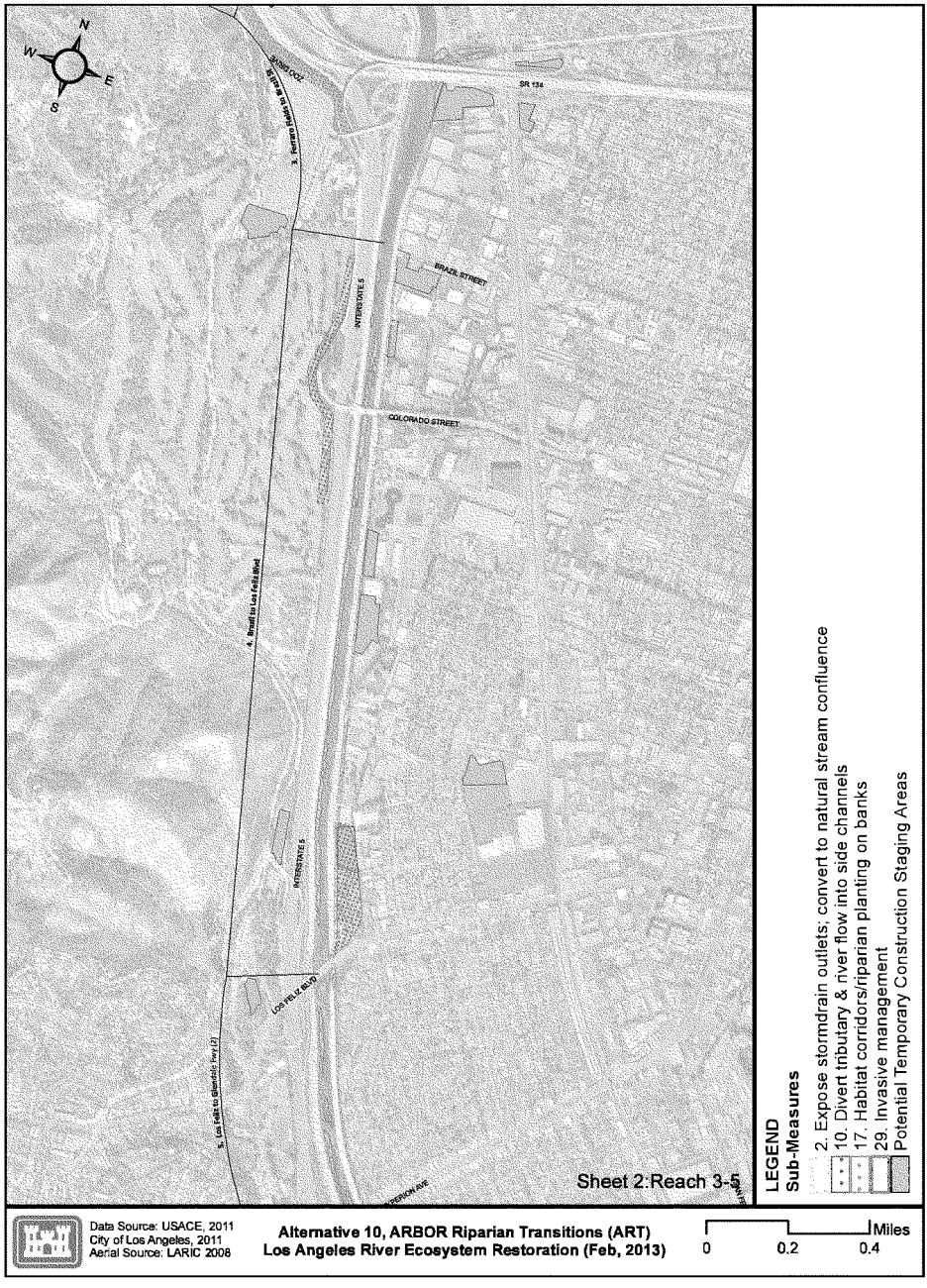
N
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SR 134
BRAZIL STREET
INTERSTATE 5
COLORADO STREET
4. Road to Los Feliz Blvd
INTERSTATE 5
LOS FELIZ BLVD
3a. Los Feliz to Glendale Fwy (-2')
TYBURON AVE
Sheet 2:Reach 3-5
LEGEND
Sub-Measures
2. Expose stormdrain outlets; convert to natural stream confluence
10. Divert tributary & river flow into side channels
17. Habitat corridors/riparian planting on banks
29. Invasive management
Potential Temporary Construction Staging Areas
Data Source: USACE, 2011
City of Los Angeles, 2011
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Los Angeles River Ecosystem Restoration (Feb, 2013)
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0.2
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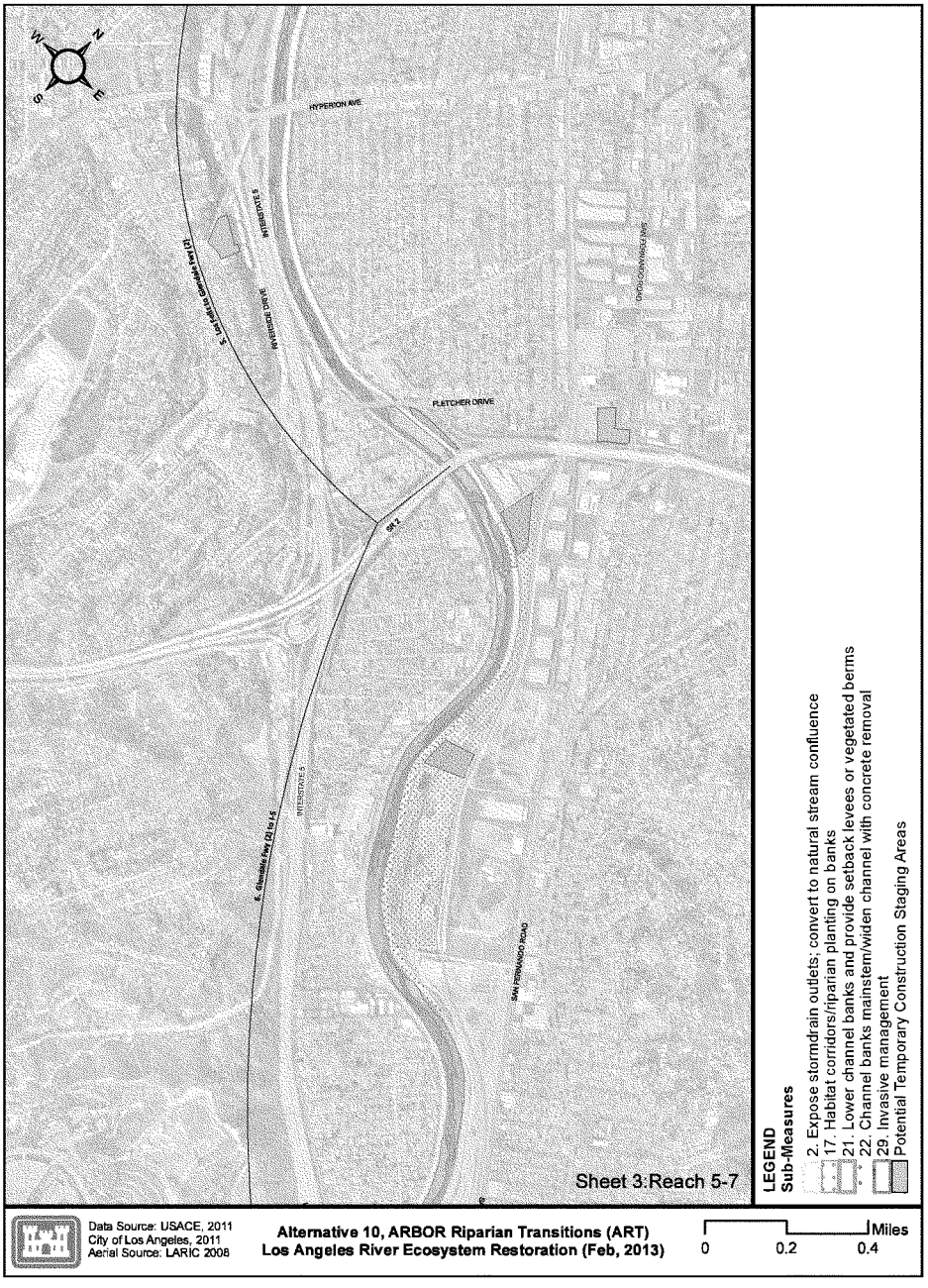
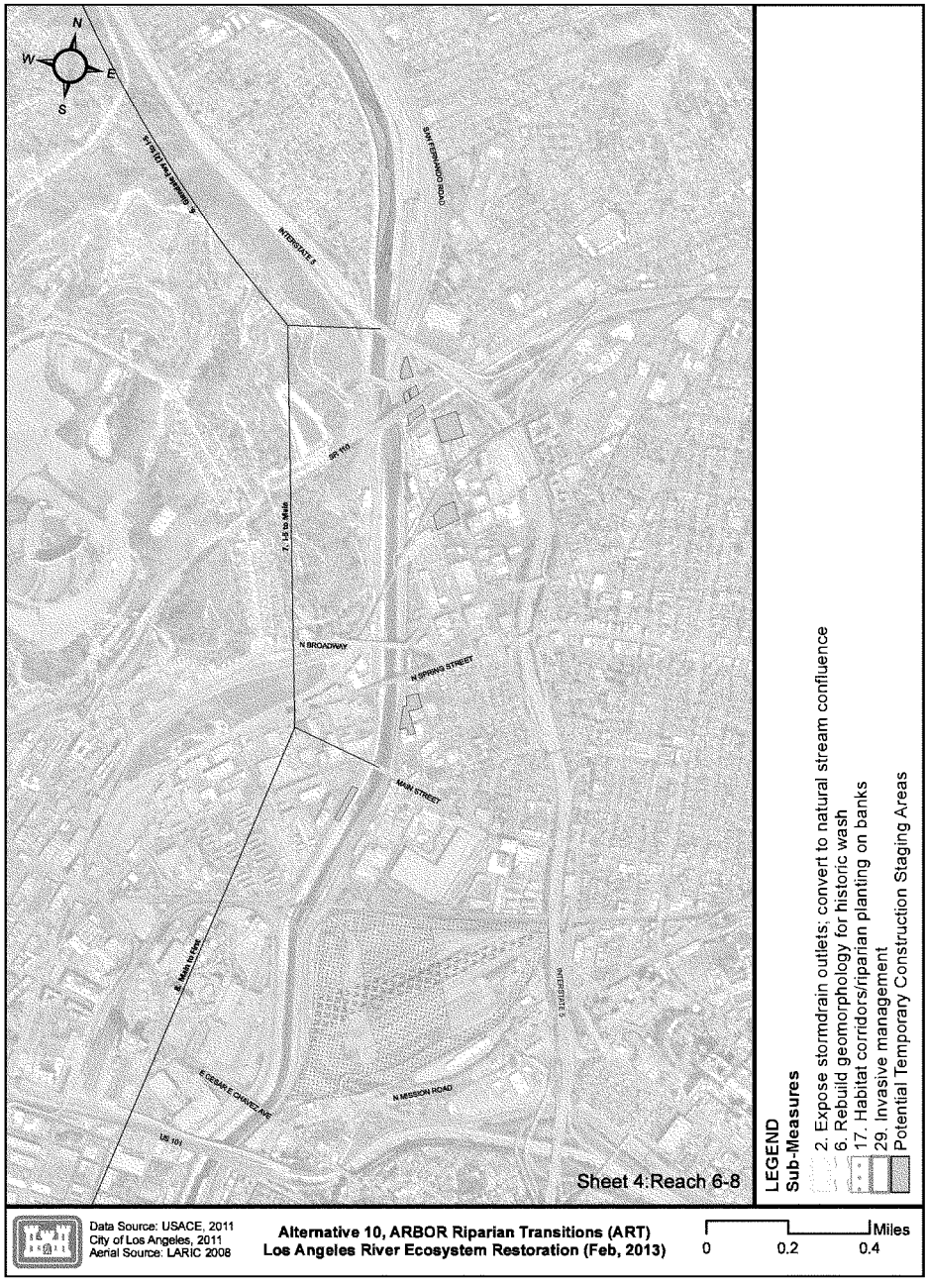
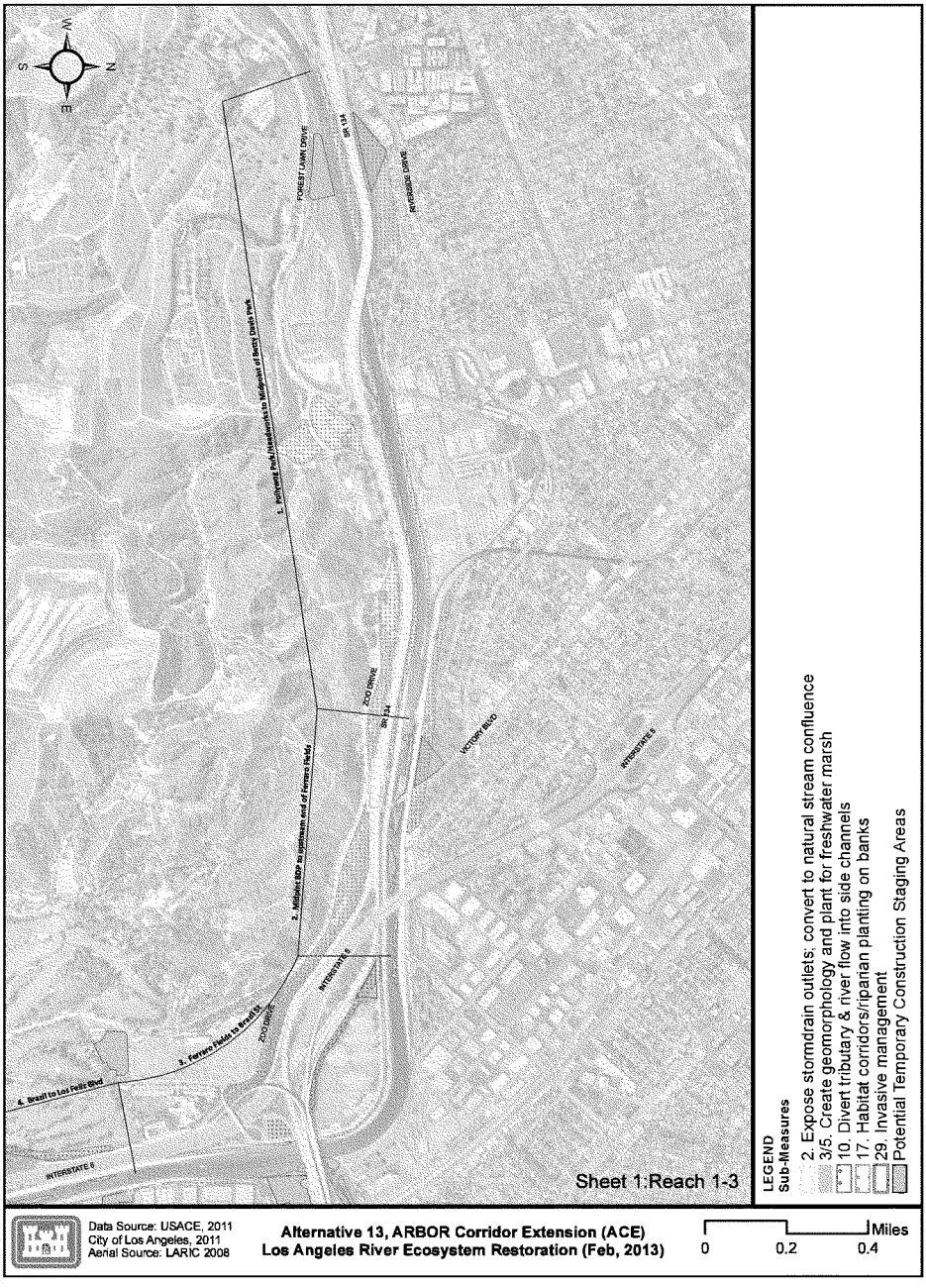
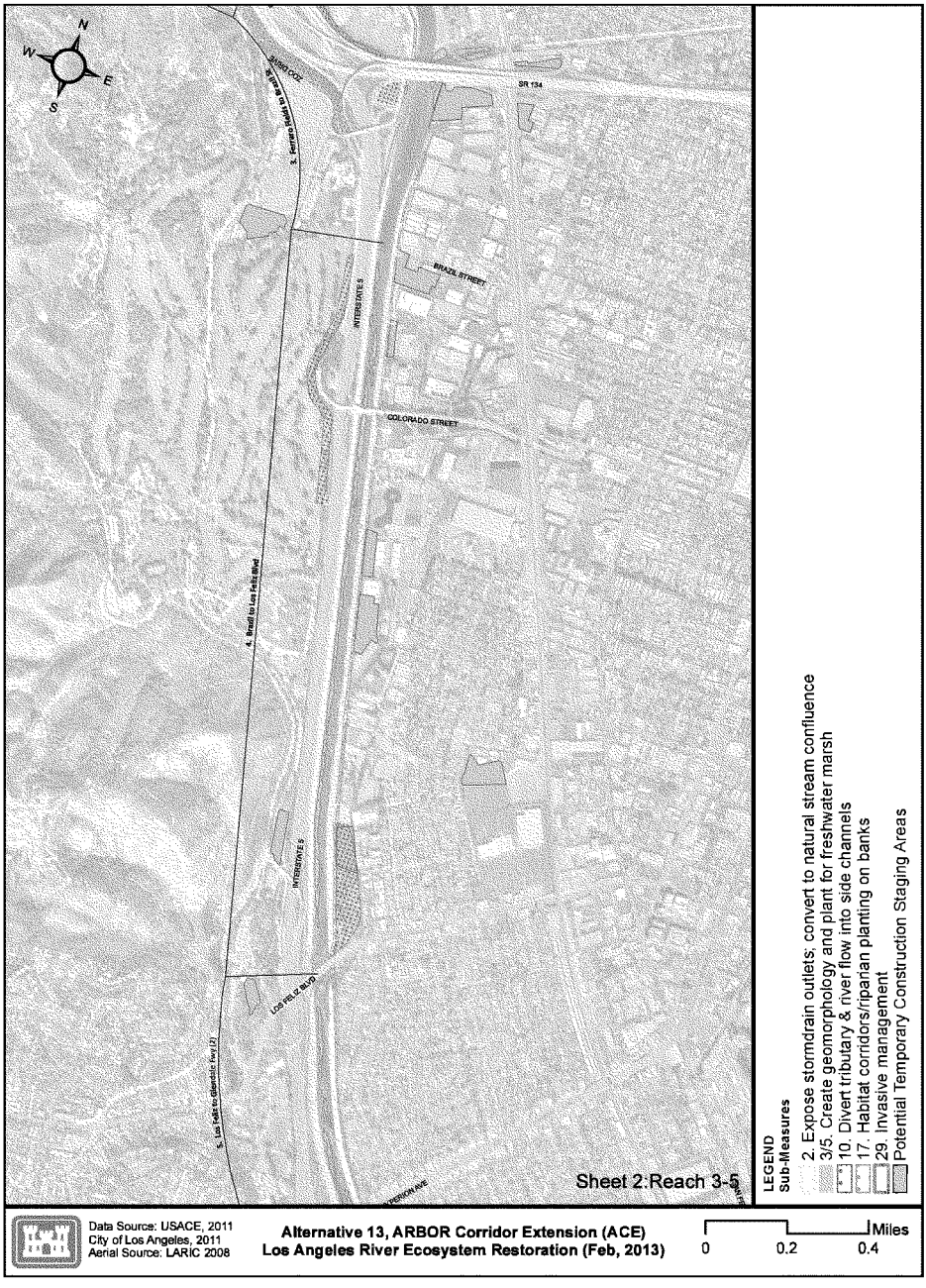
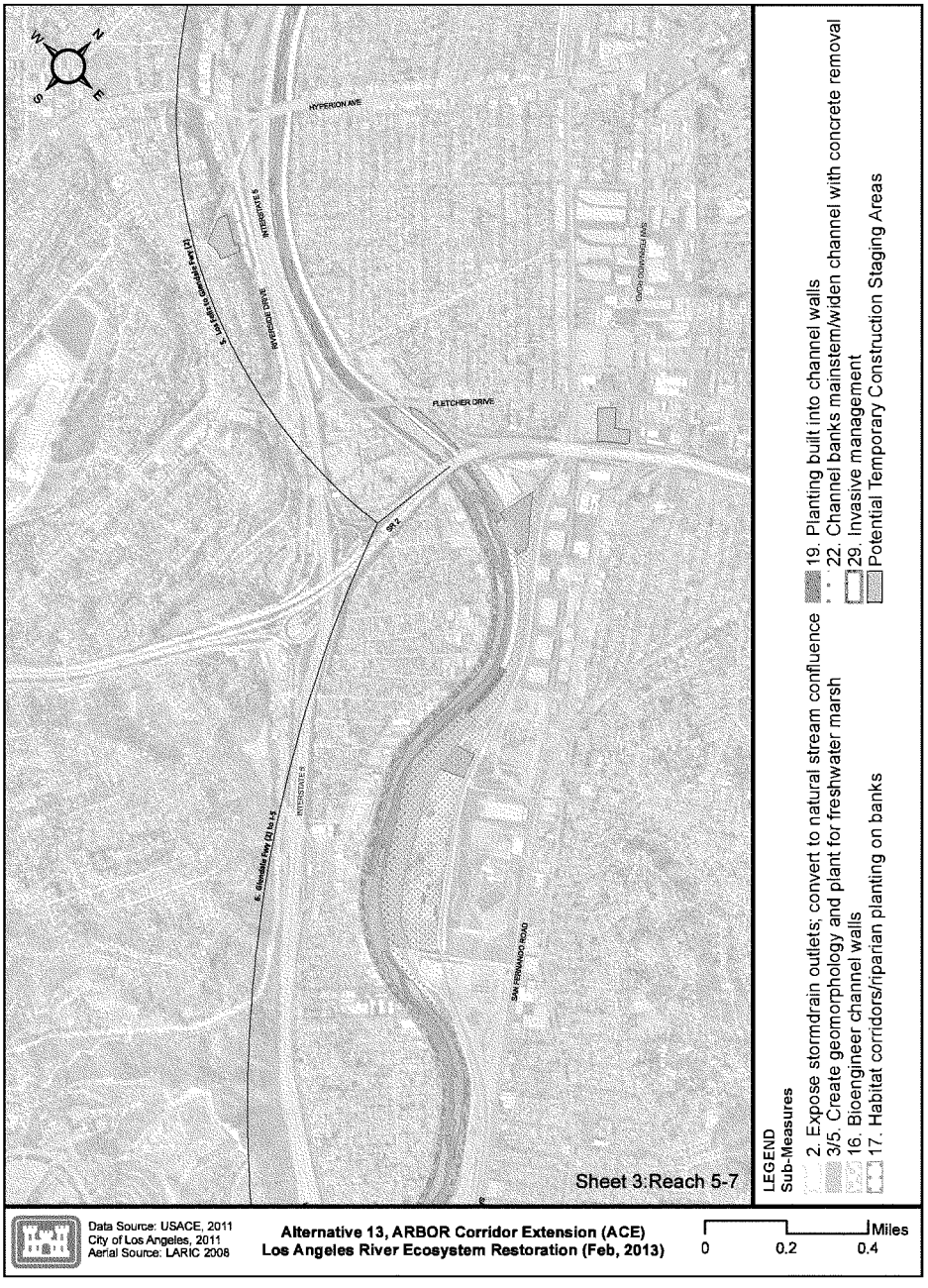
Miles

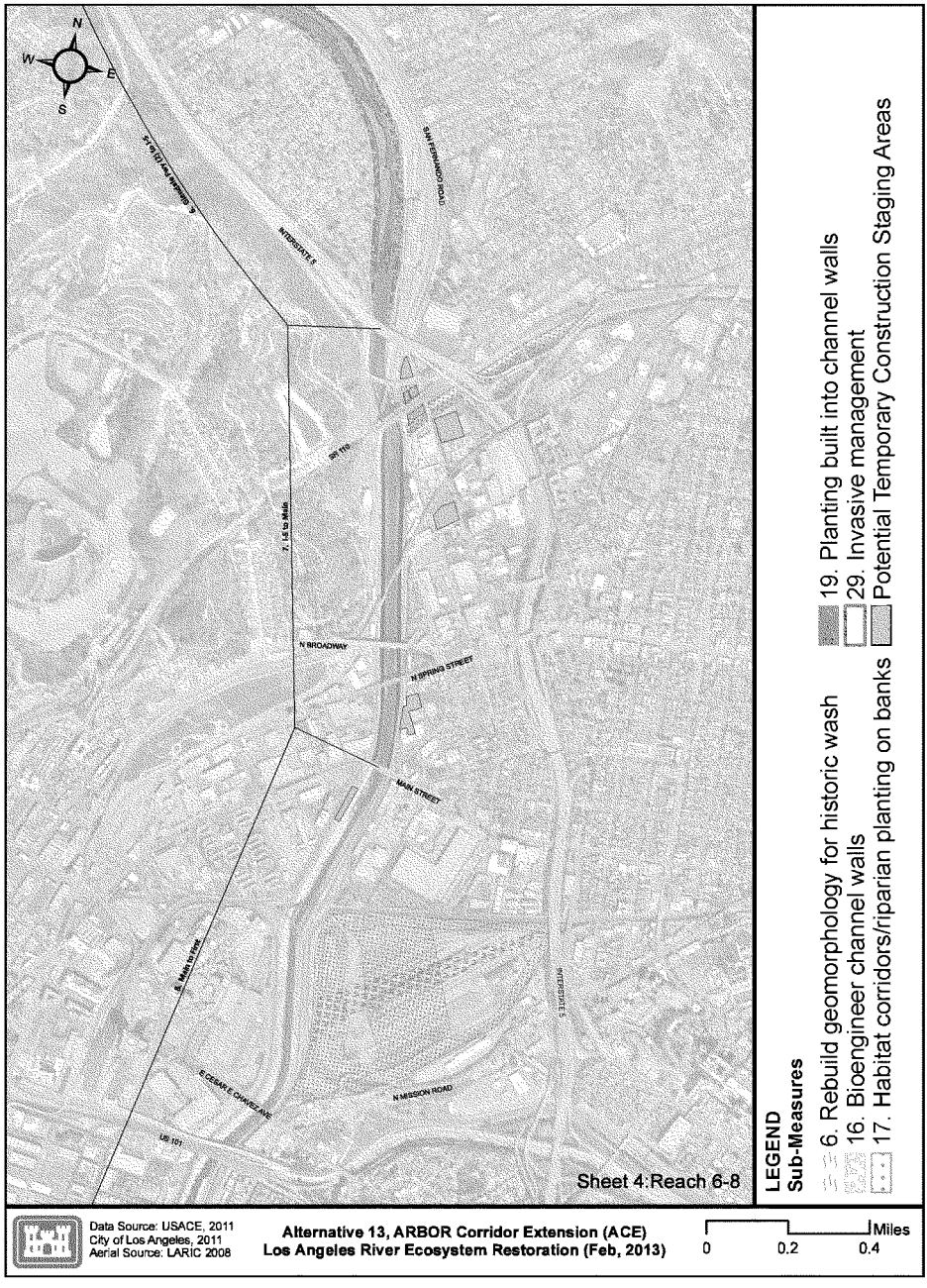

N
S
E
W
HYPERION AVE
NEWELL ST
RIVERSIDE DR
S. Los Angeles Branch Line (LAD)
FLETCHER DRIVE
SR-2
INTERSTATE 5
E. Glendale Fwy (2) to I-5
SAN FERNANDO ROAD
SAN FERNANDO ROAD
Sheet 3:Reach 5-7
LEGEND
Sub-Measures
2. Expose stormdrain outlets; convert to natural stream confluence
17. Habitat corridors/riparian planting on banks
21. Lower channel banks and provide setback levees or vegetated berms
22. Channel banks mainstem/widen channel with concrete removal
29. Invasive management
Potential Temporary Construction Staging Areas
Data Source: USACE, 2011
City of Los Angeles, 2011
Aerial Source: LARIC 2008
Alternative 10, ARBOR Riparian Transitions (ART)
Los Angeles River Ecosystem Restoration (Feb, 2013)
0
0.2
0.4
Miles

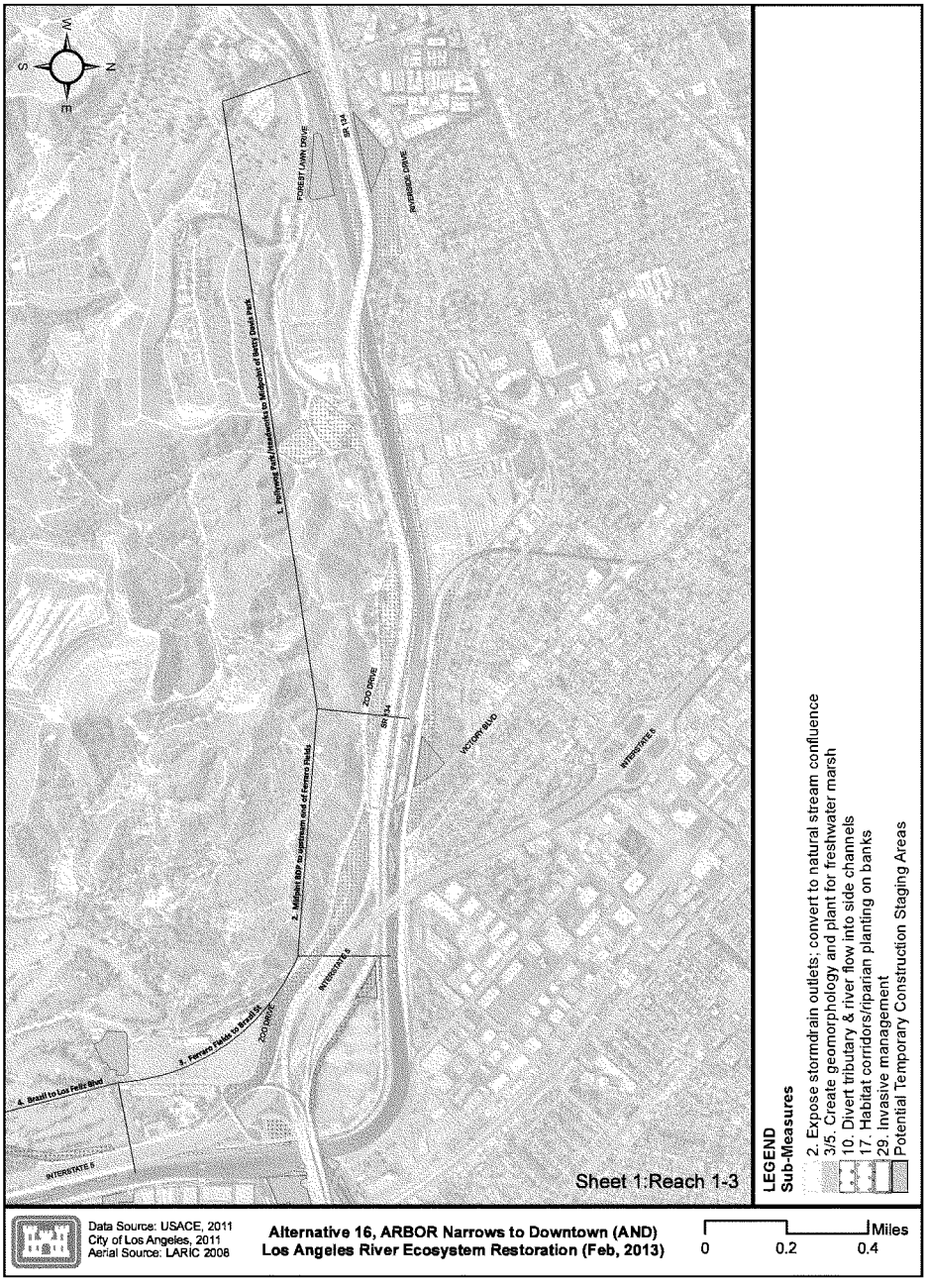

N
W
E
S
S. SAN GABRIEL RIVER (LOS ANGELES)
INTERSTATE 5
SAN FERNANDO ROAD
SR 110
7 - 1/2 to Mile
N BROADWAY
N SPRING STREET
MAIN STREET
E. MAIN STREET
E CESAR E CHAVEZ AVE
N MISSION ROAD
US 101
INTERSTATE 5
Sheet 4:Reach 6-8
LEGEND
Sub-Measures
2. Expose stormdrain outlets; convert to natural stream confluence
6. Rebuild geomorphology for historic wash
17. Habitat corridors/riparian planting on banks
29. Invasive management
Potential Temporary Construction Staging Areas
Data Source: USACE, 2011
City of Los Angeles, 2011
Aerial Source: LARIC 2008
Alternative 10, ARBOR Riparian Transitions (ART)
Los Angeles River Ecosystem Restoration (Feb, 2013)
0
0.2
0.4
Miles


W
S
N
E
FOREST LAWN DRIVE
SR 134
RIVERSIDE DRIVE
1. Relocate Park Headworks to Midpoint of Sand Dunes Park
2. Midpoint SDP as upstream end of Ferrara Fields
ZOO DRIVE
SR 134
VICTORY BLVD
INTERSTATE 5
3. Ferrara Fields to End SR
ZOO DRIVE
INTERSTATE 5
4. Brazil to Los Feliz Blvd
INTERSTATE 5
Sheet 1 Reach 1-3
LEGEND
Sub-Measures
2. Expose stormdrain outlets: convert to natural stream confluence
3/5. Create geomorphology and plant for freshwater marsh
10. Divert tributary & river flow into side channels
17. Habitat corridors/riparian planting on banks
29. Invasive management
Potential Temporary Construction Staging Areas
Data Source: USACE, 2011
City of Los Angeles, 2011
Aerial Source: LARIC 2008
Alternative 13, ARBOR Corridor Extension (ACE)
Los Angeles River Ecosystem Restoration (Feb, 2013)
0
0.2
0.4
Miles

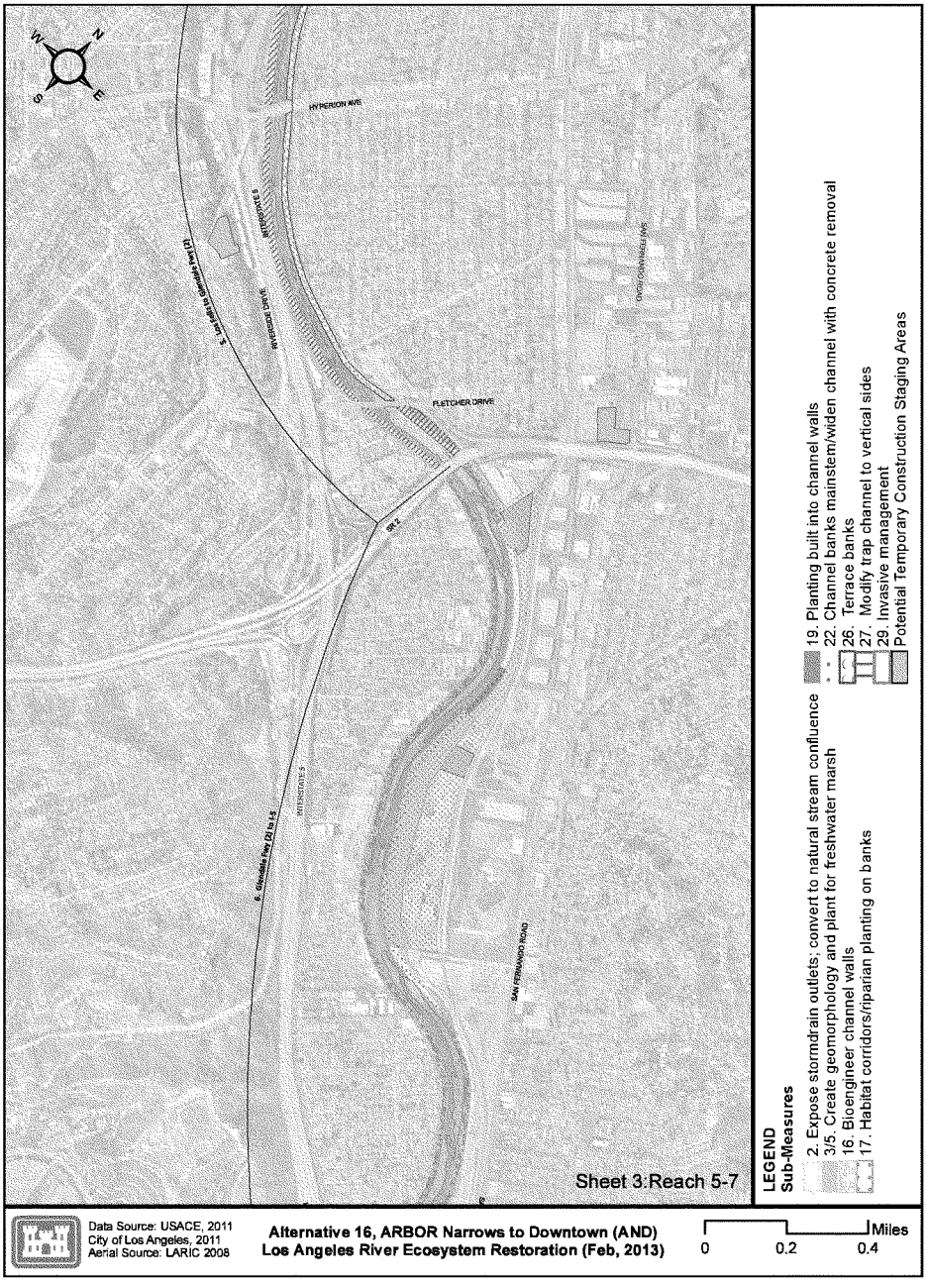

N
W
E
S
SR 134
BRAZIL STREET
INTERSTATE 5
COLORADO STREET
4. Road to Los Feliz Blvd
INTERSTATE 5
LOS FELIZ BLVD
3. Los Feliz to Glendale Fwy (2)
VERDUGO AVE
Sheet 2:Reach 3-5
LEGEND
Sub-Measures
2. Expose stormdrain outlets; convert to natural stream confluence
3/5. Create geomorphology and plant for freshwater marsh
10. Divert tributary & river flow into side channels
17. Habitat corridors/riparian planting on banks
29. Invasive management
Potential Temporary Construction Staging Areas
Data Source: USACE, 2011
City of Los Angeles, 2011
Aerial Source: LARIC 2008
Alternative 13, ARBOR Corridor Extension (ACE)
Los Angeles River Ecosystem Restoration (Feb, 2013)
0
0.2
0.4
Miles

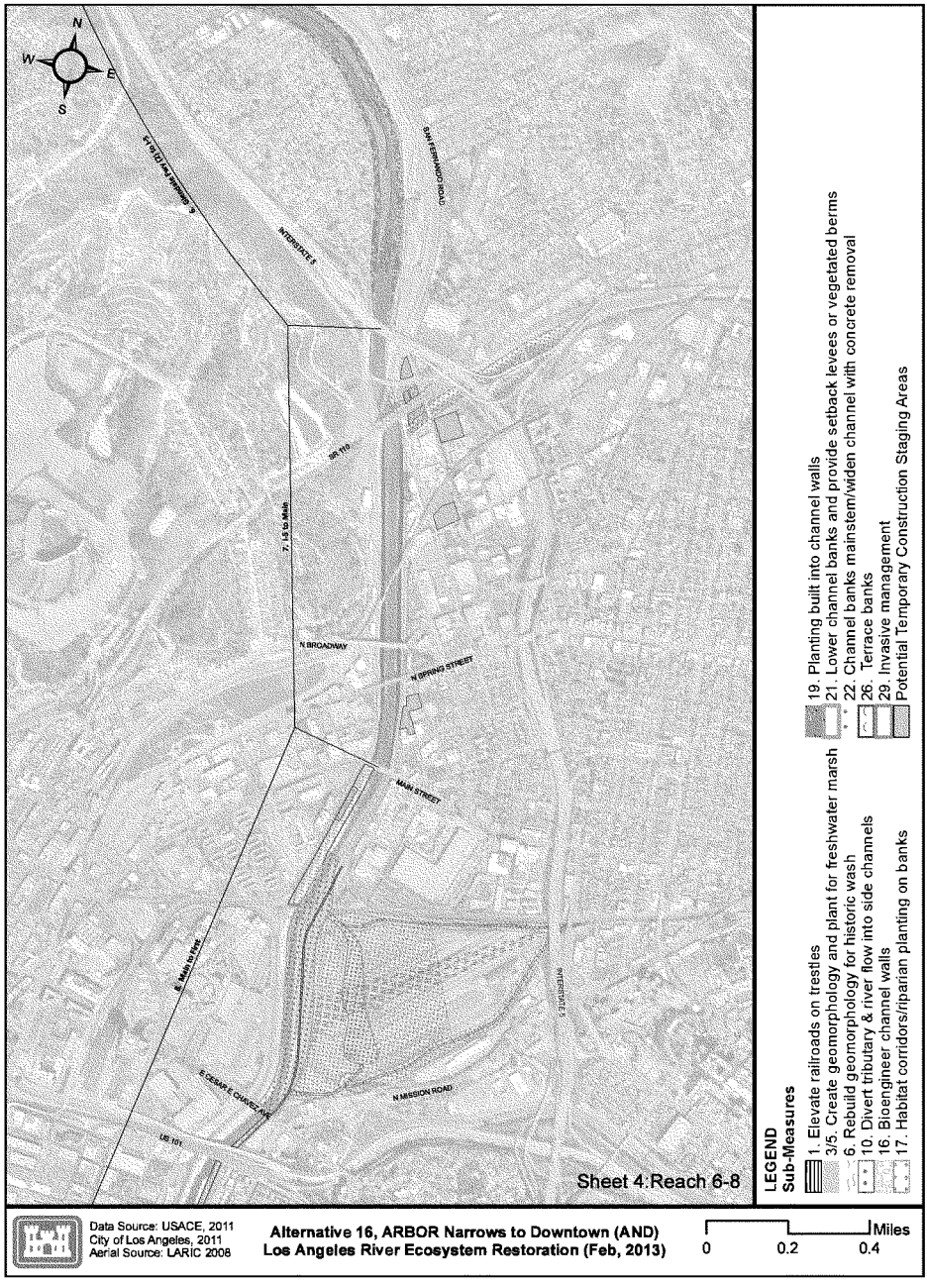

HYPERION AVE
FLETCHER DRIVE
SAN FERNANDO ROAD
INTERSTATE 5
Sheet 3:Reach 5-7
LEGEND
Sub-Measures
2. Expose stormdrain outlets; convert to natural stream confluence
3/5. Create geomorphology and plant for freshwater marsh
16. Bioengineer channel walls
17. Habitat corridors/riparian planting on banks
19. Planting built into channel walls
22. Channel banks mainstem/widen channel with concrete removal
29. Invasive management
Potential Temporary Construction Staging Areas
Data Source: USACE, 2011
City of Los Angeles, 2011
Aerial Source: LARIC 2008
Alternative 13, ARBOR Corridor Extension (ACE)
Los Angeles River Ecosystem Restoration (Feb, 2013)
0
0.2
0.4
Miles


N
W
E
S
SAN FERNANDO ROAD
INTERSTATE 5
SR 110
N BROADWAY
N SPRING STREET
MAIN STREET
E CESAR E CHAVEZ AVE
N MISSION ROAD
US-101
Sheet 4:Reach 6-8
LEGEND
Sub-Measures
6. Rebuild geomorphology for historic wash
16. Bioengineer channel walls
17. Habitat corridors/riparian planting on banks
19. Planting built into channel walls
29. Invasive management
Potential Temporary Construction Staging Areas
Data Source: USACE, 2011
City of Los Angeles, 2011
Aerial Source: LARIC 2008
Alternative 13, ARBOR Corridor Extension (ACE)
Los Angeles River Ecosystem Restoration (Feb, 2013)
0
0.2
0.4
Miles


W
S
N
E
FOREST LAWN DRIVE
SR 134
RIVERSIDE DRIVE
1. Improve Trail Intersects to Midpoint of Harry Davis Park
ZOO DRIVE
SR 134
VICTORY BLVD
2. Midpoint SDP to upstream end of Ferraro Fields
INTERSTATE 5
INTERSTATE 5
ZOO DRIVE
3. Ferraro Fields to Brazil St.
4. Brazil to Los Feliz Blvd
INTERSTATE 5
Sheet 1 Reach 1-3
LEGEND
Sub-Measures
2. Expose stormdrain outlets; convert to natural stream confluence
3/5. Create geomorphology and plant for freshwater marsh
10. Divert tributary & river flow into side channels
17. Habitat corridors/riparian planting on banks
29. Invasive management
Potential Temporary Construction Staging Areas
Data Source: USACE, 2011
City of Los Angeles, 2011
Aerial Source: LARIC 2008
Alternative 16, ARBOR Narrows to Downtown (AND)
Los Angeles River Ecosystem Restoration (Feb, 2013)
0
0.2
0.4
Miles

N
W
E
S
SR 134
BRAZIL STREET
INTERSTATE 5
COLORADO STREET
3. Pasadena to Los Feliz Blvd
4. Brazil to Los Feliz Blvd
INTERSTATE 5
LOS FELIZ BLVD
5. Los Feliz to Glendale Fwy (2)
TERRON AVE
Sheet 2:Reach 3-5
LEGEND
Sub-Measures
2. Expose stormdrain outlets; convert to natural stream confluence
3/5. Create geomorphology and plant for freshwater marsh
10. Divert tributary & river flow into side channels
16. Bioengineer channel walls
17. Habitat corridors/riparian planting on banks
26. Terrace banks
27. Modify trap channel to vertical sides
29. Invasive management
Potential Temporary Construction Staging Areas
Data Source: USACE, 2011
City of Los Angeles, 2011
Aerial Source: LARIC 2008
Alternative 16, ARBOR Narrows to Downtown (AND)
Los Angeles River Ecosystem Restoration (Feb, 2013)
0
0.2
0.4
Miles


N
S
E
W
HYPERION AVE
INTERSTATE 5
RIVERSIDE DR.
S. Los Angeles River (D) Rs 1-2
FLETCHER DRIVE
SR-2
SAN FERNANDO ROAD
R. Glendale Fwy (D) Rs 1-2
INTERSTATE 5
Sheet 3:Reach 5-7
LEGEND
Sub-Measures
2. Expose stormdrain outlets; convert to natural stream confluence
3/5. Create geomorphology and plant for freshwater marsh
16. Bioengineer channel walls
17. Habitat corridors/riparian planting on banks
19. Planting built into channel walls
22. Channel banks mainstem/widen channel with concrete removal
26. Terrace banks
27. Modify trap channel to vertical sides
29. Invasive management
Potential Temporary Construction Staging Areas
Data Source: USACE, 2011
City of Los Angeles, 2011
Aerial Source: LARIC 2008
Alternative 16, ARBOR Narrows to Downtown (AND)
Los Angeles River Ecosystem Restoration (Feb, 2013)
0
0.2
0.4
Miles


N
W
E
S
SAN FERNANDO ROAD
INTERSTATE 5
SR 110
7, I-5 to Main
N BROADWAY
W SPRING STREET
MAIN STREET
S. MAIN STREET
E CESAR E CHAVEZ AVE
N MISSION ROAD
US 101
Sheet 4:Reach 6-8
LEGEND
Sub-Measures
1. Elevate railroads on trestles
3/5. Create geomorphology and plant for freshwater marsh
6. Rebuild geomorphology for historic wash
10. Divert tributary & river flow into side channels
16. Bioengineer channel walls
17. Habitat corridors/riparian planting on banks
19. Planting built into channel walls
21. Lower channel banks and provide setback levees or vegetated berms
22. Channel banks mainstem/widen channel with concrete removal
26. Terrace banks
29. Invasive management
Potential Temporary Construction Staging Areas
Data Source: USACE, 2011
City of Los Angeles, 2011
Aerial Source: LARIC 2008
Alternative 16, ARBOR Narrows to Downtown (AND)
Los Angeles River Ecosystem Restoration (Feb, 2013)
0
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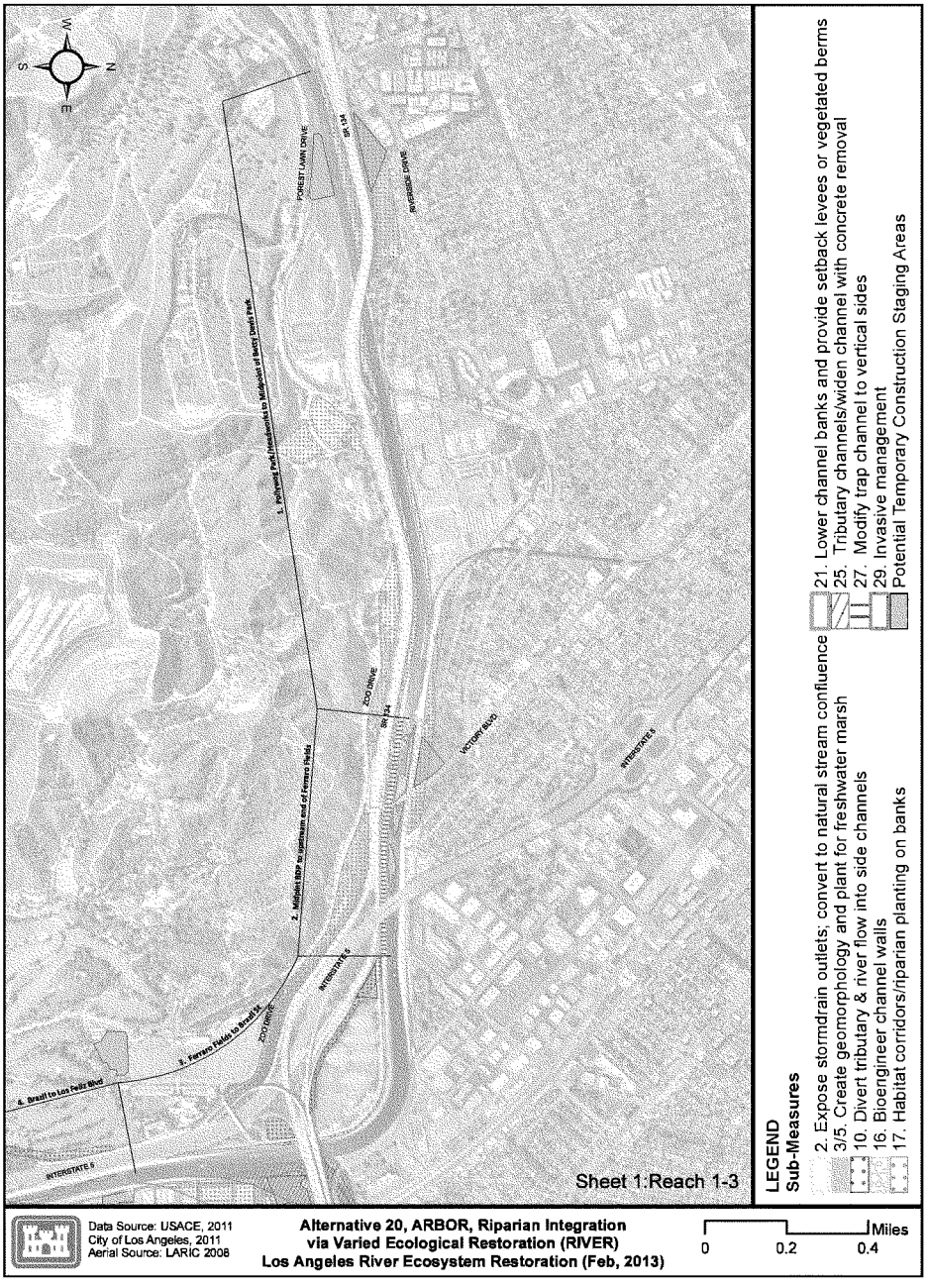
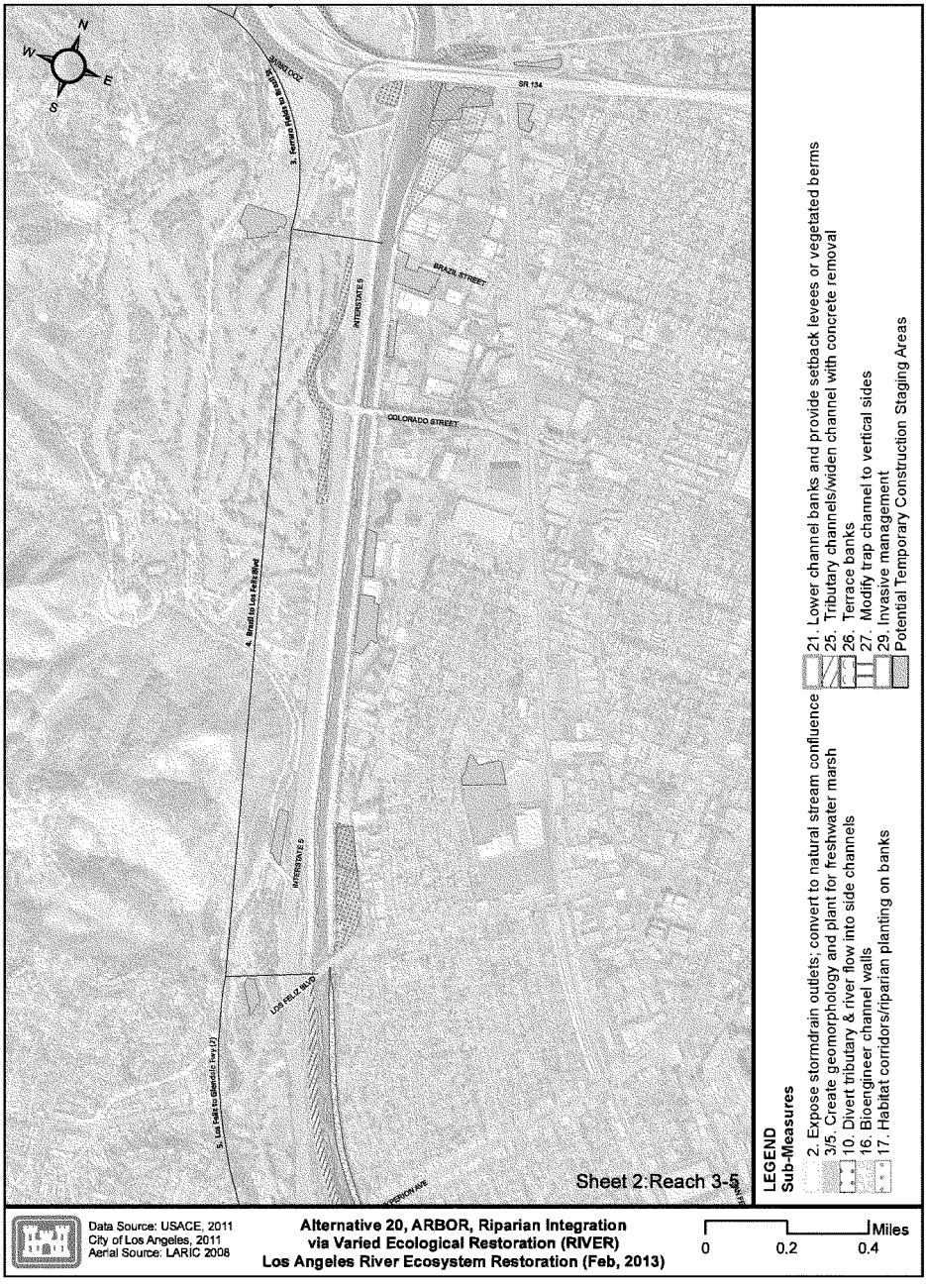
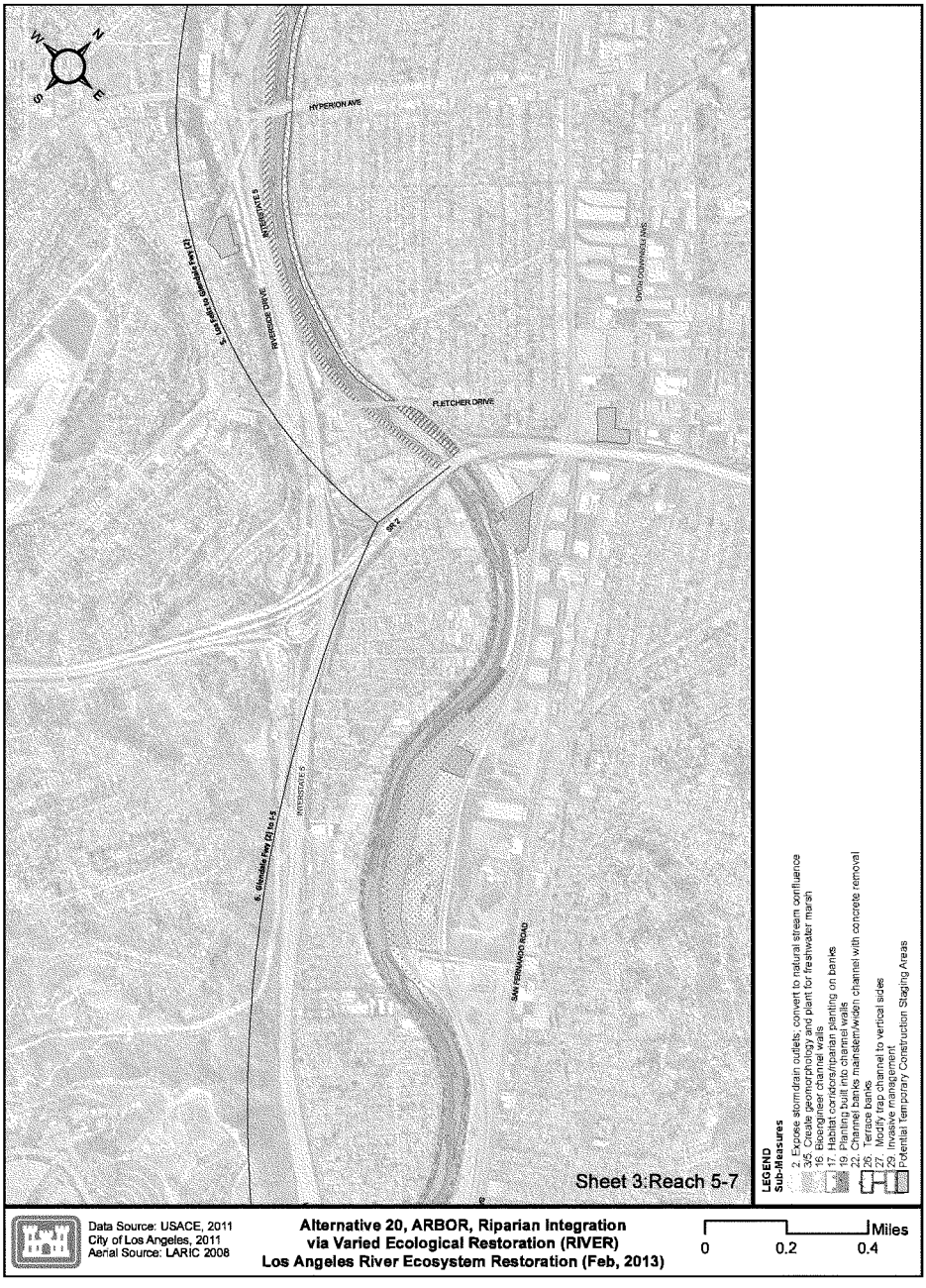
Miles


Sheet 1 Reach 1-3
1. Pathway Park Headwaters to Midpoint of Sheep Creek Park
2. Midpoint SCP to upstream end of Ferrero Fields
3. Ferrero Fields to Brazil St
4. Brazil to Los Feliz Blvd
FOREST LAWN DRIVE
SR 134
RIVERSIDE DRIVE
ZOO DRIVE
SR 134
VICTORY BLVD
INTERSTATE 5
ZOO DRIVE
INTERSTATE 5
INTERSTATE 5
LEGEND
Sub-Measures
2. Expose stormdrain outlets; convert to natural stream confluence
3/5. Create geomorphology and plant for freshwater marsh
10. Divert tributary & river flow into side channels
16. Bioengineer channel walls
17. Habitat corridors/riparian planting on banks
21. Lower channel banks and provide setback levees or vegetated berms
25. Tributary channels/widen channel with concrete removal
27. Modify trap channel to vertical sides
29. Invasive management
Potential Temporary Construction Staging Areas
Data Source: USACE, 2011
City of Los Angeles, 2011
Aerial Source: LARIC 2008
Alternative 20, ARBOR, Riparian Integration
via Varied Ecological Restoration (RIVER)
Los Angeles River Ecosystem Restoration (Feb, 2013)
0
0.2
0.4
Miles


N
W
E
S
SR 134
BRAZIL STREET
COLORADO STREET
INTERSTATE 5
TOPANGA CANYON BLVD
LOS FELIZ BLVD
VICTORY AVE
3. Los Feliz to Glendale Fwy (2)
4. Road to Los Feliz Blvd
Sheet 2:Reach 3-5
LEGEND
Sub-Measures
2. Expose stormdrain outlets; convert to natural stream confluence
3/5. Create geomorphology and plant for freshwater marsh
10. Divert tributary & river flow into side channels
16. Bioengineer channel walls
17. Habitat corridors/riparian planting on banks
21. Lower channel banks and provide setback levees or vegetated berms
25. Tributary channels/widen channel with concrete removal
26. Terrace banks
27. Modify trap channel to vertical sides
29. Invasive management
Potential Temporary Construction Staging Areas
Data Source: USACE, 2011
City of Los Angeles, 2011
Aerial Source: LARIC 2008
Alternative 20, ARBOR, Riparian Integration
via Varied Ecological Restoration (RIVER)
Los Angeles River Ecosystem Restoration (Feb, 2013)
0
0.2
0.4
Miles


HYPERION AVE
RIVERSIDE DR
FLETCHER DRIVE
SAN FERNANDO ROAD
INTERSTATE 5
SR 2
L. LA River Confluence Park (2)
E. Glendale Fwy (2) to 3
Sheet 3:Reach 5-7
LEGEND
Sub-Measures
2. Excise stormdrain outlets; convert to natural stream confluence
35. Create geomorphology and plant for freshwater marsh
16. Bioengineer channel walls
17. Habitat corridors/riparian planting on banks
19. Planting built into channel walls
22. Channel banks maintain/widen channel with concrete removal
25. Terrace banks
27. Work from channel to vertical sides
29. Invasive management
Potential Temporary Construction Staging Areas
Data Source: USACE, 2011
City of Los Angeles, 2011
Aerial Source: LARIC 2008
Alternative 20, ARBOR, Riparian Integration
via Varied Ecological Restoration (RIVER)
Los Angeles River Ecosystem Restoration (Feb, 2013)
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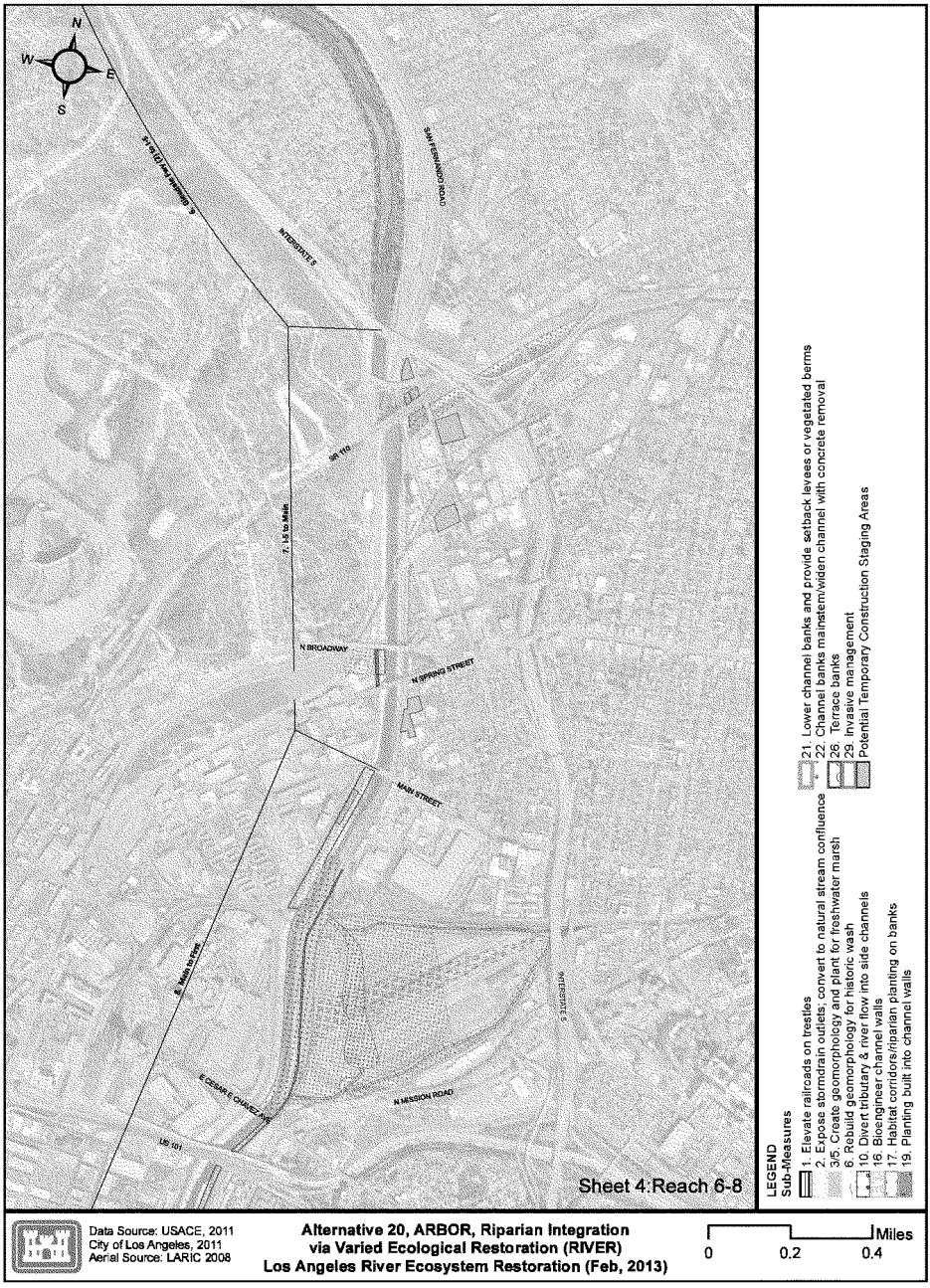
Miles


N
W
E
S
N. San Fernando Rd (SR 5)
INTERSTATE 5
SAN FERNANDO ROAD
SR 110
7. I-5 to Main
N BROADWAY
N SPRING STREET
MAIN STREET
INTERSTATE 5
S. Main Street
E CESAR E CHAVEZ AVE
N MISSION ROAD
US 101
Sheet 4:Reach 6-8
LEGEND
Sub-Measures
1. Elevate railroads on trestles
2. Expose stormdrain outlets; convert to natural stream confluence
3/5. Create geomorphology and plant for freshwater marsh
6. Rebuild geomorphology for historic wash
10. Divert tributary & river flow into side channels
16. Bioengineer channel walls
17. Habitat corridors/riparian planting on banks
19. Planting built into channel walls
21. Lower channel banks and provide setback levees or vegetated berms
22. Channel banks mainstem/widen channel with concrete removal
26. Terrace banks
29. Invasive management
Potential Temporary Construction Staging Areas
Data Source: USACE, 2011
City of Los Angeles, 2011
Aerial Source: LARIC 2008
Alternative 20, ARBOR, Riparian Integration
via Varied Ecological Restoration (RIVER)
Los Angeles River Ecosystem Restoration (Feb, 2013)
0
0.2
0.4
Miles

US Army Corps
of Engineers®
Los Angeles District

Los Angeles River Ecosystem Restoration

Feasibility Study

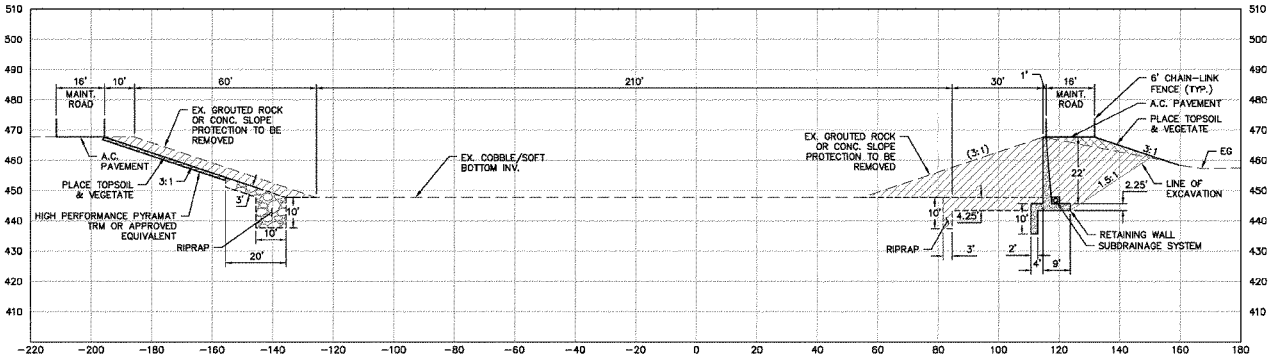
Attachment 4 – Revised Cross Sections

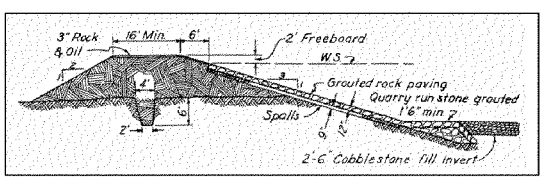
September 2014

Attachment 4- Revised Cross Sections

Sheet	Alternative(s)	Location
1	Alternative 20	Reach 2
2	Alternatives 16 & 20	Reach 5
3	Alternatives 13,16 & 20	Reach 6a
4	Alternative 10	Taylor Yard
5	Alternatives 13, 16 & 20	Taylor Yard (6b)
6	Alternative 13, 16, & 20	Reach 6c
7	Alternatives 13 & 16	Reach 7
8	Alternatives 16 & 20	Piggyback Yard
9	Alternative 20	Verdugo Wash
10	Alternative 20	Verdugo Wash
11	Alternative 20	Verdugo Wash
12	Alternatives 13, 16 & 20	Arroyo Seco
13	Alternative 20	Cornfields

THIS IS A PRELIMINARY, PLANNING-LEVEL, CONCEPTUAL IMAGE USED FOR COST ESTIMATING PURPOSES ONLY.





EXISTING TYPICAL SECTION
NTS

0 15 30 60

LEGEND

- EX. GROUND
- PROPOSED CHANNEL
- EXCAVATION
- COMPACTED FILL
- RIPRAP
- REINFORCED CONCRETE
- HIGH PERFORMANCE PYRAMAT TURF REINFORCEMENT MAT (TRM) OR APPROVED EQUIVALENT

NOTE: ALL DIMENSIONS SHOWN ARE APPROXIMATE AND SUBJECT TO REVISIONS DURING FINAL DESIGN.

REVISIONS				LOS ANGELES RIVER FEASIBILITY STUDY PRELIMINARY DESIGN	DATE 04/16/13
MARK	DATE	DESCRIPTION	BY		
				ALTERNATIVE 20 REACH 2 (R2A13)	SHT NO. 1 OF 13

TETRA TECH, INC.
17885 Von Karman Avenue, Suite 500
Irvine, CA 92614
Phone (949) 809-5000, FAX (949) 809-5003

P:\Work\126313 LA River Feasibility FY13\05_Design\CAD\126313D-RSX-R2A13.DWG 04/18/2013 13:47

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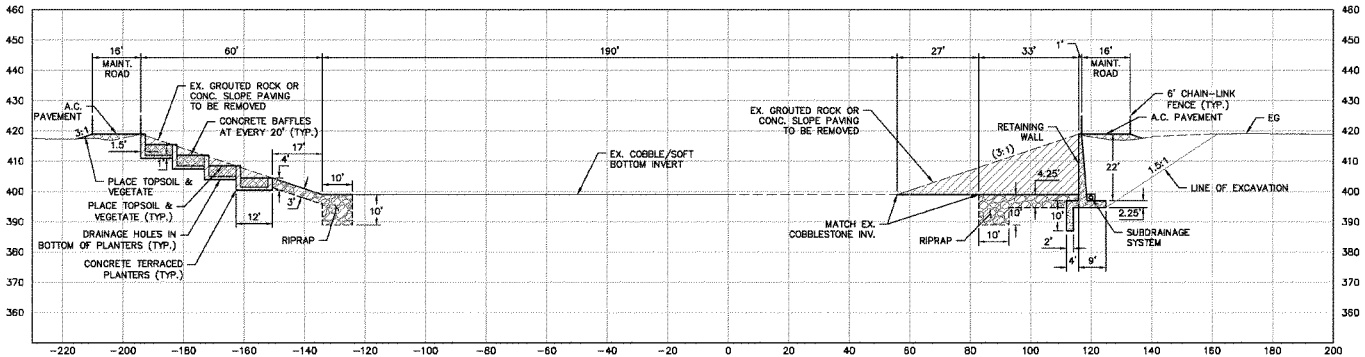
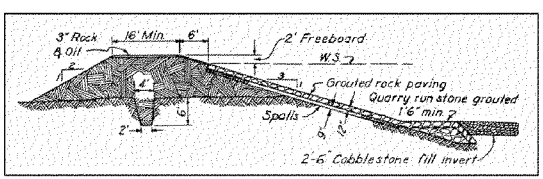
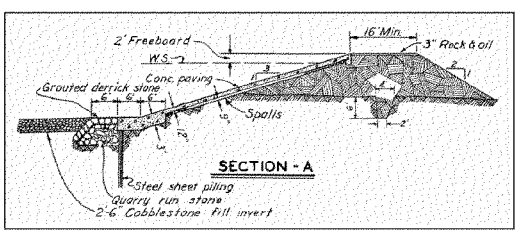




EXISTING TYPICAL SECTION
NTS



EXISTING TYPICAL SECTION
NTS

0 15 30 60

LEGEND

- EX. GROUND
- PROPOSED CHANNEL
- EXCAVATION
- COMPACTED FILL
- RIPRAP
- REINFORCED CONCRETE
- HIGH PERFORMANCE PYRAMAT TURF REINFORCEMENT MAT (TRM) OR APPROVED EQUIVALENT

NOTE: ALL DIMENSIONS SHOWN ARE APPROXIMATE AND SUBJECT TO REVISIONS DURING FINAL DESIGN.

REVISIONS			
MARK	DATE	DESCRIPTION	BY

TETRA TECH, INC.
17885 Von Karman Avenue, Suite 300
Irvine, CA 92614
Phone (949) 809-5000, FAX (949) 809-5003

LOS ANGELES RIVER FEASIBILITY STUDY
PRELIMINARY DESIGN

ALTERNATIVES 16 & 20
REACH 5 (R5A5)

DATE 04/16/13

SHT NO. 2 OF 13

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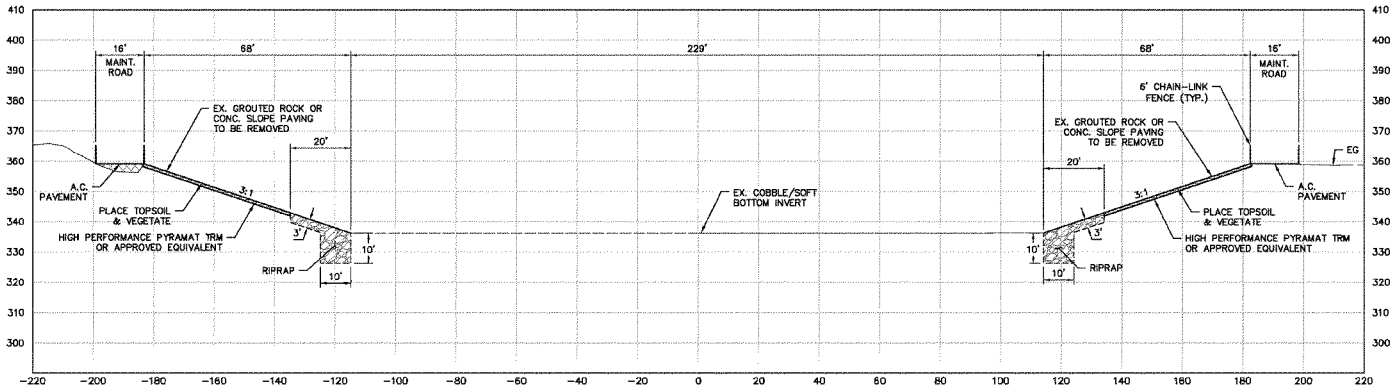
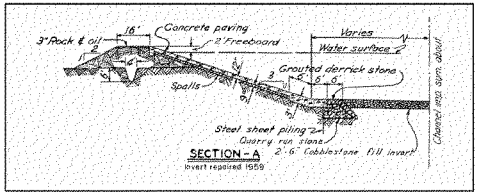
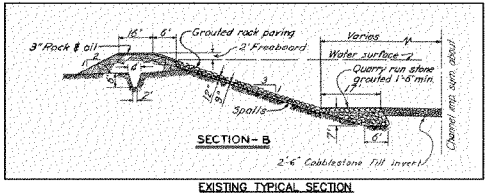




EXISTING TYPICAL SECTION
NTS



EXISTING TYPICAL SECTION
NTS

0 15 30 60

LEGEND

- EX. GROUND
- PROPOSED CHANNEL
- EXCAVATION
- COMPACTED FILL
- RIPRAP
- REINFORCED CONCRETE
- HIGH PERFORMANCE PYRAMAT TURF REINFORCEMENT MAT (TRM) OR APPROVED EQUIVALENT

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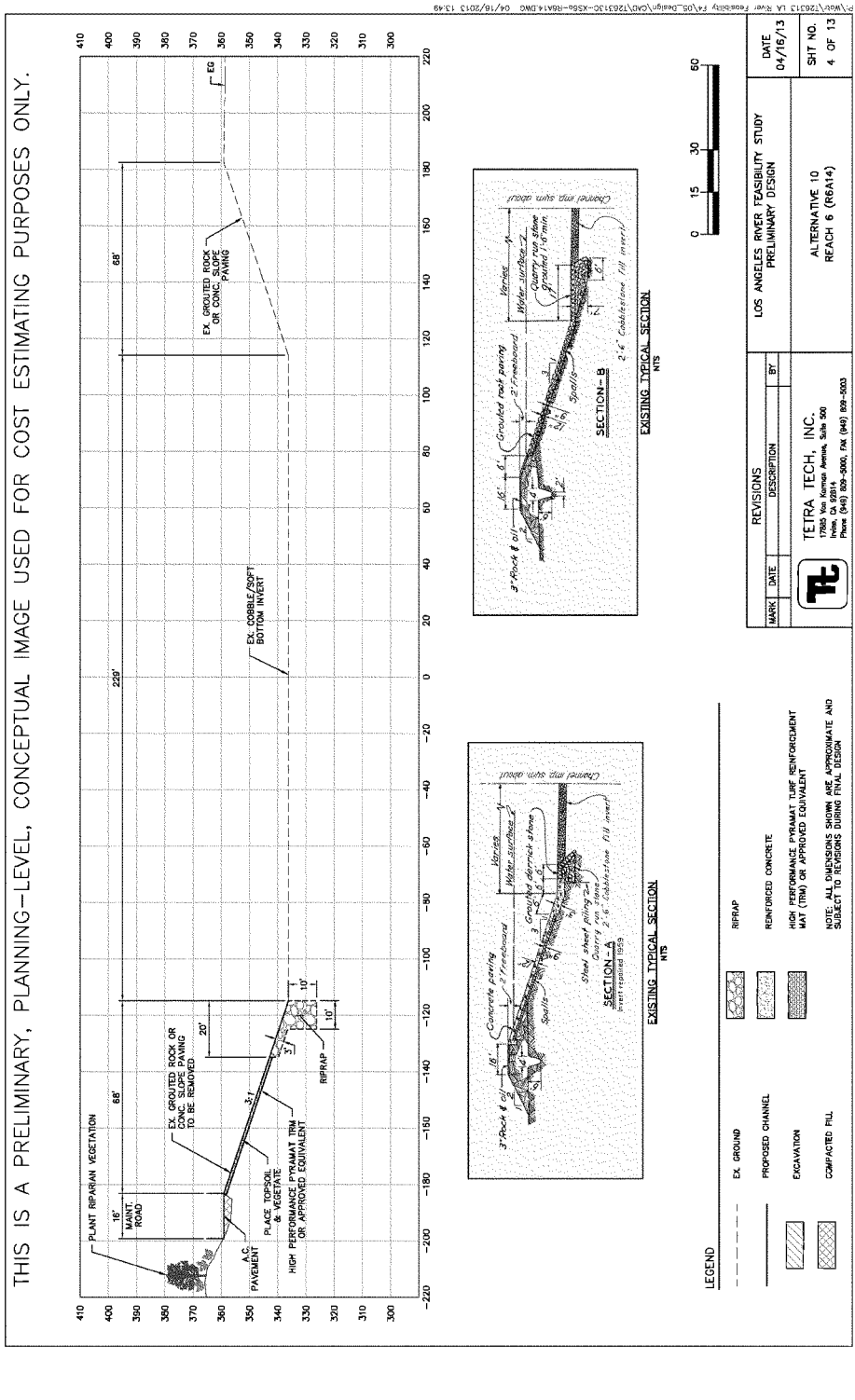
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Invert repaired 1959
3"-Rock @ 0%
18"
Concrete paving
2' Freeboard
Varies
Water surface
Grouted derrick stone
Spalls
Sheet piling
Quarry run stone
2'-6" Cobblestone fill (invert)
Channel slope varies (about)
EXISTING TYPICAL SECTION
NTS
SECTION - B
3"-Rock @ 0%
Grouted rock paving
2' Freeboard
Varies
Water surface
Quarry run stone grouted 1'-0" min
Spalls
2'-6" Cobblestone fill (invert)
Channel slope varies (about)
0
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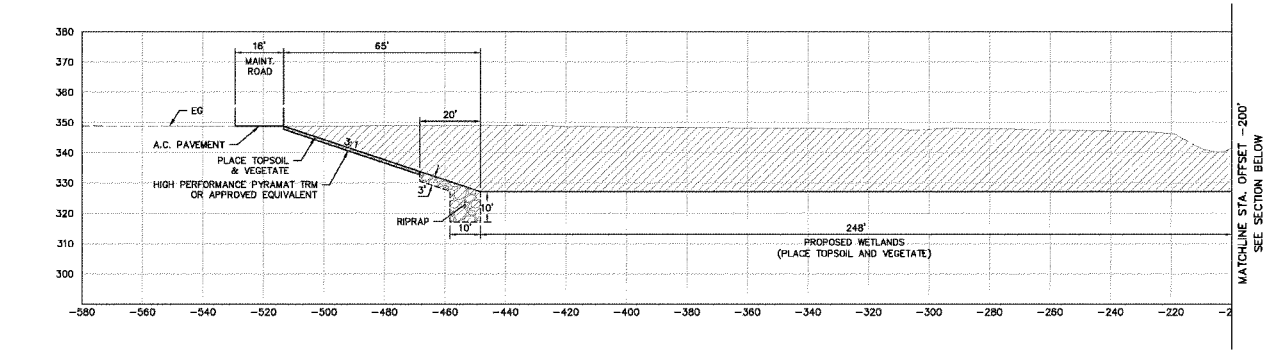

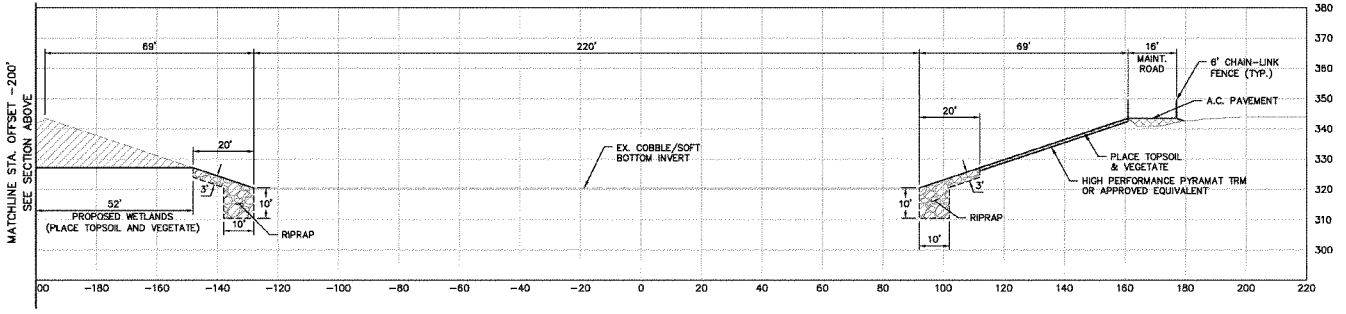

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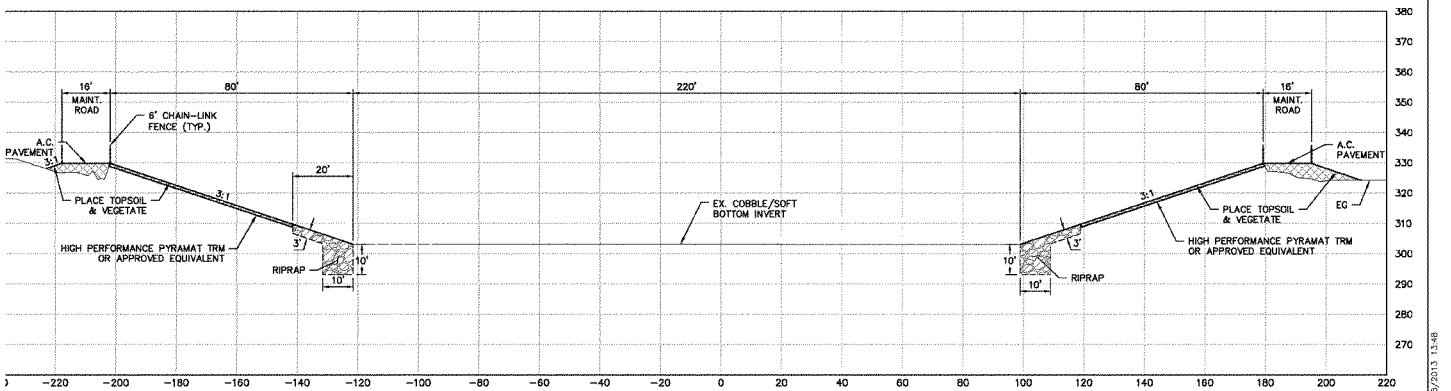

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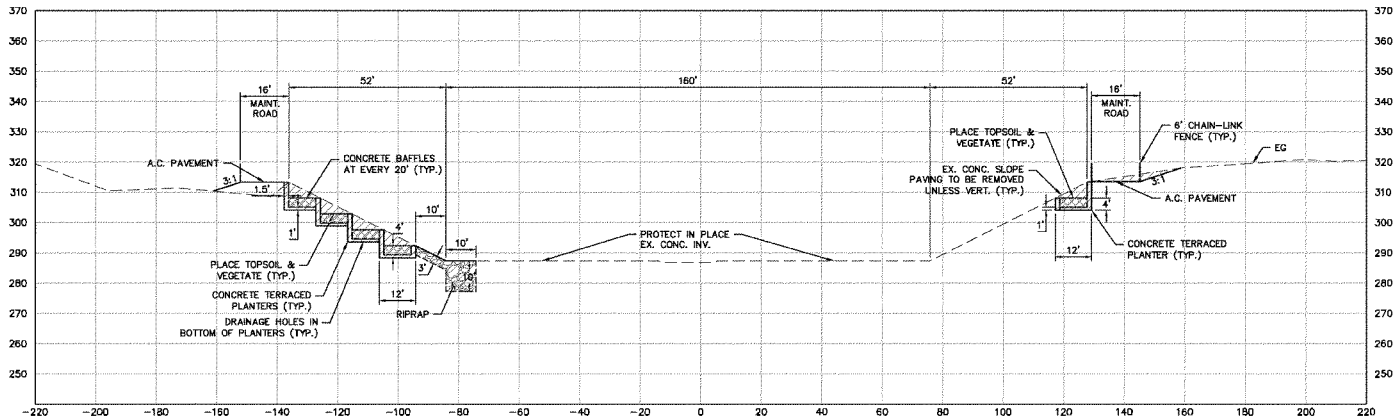

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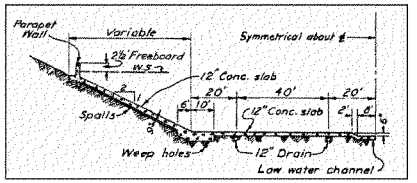

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- EXCAVATION
- COMPACTED FILL
- RIPRAP
- REINFORCED CONCRETE
- HIGH PERFORMANCE PYRAMAT TURF REINFORCEMENT MAT (TRM) OR APPROVED EQUIVALENT

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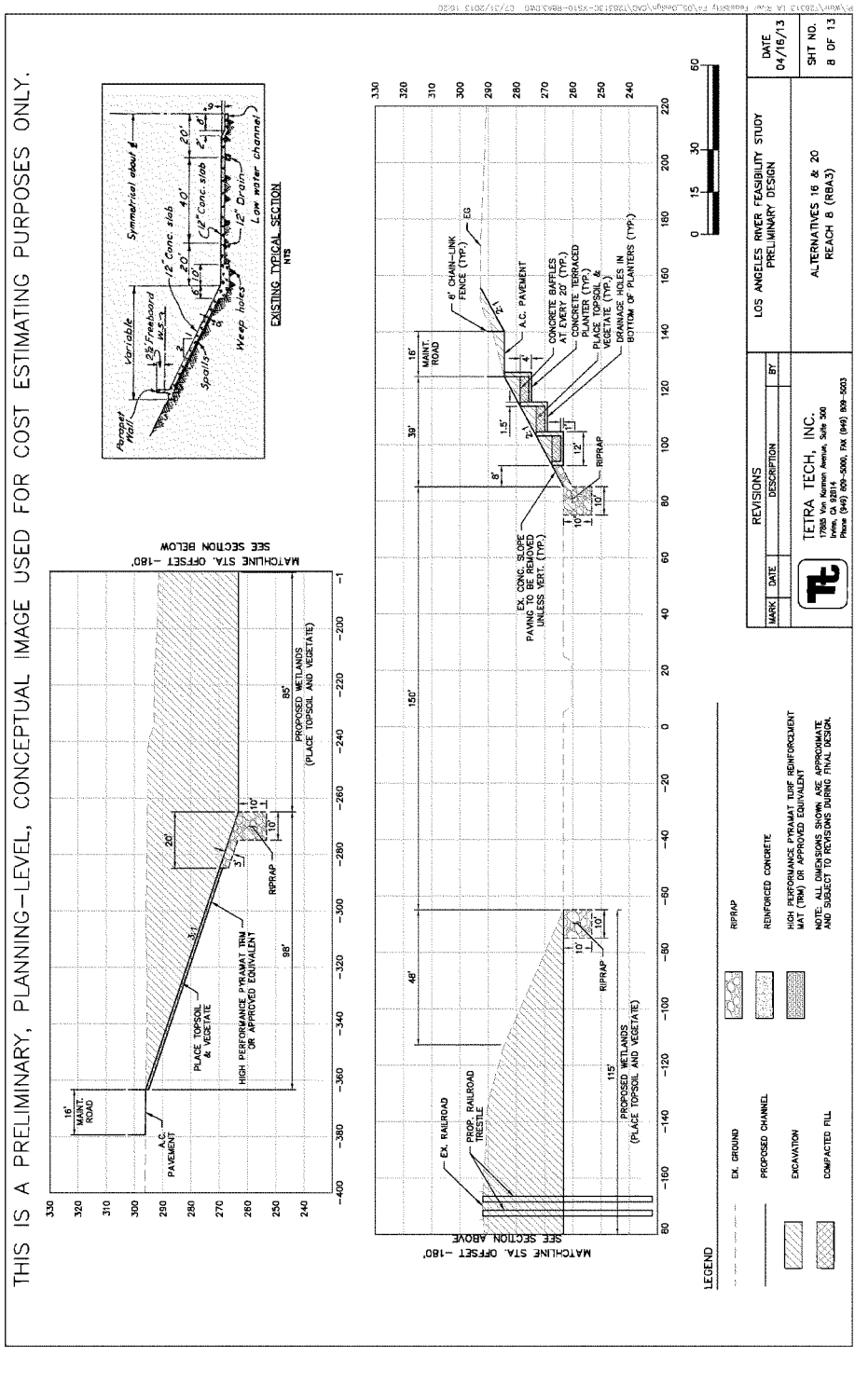
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EXISTING TYPICAL SECTION
NTS
Parapet Wall
Variable
1'-8" Freeboard
12" Conc. slab
Spalls
Weep holes
Symmetrical about ℄
20'
10'
12" Conc. slab
12" Drain
Low water channel
MATCHLINE STA. OFFSET -180'
SEE SECTION BELOW
15' MAINT. ROAD
A.C. PAVEMENT
PLACE TOPSOIL & VEGETATE
HIGH PERFORMANCE PYRAMAT TRM OR APPROVED EQUIVALENT
RIPRAP
PROPOSED WETLANDS (PLACE TOPSOIL AND VEGETATE)
98'
85'
115'
MATCHLINE STA. OFFSET -180'
SEE SECTION ABOVE
EX. RAILROAD
PROP. RAILROAD TRESTLE
48'
150'
39'
16' MAINT. ROAD
6' CHAIN-LINK FENCE (TYP.)
EG
A.C. PAVEMENT
CONCRETE BAFFLES AT EACH END (TYP.)
CONCRETE TERRACED PLANTER (TYP.)
PLACE TOPSOIL & VEGETATE (TYP.)
DRAINAGE HOLES IN BOTTOM OF PLANTERS (TYP.)
EX. CONC. SLOPE PAVING TO BE REMOVED UNLESS VERT. (TYP.)
RIPRAP
LEGEND
EX. GROUND
PROPOSED CHANNEL
EXCAVATION
COMPACTED FILL
RIPRAP
REINFORCED CONCRETE
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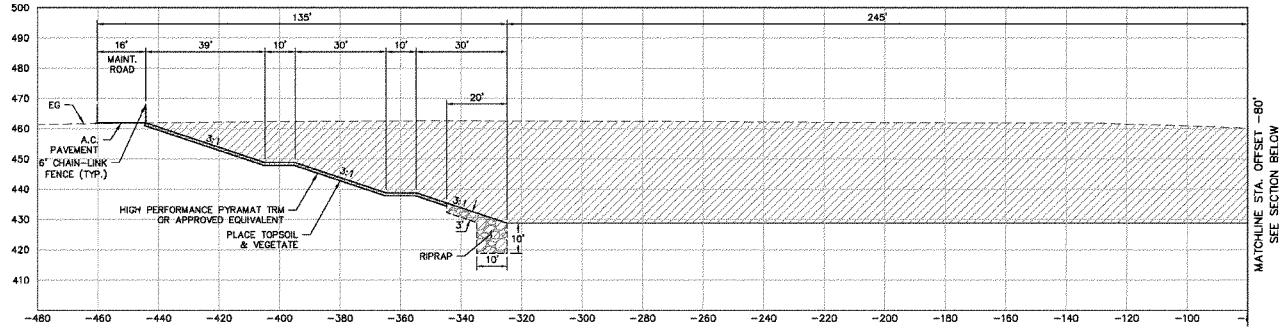

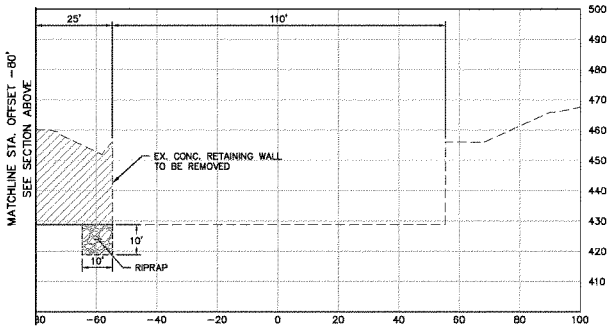

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- EXCAVATION
- COMPACTED FILL
- RIPRAP
- REINFORCED CONCRETE
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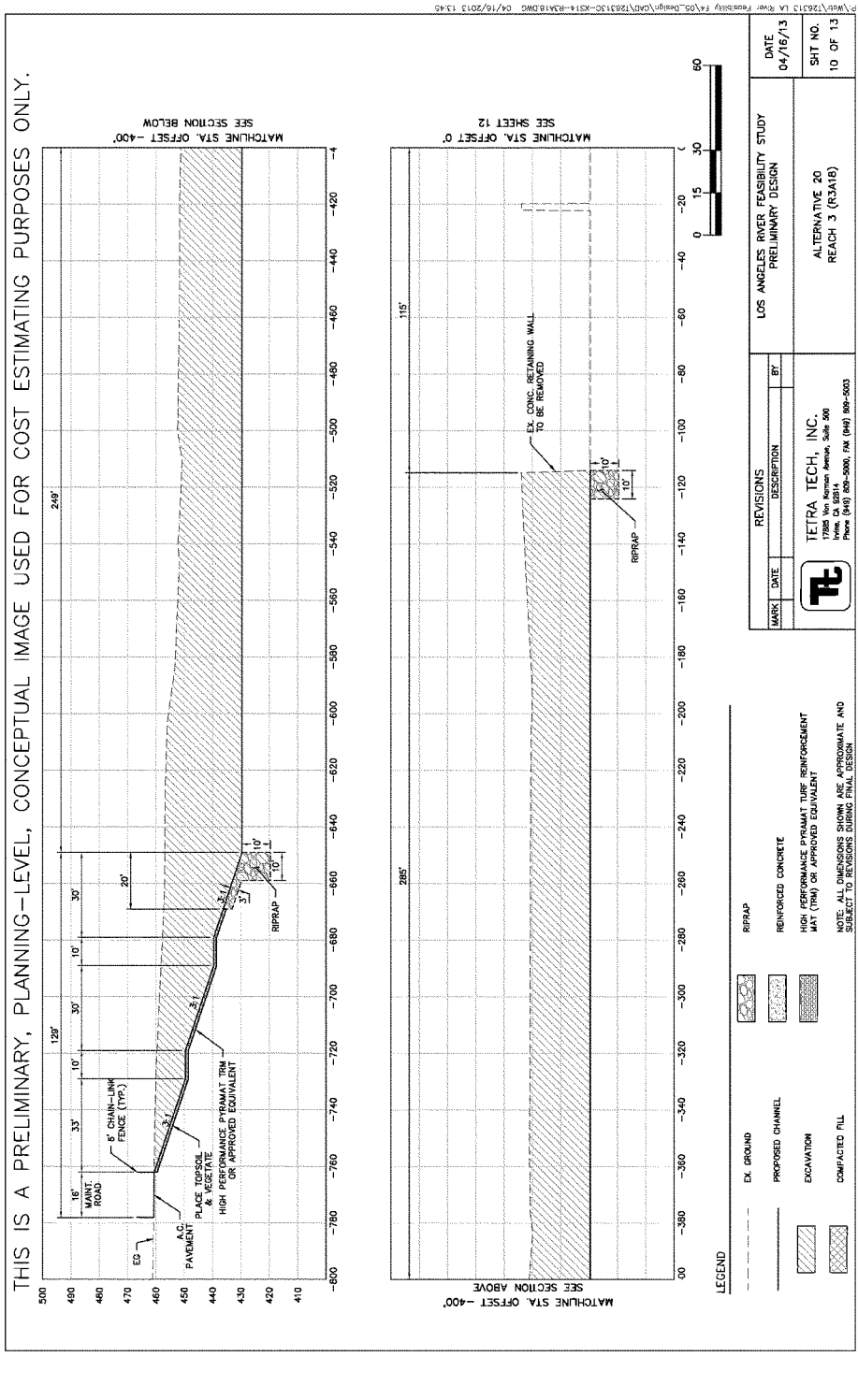
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SEE SHEET 12
MATCHLINE STA. OFFSET -400'
SEE SECTION ABOVE
16' MAINT. ROAD
33'
10'
30'
10'
30'
20'
249'
128'
115'
285'
6' CHAIN-LINK FENCE (TYP.)
A.C. PAVEMENT
PLACE TOPSOIL & VEGETATE
HIGH PERFORMANCE PYRAMAT TRM OR APPROVED EQUIVALENT
RIPRAP
EX. CONC. RETAINING WALL TO BE REMOVED
EG
3:1
37'
10'
LEGEND
EX. GROUND
PROPOSED CHANNEL
EXCAVATION
COMPACTED FILL
RIPRAP
REINFORCED CONCRETE
HIGH PERFORMANCE PYRAMAT TURF REINFORCEMENT MAT (TRM) OR APPROVED EQUIVALENT
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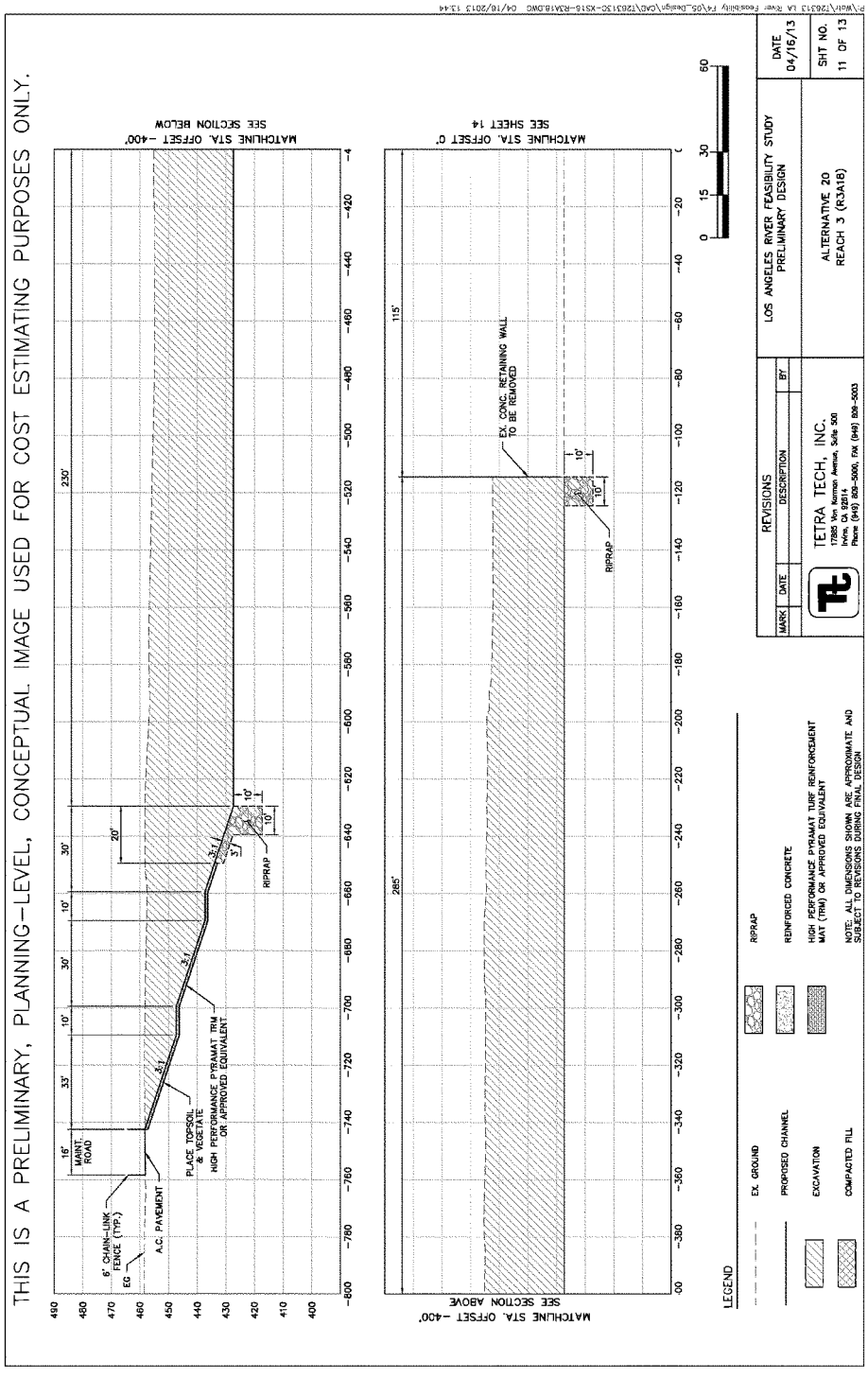
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5' CHAIN-LINK FENCE (TYP.)
EG
A.C. PAVEMENT
PLACE TOPSOIL & VEGETATE
HIGH PERFORMANCE PYRAMAT TRM OR APPROVED EQUIVALENT
RIPRAP
EX. CONC. RETAINING WALL TO BE REMOVED
LEGEND
EX. GROUND
PROPOSED CHANNEL
EXCAVATION
COMPACTED FILL
RIPRAP
REINFORCED CONCRETE
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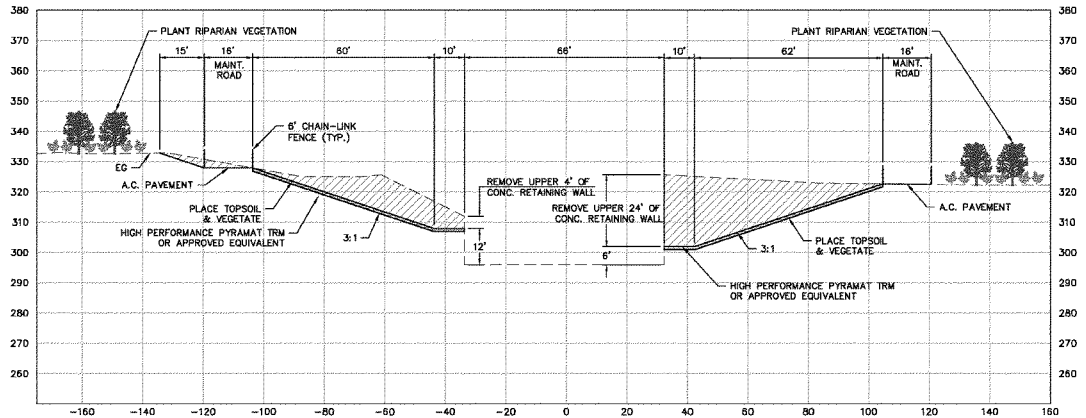

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- REINFORCED CONCRETE
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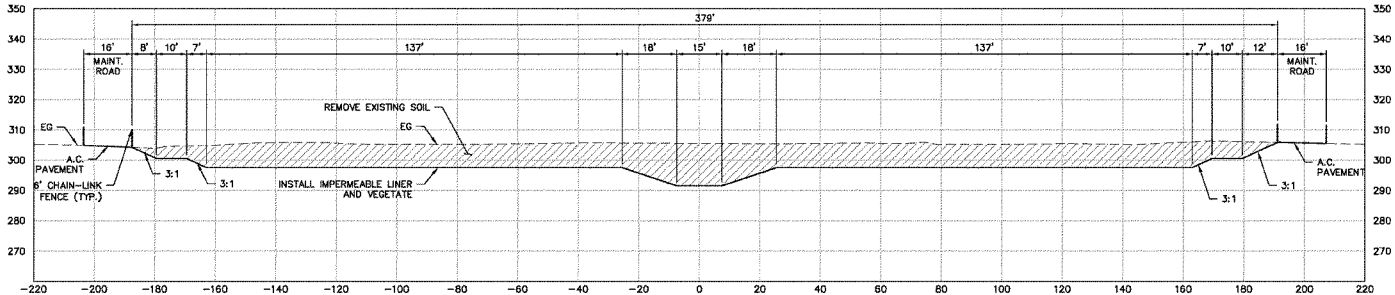

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Los Angeles District

Los Angeles River Ecosystem Restoration Feasibility Study

FINAL
Economic Appendix

September 2015

LOS ANGELES RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY
ECONOMIC APPENDIX

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Attachment 1 – Recreation Analysis

Attachment 2 – Regional Economic Development and Other Social Effects Analysis

1. INTRODUCTION

1.1 Purpose

The purpose of this appendix is to document the socioeconomic resources, regional economic development considerations and to present the economic evaluation of the benefits and costs associated with habitat restoration and compatible recreation features along the Los Angeles River (River) within the City of Los Angeles (City) in Los Angeles County, California.

1.2 Guidance and Reference

The principal controlling guidance of the analysis comes from the U.S. Army Corps of Engineers' (USACE) *Engineering Regulation (ER) 1105-2-100, Planning Guidance Notebook,* with specific guidance from Appendix D, Economic and Social Considerations. Evaluation of alternatives has been completed in accordance with *IWR Report #95-R-1, Evaluation of Environmental Investments Procedures Manual, Interim: Cost Effectiveness and Incremental Cost Analyses, May 1995.* Benefits and costs for plan formulation, comparison and evaluation were calculated at FY 2013 price levels utilizing a discount rate of 3.75 percent and a base year of 2022. Benefits and costs for the NER and LPP were refined and updated and are presented at October 2015 price levels, utilizing the current 3.375% federal discount rate, a 50 year period of analysis, and an assumed Base Year of 2033.

2. STUDY AREA

2.1 Watershed Description and Location

The confluence of Arroyo Calabasas and Bell Creek forms the start of the Los Angeles River. From the confluence, the River flows through the western San Fernando Valley and through Sepulveda Reservoir and then is joined from the north by Tujunga Wash. Tujunga Wash includes flow from both Hansen Dam and Pacoima Wash. Further downstream, the Burbank-Western channel and smaller creeks draining the western San Gabriel Mountains join the River as it flows easterly through the eastern San Fernando Valley. The River bends south around the Hollywood Hills and is joined from the east by Verdugo Wash, and then flows south though the Glendale Narrows and onto the broad coastal plain. The River is joined by a number of tributaries, including the Arroyo Seco and the Rio Hondo Diversion Channel, which carries runoff from Whittier Narrows Dam. From the Rio Hondo Diversion Channel confluence, the River continues south another 12 miles and discharges into the Pacific Ocean at the San Pedro/Long Beach Harbor.

The watershed has highly varied terrain consisting of precipitous mountains, low-lying foothills, valleys, and coastal plains. The upper portion of the watershed (~360 square miles) is predominantly forest or open space including more than 100 square miles of the Angeles National Forest. The remainder of the watershed (~464 square miles) lies in the coastal plain, which includes the entire City of Los Angeles. It is a highly developed area with commercial, industrial, and residential land uses. North of downtown Los Angeles to the confluence with the Rio Hondo, the river flows through industrial and commercial areas and is bordered by rail

yards, freeways, and major commercial and government buildings. From the Rio Hondo Diversion Channel to the Pacific Ocean, the river flows through industrial, residential, and commercial areas, including major refineries and petroleum products storage facilities, major freeways, rail lines, and rail yards serving the Ports of Los Angeles and Long Beach. The river and most of its tributaries in the urbanized portions of the Los Angeles watershed have been highly modified from their original natural courses to protect property and human life from the effects of flooding.

From its headwaters to the Pacific Ocean, the River drops approximately 790 feet in elevation over roughly 51 miles (about 15 feet per mile, yielding an average slope of approximately 0.3 percent). During the rainy season from October to March, heavy flows and occasional floods occur. In times of peak flow the river carries more than 180,000 cubic feet of water per second (cfs) at velocities exceeding 25 feet per second in some areas. That volume of discharge is approximately 14 times the flow of New York's Hudson River moving at a velocity of upwards of 17 miles per hour.

Today, the River no longer resembles the naturally meandering and ephemeral river that periodically caused devastating floods during winter. Even though the River could no longer support the area's rapidly growing water demands by the late 19th century, extensive development on its natural floodplain have continued into the present. Seasonal flows slowed to a trickle throughout most of the dry season, and the winter storm flood threat increased as development expanded on the River's natural floodplain. Storms produced massive flows in the River causing flooding that resulted in the loss of lives and millions of dollars in property damage in the late 19th and early 20th centuries.

Modifying the River to contain these periodic floods has rendered it a flood conveyance channel that does not resemble a natural river system. Improvements for flood risk management have included bank hardening and lining the bed of the channel with concrete for approximately 44 of its 51 miles. An approximately 7 mile stretch of the River near the Verdugo Wash confluence has grouted riprap side slopes and is the only portion of the study area left with a soft bed, albeit this area has also been engineered with a cobblestone bed that has migrated or washed away over the years. During the dry season, base flows in the channel are often less than 100 cfs and are entirely comprised of discharge from municipal and industrial wastewater treatment plants and urban/irrigation runoff. Open space, parks, and greenways are scarce. Instead, impervious surfaces, industrial development, and residential and commercial areas dominate the study area. Additional details and figures of the watershed can be found in sections 1 and 2 of the Integrated Feasibility Report.

2.2 ARBOR Reach

The baseline study area that was initially considered during the planning process includes 32 miles of the River that is within the City of Los Angeles, within a half mile of each bank. It begins at the confluence of Bell Creek and Arroyo Calabasas in the northwest San Fernando Valley at Owensmouth Boulevard, and ends near the City of Vernon in the downtown Los Angeles area. Through initial investigation of constraints in the baseline study area and the identification of where ecosystem restoration might best be accomplished, the planning process resulted in defining the focused study area as the ARBOR (Area with Restoration Benefits and

Opportunities for Revitalization) Reach. This area extends from the Headworks downstream to First Avenue (See Figure 2.1). This study area includes the Glendale Narrows, which is the only portion of the River that does not have a hardened bed (bottom of the river channel), and contains several distinctive sites and connections including the Headworks, Pollywog Park, Bette Davis Park, the Burbank-Western Channel and Glendale River Walk, Griffith Park, Ferraro Fields, Verdugo Wash, Atwater Village, Taylor Yard and the Rio de Los Angeles State Park, the "Cornfields" (LA State Historic Park), Arroyo Seco, Elysian Park, "Piggyback Yard" (also known as "Los Angeles Transportation Center" as well as "Mission Yard"), and downtown Los Angeles. These sites, which are identified in later figures, provide key opportunities for restoration and enhanced connectivity.

2.2.1 Reaches

There are eight geomorphically different reaches within the study area (Figure 2.1). They were defined based on the physical characteristics of channel morphology, bank characteristics, soil exposure, existing habitat, and surrounding land uses. Specific geomorphic criteria include: (1) channel bed type (either soft bed with groundwater/surface water exchange, or concrete), (2) side slope type (vertical or trapezoidal), and (3) adjacent land uses or open space.

Reach 1: Pollywog Park/Headworks to Midpoint of Bette Davis Park: Reach 1 is the upstream segment of the study area and is approximately 1.5 river miles in length. It connects the study area to Burbank at Disney Studios and the Headworks Ecosystem Restoration Site. The channel here has a rectangular concrete-lined configuration with subdrains and no low flow channel. There is a rubber dam within the river bed near the upstream end of this reach that was once used to help divert water to the Headworks spreading grounds operated by Los Angeles Department of Water and Power (LADWP). The channel is approximately 18 feet deep and the bank-to-bank width is approximately 115 feet.

Reach 2: Midpoint Bette Davis Park to Upstream end Ferraro Fields: This reach is approximately 0.75 mile in length. It extends from the midpoint of Bette Davis Park on the left bank (facing downstream), where the bed transitions from concrete-lined to a cobble bed, and then transitions back to concrete at approximately the upstream edge of Ferraro Fields on the right bank. The channel has a trapezoidal configuration with grouted Derrick stone banks. The banks are toed-down (secured by extending the bank wall below the river bed) with sheet pile and quarry run stone. The bed is approximately 18 feet deep from the top of bank and approximately 175 feet wide. Sediment deposited in the channel has formed sand bars/islands, which have stabilized as the root systems of the many trees and other vegetation have trapped sediment over time. This reach, however, is not as densely vegetated as areas farther downstream in Reaches 4 to 6.

Reach 3: Ferraro Fields to Brazil Street: This reach is approximately 1 mile in length. It begins at the upstream edge of the Ferraro Soccer Fields on the right bank where the bed transitions from cobbles to concrete. It makes an approximately 90-degree curve to the south around Griffith Park and transitions back to cobbles at approximately Brazil Street on the left bank. The channel in this area has a rectangular concrete configuration. The bed is approximately 18 to 23 feet deep from the top of bank and approximately 180 feet wide, widening to 380 feet

wide downstream of the Verdugo Wash confluence. State Route (SR)-134 (Ventura Freeway) crosses the River at Verdugo Wash.

Reach 4: Brazil Street to Los Feliz Boulevard: This reach is approximately 1.75 miles long and extends from Brazil Street on the left bank downstream to the Los Feliz Boulevard Bridge. The bed transitions from a concrete-lined rectangular channel to a trapezoidal channel with a cobble bed and grouted Derrick stone banks. Banks are toed-down with sheet pile and quarry run stone. The bed was constructed approximately 18 feet deep from the top of slope, and the channel ranges from approximately 130 to 160 feet wide from top of bank to top of bank. Sediment deposited in the channel has formed sand bars/islands, which are stabilized by the root systems of the many trees and other vegetation. This reach ends at the Los Feliz Boulevard Bridge, where localized concrete lining of the bed and banks plus pier noses that extend upstream have been constructed to protect the bridge and lower the water surface underneath the bridge.

Reach 5: Los Feliz Boulevard to Glendale Freeway: This reach is approximately 1.55 miles long and veers east between Hyperion Avenue and SR-2 (Glendale Freeway). The reach extends from the Los Feliz Boulevard Bridge, under the Sunnynook pedestrian bridge and the Hyperion Avenue Bridge, downstream to the Fletcher Drive Bridge and ends at the SR-2 Bridge. The bed transitions from concrete under each of the large bridges (e.g., Los Feliz Boulevard, Hyperion Avenue) to a trapezoidal channel with a cobble bed and grouted Derrick stone banks between the bridges. Banks are toed-down with sheet pile and quarry run stone. The bed is approximately 18 feet deep and the top of the channel is approximately 130 to 160 feet wide. Sediment deposited in the channel has formed sand bars/islands, which have stabilized as the root systems of the many trees and other vegetation have trapped sediment. This reach ends as the River begins to curve back east as it approaches Taylor Yard.

Reach 6: Glendale Freeway to I-5: This reach is approximately 2.34 miles long and meanders through three river bends. It extends from the SR-2 Bridge to the downstream crossing of Interstate 5 (I-5), where the bed transitions from cobble to concrete-lined. Here, the channel is in a trapezoidal configuration with a cobble bed and grouted Derrick stone banks. The banks are toed-down with sheet pile and quarry run stone. The bed is approximately 30 feet deep from the top of slope and the top of the channel ranges from approximately 190 to 215 feet wide. Sediment deposited in the channel has formed sand bars/islands, which have become stabilized as the root systems of the many trees and other vegetation have trapped sediment. The channel narrows to 170 feet and transitions to a rectangular configuration just upstream of the complicated I-5 and SR-110 interchange.

Reach 7: I-5 to Main Street: This approximately 1-mile-long reach begins at the I-5 Bridge and extends to the Main Street Bridge. The channel in this area transitions out of the rectangular concrete channel at the Arroyo Seco confluence, and becomes a trapezoidal concrete channel that is approximately 30 feet deep, with a top of bank width that ranges from approximately 150 to 190 feet. Three bridges cross the River in this reach, including a railroad bridge, the North Broadway Bridge, and the Spring Street Bridge. The channel has adjacent rail lines on both banks.

Reach 8: Main Street to First Street: This approximately 1-mile-long reach begins at the Main Street Bridge and extends downstream to the First Street Bridge. The trapezoidal concrete channel is approximately 30 feet deep with a top of channel width that ranges from approximately 170 to 200 feet. Rail lines run adjacent to the channel on both banks, and two railroad bridges cross the river. US-101 crosses the river between Cesar Chavez and First Street.

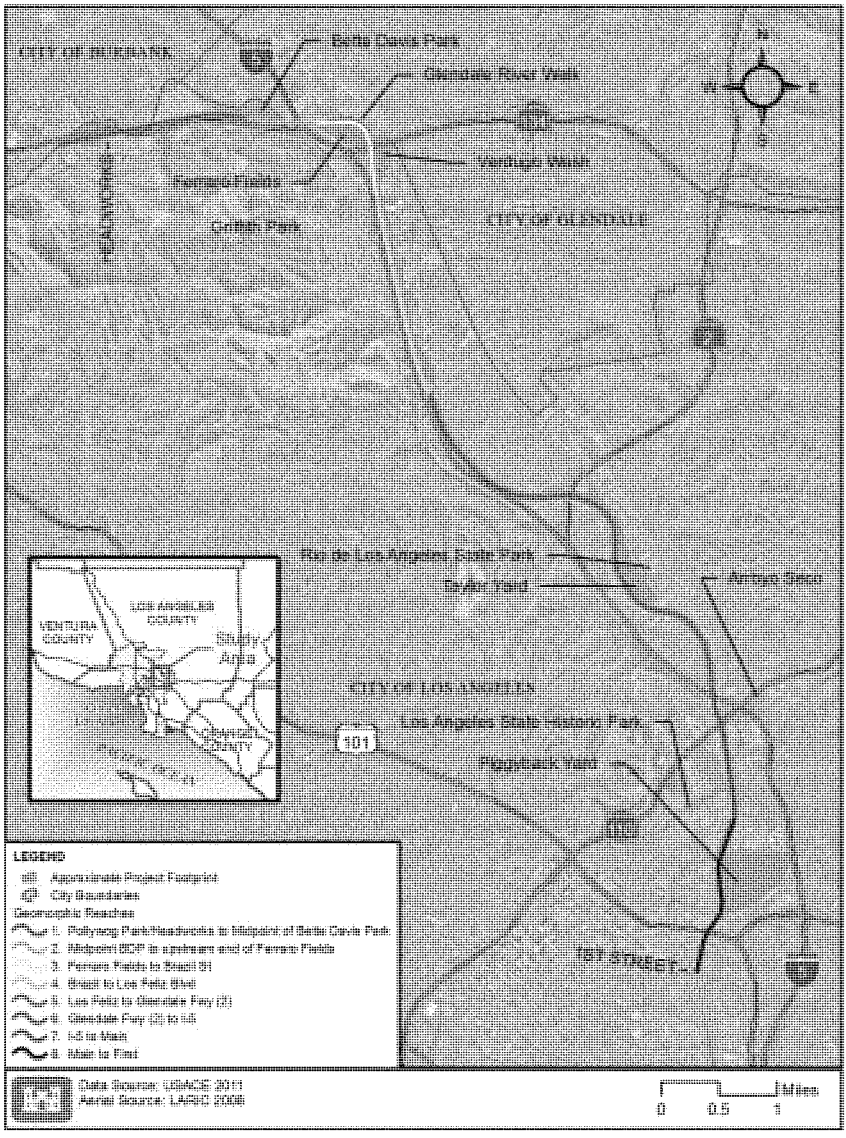

Figure 2.1 ARBOR Reach

2.3 Problems and Opportunities

The Los Angeles River watershed is unique due to the extremely large human population and massive infrastructure development in and adjacent to the river channel and floodplain. While flooding remains a concern in this reach, much had already been accomplished to manage flood risk, including construction and operation of Corps of Engineers and other dams in the watershed and channelization of the LA River and its tributaries. Further reductions in residual flood risk are not the focus of the current investigation. The following problems, which could potentially be addressed by the feasibility study, were agreed upon during planning charettes with key agency and stakeholder representatives and the Corps held in December of 2009 and are listed below.

2.3.1 Problems

Urbanization and flood risk management projects have created the following problems:

1. Loss of aquatic habitat for native valley foothills riparian, freshwater marsh, fish, and wildlife species since channelization of the river system and urbanization of the surrounding area during the 20th Century
2. Lack of ecological processes necessary to support ecosystem function in valley foothills riparian, and freshwater marsh habitat
3. Lack of substrate supporting valley foothills riparian, freshwater marsh, and fish habitats
4. Lack of connectivity to floodplains and functioning ecological zones
5. Highly altered bydrologic regime
6. High velocity flows within the study area that prevent establishment of riparian habitat
7. Disruption of natural sedimentation processes
8. Impervious surfaces in the drainage area preventing infiltration and recharge
9. Poor water quality caused by urban runoff and pollution that degrades aquatic habitat
10. Presence of non-native vegetation/exotics and trash accumulation in the river degrading aquatic habitat and prevent establishment of native vegetation
11. Lack of recreation and opportunities to interact with the natural environment

2.3.2 Public Concerns

Following construction of the Los Angeles County Drainage Area (LACDA) Project, walls were built higher downstream to protect the interests of downstream cities. However, in the years since LACDA, extensive growth of vegetation and concentration of sediment has occurred within the soft-bottomed reaches of the river, including within the study area. This condition has

provided habitat but also reduced flood conveyance. Therefore, this condition is an important consideration—and both a problem related to potential flooding and an opportunity related to providing habitat—in formulating the study alternatives.

2.3.3 Opportunities

The study team and the agencies involved with these planning efforts agreed that the problems present the following opportunities for restoration of nationally and regionally significant ecosystem function within the study reach. The relationship between each problem and opportunity is noted with a notation. For example P1 would refer to problem one in the previous list. Opportunities are as follows:

- Restore lost aquatic habitat including valley foothill riparian, freshwater marsh, and native fish habitat (P1).
- Improve diversity and abundance of native valley foothill riparian and freshwater marsh plants to support the diversity and abundance of wildlife species (P1).
- Improve and restore ecological processes in the project area to support ecosystem function in valley foothill riparian communities, freshwater marsh, and native fish habitats (P2).
- Restore substrate in valley foothill riparian, freshwater marsh, and native fish habitats (P3).
- Improve connectivity to floodplains and functioning ecological zones (P4).
- Restore a more natural hydrologic regime (P5).
- Decrease peak discharges and/or increase floodplain area in the mainstem and at tributary confluences to reduce discharges and velocities that prevent establishment of native habitats (P6).
- Improve natural sedimentation processes (P7).
- Improve infiltration and recharge (P8).
- Improve water quality from urban runoff in the river, its tributaries, and other drainages entering the river to prevent degradation of aquatic habitat (P9).
- Remove and manage invasives/exotics and trash to reestablish native vegetation (P10).
- Increase recreation allowing compatible human interaction with restored ecosystems (P11).

3. SOCIOECONOMIC RESOURCES

This analysis focuses on the ARBOR Reach as defined in Section 2 (Figure 2.1). The study area is in a densely populated area of Los Angeles County with centers of substantial commercial and industrial activities. The study area contains a wide range of land uses and economic activities.

3.1 Land Use

Figure 3.1 shows the land use patterns along the three stretches of the river within the study area. In general, the land in the study area is dominated by high-density residential and mixed

residential development[1]. The vast majority of land along and around the San Fernando Valley stretch is comprised of high-density single family residential development, a significant portion is also occupied by low-rise apartments, condominiums, and townhouses. Within a two-mile radius of the river the land use is almost exclusively residential with interspersed commercial and retail centers supporting the residential neighborhoods. Significant manufacturing and industrial activity (shown in light blue in Figure 3.1) occurs slightly further away from the river. The Sepulveda Dam and Reservoir are located along this stretch of the river.

The land immediately adjacent to and west of the Glendale Narrows reach is dominated by single-family and mixed residential use, while the land on the east side of the river is less homogeneous and is a combination of mixed residential use (high-density single family, low-rise apartments, condominiums, and townhouses), manufacturing and industrial uses, and some commercial and retail centers. This area includes the Silver Lake Reservoir and the Griffith Park recreational area.

The Downtown Los Angeles area is surrounded by mixed residential, commercial, and manufacturing and industrial uses, and, as can be seen in Figure 3.1, a high percentage of the area is used for manufacturing and industrial activity, as well as wholesaling and warehousing. While the land east of and immediately adjacent to the river is mostly used for manufacturing, industrial, and wholesaling purposes, beyond this narrow strip of land exists a densely-populated area comprised of mixed residential land use.

[1] "Mixed residential" refers here to areas with a variety of residential structure types and densities, such as single family homes, townhomes, condominiums, apartment complexes, etc.

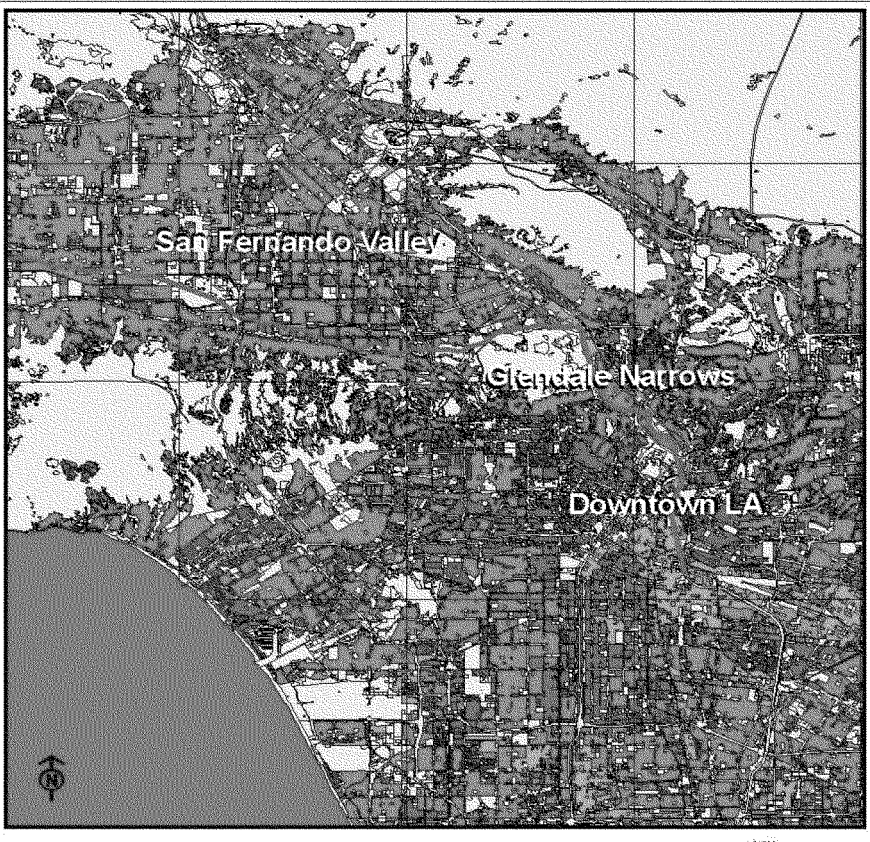

Figure 3.1 LA River Restoration (LARR) Study Area Land Use

3.1.1 Future Land Use

The study area is essentially built out; nearly all new housing development activity will involve recycling of land, as noted in the 2006 – 2014 Housing Element of the General Plan (City of Los Angeles 2009). No large scale changes to land use patterns are anticipated, however there are some trends and small scale changes which are noted below. The City's Planning Department has recently recommended zoning changes to the downtown industrial core that would rezone land from industrial to commercial and mixed-use in order to allow development that is "consistent with existing and surrounding areas".[2] At this point it is not clear to what extent, if any, this would include residential development. The City is also evaluating opportunities adjacent to the river to promote redevelopment – including the creation of recreation areas as well as commercial, residential, and mixed-use areas. The City has made it a priority to promote higher density housing development and mixed-use commercial and residential development through an increasing number of housing initiatives and incentive programs.

3.2 ARBOR Reach Demographics

The ARBOR Reach (Figure 2.1) starts slightly upstream of the Burbank-Western Channel's interception with the Los Angeles River through E 1st Street in downtown Los Angeles. Portions of three cities: Los Angeles, Glendale and Burbank are included in the census tracts located within a half mile of the river. The ½ mile zone is the most likely area to be directly influenced by project features.

Census tract and community level socioeconomic and demographic data is presented in this section. At the community level, data for the cities of Los Angeles, Glendale, and Burbank are presented. The map in Figure 3.2 displays the 35 census tracts, covering approximately 25.1 square miles that are used to compute census tract level statistics. These census tracts were chosen by selecting all census tracts located partially or wholly within a one-half mile buffer on either side of the river. The combined 35 census tracts are referred to as the assessment area in this appendix.

The description of the existing or without project socioeconomic conditions contained in the various sections below is based on the 2008-2012 American Community Survey as well as other regional and local data as available (U.S. Census Bureau 2012). Additional census data was obtained for incorporation into the final report in response to public comments. At release of the draft report, all available tract-level data was based on Census 2000 tract boundaries. Recently, detailed tract-level data based on the Census 2010 tract boundaries became available. The analysis has been updated to reflect Census 2010 tract boundaries in the final report.

[2] http://cityplanning.lacity.org/

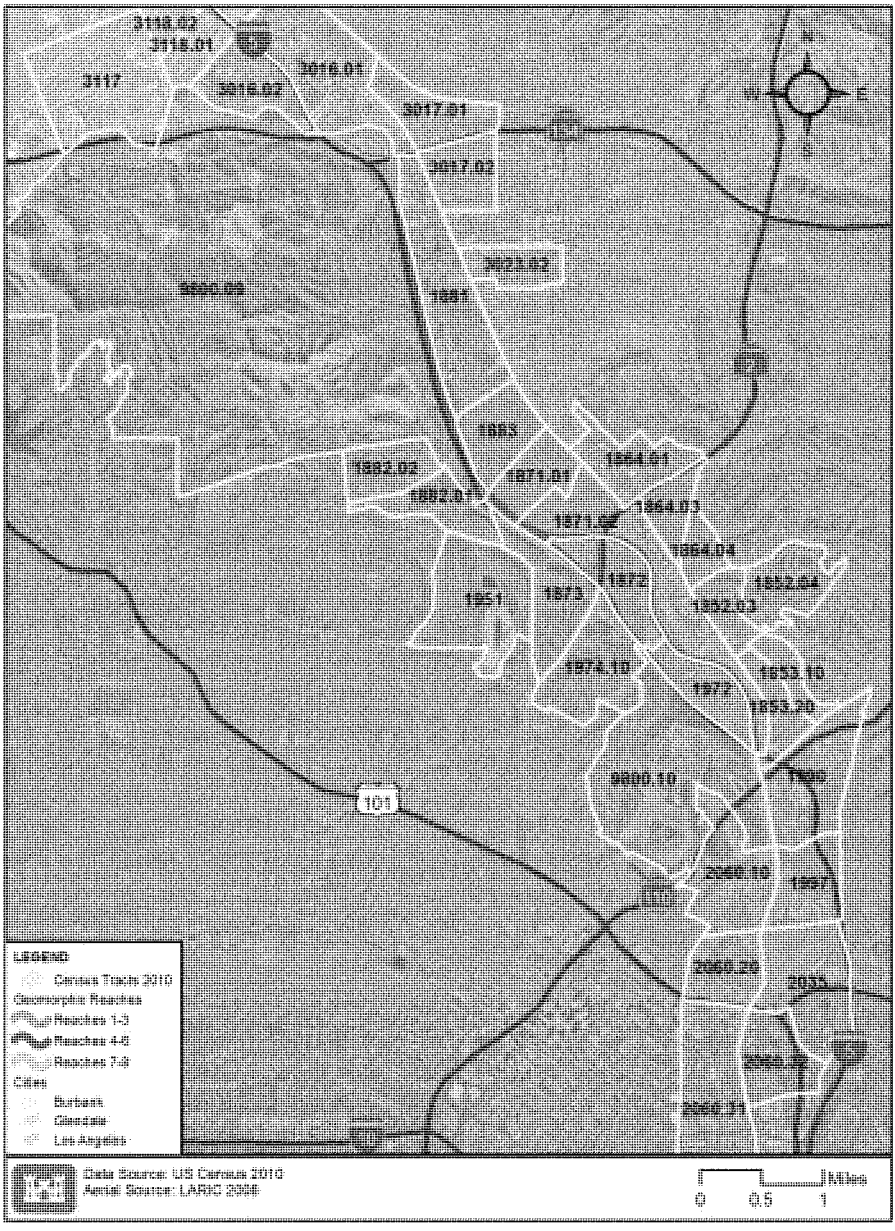

Figure 3.2 Study Area Census Tracts

3.2.1 Population and Housing

Los Angeles County spans over 4,700 square miles and has approximately ten million residents (U.S. Census Bureau 2010b). Within the 35 census tracts in the assessment area, total population is estimated at approximately 127,000 residents, equating to an average density of 5, 060 residents per square mile, about twice the density of the county as a whole. The population, density, and racial profile of each census tract are provided in Table 3-1.

Table 3-2 and Figure 3.3 show the recent and projected population for the county and cities in the study area. For both, the rate of annual growth has generally been declining, and the county and City population rate of growth is projected to be around 0.3 percent by 2040 (LAEDC 2012).

Because the extent to which redevelopment and increased density will affect population in the socioeconomic assessment area has not been quantified, it is assumed that conditions in the assessment area will generally follow the same trends as the county and the City, with overall growth slowing throughout the period of analysis.

Housing in the socioeconomic assessment area is summarized in Table 3-3, which includes household, housing and ownership metrics. Among the 35 census tracts, total housing units range from 0 to 2,707, with a total of 46,246 units in the assessment area, and an overall vacancy rate of 6.45 percent. The vacancy rate in the assessment area is 0.4 percent less than the City of Los Angeles, and 0.2 percent less than the county. Additionally, the assessment area contains a larger proportion of rental units, with only 33 percent owner-occupied units, compared to 38 percent in the City of Los Angeles and 47 percent in the county.

Table 3-1 Population, Density, and Race[1]

Area	2010 Population[2]	Density (per square mile)	% White	% Black	% Hispanic	% Asian	% Other
City of Burbank	103,340	5,890	58	3	25	12	3
City of Glendale	191,719	6,405	62	1	17	16	3
City of Los Angeles	3,792,621	8,092	29	10	49	11	3
Los Angeles County	9,818,605	2,397	27	9	48	15	1
Assessment Area Tracts							
1852.03	3,106	14,680	14	1	77	7	1
1852.04	2,087	5,609	26	3	45	26	0
1853.10	3,383	20,808	3	1	94	2	0
1853.20	3,072	13,473	4	0	85	11	0
1864.01	3,791	10,217	4	1	83	12	0
1864.03	2,947	14,132	5	2	72	22	0
1864.04	2,291	14,792	7	1	86	6	0
1871.01	3,004	9,872	38	1	39	21	0
1871.02	3,018	3,558	19	0	62	19	0
1872.00	3,058	8,325	5	1	82	12	0
1873.00	3,461	7,669	53	2	26	18	1
1881.00	4,113	5,013	23	2	64	11	0
1882.01	3,282	10,951	65	1	13	21	0
1882.02	2,613	8,920	65	2	15	17	0
1883.00	3,335	9,360	37	1	40	21	1
1951.00	4,673	6,385	72	4	10	14	0
1972.00	4,028	13,425	2	1	54	41	1
1974.10	4,005	7,445	41	2	41	15	1
1990.00	5,095	8,456	3	0	60	37	0
1997.00	3,314	8,843	6	0	72	21	0
2035.00	3,507	5,480	2	0	86	11	0
2060.10	2,963	5,334	4	2	59	33	3
2060.20	7,298	21,638	21	33	41	4	1
2060.31	2,736	1,498	43	11	12	35	0
2060.32	5,318	14,010	3	2	79	17	1
3016.01	6,324	7,221	78	2	17	3	0
3016.02	4,154	10,595	38	3	38	20	1
3017.01	2,678	7,443	62	1	24	13	0
3017.02	6,025	19,171	59	1	21	20	0
3023.02	5,134	21,006	46	3	33	17	1
3117.00	6,204	6,829	63	3	24	10	0
3118.01	3,378	14,935	42	2	46	10	0
3118.02	3,680	11,570	27	3	54	16	1
9800.09	2	0	50	0	0	50	0
9800.10	192	130	40	2	20	38	0
Totals[1]	127,269	5,077	32	4	48	16	0

[1]The most recent complete data source was the 2008-2012 American Community Survey. Race information derived from tables "Hispanic or Latino and Race," where Hispanic includes all those identifying as Hispanic or Latino, and races are one-race statistics (White-Alone, Black-Alone, etc.).

[2] Population is a sum. Race profile totals are weighted averages using population as the weights. Source: U.S. Census Bureau 2012.

Table 3-2 Historical and Projected Population

Year	Compound Annual Growth Rate[1]	Population (thousands)[2]			
		LA County	City of Los Angeles	City of Burbank	City of Glendale
2000	-	9,540	3,695	100	195
2005	-	9,810	3,731	100	195
2010	-	9,819	3,793	103	192
2015	0.65%	10,140	3,917	107	198
2020	0.70%	10,500	4,056	110	205
2030	0.59%	11,140	4,303	117	217
2040	0.27%	11,450	4,423	120	224

[1] Growth rate from LAEDC 2012 and applied to area cities. [2] LAEDC 2012 and U.S. Census American Fact Finder

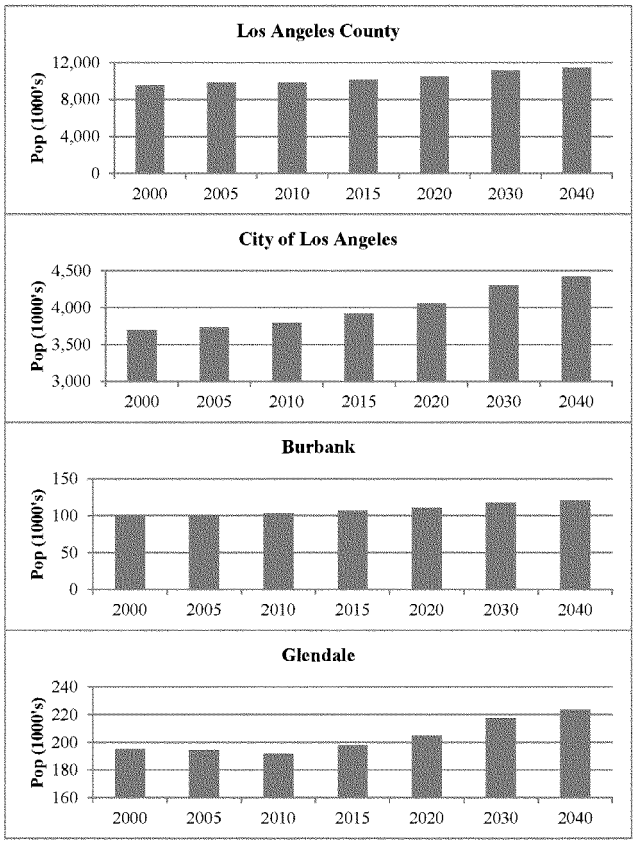

Figure 3.3 Historical and Projected Population

Table 3-3 Housing in the Assessment Area

Area	# Households	# Housing Units	% Vacant	% Owner Occupied
City of Burbank	40,864	44,309	7.8	44,0
City of Glendale	70,710	76,269	7,3	39.2
City of Los Angeles	1,317,663	1,413,995	6.8	38.0
Los Angeles County	3,218,511	3,444,342	6,6	47.3
Assessment Area Tracts				
1852.03	941	956	1.6	47.1
1852.04	669	727	8.0	86.2
1853.10	779	901	13.5	37.9
1853.20	903	930	2.9	42.3
1864.01	989	1,061	6.8	16.4
1864.03	832	861	3.4	32.1
1864.04	668	719	7.1	28.9
1871.01	1,285	1,319	2.6	51.0
1871.02	1,109	1,218	8.9	33.1
1872.00	907	958	5.3	36.9
1873.00	1,514	1,636	7.5	34.3
1881.00	1,726	1,827	5.5	23.2
1882.01	1,938	2,017	3.9	13.1
1882.02	1,189	1,297	8.3	60.1
1883.00	1,382	1,494	7.5	51.7
1951.00	2,079	2,176	4.5	59.7
1972.00	1,141	1,215	6.1	43.9
1974.10	1,738	1,810	4.0	44.0
1990.00	1,526	1,707	10.6	22.5
1997.00	997	1,057	5.7	19.1
2035.00	920	1,046	12.0	13.5
2060.10	981	1,086	9.7	10.1
2060.20	206	220	6.4	1.5
2060.31	1,499	1,700	11.8	40.2
2060.32	1,564	1,625	3.8	11.0
3016.01	2,257	2,308	2.2	11.3
3016.02	1,597	1,697	5.9	36.1
3017.01	1,063	1,151	7.6	61.6
3017.02	1,916	2,083	8.0	26.1
3023.02	1,760	1,818	3.2	9.1
3117.00	2,505	2,707	7.5	55.7
3118.01	1,321	1,352	2.3	16.4
3118.02	1,303	1,484	12.2	12.0
9800.09	0	0	-	-
9800.10	58	83	30.1	34.5
TOTAL	**43,262**	**46,246**	**6.5**	**33.0**
Source: U.S. Census Bureau 2012.				

3.2.2 Employment and Income

Los Angeles County has a highly diverse economy, with a gross annual product in 2010 of approximately $544 billion (LAEDC 2012), or approximately 29 percent of the gross annual product for all of California. Table 3-4 shows some of the basic economic indicators at the county and state level. Socioeconomic conditions in the assessment area are likely to reflect

similar trends as the county and state. Trends over the last decade largely mimic the effects of the Great Recession that began in 2008 and has had national impact. California still has one of the highest unemployment rates in the nation, and this is reflected in parts of the assessment area, though on the whole, the unemployment rate in the assessment area is about 2 percent lower than the unemployment rate for Los Angeles County (12.4 percent) and 2.6 percent lower than the City of Los Angeles. Within the census tracts making up the environmental justice communities, the unemployment rate ranges from 6.2 to 21.8 percent, with an average of 12.6 percent, nearly 50 percent higher than in the study area as a whole.

Table 3-4 Comparison of Southern California Economic Indicators

Area	Median Household Income	2010 Unemployment Rate	2010 Poverty Rate	2010 Median Home Value
City of Burbank	$67,693	9.2	8.5	$570,500
City of Glendale	$54,369	12.7	12.9	$597,000
City of Los Angeles	$49,745	13.0	21.2	$470,000
Los Angeles County	$56,241	12.4	17.1	$443,400
All of California	$61,400	12.8	15.3	$383,900
Assessment Area Tracts				
1852.03	$46,744	10.4	16.30	$350,400
1852.04	$80,950	11.6	18.30	$522,900
1853.10	$40,915	6.2	28.90	$352,800
1853.20	$44,253	11.7	13.10	$371,600
1864.01	$33,382	15	30.70	$371,400
1864.03	$49,353	5.1	15.30	$436,300
1864.04	$48,250	4.8	18.20	$433,500
1871.01	$55,391	4	14.50	$509,300
1871.02	$45,781	6.1	8.70	$566,900
1872.00	$45,455	8.2	20.40	$357,700
1873.00	$74,135	13.8	9.10	$605,100
1881.00	$45,759	11.9	22.50	$567,200
1882.01	$65,859	8.8	8.90	$576,900
1882.02	$100,325	13.5	8.30	$1,000,000+
1883.00	$61,934	9.2	10.90	$600,900
1951.00	$95,184	13.3	8.60	$889,600
1972.00	$43,205	14.1	16.70	$356,800
1974.10	$51,493	9.6	14.70	$566,700
1990.00	$25,149	13.5	39.00	$358,800
1997.00	$35,484	21.8	40.40	$322,000
2035.00	$39,345	12.7	28.00	$389,500
2060.10	$14,583	10.2	49.40	$371,000
2060.20	$102,617	5.3	10.20	-
2060.31	$43,102	12.4	31.20	$402,900
2060.32	$23,511	11.1	37.40	$317,600
3016.01	$43,066	12.5	18.20	$543,500
3016.02	$55,202	13.1	14.40	$550,000
3017.01	$63,304	5.9	3.90	$575,300
3017.02	$48,456	12	15.20	$463,500
3023.02	$40,644	11.2	17.90	$436,500
3117.00	$74,539	5.6	4.90	$585,100
3118.01	$62,500	8.5	10.30	$549,700
3118.02	$43,560	9.8	8.90	$558,800

Area	Median Household Income	2010 Unemployment Rate	2010 Poverty Rate	2010 Median Home Value
9800.09	$117,905	50	-	-
9800.10	$108,472	15.6	36.60	-
TOTAL	**$53,072**	**10.4**	**18.4**	**$485,100**
Sources: U.S. Census Bureau 2012, U.S. Census Bureau 2011, LAEDC 2012.				

According to the Los Angeles County Economic Development Corporation (LAEDC 2012), Los Angeles County's economic base (based on the concept of exports of goods and services), in order of importance, resides in the entertainment, trade (transportation, logistics, distribution), business services, knowledge creation, and fashion industry clusters. Los Angeles County had an estimated non-farm employment of 3.77 million in 2010, reflecting a loss of over 350,000 jobs during the recession which began in 2008, a loss which contributed to the high unemployment rate. Unemployment rates are currently estimated at 7.0 percent for California and 7.5 percent for LA County.[3]. Like the state overall, the LAEDC forecasts a slow but steady recovery for Los Angeles County. Table 3–4 includes the most recent available tract level data, however it should be assumed that the unemployment rates shown there have had similar declines to the County.

Table 3-5 provides the aggregated employment by industry for the 35 census tracts in the socioeconomic assessment area. This data illustrates that while the largest industries in the county are entertainment and trade, employment in the assessment area is driven by the education, health care, social services, and professional and scientific industries.

Table 3-5 Assessment Area Employment by Industry

Industry	Percent
Educational services, and health care and social assistance	18.4
Professional, scientific, and management, and administrative and waste management services	13.3
Retail trade	10.8
Arts, entertainment, and recreation, and accommodation and food services	10.6
Information	9.3
Manufacturing	8.6
Construction	6.2
Other services, except public administration	5.3
Finance and insurance, and real estate and rental and leasing	4.9
Transportation and warehousing, and utilities	4.7
Public administration	3.7
Wholesale trade	3.7
Agriculture, forestry, fishing and hunting, and mining	0.5
Source: U.S. Censns Bureau 2010b	

3.2.3 Environmental Justice

This section provides a discussion of environmental justice in accordance with Executive Order (EO) 12898 and the protection of children from environmental health risks in accordance with

[3] February 2015, Bureau of Labor Statistics www.data.bls.gov

EO 13045. The racial and ethnic data from the 2008-2012 American Community Survey and the 2010 Census (U.S. Census Bureau 2010a, 2012) for the census tracts comprising the assessment area, as well as Los Angeles County, are illustrated in Table 3-1 above.

Within the census tracts that encompass the study area, the Hispanic or Latino population was the dominant group with about 48 percent of the population. The White population was second, with about 30 percent of the population. Third was the Asian population, with 14 percent, followed by the African-American population at 4 percent, and other races at 2 percent. Largely similar, the City of Los Angeles reported a 49 percent Hispanic, 29 percent White, 11 percent Asian, 10 percent African-American, and 1 percent other races. In the county, some differences become apparent, where the population is 60 percent White, 25 percent Hispanic, 10 percent Asian, 2 percent African-American, and 3 percent other races.[4]

In 2010, approximately 25 percent of the state's population was under 18 years old. Approximately 24 percent of the population in Los Angeles County was under 18 years of age (U.S. Census Bureau 2011). Within the 28 census tracts of the assessment area, approximately 22 percent of the population was under 18 years of age (U.S. Census Bureau 2010a).

As shown in Table 3-6, about two thirds of the population's primary language spoken at home is non-English. About 41 percent of the population in the study area tracts speak Spanish at home, 35 percent speak English, and the remaining 24 percent speak other languages. The substantial Spanish-speaking population is consistent with the demographic information summarized previously.

Table 3-6 Language Spoken at Home

Area	English Only	Other than English	Spanish	Other Indo-European languages	Asian and Pacific Islander languages	Other languages
Study Area Tracts	34.7	65.3	41.2	10.6	12.9	0.5
Los Angeles County	43.9	56.1	39.6	5.3	10.2	1.0
Burbank	55.9	44.1	20.1	16.0	6.3	1.7
Glendale	32.7	67.3	15.2	37.8	12.8	1.5
Los Angeles	40.3	59.7	43.6	6.7	8.1	1.4
U.S. Census 2010, 2010a, and 2012. Percentages for study area tracts are based on a weighted average using population as the weights.						

As shown in Table 3-7 below, poverty in the study area is generally consistent with regional data. Poverty in the study area is slightly lower than the City of Los Angeles, but about 1 percent higher than in the whole County. Burbank and Glendale have much lower overall poverty rates than the areas of those cities in the study area.

[4] Data source: 2005-2009 American Community Survey. Race information derived from tables "Hispanic or Latino and Race," where Hispanic includes all those identifying as Hispanic or Latino, and races are one-race statistics (White-Alone, Black-Alone, etc.). Note that the U.S. Census Bureau considers the race category of White to include Hispanics, while it considers the ethnicity category of Hispanic or Latino as distinct.

Table 3-7 People in Poverty

Area	People in Poverty (percent)			
	All People	Under 18	18 to 64	Over 64
Study Area Tracts	18.5	28.0	16.2	15.6
Los Angeles County, California	15.4	22.1	13.5	10.7
Burbank city, California	8.3	9.7	8.3	5.8
Glendale city, California	12.3	16.4	10.8	13.1
Los Angeles city, California	19.1	27.9	16.7	13
U.S. Census 2010, 2010a, and 2012. Percentages for study area tracts are based on a weighted average using population as the weights.				

Table 3-8 presents the percent of people with disabilities in Los Angeles County, the City of Los Angeles, Burbank, and Glendale, as well as in the project area. The proportion of people with disabilities in the project area is 10 percent greater than in the County or City as a whole, 20 percent higher than Burbank, and slightly higher than Glendale. The proportion is also higher in all age groups than the corresponding rates in the County and the three cities

Table 3-8 People with Disabilities

Area	People with Disabilities (percent)			
	All People	Under 18	18 to 64	Over 64
Study Area Tracts	10.4	3.2	7.3	41.8
Los Angeles County, California	9.3	2.8	7	38.1
Burbank city, California	8.1	1.7	4.4	34.1
Glendale city, California	10.1	0.9	6.4	44
Los Angeles city, California	9.4	3	6.9	40.1
U.S. Census 2010, 2010a, and 2012.				

The information above does not illustrate the difference in race, poverty, and disabilities among the communities along the river. Census tracts with poverty rates above the Los Angeles City and County averages are found in the southern portion of Reach 6 and in most Reaches 7 and 8, and along both sides of the Los Angeles River. Census tracts with percentages of non-white population above the City and County average are generally concentrated in Reaches 4 through 8, and generally along the eastside of the river (both sides in portions of Reaches 7 and 8). Finally, a look at disabled populations show a focus again in Reaches 6 through 8 (both sides of the river), as well as in zones 2, 3, and 4 (east side of the river). When all of these factors are taken into account, the Environmental Justice communities can generally be found in the southern reaches of the project (Reaches 7 and 8). Table 3-9 highlights the variables in the environmental justice communities compared to the study area, City of Los Angeles, and Los Angeles County.

Table 3-9 Environmental Justice Criteria, Select Census Tracts (Percentages in 2010)

		% Poverty	% Disabled	% Non-White
Los Angeles City		19.1	9.4	71
Los Angeles County		15.4	9.3	73
Study Area		18.5	10.4	70
Environmental Justice Community Census Tracts				
1853.10	(Reach 6)	**29**	9	**97**
1853.20	(Reach 6)	13	**13**	**96**
1990	(Reach 7)	**39**	**11**	**97**
1997	(Reach 7/8)	**40**	**13**	**94**
2035	(Reach 7/8)	**28**	**13**	**98**
2060.10	(Reach 7/8	**49**	**11**	**96**
2060.31	(Reach 8)	**31**	**12**	59
2060.32	(Reach 8)	**37**	**13**	**97**
9800.1	(Reach 6/7)	**32**	**13**	60

Source: U.S. Census 2012
Note: Percentages in **bold** are above Los Angeles City and Los Angeles County averages.

4. FLOOD RISK CONSIDERATIONS

Flood risk was considered in the plan formulation process to address ecosystem restoration opportunities. The Hydrology and Hydraulic (H&H) Appendix E documents the existing and future with project condition as it relates to flooding and potential for induced flooding related to implementation of ecosystem restoration measures. One of the constraints taken into consideration during the formulation of alternatives was that induced flood damages should be avoided; therefore efforts were made to avoid measures that increase flooding.

As described in the H&H Appendix E, inundation mapping was generated for the 4, 2, 1, and 0.2 percent annual exceedance chance events for both existing and with project conditions. The existing conditions 100-year floodplain has two major breakout areas within the ARBOR Reach, both corresponding to vegetated reaches of the Los Angeles River. The upstream area with extensive overbank flooding is between Barham Boulevard and the confluence with Verdugo Wash, and has an average floodwater depth of 5.2 feet in the overbank areas. The downstream area with extensive overbank flooding is from the Verdugo Wash confluence to the Golden State Freeway, where the in-channel vegetation ends, and has an average floodwater depth of 3.9 feet in the overbank areas. Floodplain mapping can be found within Appendix E.

The final array of alternatives was analyzed and compared to the existing conditions to determine their impacts on the flood conveyance function of the channel. For the most part, the reaches that showed an increase in water surface elevation for the design event were at transition areas, either geometric (trapezoidal to rectangular or from a widened section to a narrow section) or construction material (soft-bottom vs. concrete). Induced flooding will be avoided by the project design and Operation and Maintenance (O&M) requirements for the project. See Appendix E, Hydrology and Hydraulics, for a detailed discussion of the effects of the final array on flood conveyance.

5. RECREATION RESOURCES

Section 5 characterizes recreational resources in the baseline study area and considers recreational opportunities within the ARBOR Reach. A draft recreation alternative has been developed and analyzed. The economic analysis of the recreation plan is summarized in Section 7 and detailed in Attachment 1 to this appendix.

5.1 Regional Context and Demand

The City of Los Angeles has approximately 24,000 acres of parks, with approximately 16,000 acres of parkland under the jurisdiction of the Department of Recreation and Parks. Other agencies managing parklands include the Los Angeles Department of Water and Power (LADWP), the Mountains Recreation and Conservation Authority (MRCA), the Santa Monica Mountains Conservancy (SMMC), California State Parks, and the Los Angeles County Department of Parks and Recreation (LACDPR). In all, this equates to a City-wide average of 6.26 acres of park per 1000 residents (Trust for Public Land 2011). The City of Glendale has 39 developed parks comprising 280 acres, or about 1.4 acres per 1000 residents (City of Glendale 2012). The City of Burbank operates 27 park facilities covering 155 acres, as well as 500 acres of open space, equating to approximately 6.34 acres of parkland per 1000 residents (City of Burbank 2010). Including all parks identified in the ARBOR reach presented below, the recreation resource area has an estimated 5,000 acres of park, or 38.77 acres per 1000 residents. This value is high compared to the City-wide average due to the presence of some larger than average parks near the study area, such as Griffith Park (the largest park at 4,210 acres) and Elysian Park (575 acres).

Much of Los Angeles is considered to be "park poor" which refers to any geographic area that provides less than three acres of green space per 1,000 residents, as defined by California law (Green Info Network 2010). In particular, the industrial areas surrounding reaches 7-8 (from the I-5 overpass to Main Street) have the least parkland, with fewer than 3 acres per 1,000 people. Other areas, particularly on the southwest side of Reaches 1-3 (from Pollywog Park to Brazil Street), have greater than 3 acres of parkland per 1,000 residents, which is due to the presence of Griffith Park. In general, access to parks and acres of parkland per 1,000 residents is lowest in areas that have the highest number of families below the poverty line of $47,331 annual income.

According to SCAG, public parks are intended to serve all residents, but not all neighborhoods and people have equal access to these public resources. SCAG calls for a multiagency effort and public transportation to improve access for all to parks throughout Southern California (SCAG 2008). The City Project has been initiated to find resolutions to improving park availability for all neighborhoods, regardless of ethnicity or income level (Garcia et al. 2009).

Residents of Los Angeles place a high priority on the quality of natural and environmental resources. In a study from 2000, 75 percent of those surveyed said that preserving wetlands, rivers, and environmentally sensitive areas would be either "somewhat effective" or "very effective" at improving their quality of life. There is also strong support for protecting cultural resources and for environmental education (Public Policy Institute of California 2000).

5.1.1 Recreational Opportunities in the Study Area

For this analysis, the recreation resources most likely to be affected by project alternatives are those within a half-mile buffer on either side of the River. The inventory of larger regional parks and other resources that exist outside the study area are beyond the geographic scope of this inventory other than to demonstrate the lack of regional parks and open space available within the greater Los Angeles area.

Approved year-round uses along the River in the study area are limited to pedestrian, cyclist, and equestrian trails along the banks. Seasonal passive recreation use, including birdwatching, walking, fishing, and non-motorized boating is allowed within the Elysian Valley portion of the study area under the auspices of the Los Angeles River Recreational Zone, under the oversight of the Mountains Recreation and Conservation Authority as approved by the City of Los Angeles in coordination with the County and the Corps. There are no areas approved for swimming in the study area, and instances of swimming and wading are likely low due to water quality concerns as local agencies and interest groups typically advise users to stay out of the water (LARRC 2011b).

Small parks along the River's pathways provide an improved pedestrian recreation experience with facilities such as benches and grassy areas. These parks are a combination of city parks and small pocket parks funded by local non-profit groups seeking to develop a greenway along the River (SMMC and MRCA 2007).

The Los Angeles River Bike Path is a Class II Bike Path (off-roadway, paved), and runs along the right bank of the River from Griffith Park through Glendale Narrows to Elysian Park, offering an off-roadway route for pedestrians and cyclists. Another route between Griffith Park and Elysian Park relies on a combination of bike lanes and bike routes (on-roadway) but does not follow the River, making it a Class III Route, less appropriate for recreation and more of a transportation route. Both of these routes are managed by Los Angeles County Metro, and are included in the City of Los Angeles Bicycle Plan (Metro 2012).

Table 5-1 Recreational Resources in Study Area

Name	Type, Location	Amenities
Bette Davis Picnic Area	Public, Los Angeles	Picnicking, walking, jogging, viewing
Chevy Chase Park and Recreation Center	Public, Los Angeles	Playground, basketball, handball, gym, picnicking, auditorium, pool
Crystal Springs Picnic Area	Public, Los Angeles	Picnicking
Ferraro Soccer Fields	Public, Los Angeles	Soccer fields
Griffith Park	Public, Los Angeles	Amphitheatre, bird sanctuary, camping, educational programming, equestrian, golf, hiking, jogging, museum, observatory, picnicking, soccer, swimming, tennis
Harding Golf Course	Public, Los Angeles	18-hole golf course
Lincoln Park	Public, Burbank	Playground, picnicking
Los Angeles Equestrian Center	Private, Los Angeles	Boarding stalls, training rings, indoor/outdoor show arenas, grass fields, riding academy, professional trainers, equestrian trails
Los Angeles Zoo	Public, Los Angeles	Municipal zoo and botanical gardens
Los Feliz Golf Course	Public, Los Angeles	9-hole golf course

Name	Type, Location	Amenities
Milford Mini Park	Public, Glendale	Playground, picnicking
Mountain View Park	Public, Burbank	Playground, restrooms, picnicking, tennis, basketball, horseshoe
North Atwater Park	Public, Los Angeles	Baseball, basketball, playground, volleyball, restrooms
Pelanconi Park	Public, Glendale	Ballfield, basketball, playground, picnicking, special facilities
Roosevelt Municipal Golf Course	Public, Los Angeles	9-hole golf course
Wilson Golf Course	Public, Los Angeles	18-hole golf course
Chavez Ravine Arboretum	Public, Los Angeles	Picnicking, playground, restrooms
Egret Park	Public, Los Angeles	Viewpoint, plantings, interpretive signage
Elysian Park	Public, Los Angeles	Walking, hiking, jogging, restrooms, picnicking, horseshoe, arboretum, baseball, sports field, therapeutic center, lodge, art exhibits, historical monument, community garden, playground
Elysian Valley Gateway Park	Public, Los Angeles	Plantings, benches, River access, picnicking
Elysian Valley Recreation Center	Los Angeles	Community rooms, auditorium, baseball, basketball, playground, handball
Glenhurst Park	Public, Los Angeles	Playground
Oso Park	Public, Los Angeles	Plantings, art, interpretive signage
Marsh Park	Public, Los Angeles	River access, viewing, picnicking, grass field, playground, infiltration area
Rattlesnake Park	Public, Los Angeles	Art exhibit, plantings, benches
Rio De Los Angeles State Park	Public, Los Angeles	Natural wetlands, hiking trails, sports fields, playground, recreation building
River Garden Park	Public, Los Angeles	Fountain, benches, picnicking, lawn area, restrooms
Silver Lake Recreation Center	Public, Los Angeles	Playground, community room, gym, picnicking, sports field, walking, jogging trails, classes, summer camps
Steelhead Park	Public, Los Angeles	Plantings, outdoor amphitheater
Sunnynook Park (under construction)	Public, Los Angeles	Plantings, walking paths, outdoor classroom
William Mulholland Memorial	Public, Los Angeles	Memorial fountain, seating, grass area
Chavez Ridge Disc Golf Course	Public, Los Angeles	18-hole course, restrooms
Confluence Park	Public, Los Angeles	Fountain, benches, plantings,
Dodger Stadium	Private, Los Angeles	Professional baseball stadium
Downey Recreation Center	Public, Los Angeles	Auditorium, baseball, playground, picnicking
Lacey Street Neighborhood Park	Public, Los Angeles	Picnicking, parking lot
Los Angeles Historic State Park	Public, Los Angeles	Walking, jogging, cycling paths, picnicking, natural and urban viewing, multipurpose field, restrooms, telescopes
Pecan Recreation Center	Public, Los Angeles	Baseball, playground, community room, handball, gym, picnicking, restrooms, seasonal pool, volleyball
Radio Hill Gardens	Public, Los Angeles	Trails, plantings, viewing
Solano Canyon Community Garden	Public, Los Angeles	Community gardening, picnicking
Sources: LARRC 2011c. City of Los Angeles 2012c, 2012d, 2012e. CDPR 2012a, 2012b, Linton 2012, PDGA 2012. Sources: SMMC & MRCA 2007. LARRC 2011c. City of Los Angeles 2012c, 2012d, 2012e, CDPR 2012a, 2012b, Linton 2012. Sources: City of Burbank 2012c, City of Glendale 2012, 2012d, City of Los Angeles 2012c, 2012d, and 2012e.		

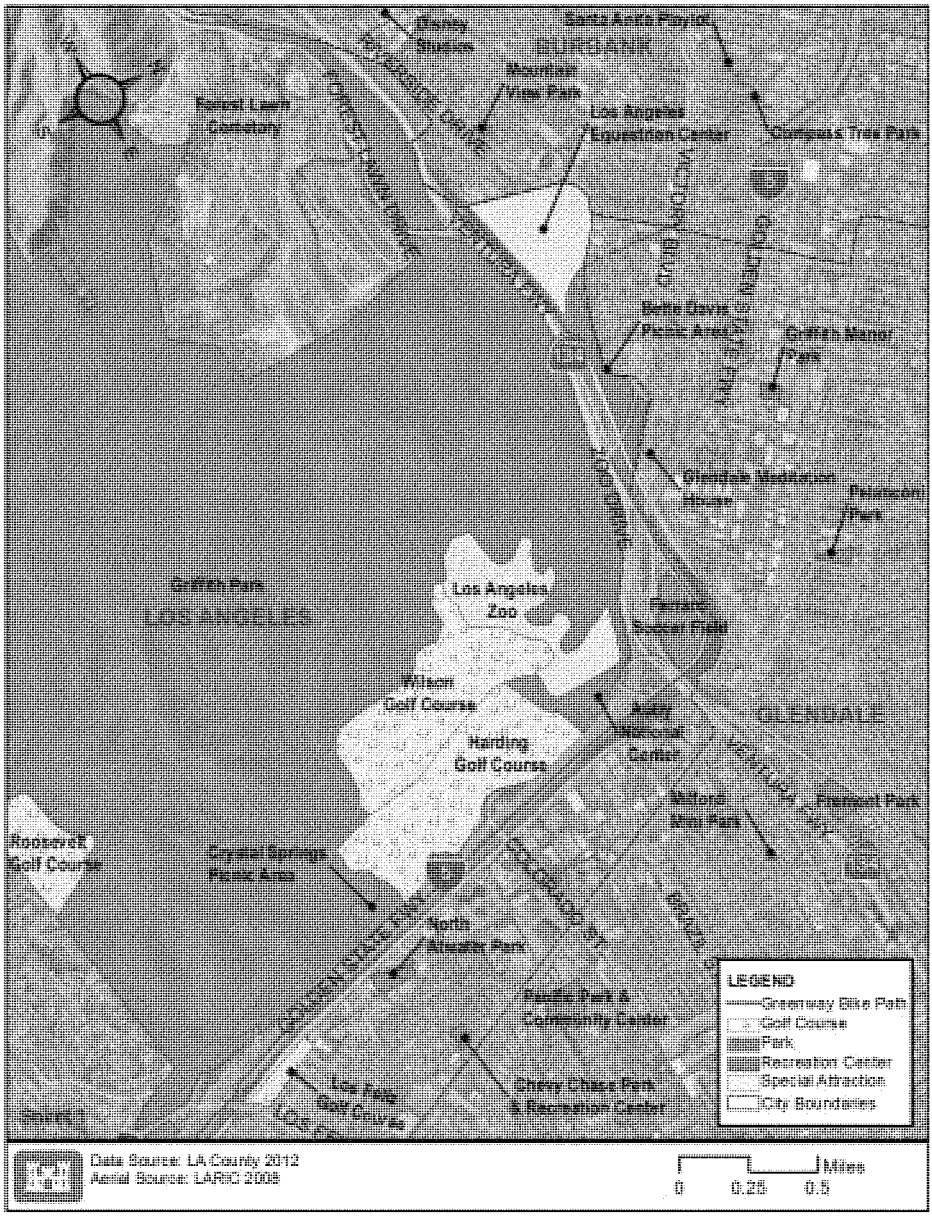

Figure 5.1 Recreation Resources, Reach 1 - 3

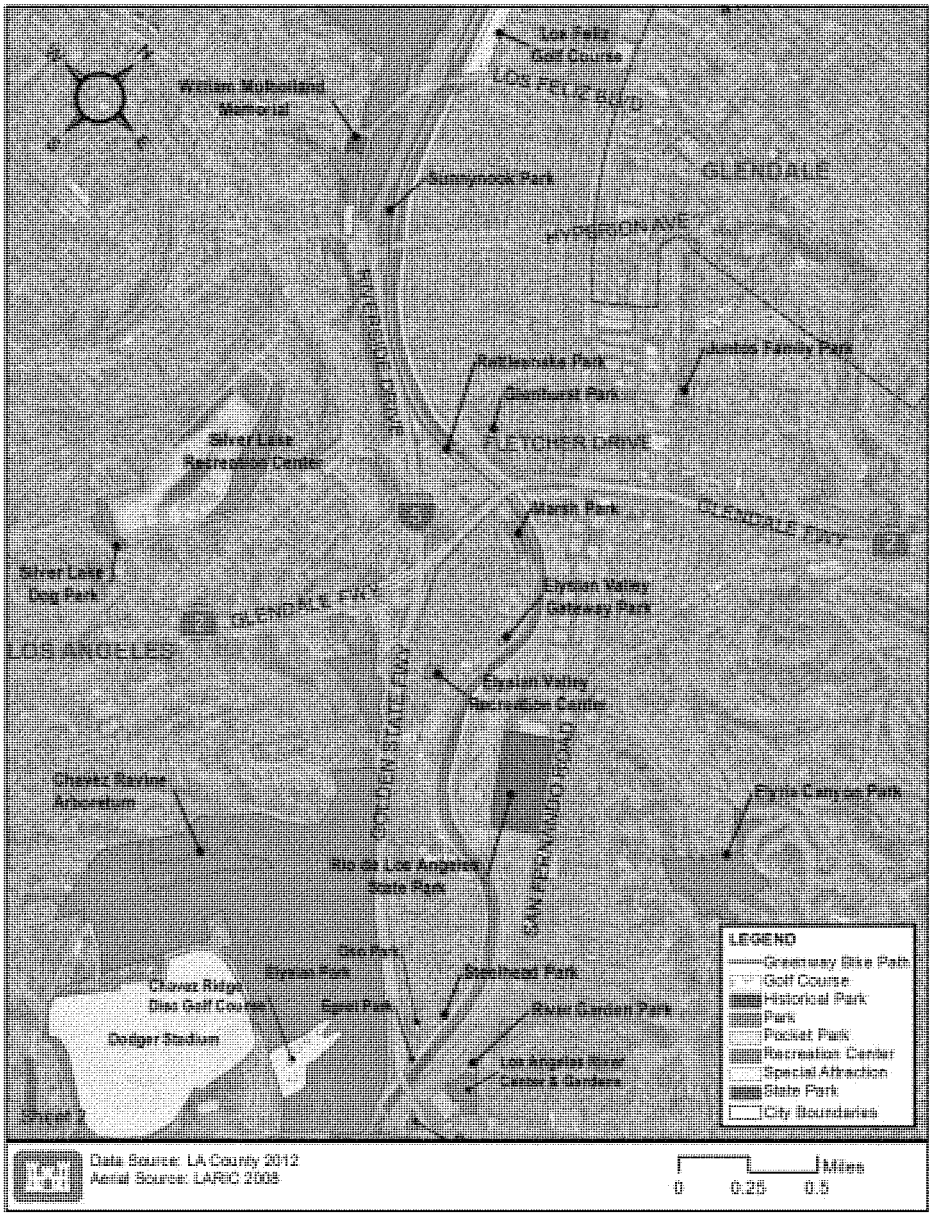

Figure 5.2 Recreation Resources, Reaches 4 - 6

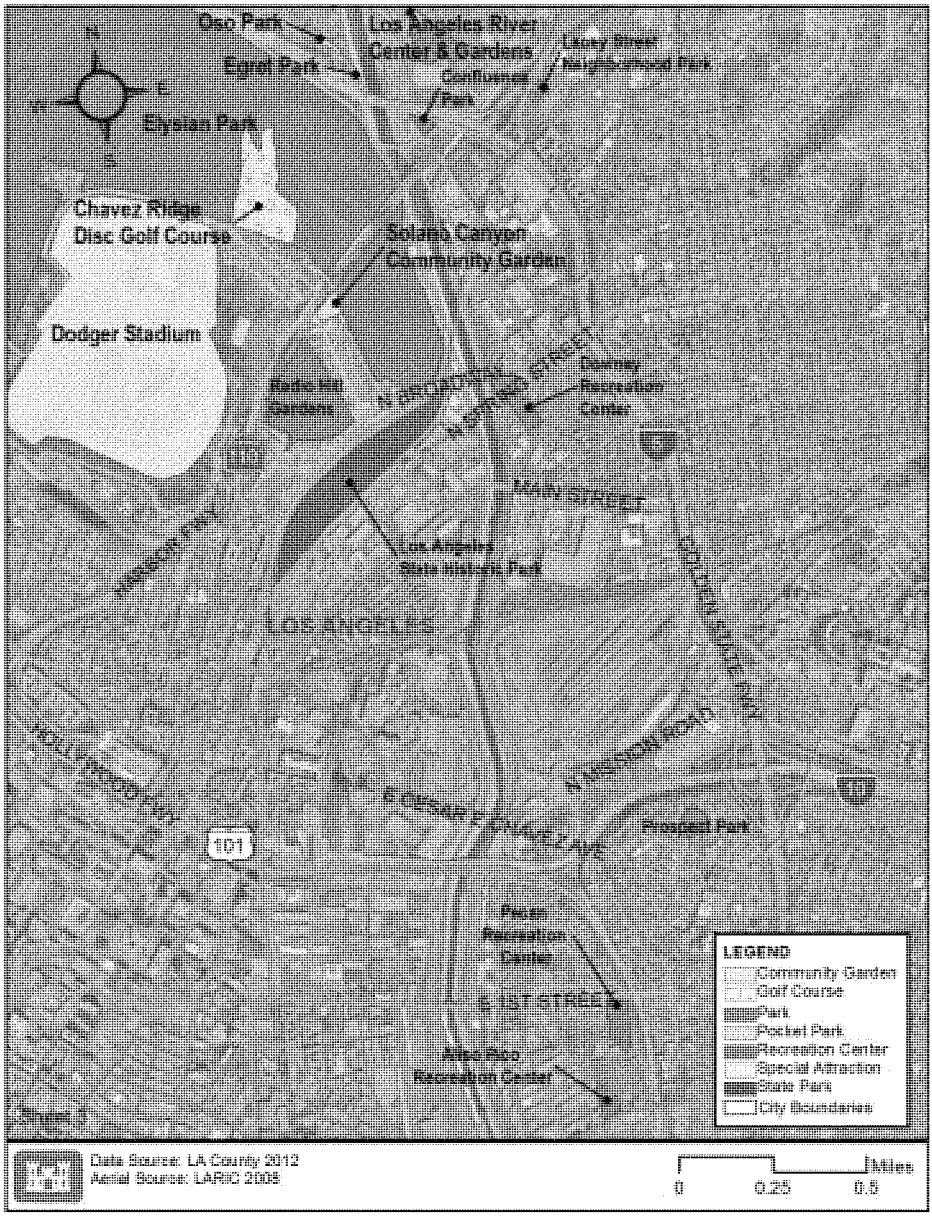

Figure 5.3 Recreation Resources, Reaches 7 - 8

5.1.2 Future Without Project Condition

Because the study area is largely developed, the potential for substantial conversion of land to recreational uses is limited. However, recreational features will continue to be pursued by state or local entities wishing to develop recreational park areas along the River corridor. Local groups, such as the Los Angeles River Revitalization Corporation (LARRC), MRCA, MRCA, North East Trees (NET), Friends of the LA River (FoLAR), and The River Project (TRP) are likely to continue working to enhance the Los Angeles River Greenway through improvements of existing facilities along the River and installation of new park features.

The MTA, LARRC, and City of Los Angeles are actively planning bridges across the river that will provide a safe and convenient bicycle and pedestrian link between the Los Angeles River Bikeway on the west bank, and the Taylor Yard on east bank. The proposed bikeway improvement will consist of a minimum 15-foot wide bridge over the LA River, and a minimum 12-foot wide connection to the Union Pacific's Taylor Yard property (LARRC 2011d). As part of the North Atwater Park Expansion Project, a multimodal bridge is proposed to provide a connection from just downstream of North Atwater Park to the west side of the River. This bridge will provide pedestrian, bicycle, and equestrian access (LARRC 2011d).

Demand for recreation in the area is expected to increase proportionally to growth of population in the study area. Continued implementation of the Los Angeles River Revitalization Master Plan (City of Los Angeles 2007a) could increase recreational opportunities significantly over the long-term in the study area.

6. ECOSYSTEM RESTORATION ALTERNATIVES

The plan formulation process is described in detail in Section 3 of the Integrated Report. That section describes how each of the alternative plans were developed and evaluated at each step in the process, and ultimately included or excluded from the array of plans being considered. This appendix mentions briefly some of the plan formulation processes, evaluation criteria and arrays of plans that were considered. It does not describe these processes or information in detail. For a more detailed description the reader should refer to Sections 3 and 6 of the Integrated Report.

Ecosystem restoration is one of the primary missions of the Corps of Engineers Civil Works program. The Corps objective in ecosystem restoration planning is to contribute to national ecosystem restoration (NER). Contributions to NER are increases in the net quantity and/or quality of desired ecosystem resources. Measurement of NER is based on changes in ecological resource quality and a function of improvement in habitat quality and/or quantity and expressed quantitatively in physical units or indexes (but not monetary units). These net changes are measured in the planning area and in the rest of the nation. Thus, single purpose ecosystem restoration plans shall be formulated and evaluated in terms of their net contributions to increases in ecosystem value (NER outputs) expressed in non-monetary units (habitat units).

For ecosystem restoration projects, a plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective, shall be selected. The selected plan must be shown to be a cost effective plan for achieving the desired level of output and

economically justified (determined to be worth its investment cost). This plan shall be identified as the NER Plan. This formulation, evaluation, and selection process is described below.

6.1 Preliminary Alternatives

Following the charette workshop held December 2-4, 2009, an initial array of alternative plans was identified, which was then subject to additional screening. The screening process that was used applied the evaluation criteria established under the Principles and Guidelines (P&Gs) to assess the feasibility of alternative solutions. Completeness, Effectiveness, Efficiency, and Acceptability were considered as well as the technical feasibility, environmental impacts/benefits, and public acceptability of the alternatives.

A significant effort was undertaken in the development of preliminary restoration features at each site. Restoration features and a set of initial alternatives were developed during the charette workshop. Alternatives were subsequently evaluated and screened and a total of 19 alternatives were formulated, with each alternative containing different combination of measures in the eight reaches. The following 19 preliminary alternative plans, each of which contains different combinations of features in the eight reaches, were evaluated in this study. More detailed description of the formulation of measures and alternatives is found in the main report.

- 1: Comprehensive A. Includes these features throughout entire River study area: development of freshwater marsh, open water ponds, fish refugia, and riparian corridors; exposing storm drain outlets and converting to natural stream confluences; diversion of flow into side channels lined with habitat; development of underground basins and culverts to attenuate flow; bioengineering of channel walls; channel modification to increase width by terracing; channel widening, and/or modification of channel walls; connections to green streets; modification along tributary confluences to more natural habitat; and development of wildlife crossings.

- 2: Atwater to Cornfields. Includes all of the above within the Atwater to Cornfields part of the reach.

- 3: Banks and Tributaries Only. Leaves the flood control channel bed primarily "as is" and restores floodplain by creating side channels in open areas along the River with freshwater marsh and riparian corridors and restoring tributary confluences. Includes modification of storm drain outlets and bank terracing.

- 4: Comprehensive B. Includes most of the features included in Alternative 1 Comprehensive A with fewer locations, less terracing and side channels, and omits elevating railroads on trestles, bioengineering walls, creating open water areas, and modifying trapezoid channels to vertical channels.

- 5: Los Feliz to Arroyo Seco. Implements all features from Comp A or B within Los Feliz to Arroyo Seco reach.

- 6: Comprehensive C. Includes most of the features included in Alternative 1 Comprehensive A with fewer locations and omits railroad elevation, bioengineering walls, open water area creation, and trapezoid channel modification to vertical. Includes

more terracing and storm drain modifications and different locations for wildlife crossings than Alternative C-17 Comprehensive B.

- 7: Channel Reshaping A. Focus is on channel reshaping and attenuation of flow through detention basins, bypass channels, and channel widening. Using culverts and underground basins to attenuate flows, the channel is geomorphically changed to a wider, softer channel, with more naturalized storm drain outlets and some restored riparian corridors.

- 8: Habitat Variation. This alternative focuses on maximizing habitat restoration for species diversity, including fish, through attenuation or reduction in flow, as well as augmentation or creation of freshwater marsh, riparian and aquatic habitat.

- 9: Soft Bed Channel and Associated Banks. This alternative focuses restoration in reaches that already have a soft riverbed. Where open areas are adjacent to the River, the River will be widened rather than terraced. Storm drains are converted to natural stream confluences and restored with riparian vegetation. Habitats include aquatic, freshwater marsh and riparian areas.

- 10: Channel Modifications. This alternative implements features in locations with the least impact to infrastructure and engineering challenges, while still including features in all reaches to attenuate flow, and restore riparian, freshwater marsh habitat and tributary confluences.

- 11: Habitat Connectivity. This alternative focuses on bank to bank and upstream to downstream connections for wildlife and linkages to wildlife areas through channel widening and terracing.

- 12: Hydrologic Connection Improvements. This alternative focuses on lowering elevations of large open areas adjacent to the River to improve connectivity to the floodplain, and features to improve hydrologic connections between the banks, storm drains and River. It also includes features for increasing wildlife movement between the River and adjacent open areas.

- 13: Channel Reshaping B. Using culverts and underground basins to attenuate flows, the channel is geomorphically changed to a wider, softer channel, with naturalized storm drain outlets and restored riparian corridors. Includes bioengineering of channel walls, side channels and has more riparian and freshwater marsh replanting than Channel Reshaping A.

- 14: Channel Widening. This alternative focuses on widening the channel. Attenuation is accomplished with culvert bypasses. Includes planting of freshwater marsh and riparian corridors.

- 15: Bypass with Bank and Tributary Confluence Restoration. Reduces flow using culvert bypass to allow for terracing and channel bank softening. Improves freshwater marsh habitat in soft bed areas and adds riparian habitat to downstream locations on the river overbank. Emphasizes widening and restoration at tributary confluences.

- 16: Side Channels Only. Leaves the flood control channel bed and banks primarily "as is" and restores floodplain by creating side channels in open areas along the river, creating freshwater marsh and riparian corridors and restoring tributary confluences.

- 17: Opportunity Area Restoration With Channel Widening at Tributaries. Restores wetlands on the overbank and major tributaries at the River Glen confluence with Verdugo Wash, Griffith Park, Bowtie/Taylor Yard, Arroyo Seco Confluence, Burbank-Western Channel, Cornfields, and LATC. Widens the river at Verdugo, Arroyo Seco and Burbank-Western Channel.

- 18: Comprehensive Pockets. Leaves flood control channel bed and banks "as is" and restores wetlands on the overbank and major tributaries at the River Glen confluence with Verdugo Wash, Bowtie/Taylor Yard, Arroyo Seco Confluence, and Cornfields.

- 19: Taylor Yard. Restores wetlands on the overbank and widens the river at this single key location on the River, and includes the Bowtie parcel.

- T: Tunnel: In addition to the 19 alternatives a tunnel measure was evaluated. Construction of tunnels or large culverts to divert storm season flows around the project reach. This would require excavation and construction of culverts that would need to be sized and designed based on results hydraulic modeling.

6.2 Cost Effectiveness and Incremental Cost Analysis

Although 19 preliminary alternatives were developed in 2009, the features that made-up each alternative were not selected based on cost effectiveness or incremental cost; they were instead based on a common concept or theme. The features are essentially management measures modified for specific locations. The preliminary alternatives represented a combination of these features, one feature per reach.

The study area was broken down into eight reaches, and the output and costs of the 19 preliminary alternatives for the study area were accordingly broken out by these eight reaches to allow recombination of the features in any of the 19 preliminary alternatives on a reach-by-reach basis, as appropriate. As shown later in Figure 6.2, the original 19 preliminary alternatives were then compared to the alternatives which were formulated via the Cost Effectiveness and Incremental Cost Analysis (CE/ICA) software methodology described below.

6.2.1 Methodology

A CE/ICA analysis was conducted using benefit and cost inputs on a reach-by-reach basis using the certified IWR-Planning Suite software version 1.0.11.0 (IWR-PLAN). The various separable element features of the alternative plans were evaluated and compared, and recombined by the software as discussed within this section. The results were then manually inspected to identify apparent break-points in order to identify a final array of alternatives.

CHAP Analysis

For this study, benefits (or outputs) have been quantified using the Combined Habitat Assessment Protocols (CHAP) approach. The CHAP analysis is an accounting and appraisal method that utilizes species-habitat-functions to derive current habitat unit values, which are annualized over the period of analysis to create average annual habitat units (AAHUs). To determine a change in these values over time, projections are needed to alter either the species, habitat, or function parameters. Applying these changes over several time periods requires some conjecture to deduce the amount of influence that might be expected during each time period. Details pertaining to the CHAP analysis are found within Appendix G.

Cost Estimates

Preliminary feasibility level cost estimates for the 19 alternatives were developed using the Civil Works Cost Database as well as input from local regional construction firms and materials suppliers. All costs are presented in FY13 price level. Supporting cost information can be found in Appendix C.

CE/ICA

Cost-effectiveness and incremental cost analyses were performed using IWR-PLAN. The CE/ICA is an evaluation tool which considers and identifies the relationship between changes in cost and changes in quantified, but not monetized, habitat benefits. The evaluation is used to identify the most cost-effective alternative plans to reach various levels of restoration output and to provide information about whether increasing levels of restoration are worth the successively added costs. The CE/ICA is a planning tool to help identify cost-effective plans which provide a certain level out habitat output at the least cost.

Functionally, the CE/ICA provides a framework for combining individual measures (called features in this case) into alternative plans. The software expedites this effort of testing each combination of features and tabulating the resulting costs and environmental benefits.

Cost Effectiveness Analysis

When there is no monetary measure of benefits but project outcomes can be described and quantified in some dimension, cost effectiveness analysis can be used to assist on the decision making process. Cost effectiveness analysis seeks to answer the question: given an adequately described objective, what is the least-costly way of attaining the objective? A plan is considered cost effective if it provides a given level of output for the least cost. Cost effectiveness analysis was used to identify the least cost solution for each level of environmental output being considered.

The cost effectiveness analysis is the first step in the CE/ICA, and compares the Average Annual Habitat Units (AAHUs) potentially achieved by each alternative to the cost of each alternative to generate a "cost per AAHU." This cost provides a means to compare the cost-effectiveness of each plan. The three criteria used for identifying non-cost effective plans or combinations include (1) the same level of output could be produced by another plan at less cost; (2) a larger output level could be produced at the same cost; or (3) a larger output level could be produced at

the least cost. Cost-effectiveness is one of the criteria by which all plans are judged and plays a role in the selection of the National Ecosystem Restoration (NER) Plan. Non-cost effective combinations of plans are dropped from further consideration.

Incremental Cost Analysis

Incremental cost analysis compares the additional costs to the additional outputs of an alternative. It is a tool that can assist in the plan formulation and evaluation process, rather than a dictum that drives that process. The analysis consists of examining increments of plans or project features to determine their incremental costs and incremental benefits. Increments of plans continue to be added and evaluated as long as the incremental benefits exceed the incremental costs. When the incremental costs exceed the incremental benefits, no further increments are added. Incremental analysis helps to identify and display variations in costs among different increments of restoration measures and alternative plans. Thus, it helps decision makers determine the most desirable level of output relative to costs and other decision criteria.

The incremental cost analysis portion of the CE/ICA compares the incremental costs for each additional unit of output from one cost effective plan to the next to identify "best buy" plans. The first step in developing "best buy" plans is to determine the incremental cost per unit. The plan with the lowest incremental cost per unit over the No Action Alternative is the first incremental best buy plan. Plans that have a higher incremental cost per unit for a lower level of output are eliminated. The next step is to recalculate the incremental cost per unit for the remaining plans. This process is reiterated until the lowest incremental cost per unit for the next level of output is determined. The intent of the incremental analysis is to identify successively larger plans with the smallest incremental cost per unit of incremental output.

Selection Considerations

For ecosystem restoration, the recommended plan should be the justified alternative and scale having the maximum excess of monetary and non-monetary beneficial effects over monetary and nonmonetary costs. This plan occurs where the incremental beneficial effects just equal the incremental costs, or alternatively stated, where the extra environmental value is just worth the extra costs. A plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective, is identified as the National Ecosystem Restoration (NER) Plan. The selected plan should be cost effective and justified in achieving the desired level of output. Thus, the NER plan is selected from the suite of cost effective plans identified in the CE/ICA. While the NER Plan is not required to be a best buy plan, this is often the case. The results of the CE/ICA do not provide a discrete decision, but rather they offer tools to help inform a decision.

Development of Features

For the purposes of the CE/ICA, the aforementioned 19 preliminary alternatives were broken down into the component features for each reach. The breakdown was necessary for the incremental analysis of alternatives and appropriate because the alternatives had been conceptualized as separable elements. In each of the eight reaches, not all 19 alternatives included a feature.

In addition to whether or not each reach contained a feature for a given alternative, some features were dependent on the inclusion of a diversion tunnel to alleviate flows in the channel. The diversion tunnel costs were developed as a separate measure. The features dependent on the diversion tunnel are indicated by pink highlighting in Table 6-1.

Once the alternatives were broken down into the measures presented in Table 6-1 and entered into IWR-PLAN, the software program considered all possible combinations of these measures (taking dependencies into account). The cost-effective and best buy plans were drawn from a list of all possible reach-wise combinations of the preliminary 19 alternatives, as explained in the following section.

Table 6-1 Matrix of Features Comprising the Preliminary Alternatives

Preliminary Alternative	Reach							
	1	2	3	4	5	6	7	8
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								

Pink-highlighted cells indicate features dependent on the diversion tunnel.

6.2.2 CE/ICA Model Implementation

To conform to the software structure, each of the eight reaches was defined as a "measure"[5] (in the language of the software). For each reach, there were a possible 19 different mutually

[5] Measures—also called "features" when they are structural measures and "activities" when they are non-structural measures—are typically defined as a type of restoration action (create wetland, remove levee, etc.). In this case, the measures are defined as each of the eight study reaches.

exclusive "scales"[6] that might be implemented (corresponding to the measures with checkmarks in Table 6-1). "Scales," in the CE/ICA software, are mutually exclusive, so the software would choose one measure for each reach to formulate alternatives that combine multiple reaches. Costs and benefits are tabulated by the software for each suite of measures that have been combined into a new alternative plan. Costs and benefits for the diversion tunnel were a separate measure which was called using the dependency relationships in the CE/ICA software. Due to computational limitations, plans requiring the diversion tunnel and those not requiring the diversion tunnel were run separately. As it turned out, Tunnel-Dependent alternatives were screened from further analysis based on prohibitive cost. As such, the Non-Tunnel model became the only model further evaluated. The following sub-sections describe each of the two model runs.

(a) Tunnel-Dependent Model

The Tunnel-Dependent model evaluated those features which were dependent on the diversion tunnel (corresponding to the pink-shaded cells in Table 6-1). The tunnel itself had an average annual cost of $70,943,000. The least cost tunnel-dependent plan was shown to result in only a 0.12 percent increase in habitat output and a of 53 percent increase in cost compared to the largest non-tunnel plan, as illustrated by Figure 6.1 below. Based on these results, the opinion of the study team was that the benefits associated with the diversion tunnel did not exceed the costs. Features requiring the tunnel were screened from further consideration (pink cells in Table 6-1).

[6] Scales are typically defined as a potential quantity of a measure (create 100, 200, or 300 acres of wetland). In this case, the scales are reach-specific alternatives (derived from the preliminary 19 alternatives) which may be recombined (1 scale per reach) to form new alternatives.

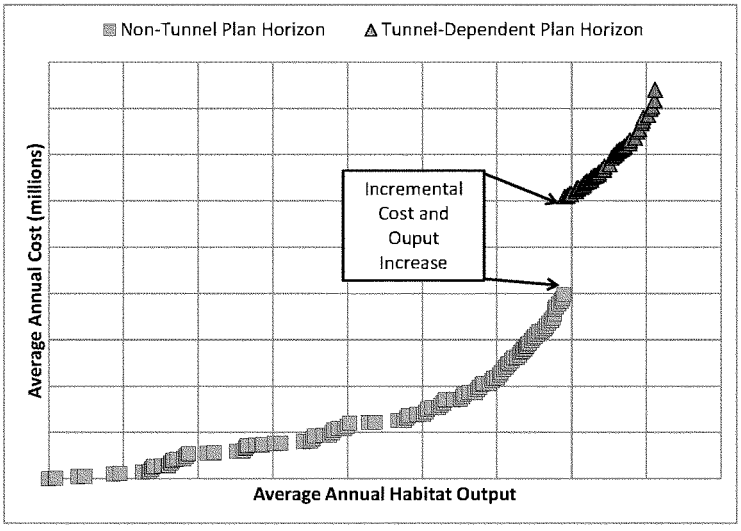

Figure 6.1 Tunnel-Dependent Plan Horizon

(b) Non-Tunnel Model

The Non-Tunnel model included only those features which could be implemented without the diversion tunnel measure. This is equivalent to the blue-shaded cells in Table 6-2 and Table 6-3, which present the annual costs and benefits for each feature, respectively.

As shown in the tables, Reach 1 contains only three features which do not require the diversion tunnel that was originally formulated at part of preliminary alternatives 11, 16, and 18 (compare to shading in Table 6-3, which also contains only three blue cells for reach 1). Thus, only these three features are included in the Non-Tunnel model for Reach 1, and are assigned a code for the reach and the scale in the software. The same methodology is applied to the other seven reaches to generate a complete input sheet for the model run.

Table 6-2 Non-Tunnel Features Annual Cost Matrix

Prelim. Alternative	Reach*							
	1	2	3	4	5	6	7	8
1						$11,996		
2						$12,009		
3						$11,265		$18,003
4						$6,861		$16,170
5					$6,871	$12,009		
6						$10,085		$16,773
7						$6,836		$11,803
8						$8,859		$12,779
9		$1,114		$9,394	$61	$10,085	$177	$105
10						$8,333		$11,561
11	$377	$147				$8,892		$16,253
12			$9,692			$11,222	$1,795	$12,680
13		$1,945				$6,413		$6,822
14		$404	$4,500			$4,557		$14,627
15		$405	$3,833	$150		$7,741		$8,864
16	$2,038	$736	$1,243	$1,775	$61	$3,690	$4,815	$12,727
17			$105	$589		$5,088		$4,539
18	$377		$9,312			$8,922	$3,591	
19						$10,074		

**Costs presented in thousands ($1000), Based on FY2013 Price levels and 3.75% discount rate*

Table 6-3 Non-Tunnel Features Annual Output Matrix

Prelim. Alternative	Reach*							
	1	2	3	4	5	6	7	8
1						1,489		
2						1,489		
3						1,476		2,501
4						1,265		2,379
5					352	1,489		
6						1,316		2,340
7						1,334		1,843
8						1,548		2,192
9		425		474	87	1,316	29	20
10						1,465		1,942
11	866	392				1,545		2,282
12			269			1,476	259	2,170
13		447				1,447		734
14		392	201			1,256		1,942
15		392	109	120		1,316		2,159
16	884	395	200	492	87	570	347	2,080
17			40	120		661		701
18	866		330			1,476	251	
19						1,287		

**Output presented in Average Annual Habitat Units (AAHUs)*

6.2.3 Results Summary

The model run resulted in a total of 171 cost effective plans, including the no action plan. Of these cost effective plans, 21 plans were identified as best buy plans. Table 6-4 presents the cost, benefits, and incremental cost for each of the 21 best buy plans. The best buy plans were numbered from 1 to 21. Letters A through H in the plan code stand for reaches 1 through 8, while numbers in the plan code correspond to the preliminary alternative numbers in Table 6-2 and Table 6-3.

For the purposes of comparison, the costs and benefits for the 19 preliminary alternatives were tabulated as well. Table 6-5 presents the costs and benefits of these alternatives. The code 'P-#' denotes that the plan is one of the 19 preliminary alternatives.

Table 6-4 Best Buys Incremental Cost Summary

#	Plan	AACost ($)	AAHU	Inc AACost ($)	Inc AAHU	Inc Cost ($)
1	No Action Plan	$0	0	$0	0	$0
2	B2	$146,743	392	$146,743	392	$374
3	A1B2	$523,358	1,258	$376,615	866	$435
4	A1B2E2	$583,950	1,345	$60,592	87	$696
5	A1B2D2E2	$733,885	1,465	$149,935	120	$1,249
6	A1B2C5D2E2	$839,159	1,505	$105,274	40	$2,632
7	A1B2C5D2E2F14	$5,396,226	2,761	$4,557,067	1,256	$3,628
8	A1B2C5D2E2F14H12	$14,260,310	4,920	$8,864,084	2,159	$4,106
9	A1B2C5D3E2F14H12	$15,884,884	5,292	$1,624,574	372	$4,367
10	A1B2C5D3E2F14G1H12	$16,062,161	5,321	$177,277	29	$6,113
11	A1B2C5D3E2F14G2H12	$17,680,091	5,551	$1,617,930	230	$7,034
12	A1B2C4D3E2F14G2H12	$18,817,690	5,711	$1,137,599	160	$7,110
13	A1B2C4D3E2F13G2H12	$20,673,266	5,902	$1,855,576	191	$9,715
14	A1B2C4D3E2F8G2H12	$23,119,812	6,003	$2,446,546	101	$24,223
15	A1B2C4D3E1F8G2H12	$29,930,469	6,268	$6,810,657	265	$25,701
16	A1B2C4D3E1F8G2H1	$39,069,505	6,610	$9,139,036	342	$26,722
17	A1B1C4D3E1F8G2H1	$40,036,386	6,643	$966,881	33	$29,299
18	A1B1C4D3E1F8G3H1	$43,055,891	6,731	$3,019,505	88	$34,313
19	A1B3C4D3E1F8G3H1	$43,887,027	6,753	$831,136	22	$37,779
20	A1B3C6D3E1F8G3H1	$51,955,779	6,883	$8,068,752	130	$62,067
21	A2B3C6D3E1F8G3H1	$53,616,857	6,901	$1,661,078	18	$92,282

Table 6-5 Preliminary Alternatives Costs and Benefits

Alternative	AA Cost ($)	AAHU
P-1	$11,996,483	1489
P-2	$12,009,286	1489
P-3	$29,267,897	3976
P-4	$23,030,955	3644
P-5	$18,880,535	1841
P-6	$26,858,358	3656
P-7	$18,638,396	3177
P-8	$21,638,317	3740
P-9	$20,936,199	2352
P-10	$19,894,592	3406
P-11	$25,668,150	5084
P-12	$35,389,302	4173
P-13	$15,179,266	2629
P-14	$24,087,662	3790
P-15	$20,992,030	4096
P-16	$27,083,375	5054
P-17	$10,321,082	1522
P-18	$22,201,739	2923
P-19	$10,074,318	1287

In order to summarize the results of the model graphically, three figures are included on the following pages. Data labels in the figures correspond to the left columns in Table 6-4 and Table 6-5.

- Figure 6.2 displays the cost effective plans, the best buy plans, and the 19 preliminary alternatives. The Y-axis measures average annual cost, and the X-axis measures average annual habitat output. The figure also notes which of the best buy plans included features in all eight reaches, and which did not.

- Figure 6.3 displays the incremental cost box plot for all 21 of the best buy plans. The X-axis measures incremental cost per unit incremental output, and the Y-axis measures total average annual habitat units.

- Figure 6.4 is also an incremental cost box plot, but displays only those alternatives which included features in all eight of the study reaches. This corresponds to best buys 10 through 21.

Following the figures, Table 6-6 provides a detailed breakdown of each best buy plan. In the table, each plan is broken down to show which feature is applied in each reach. The naming convention in this table references the name of the preliminary 19 alternatives in order to trace where each feature came from. The first column indicates Best Buys in numerical order. Column two indicates the Reach and which of the preliminary array of alternatives make up the best buy alternatives. The table also shows the average annual cost and output, incremental cost, and Net Present Value (NPV). NPV reflects the current worth of the future stream of annual costs for each alternative, and consistent with the annual costs used in the CE/ICA, includes construction, mobilization, contingency, PED/EDC, S&A, IDC, LERRDs, and O&M.

6.2.3.1 Interpretation of Results

As shown in Figure 6.2, by recombining the reach-specific features from the preliminary 19 alternatives, a new horizon of cost effective and best buy alternatives was created. The figure shows that none of the preliminary 19 alternatives meet the cost effective criteria when compared with the new horizon of plans. Additionally, the new plans offer higher total habitat benefits. As an example, preliminary alternative 11 is close to Best Buy plan 10 on Figure 6.2. Best buy 10 has an annual investment cost of $16 million compared to preliminary alternative 11 which has an annual cost of nearly $26 million. However Best Buy 10 provides 5,321 AAHU versus the 5,084 in preliminary alternative 11.

Among the cost effective plans generated in the CE/ICA analysis, 21 are best buy plans, as indicated by blue triangles and purple diamonds in Figure 6.2. Of particular value are the best buy plans which contain a feature in all eight reaches of the ARBOR stretch of river (purple diamonds in the figure), continuous and complete restoration of the reach was a key consideration in formulation for the study team. Of the best buy plans, Alternatives 10-21 include restoration in all reaches.

As shown in Figure 6.4, best buy plans 10 through 13 show gradual growth incremental cost and output, followed by a large jump in cost to plans 14 through 16, and then sharply rising incremental cost and more slowing rising incremental output for plans 17 through 21.

Alternative 10 total costs are $360 million, adds the additional reach (7) connecting the entire study area and provides 5,321 habitat units. The group of alternatives 10-13 range in total costs from $347 million to $444 million dollars for Alternative 13. Habitat benefits increase from 5,321 units to 5,902 for Alternative 13. Within this grouping there are significant changes within Alternatives 10 to 13. Reach 3, 6, and 7 are changed. Alternative 13 accomplishes all that Alternative 10 does, and adds freshwater marsh habitat to better meet objectives. Connectivity is increased with additional contiguous riparian corridors and restoration of the confluence at Arroyo Seco, the most significant tributary in the ARBOR reach with potential to connect to future restoration planning on that tributary.

The next incrementally grouped alternatives are 14-16. These alternatives range in benefits from 6,003 to 6,610 with a total cost range from $518 million to $876 million. These all meet targets for performance on Objective 1 with Alternative 16 showing an incremental jump in restoration of freshwater marsh, riffle-pool complexes, and conditions for native fish survival, greater hydrologic/hydraulic connections and other related conditions.

The remaining alternatives 17-21 incrementally increase the habitat value from 6,643 to 6,901 and have significantly increased total costs ranging from $898 million to $1.2 billion. In addition to the benefits and measures included in the other alternatives, these alternatives include widening and increased habitat in the river bed in reach 2, and connection to the Los Angeles River State Historic Park (Cornfields) in Alternatives 18-21. Alternative 20 shows the greatest single increase in habitat value in this group with the addition of restoration at the confluence of a major tributary (Verdugo Wash), increasing natural hydraulic conditions and regional connectivity.

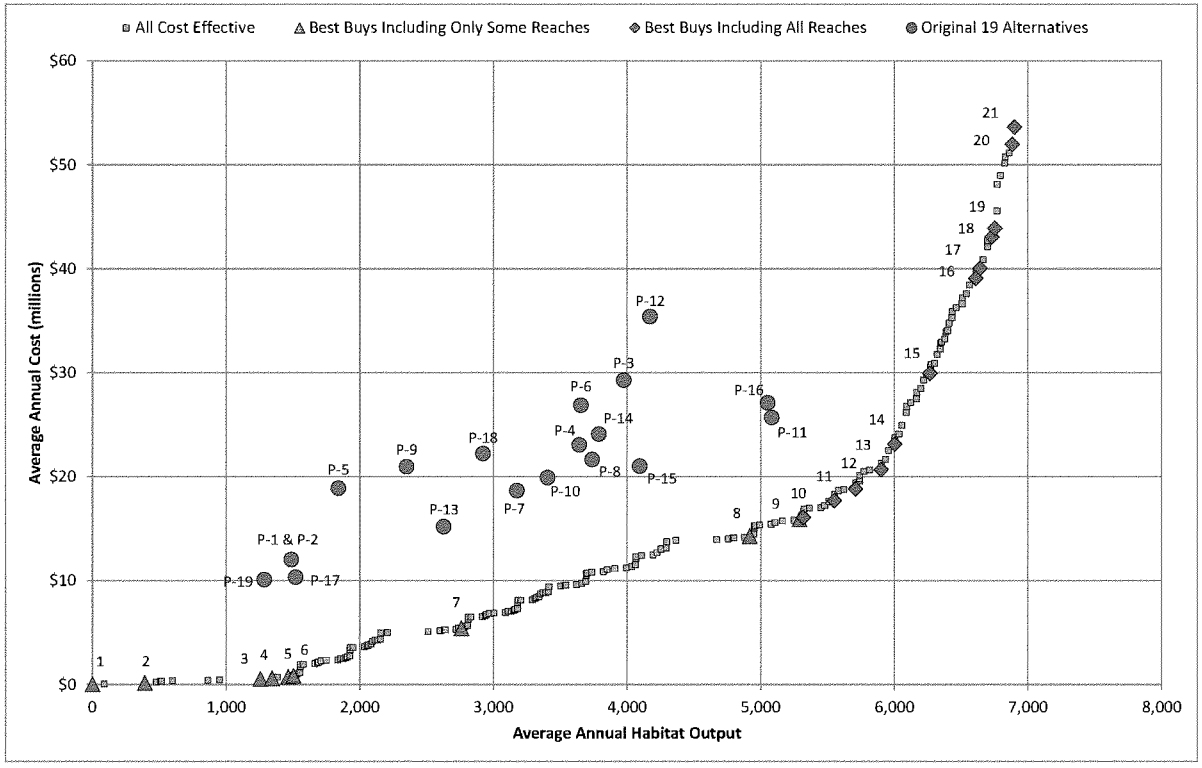

Figure 6.2 Model Output Summary

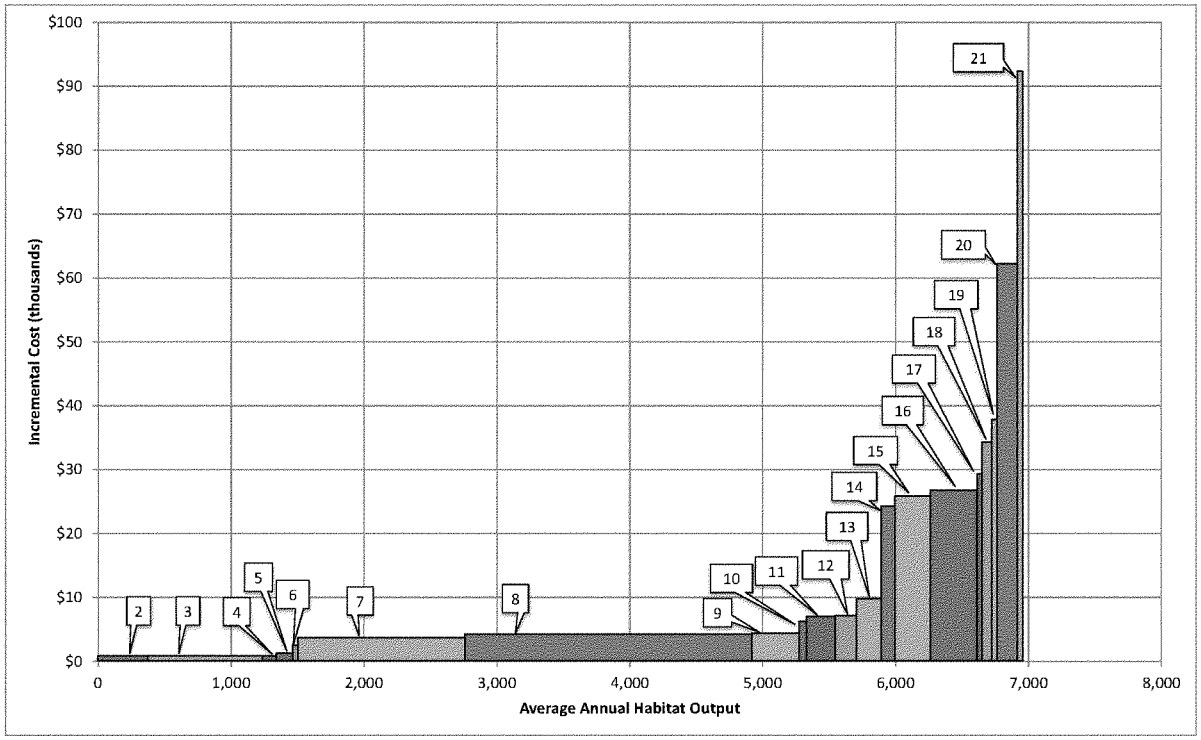

Figure 6.3 All Best Buy s Incremental Cost Box Plot

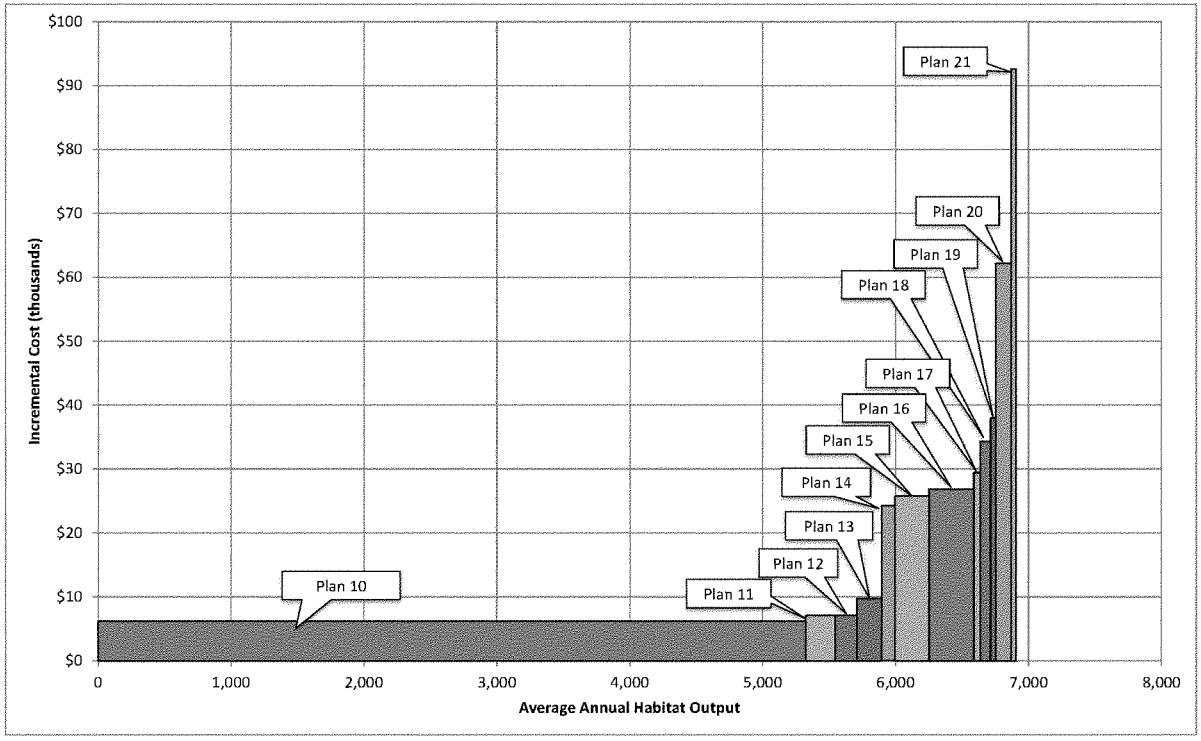

Figure 6.4 Best Buy Plans 10-21 Incremental Cost Box Plot

Table 6-6 Combined Model – Best Buy Plans Descriptions and Cost Data

Best Buy #	Plan Components (Meas./Scale)	Plan Components (Reach - Alt./Feat.)	Plan Components (Name)	Average Annual Cost ($)	Average Annual Habitat Units	Incremental Cost ($)	Net Present Value ($)
1	No Action	No Action	No Action	$0	0	$0	$0
2	B2	R2 - A11	Reach 2 - Charette Team 4	$146,743	392	$374	$3,292,105
3	**A1**	**R1 - A11**	**Reach 1 - Charette Team 4**	$523,358	1,258	$435	$11,741,271
	B2	R2 - A11	Reach 2 - Charette Team 4				
4	A1	R1 - A11	Reach 1 - Charette Team 4	$583,950	1,345	$696	$13,100,622
	B2	R2 - A11	Reach 2 - Charette Team 4				
	E2	R5 - A9 OR R5 - A16	Reach 5 - (Soft Bot. Ch. & Assoc. Banks) OR (Side Channels Only)				
5	A1	R1 - A11	Reach 1 - Charette Team 4	$733,885	1,465	$1,249	$16,464,338
	B2	R2 - A11	Reach 2 - Charette Team 4				
	D2	**R4 - A15**	**Reach 4 - Charette Team 2**				
	E2	R5 - A9 OR R5 - A16	Reach 5 - (Soft Bot. Ch. & Assoc. Banks) OR (Side Channels Only)				
6	A1	R1 - A11	Reach 1 - Charette Team 4	$839,159	1,505	$2,632	$18,826,107
	B2	R2 - A11	Reach 2 - Charette Team 4				
	C5	**R3 - A17**	**Reach 3 - Charette Team 7**				
	D2	R4 - A15	Reach 4 - Charette Team 2				
	E2	R5 - A9 OR R5 - A16	Reach 5 - (Soft Bot. Ch. & Assoc. Banks) OR (Side Channels Only)				
7	A1	R1 - A11	Reach 1 - Charette Team 4	$5,396,226	2,761	$3,628	$121,061,595
	B2	R2 - A11	Reach 2 - Charette Team 4				
	C5	R3 - A17	Reach 3 - Charette Team 7				
	D2	R4 - A15	Reach 4 - Charette Team 2				
	E2	R5 - A9 OR R5 - A16	Reach 5 - (Soft Bot. Ch. & Assoc. Banks) OR (Side Channels Only)				
	F14	**R6 - A14**	**Reach 6 - Charette Team 5**				
8	A1	R1 - A11	Reach 1 - Charette Team 4	$14,260,310	4,920	$4,106	$319,922,827
	B2	R2 - A11	Reach 2 - Charette Team 4				
	C5	R3 - A17	Reach 3 - Charette Team 7				
	D2	R4 - A15	Reach 4 - Charette Team 2				
	E2	R5 - A9 OR R5 - A16	Reach 5 - (Soft Bot. Ch. & Assoc. Banks) OR (Side Channels Only)				
	F14	R6 - A14	Reach 6 - Charette Team 5				
	H12	**R8 - A15**	**Reach 8 - Charette Team 2**				
9	A1	R1 - A11	Reach 1 - Charette Team 4	$15,884,884	5,292	$4,367	$356,369,322
	B2	R2 - A11	Reach 2 - Charette Team 4				
	C5	R3 - A17	Reach 3 - Charette Team 7				
	D3	**R4 - A16**	**Reach 4 - Side Channels Only**				
	E2	R5 - A9 OR R5 - A16	Reach 5 - (Soft Bot. Ch. & Assoc. Banks) OR (Side Channels Only)				
	F14	R6 - A14	Reach 6 - Charette Team 5				
	H12	R8 - A15	Reach 8 - Charette Team 2				
10	A1	R1 - A11	Reach 1 - Charette Team 4	$16,062,161	5,321	$6,113	$360,346,441
	B2	R2 - A11	Reach 2 - Charette Team 4				
	C5	R3 - A17	Reach 3 - Charette Team 7				
	D3	R4 - A16	Reach 4 - Side Channels Only				
	E2	R5 - A9 OR R5 - A16	Reach 5 - (Soft Bot. Ch. & Assoc. Banks) OR (Side Channels Only)				
	F14	R6 - A14	Reach 6 - Charette Team 5				
	G1	**R7 - A9**	**Reach 7 - Soft Bot. Ch. & Assoc. Banks**				
	H12	R8 - A15	Reach 8 - Charette Team 2				
11	A1	R1 - A11	Reach 1 - Charette Team 4	$17,680,091	5,551	$7,034	$396,643,881
	B2	R2 - A11	Reach 2 - Charette Team 4				
	C5	R3 - A17	Reach 3 - Charette Team 7				
	D3	R4 - A16	Reach 4 - Side Channels Only				
	E2	R5 - A9 OR R5 - A16	Reach 5 - (Soft Bot. Ch. & Assoc. Banks) OR (Side Channels Only)				
	F14	R6 - A14	Reach 6 - Charette Team 5				
	G2	**R7 - A12**	**Reach 7 - Charette Team 3**				
	H12	R8 - A15	Reach 8 - Charette Team 2				
12	A1	R1 - A11	Reach 1 - Charette Team 4	$18,817,690	5,711	$7,110	$422,165,338
	B2	R2 - A11	Reach 2 - Charette Team 4				
	C4	**R3 - A16**	**Reach 3 - Side Channels Only**				
	D3	R4 - A16	Reach 4 - Side Channels Only				
	E2	R5 - A9 OR R5 - A16	Reach 5 - (Soft Bot. Ch. & Assoc. Banks) OR (Side Channels Only)				
	F14	R6 - A14	Reach 6 - Charette Team 5				
	G2	R7 - A12	Reach 7 - Charette Team 3				
	H12	R8 - A15	Reach 8 - Charette Team 2				
13	A1	R1 - A11	Reach 1 - Charette Team 4	$20,673,266	5,902	$9,715	$463,794,245
	B2	R2 - A11	Reach 2 - Charette Team 4				
	C4	R3 - A16	Reach 3 - Side Channels Only				
	D3	R4 - A16	Reach 4 - Side Channels Only				
	E2	R5 - A9 OR R5 - A16	Reach 5 - (Soft Bot. Ch. & Assoc. Banks) OR (Side Channels Only)				
	F13	**R6 - A13**	**Reach 6 - Charette Team 6**				
	G2	R7 - A12	Reach 7 - Charette Team 3				
	H12	R8 - A15	Reach 8 - Charette Team 2				

Best Buy #	Plan Components (Meas./Scale)	Plan Components (Reach - Alt./Feat.)	Plan Components (Name)	Average Annual Cost ($)	Average Annual Habitat Units	Incremental Cost ($)	Net Present Value ($)
14	A1	R1 - A11	Reach 1 - Charette Team 4	$23,119,812	6,003	$24,223	$518,681,264
	B2	R2 - A11	Reach 2 - Charette Team 4				
	C4	R3 - A16	Reach 3 - Side Channels Only				
	D3	R4 - A16	Reach 4 - Side Channels Only				
	E2	R5 - A9 OR R5 - A16	Reach 5 - (Soft Bot. Ch. & Assoc. Banks) OR (Side Channels Only)				
	F8	**R6 - A8**	**Reach 6 - Charette Team 1**				
	G2	R7 - A12	Reach 7 - Charette Team 3				
	H12	R8 - A15	Reach 8 - Charette Team 2				
15	A1	R1 - A11	Reach 1 - Charette Team 4	$29,930,469	6,268	$25,701	$671,474,902
	B2	R2 - A11	Reach 2 - Charette Team 4				
	C4	R3 - A16	Reach 3 - Side Channels Only				
	D3	R4 - A16	Reach 4 - Side Channels Only				
	E1	**R5 - A5**	**Reach 5 - City: Los Feliz to Arroyo Seco**				
	F8	R6 - A8	Reach 6 - Charette Team 1				
	G2	R7 - A12	Reach 7 - Charette Team 3				
	H12	R8 - A15	Reach 8 - Charette Team 2				
16	A1	R1 - A11	Reach 1 - Charette Team 4	$39,069,505	6,610	$26,722	$876,504,543
	B2	R2 - A11	Reach 2 - Charette Team 4				
	C4	R3 - A16	Reach 3 - Side Channels Only				
	D3	R4 - A16	Reach 4 - Side Channels Only				
	E1	R5 - A5	Reach 5 - City: Los Feliz to Arroyo Seco				
	F8	R6 - A8	Reach 6 - Charette Team 1				
	G2	R7 - A12	Reach 7 - Charette Team 3				
	H1	**R8 - A3**	**Reach 8 - Banks & Tribs Only**				
17	A1	R1 - A11	Reach 1 - Charette Team 4	$40,036,386	6,643	$29,299	$898,196,028
	B1	**R2 - A9**	**Reach 2 - Soft Bot. Ch. & Assoc. Banks**				
	C4	R3 - A16	Reach 3 - Side Channels Only				
	D3	R4 - A16	Reach 4 - Side Channels Only				
	E1	R5 - A5	Reach 5 - City: Los Feliz to Arroyo Seco				
	F8	R6 - A8	Reach 6 - Charette Team 1				
	G2	R7 - A12	Reach 7 - Charette Team 3				
	H1	R8 - A3	Reach 8 - Banks & Tribs Only				
18	A1	R1 - A11	Reach 1 - Charette Team 4	$43,055,891	6,731	$34,313	$965,937,093
	B1	R2 - A9	Reach 2 - Soft Bot. Ch. & Assoc. Banks				
	C4	R3 - A16	Reach 3 - Side Channels Only				
	D3	R4 - A16	Reach 4 - Side Channels Only				
	E1	R5 - A5	Reach 5 - City: Los Feliz to Arroyo Seco				
	F8	R6 - A8	Reach 6 - Charette Team 1				
	G3	**R7 - A16**	**Reach 7 - Side Channels Only**				
	H1	R8 - A3	Reach 8 - Banks & Tribs Only				
19	A1	R1 - A11	Reach 1 - Charette Team 4	$43,887,027	6,753	$37,779	$984,583,208
	B3	**R2 - A13**	**Reach 2 - Charette Team 6**				
	C4	R3 - A16	Reach 3 - Side Channels Only				
	D3	R4 - A16	Reach 4 - Side Channels Only				
	E1	R5 - A5	Reach 5 - City: Los Feliz to Arroyo Seco				
	F8	R6 - A8	Reach 6 - Charette Team 1				
	G3	R7 - A16	Reach 7 - Side Channels Only				
	H1	R8 - A3	Reach 8 - Banks & Tribs Only				
20	A1	R1 - A11	Reach 1 - Charette Team 4	$51,955,779	6,883	$62,067	$1,165,601,569
	B3	R2 - A13	Reach 2 - Charette Team 6				
	C6	**R3 - A18**	**Reach 3 - Comprehensive Pockets**				
	D3	R4 - A16	Reach 4 - Side Channels Only				
	E1	R5 - A5	Reach 5 - City: Los Feliz to Arroyo Seco				
	F8	R6 - A8	Reach 6 - Charette Team 1				
	G3	R7 - A16	Reach 7 - Side Channels Only				
	H1	R8 - A3	Reach 8 - Banks & Tribs Only				
21	**A2**	**R1 - A16**	**Reach 1 - Side Channels Only**	$53,616,857	6,901	$92,282	$1,202,867,012
	B3	R2 - A13	Reach 2 - Charette Team 6				
	C6	R3 - A18	Reach 3 - Comprehensive Pockets				
	D3	R4 - A16	Reach 4 - Side Channels Only				
	E1	R5 - A5	Reach 5 - City: Los Feliz to Arroyo Seco				
	F8	R6 - A8	Reach 6 - Charette Team 1				
	G3	R7 - A16	Reach 7 - Side Channels Only				
	H1	R8 - A3	Reach 8 - Banks & Tribs Only				

6.3 Final Array of Alternatives

Four alternatives were identified from the list of best buys as the final array for analysis and given a new name to identify the recombination of restoration features. Those four alternatives include: 10-ARBOR Riparian Transitions, 13-ARBOR Corridor Extension, 16-ARBOR Narrows to Downtown, and 20-ARBOR Riparian Integration via Varied Ecological Reintroduction (numbers correspond to the best buy plan numbers in the previous section's tables and figures). These four alternatives were identified as the best representation of the range of restoration approaches that resulted from the CE/ICA. General description and rationale for selection is provided below.

Substitution

The study team reviewed and considered the sub reach plans identified in the best buys. In Reach 6 a recommended modification was made that the team considers a more effective plan. Best buy Alternative 13 includes preliminary Alternative 13 in Reach 6. However, Best Buy 16 and 20 included Preliminary Alternative 8 instead. Preliminary Alternative 13 in Reach 6 includes freshwater marsh and widens the riverbed more than the reach sub-plan from Preliminary Alternative 8. Preliminary Alternative 13 also represents a cost savings of $51 million dollars versus Preliminary Alternative 8. Therefore, reach sub-plan Reach 6 Alternative 13 will be carried forward in place of Reach 6 Alternative 8 in the Final Array Alternatives 16 and 20. To distinguish these alternatives they will be designated Alternatives 16A and 20A with the understanding that this change has been made. Table 6-7 includes a summary of the measures included in each alternative and total acres restored.

Alternative 10, ARBOR Riparian Transitions (ART) - Focuses on areas upstream and downstream of existing soft-bottomed Glendale Narrows; includes all reaches but limited restoration in reaches 3, 4 and 5.

- Alternative 10 is the first best buy plan which included restoration in all eight ARBOR reaches. Creating a corridor of continuous restoration was an important formulation consideration for the study team.
- Alternative 10 provides 5,321 AAHU.
- Relative to the No Action alternative, Alternative 10 has an incremental cost per unit output of $3,000.

Alternative 13, ARBOR Corridor Extension (ACE) - Includes all 8 river reaches, with side-channels in key locations and treatments into Downtown LA, but not at the Cornfields/LA State Historic Park.

- Alternative 13 provides an 11 percent increase in habitat output versus Alternative 10 for a 29% increase in project cost.
- As shown in Figure 6.4, Alternative 13 is located just before a large increase in incremental cost associated with Alternative 14, making it a logical break point on the incremental cost box plot.

- Relative to Alternative 10, Alternative 13 has an incremental cost per unit output of $7,900.

Alternative 16A, ARBOR Narrows to Downtown (AND) - Includes all river reaches and reaches 1-4 are similar to the smaller two alternatives. Reach 5 includes channel widening and terracing, includes restoration of Arroyo Seco and LATC.

- Alternative 16 provides a 12 percent increase in habitat output versus Alternative 13 for an 89 percent increase in project cost.
- As shown in Figure 6.4, this alternative is located at the next logical major breakpoint on the incremental cost box plot. It provides a relatively substantial increase in habitat benefit at a low incremental cost relative to Alternative 15. Moving to Alternative 17 would provide little increased habitat benefit at relatively high incremental cost.
- Relative to Alternative 13, Alternative 16 has an incremental cost per unit output of $26,000.

Alternative 20A, ARBOR Riparian Integration via Varied Ecological Reintroduction (RIVER) - Most extensive, includes measures in all eight reaches with channel widening at Verdugo Wash, Arroyo Seco, Cornfields/LA State Historic Park, and LATC.

- Alternative 20 provides a 4 percent increase in habitat output versus Alternative 16 for a 33 percent increase in project cost.
- Alternative 20 is the second to last best buy plan. Figure 6.4 shows that among all the plans larger than Alternative 16, Alternative 20 provides the largest marginal increase in habitat benefits.
- Relative to Alternative 16, Alternative 20 has an incremental cost per unit output of $47,200.

Table 6-7 Final Alternative Measure Matrix

Reach	Submeasure	Alternative			
		10	13	16	20
1. Pollywog Park area of Griffith Park	Riparian habitat corridors	x	x	x	x
2. Bette Davis Park area of Griffith Park	Restructure top of bank to support vines				x
	Riparian habitat corridors	x	x	x	x
	Modify trap channel to vertical banks				x
3. Ferraro Fields area of Griffith Park	Create pool & riffle system and plant for freshwater marsh		x	x	x
	Daylight streams plant with riparian fringe and freshwater marsh	x	x	x	x
	Divert flow into side channels with riparian fringe and return to the river		x	x	x
	Riparian habitat corridors		x	x	x
	Open water habitat	x			

	Widen mainstem				x
	Widen tributaries				x
4. Griffith Park	Create pool & riffle system and plant for freshwater marsh	x	x	x	x
	Daylight streams plant with riparian fringe and freshwater marsh	x	x	x	x
	Divert flow into side channels with riparian fringe and return to the river	x	x	x	x
	Riparian habitat corridors	x	x	x	x
5. Riverside Drive	Create pool & riffle system and plant for freshwater marsh			x	x
	Daylight streams plant with riparian fringe and freshwater marsh	x	x	x	x
	Wildlife access from river to bank (in daylighted streams)			x	x
	Restructure channel walls to support vines			x	x
	Riparian habitat corridors	x	x	x	x
	Terrace banks			x	x
	Modify trap channel to vertical banks			x	x
6. Taylor Yard	Create pool & riffle system and plant for freshwater marsh		x	x	x
	Restructure channel walls to support vegetation		x	x	x
	Riparian habitat corridors	x	x	x	x
	Restructure top of bank to support vines and other vegetation		x	x	x
	Widen channel mainstem	x	x	x	x
	Widen channel sloping or terracing back to overbank levels	x	x	x	x
7. Arroyo Seco/ Los Angeles State Historic Park	Create pool & riffle system and plant for freshwater marsh				x
	Daylight streams plant with riparian fringe and freshwater marsh	x			x
	Divert flow into side channels with riparian fringe and return to the river				x
	Riparian habitat corridors		x	x	x
	Restructure channel walls to support vegetation, plantings.		x	x	
	Widen channel (Arroyo Seco) sloping or terracing back to overbank levels		x	x	x
8. LATC	Create pool & riffle system and plant for freshwater marsh			x	x
	Restore historic wash with riparian habitat	x	x	x	x
	Divert flow into side channels with riparian fringe and return to the river			x	x
	Wildlife access from river to bank	x	x	x	x
	Riparian habitat corridors	x	x	x	x
	Widen channel			x	x
	Terrace banks			x	x

Preliminary costs and benefits included in the Draft IFR for each of the final array are summarized in Table 6-8. This includes first costs and annualized costs. Average Annual Habitat Units per alternative are also displayed. Note that the costs in this table have been further refined after those displayed in Table 6-6 so do not match precisely. These refinements include the risk based contingencies developed as part of the Abbreviated Risk Analysis, refined LERRDs estimates, and update to the FY2015 interest rate of 3.375%. See Appendix C– Cost Appendix, for further description. The refinements to the costs for the Final Array alternatives resulted in

minor changes in total first cost and average annual cost (less than 10% for all alternatives). Economic evaluation confirmed that these impacts would not have had a material impact on the CE/ICA analysis, best buy plans, or Final Array plan selection.

Table 6-8 Final Array Cost Information Ecosystem Restoration

	Alt 10	Alt 13	Alt 16	Alt 20
Construction	$37,160,342	$82,287,850	$241,814,809	336,184,471
Mobilization (7.5%)	$2,787,026	$6,171,589	$19,938,361	$27,391,085
Construction First Cost	$39,947,368	$88,459,438	$261,753,170	$363,575,556
Construction Contingency	38.83%	36.01%	37.89%	39.38%
Total Construction Cost	**$55,456,944**	**$120,312,641**	**$360,927,221**	**$506,743,287**
PED/EDC (11%)	$4,394,210	$9,730,538	$31,436,149	$43,186,611
PED/EDC Contingency	24.40%	24.40%	24.40%	24.40%
Total PED/EDC	**$5,466,398**	**$12,104,790**	**$39,106,569**	**$53,724,144**
S&A (6.5%)	$2,596,579	$5,749,864	$18,575,906	$25,519,361
S&A Contingency	26.25%	26.25%	26.25%	26.25%
Total S&A	**$3,278,181**	**$7,259,203**	**$23,452,081**	**$32,218,193**
Lands & Damages	$247,425,237	$250,048,826	$278,031,210	$352,858,303
Lands & Damages Contingency	20.00%	20.00%	20.00%	20.00%
Relocations	$11,392,360	$11,392,360	$35,422,360	$49,072,002
Relocations Contingency	20.00%	20.00%	32.14%	31.46%
Total LERRDs	**$310,581,116**	**$313,729,423**	**$380,442,863**	**$487,941,715**
TOTAL FIRST COST	**$374,782,639**	**$453,406,057**	**$803,928,734**	**$1,080,627,339**
Interest During Construction	$8,525,508	$11,466,426	$49,902,201	$60,615,729
Total Investment Cost	**$383,308,147**	**$464,872,483**	**$853,830,935**	**$1,141,243,068**
Annualized Investment Cost	$15,975,233	$19,374,611	$35,585,332	$47,563,882
Annualized O&M	$579,141	$872,445	$2,257,215	$2,515,390
Total Annual Cost	**$16,554,374**	**$20,247,056**	**$37,842,547**	**$50,079,272**
AAHU	**5,321**	**5,902**	**6,509**	**6,782**
Final Array costs based upon FY2013 Price levels, Annual costs updated with FY2015 Interest Rate 3.375%				

6.4 National Ecosystem Restoration (NER) and Locally Preferred Plan (LPP)

As part of the planning process, the Corps and City identify an "NER" Plan, the National Ecosystem Restoration Plan. As described in Corps planning guidance, the NER Plan is the alternative and scale having the maximum monetary and non-monetary beneficial effects over monetary and nonmonetary costs. This plan occurs where the incremental beneficial effects just equal the incremental costs, or alternatively stated, where the extra environmental value is just worth the extra costs. The Los Angeles District (District) circulated the Los Angeles River Ecosystem Restoration Feasibility Study Integrated Feasibility Report (IFR) for a 45-day public review period beginning on September 20, 2013, and a public meeting was held on October 17, 2013. The Draft IFR identified Alternative 13 as the Tentatively Selected Plan (TSP) as it reasonably maximizes net NER benefits.

6.4.1 Preliminary Identification of NER Plan

Alternative 13 was identified as the NER Plan in the Draft Report based on comparison of costs and outputs, and the planning objectives. The CE/ICA supports selection of Alternative 13 as the NER Plan. The incremental Average Annual Cost/AAHU for Alternative 16 is over four times higher than for Alternative 13. Alternative 13 meets objectives through restoration of Valley Foothill Riparian strand and freshwater marsh and also provides the greatest percent incremental increase in habitat connectivity.

6.4.2 Public Review Comments

Review comments during the public comment period came from letters, emails, and participants at the Public Meeting. The District received and evaluated nearly 500 comments. Federal agencies including U.S Environmental Protection Agency, U.S. Fish and Wildlife Service, Department of Interior, the Urban Waters Federal Partnership, state and local agencies, non-governmental organizations, interest groups, elected officials, and private citizens provided comments. The public meeting included over 300 attendees, with close to unanimous support for Alternative 20. In addition, the District received over 8,000 petition signatures in support of Alternative 20.

Key comments related to the following topics:

- Scope of the recommended plan
- Acceptability and completeness of the plans
- Habitat and hydrologic connectivity benefits associated with the plans
- Model used to calculate benefits
- Environmental justice
- Union Pacific Rail Road Yard (LATC) relocation

6.4.3 Independent External Peer Review

Independent External Peer Review (IEPR) was conducted on the Draft IFR and Appendices. IEPR comments were addressed and responses provided in December 2013. The IEPR Panel recommended quantification of connectivity outputs of proposed alternatives and reevaluation of Alternative 13 as the TSP after factoring in connectivity outputs as well as public review comments in support of Alternative 20. A framework suggested by the IEPR panel was applied to quantify the beneficial outputs of connectivity noted by public comments as not being fully captured in the alternatives analysis. By evaluating hydrologic, local, and regional connectivity and combining the resultant output with the initial habitat model output, USACE was able to more comprehensively compare the alternatives in the final array.

Quantifying connectivity benefits showed more restoration outputs for each of the alternatives, as well as for key features included in Alternatives 16 and 20 but not Alternative 13. By capturing these additional benefits, this analysis showed that the incremental costs per output for larger scale plans were substantially lower, but still in excess of $100 million. Notwithstanding the incremental increase in benefits, based on the magnitude of this incremental increase in cost

it was determined that the additional benefits were not worth the additional investment. Accordingly, Alternative 13 remained as the NER and Corps supported recommended plan.

6.4.4 Locally Preferred Plan Request

By letter dated April 10, 2014, the City of Los Angeles requested a recommended plan of Alternative 20. The basis for the sponsor's request for Alternative 20 included: the Administration's America's Great Outdoors and Urban Waters Federal Partnership initiatives; strong public, agency, and stakeholder support; Los Angeles Congressional delegation support; the Corps' acceptability criteria; redressing environmental injustice; the scarcity of Mediterranean-type habitat; and the need to connect to opportunity areas highlighted in the City's LA River Revitalization Master Plan.

The April 10, 2014 letter also referenced the August 8, 2013, approval of the City's request to waive Federal reimbursement for land, easements, rights-of-way, relocation, and disposal area (LERRD) costs above the standard 35% cost commitment of local sponsors. It proposed that the Corps and City divide the costs of implementing Alternative 20 at 50% Federal cost and 50% City cost. The letter also reaffirmed the City's understanding of its responsibility to acquire the necessary real estate interests.

Section 103 of WRDA 1986, as amended by Section 210 of WRDA 1996, specifies non-Federal share for "environmental protection and restoration" to be 35% of project costs. Implementation requirements are found in the Planning Guidance Notebook (ER 1105-2-100), Appendix E. In summary: projects may deviate from the NER Plan if requested by the non-Federal sponsor and approved by ASA(CW). Plans requested by the non-Federal sponsor that deviate from the NER plan shall be identified as the LPP. If the sponsor prefers a plan more costly than the NER Plan, and the increased scope of the plan is not sufficient to warrant full Federal participation, ASA(CW) may grant an exception as long as the sponsor pays the difference in cost between the NER plan and the locally preferred plan. The LPP, in such a case, must have outputs similar in-kind and equal to or greater than the outputs of the Federal plan. It may also have other outputs.

6.4.5 Updated NER Plan Features

Subsequent to release of the Draft Report, cost estimates for the NER Plan and Locally Preferred Plan were updated and refined to reflect: updated assumptions relating to the design and layout of plan features; a full cost and schedule risk analysis applied to generate cost contingencies; more detailed and accurate estimates of LERRDs costs based upon a Gross Appraisal; and utilization of the Corps MCACES software to generate more detailed project cost estimates than those used in the initial evaluation to identify the NER Plan. During the process of completing design and cost refinements, it was determined that the plan features in Reach 7 included in the NER Plan (Alternative 13) were less cost effective and efficient than the plan features in Reach 7 included in the LPP (Alternative 20). This was attributable to both a reduction in LPP Reach 7 plan costs, as well as an increase in Alternative 13 Reach 7 plan costs. The relative changes in costs resulted in the LPP Reach 7 Plan having a lower cost and higher output than the Alternative 13 Reach 7 plan. Therefore, the NER Plan has been modified for Reach 7 to include the same features for this reach as are included in the LPP. Specifically, the NER Plan will include restoration at Arroyo Seco, terracing of the right bank near the Los Angeles State Historic Park

and wetland/riparian restoration at the Park. The revised NER Plan is identified as Alternative 13v (indicating it is a variation of Alternative 13).

The most significant change to the costs estimates for both the NER Plan and the LPP relate to the basis for costs in Reach 8 at the LATC Intermodal Facility. Both plans require the acquisition of the LATC parcel for restoration purposes. However, the costs developed for plan formulation, comparison, and evaluation purposes (as shown in Table 6-8) were based upon the appraised value of the property, and did not include the relocation costs for LATC operations. Updated costs for these plans include these relocation costs, which resulted in a substantial increase in overall project costs. The inclusion of utility relocation costs not accounted for in previous cost estimates also resulted in cost increases for this reach. Most of the difference in updated costs for both the NER Plan and LPP is attributable to the increase in costs in Reach 8.

Table 6–9 provides a summary comparison of Alternative 13 and Alternative 13v (the updated NER Plan). As shown, the updated NER Plan provides 87 additional AAHUs and 10 additional acres of restoration, with reduced project costs relative to Alternative 13.

Table 6-9 Comparison of Alternative 13 and Alternative 13v (October 2014 Prices)

	Alt 13	Alt 13v
Construction Cost	$147,851,000	$113,958,000
PED/EDC (14%)*	$24,182,000	$15,954,120
S&A (9.5%)*	$16,856,000	$10,826,010
Lands & Damages	$350,474,000	$348,648,000
Relocations	$168,437,000	$177,886,000
Total LERRDs**	$518,911,000	$526,534,000
TOTAL FIRST COST	$707,800,000	$667,272,130
AAHU	5,902	5,989
Annualized Investment Cost***	$31,147,128	$27,810,000
Annual O&M	$941,566	$951,887
Total Annual Cost	$32,088,695	$28,761,887
Total Annual Cost per AAHU	$5,438	4,802
Acres	588	598

* A portion of the PED and CM costs relate to Relocations, and are therefore a LERRDs costs. The IFR identifies these specific costs and categorizes them appropriately in cost apportionment tables.
** Lands and Damages include some costs for federal administration, which are not part of LERRDs
*** IDC is included via simple addition of individual reach-based IDC calculations.

6.4.6 Updated NER Plan and LPP Summary

MCACES cost estimates were developed for both the NER and LPP, and are included in Appendix C. Table 6–10 summarizes project cost for both plans. These costs reflect the TPCS,

updated NER plan configuration, final LERRDs estimates, and the FY2015 interest rate of 3.375%.

Table 6-10 NER and LPP Project Cost Summary

ECOSYSTEM RESTORATION	NER	LPP
Construction	$85,685,000	$329,118,000
Contingency	$28,952,000	$121,115,000
Total Construction Cost	**$114,637,000**	**$450,233,000**
PED/EDC	$19,760,000	$62,305,000
Contingency	$6,555,000	$20,666,000
Total PED/EDC*	**$26,315,000**	**$82,971,000**
Construction Management	$9,649,000	$28,711,000
Contingency	$3,207,000	$9,541,000
Total Construction Management*	**$12,856,000**	**$38,252,000**
Adaptive Management & Monitoring	$7,763,000	$8,955,000
Contingency	$2,623,000	$3,295,000
Total Adaptive Management & Monitoring	**$10,386,000**	**$12,250,000**
Lands & Damages	$303,144,000	$457,104,000
Contingency	$45,471,000	$69,181,000
Relocations	$134,387,000	$168,718,000
Contingency	$46,918,000	$59,844,000
Total LERRDs**	**$529,920,000**	**$754,847,000**
Ecosystem Restoration First Cost	**$694,114,000**	**$1,338,553,000**
Interest During Construction	$26,235,000	$57,911,000
Total Investment Cost	**$720,349,000**	**$1,396,464,000**
Annualized Investment Cost	$30,022,000	$58,201,000
Annualized O&M	$1,366,000	$2,306,000
Total Annual Cost	**$31,388,000**	**$60,507,000**
AAHU	**5,989**	**6,782**
Average Annual Costs/AAHU	**$5,172**	**$8,825**
Acres Restored	**598**	**719**

* A portion of the PED and CM costs relate to Relocations, and are therefore a LERRDs costs. The IFR identifies these specific costs and categorizes them appropriately in cost apportionment tables.
** Lands and Damages include some costs for federal administration, which are not part of LERRDs

Costs shown in Table 6-10 above are categorized consistent with the Total Project Cost Summary certified by the Cost Estimating Mandatory Center of Expertise. The Lands and Damages costs shown in the table include some costs for federal administration, which are not part of LERRDs. Also, a portion of the PED and Construction Management costs relate to Relocations, and are therefore a LERRDs costs. The IFR identifies these specific costs and categorizes them appropriately in cost apportionment tables.

6.4.7 Recommended Plan

By memorandum dated May 27, 2014 the Assistant Secretary of the Army (Civil Works) approved the Locally Preferred Plan Request. A memorandum dated July 3 2014 provided further guidance per the Locally Preferred Plan. It directed that the Final Feasibility Report is to present the LPP as the recommended plan instead of the NER Plan (Alternative 13). Costs and

benefits of the Recommended Plan (Alternative 20) are show in Table 6-10 above and further described in the IFR.

7. Recreation Plan

This section provides a summary of the recreation analysis conducted for the IFR. Attachment 1 to this appendix contains detailed documentation of the analysis. For this analysis, the recreation resource area is the ARBOR reach. The focus is on those recreation resources connected to or otherwise affected by the River.

The objective of the recreation plan is to maintain and improve the quality and quantity of recreation amenities that complement the ecosystem restoration in the ARBOR reach, especially in regard to promoting access and connectivity between both banks of the river and throughout the length of the ARBOR reach. The recreation features will be designed to avoid any negative impacts to the restoration areas. The recreation plan was formulated cooperatively by USACE and the non-Federal sponsor. The features of the recreation plan are designed to capitalize on the areas where substantial ecosystem restoration is proposed.

Two potential recreation plan options were defined, with the second building incrementally on the first, corresponding to ecosystem restoration Alternatives 13 and 20, respectively. Each recreation plan option was developed to be consistent with, and complementary to, its corresponding ecosystem restoration alternative. Both plan options are documented in detail in Attachment 1.

Both of the recreation plan options include modification, upgrade, or creation of multi-use trails and related basic amenities (access points, wildlife viewpoints, parking lots, restrooms, signage). The plan options also include non-motorized multi-use bridges and smaller pedestrian bridges across tributaries or within large restored areas. The plan options differ in the location and quantity of the recreation features included.

- The Alternative 13 recreation plan option would result in a 41% increase in accessible trail and multi-use pathways. Including multi-use pathways created by the ecosystem restoration plan, the total increase in accessible trails and pathways would be 51.2%. This plan option would also include two bridges, one small pedestrian bridge in Taylor Yard, and a medium bridge within LATC.
- The Alternative 20 recreation plan option would result in a 58.1% increase in accessible trail and multi-use pathways. Including multi-use pathways created by the ecosystem restoration plan, the total increase in accessible trails and pathways would be 66.9%. This plan option would also include seven bridges, ranging from small to large, with two bridges spanning the LA River, one at Verdugo Wash, and one at LATC.

The two recreation plan options would provide both direct and indirect benefits to recreation participants as well as the communities surrounding the ARBOR reach, albeit to varying amounts. Direct benefits of either recreation plan option would include:

- Improved quality and quantity of trails for multiple user groups along the river
- Increased connectivity of each side of the river's recreation resources

- Increased public safety through better signage and trail development along the river
- Improved viewing and lines of sight along the river, especially in areas of substantial restoration via the ecosystem restoration plan
- Opportunity for interpretive signage and environmental education
- Improved public health by providing opportunities for exercise and psychological respite

In addition to these direct benefits, communities along the ARBOR reach will receive benefits in the form of increased quantity and quality of neighborhood parks. As discussed in the main report, parks provide OSE benefits to communities they serve. The addition of trails and amenities in the restored LATC will benefit the surrounding historically-underserved communities along the downstream end of the ARBOR reach, providing substantial open space in highly-developed neighborhoods which are currently considered park-deficient. Both recreation plan options will also help support the projected RED benefits related to redevelopment in the study area. For documentation of the Recreation analysis and RED/OSE analysis, see Attachments 1 and 2 to this appendix.

The benefits and costs of the proposed recreation features were estimated based on the guidelines in Appendix E, ER 1105-2-100 Planning Guidance Notebook, dated 22 April 2000. The Unit Day Value (UDV) method was selected as the appropriate valuation method as detailed in EGM 15-03 (USACE 2014). Table 7-1 presents the MCACES cost estimates and benefits summary table for both the NER plan and the recommended LPP. These costs reflect the TPCS, updated NER plan configuration, final LERRDs estimates, and the FY2015 interest rate of 3.375%.

- The Alternative 13 recreation plan option had annual benefits of $2.48 million and annual costs of $606,000, resulting in net benefits of $1.87 million and a BCR of 4.09.
- The Alternative 20 recreation plan option had annual benefits of $3.51 million and annual costs of $978,000, resulting in net benefits of $2.53 million and a BCR of 3.59.

Table 7-1 NER and LPP Recreation Component Summary

RECREATION	NER	LPP
Construction	$6,396,000	$10,907,000
Contingency	$2,160,000	$4,014,000
Total Construction Cost	**$8,556,000**	**$14,921,000**
PED/EDC	$932,000	$1,625,000
Contingency	$309,000	$539,000
Total PED/EDC	**$1,241,000**	**$2,164,000**
Construction Management	$418,000	$728,000
Contingency	$138,000	$242,000
Total Construction Management	**$556,000**	**$970,000**
Recreation First Cost	**$10,353,000**	**$18,055,000**
Interest During Construction	$33,200	$53,700
Total Investment Cost	**$10,386,000**	**$18,109,000**
Annualized Investment Cost	$433,000	$755,000
Annualized O&M	$173,000	$223,000
Total Annual Cost	**$606,000**	**$978,000**
Average Annual Benefits	**$2,479,000**	**$3,510,000**
Net Benefits	**$1,873,000**	**$2,532,000**
BCR	**4.09**	**3.59**

The results of the analysis show that the Alternative 20 recreation plan is expected to provide positive net benefits, and is economically justified. Between the two recreation plan options evaluated, the Alternative 20 recreation plan provided the largest net recreation benefits. Sensitivity analysis showed that the Alternative 20 option would result in positive net benefits even if visitation grew just 10% above the without project condition and UDV scores used in the analysis were reduced by 9 points. Further, the Alternative 20 recreation plan option adds additional features considered essential by the project sponsor.

As documented in Section 6.4, ecosystem restoration Alternative 20 is selected for recommendation as a locally preferred plan (LPP). As such, the corresponding Alternative 20 recreation plan option is selected as well, and will be carried forward into the pre-construction engineering and design (PED) phase of the study. For detailed documentation of the recreation analysis, see Attachment 1 to this appendix.

8. RED and OSE Considerations

Attachment 2 to this appendix documents the analysis of Regional Economic Development (RED) effects and Other Social Effects (OSE). The analysis was completed during the alternatives evaluation and comparison phase, based upon planning level alternatives formulation and cost estimates. For these results, please see the Attachment.

The RECONS model was run again to update the estimated RED impacts of construction spending based upon February 2015 NER and LPP estimates. These updated results are summarized below. Note that subsequent to the February 2015 cost update upon which the construction related RED impacts were calculated and presented in Sections 8.1 and 8.2 below, costs were further refined, with certification by the Cost Mandatory Center of Expertise on March 9, 2015. The difference in construction costs for the Recommended Ecosystem Restoration Plan is only one percent, and the difference in construction costs for the Recommended Recreation Plan is less than one percent. Therefore, RED benefits relating to construction of project features were not reanalyzed to reflect the March 2015 updated costs.

Note that redevelopment impacts modeled in IMPLAN were not updated. Because redevelopment effects are a function of the restoration plan components rather than their costs, no substantial changes in the redevelopment effects documented in Attachment 2 are expected. Additionally, the updated NER and Recommended plans aren't expected to result in substantial differences OSE effects compared to those already documented in Attachment 2.

Updated effects of construction spending are summarized via four tables, as bulleted below:

- Table 8-1: Overall Impacts for NER plan Ecosystem Restoration Construction Spending
- Table 8-2: Overall Impacts for the NER-plan-compatible Recreation Plan
- Table 8-3: Overall Impacts for the Recommended Plan Ecosystem Restoration Construction Spending
- Table 8-4: Overall Impacts for the Recommended-plan-compatible Recreation Plan

These results represent total effect over the duration of construction, not average annual effect. Results are presented in total for quicker comparison to the results shown in Section 2. Average annual effects can be estimated on a constant annual expenditure basis by dividing these total by the approximate construction duration in years.

8.1 NER Plan

Ecosystem Restoration Construction

The USACE is planning on expending $336,339,000 on the project, excluding lands and damages. Of this total project expenditure $312,413,859 will be captured within the regional impact area. The rest will be leaked out to the state or the nation.

Table 8-1 NER Plan - Ecosystem Construction RED Impacts

Impact Areas / Impacts		Regional	State	National
Total Spending		$336,339,000	$336,339,000	$336,339,000
Direct Impact				
	Output	$312,413,859	$333,770,155	$334,993,047
	Job	2,769.17	3,271.69	3,305.29
	Labor Income	$151,798,611	$168,680,986	$169,647,695
	GRP	$177,116,961	$193,661,261	$194,608,611
Total Impact				
	Output	$659,750,801	$737,860,216	$966,318,565
	Job	4,781.31	5,609.80	6,964.07
	Labor Income	$275,351,761	$307,327,529	$373,034,022
	GRP	$384,759,602	$429,748,303	$540,718,316

Recreation Construction

The USACE is planning on expending $10,377,000 on the project, and there are no lands and damages for recreation. Of this total project expenditure $10,377,000 will be captured within the regional impact area. The rest will be leaked out to the state or the nation.

Table 8-2 NER Plan - Recreation Construction RED Impacts

Impact Areas / Impacts		Regional	State	National
Total Spending		$10,377,000	$10,377,000	$10,377,000
Direct Impact				
	Output	$10,377,000	$10,377,000	$10,377,000
	Job	58.51	58.51	58.51
	Labor Income	$4,288,202	$4,288,202	$4,288,202
	GRP	$5,368,902	$5,368,902	$5,368,902
Total Impact				
	Output	$21,920,484	$23,023,824	$30,105,589
	Job	125.22	131.57	172.60
	Labor Income	$8,455,129	$8,694,361	$10,741,646
	GRP	$12,289,089	$12,765,131	$16,226,295

8.2 Recommended Plan

Ecosystem Restoration Construction

The USACE is planning on expending $804,017,000 on the project, excluding lands and damages. Of this total project expenditure $746,824,048 will be captured within the regional impact area. The rest will be leaked out to the state or the nation.

Table 8-3 Locally Preferred Plan - Ecosystem Construction RED Impacts

Impact Areas / Impacts		Regional	State	National
Total Spending		$804,017,000	$804,017,000	$804,017,000
Direct Impact				
	Output	$746,824,048	$797,876,186	$800,799,505
	Job	6,619.69	7,820.95	7,901.29
	Labor Income	$362,873,957	$403,231,205	$405,542,119
	GRP	$423,397,369	$462,946,449	$465,211,087
Total Impact				
	Output	$1,577,131,584	$1,763,851,820	$2,309,980,566
	Job	11,429.69	13,410.20	16,647.58
	Labor Income	$658,227,256	$734,665,198	$891,736,300
	GRP	$919,766,251	$1,027,311,555	$1,292,584,917

Recreation Construction

The USACE is planning on expending $18,014,000 on the project, and there are no lands and damages for recreation. Of this total project expenditure $18,014,000 will be captured within the regional impact area. The rest will be leaked out to the state or the nation.

Table 8-4 Locally Preferred Plan - Recreation Construction RED Impacts

Impacts	Impact Areas	Regional	State	National
Total Spending		$18,014,000	$18,014,000	$18,014,000
Direct Impact				
	Output	$18,014,000	$18,014,000	$18,014,000
	Job	101.57	101.57	101.57
	Labor Income	$7,444,124	$7,444,124	$7,444,124
	GRP	$9,320,169	$9,320,169	$9,320,169
Total Impact				
	Output	$38,052,963	$39,968,311	$52,261,934
	Job	217.37	228.39	299.62
	Labor Income	$14,677,719	$15,093,015	$18,647,009
	GRP	$21,333,299	$22,159,686	$28,168,111

8.3 Regional Economic Development and Economic Impacts Summary

Table 8-5 presents the cumulative regional economic impacts from construction through the study's period of analysis for the alternatives. These results were developed by the study team as reasonable factors, based upon available information, for developing a general estimate of potential redevelopment RED benefits associated with project alternatives.

Table 8-5 Cumulative RED & Economic Impacts of Ecosystem Restoration

Ecosystem Construction Cumulative Impacts		
	NER	**LPP**
Jobs	4,781	11,430
Labor Income	$275,351,761	$658,227,256
Sales	$659,750,801	$1,577,131,584
GRP	$384,759,602	$919,766,251
Recreation Construction Cumulative Impacts		
Jobs	125	217
Labor Income	$8,455,129	$14,677,719
Value	$12,289,089	$21,333,299
Output	$21,920,484	$38,052,963
Redevelopment Construction Cumulative Impacts		
Jobs	1,281	5,087
Labor Income	$84,665,000	$336,278,000
Value	$115,791,000	$460,153,000
Output	$193,002,000	$767,247,000
Redevelopment Long-term Economic Activity Cumulative Impacts		
Jobs	675	2,671
Labor Income	$964,851,000	$3,815,989,000
Taxes - Local	$5,789,000	$22,896,000

The cumulative effects of the construction/redevelopment components over the period of analysis will create between 6,862 (NER Plan) to 19,405 (LPP) jobs with incomes from $1.3 billion to nearly $5 billion as shown in Table 8-6.

Table 8-6 Employment and Income Cumulative Impacts

	NER	LPP
Jobs	6,862	19,405
Labor Income	$1,333,322,890	$4,825,171,975

8.4 Other Social Effects

The Other Social Effects account describes the potential effects of project alternatives in areas that are not dealt with explicitly in the NER and RED accounts. This OSE analysis describes the potential social effects of the alternatives under consideration. The OSE account explores the following categories of effects from the implementation of the alternatives considered. In most cases it is not possible to significantly differentiate between the social effects of the restoration alternatives because the scale of the categories on an overall community level exceeds the scale of differences among the alternatives.

- Displacement/Impacts to Population
- Public Health and Safety
- Displacement/Impacts to Minorities and Special Interest Groups
- Displacement/Impacts to Businesses
- Displacement/Impacts to Agriculture
- Displacement/Impacts to Recreational Areas
- Community Growth
- Project Impacts and Connectivity of the Community

Attachment 2 includes the OSE analysis. Each of the alternatives analyzed include benefits to various OSE categories such as public health and safety, environmental health, community well-being, and connectivity to the community. Both the NER and LPP result in business displacement in Reach 8, and Alternative 20 also includes business relocations in Reach 3.

9. REFERENCES

City of Burbank. 2010. City of Burbank: Keep Pace With Technology. Fact Sheet. Accessed August 2012 at http://www.ci.burbank.ca.us/Modules/ShowDocument.aspx?documentid=9636

City of Glendale. 2012. Glendale Quality of Life Indicators: 9.2 Developed Parkland. Accessed August 2012 at http://www.ci.glendale.ca.us/planning/qol/indicators09/9_parks_open_space/developed_parkland.asp

City of Los Angeles. 2007a. Los Angeles River Revitalization Master Plan. Prepared by the City of Los Angeles, Department of Public Works, Bureau of Engineering, River Project Office. May, 2007.

———. 2007b. Programmatic Environmental Impact Report/Environmental Impact Statement for the Los Angeles River Revitalization Master Plan. Prepared by The City of Los Angeles, Department of Public Works, Bureau of Engineering and the U.S. Army Corps of Engineers, Los Angeles District, Planning Division, with technical assistance from Tetra Tech, Inc.

———. 2009. Housing Element of the General Plan, 2006 – 2014. Los Angeles Department of City Planning. Council File No. 08-1933 and No. 08-1933-S1. Internet website: http://cityplanning.lacity.org/HousingInitiatives/HousingElement/Final/HE_Final.pdf

García, R., A. Rawson, M. Yellott, and C. Zaldaña. 2009 Healthy Parks, Schools and Communities for All: Park Development and Community Revitalization. Policy Report for The City Project. Accessed September 2012 at http://www.cityprojectca.org/publications/documents/PolicyReportHealthyParksSchoolsCommunitiesforAllAB31.pdf

GreenInfo Network. 2010. Park Poor, Income Poor, and People of Color. Figure presented by the City Project, Los Angeles, CA. Accessed September 2012 at http://www.mapsportal.org/thecityproject/socalmap/LosAngelesCounty.html#

Los Angeles County Economic Development Corporation (LAEDC). 2012. LAEDC 2012-2013 Economic Forecast and Industry Outlook. February 2012. Accessed December 2012 at http://laedc.org/economic-research-analysis/laedc-reports/

Los Angeles County Metropolitan Transit Authority (Metro). 2012. Bike Metro: Cyclists' Guide: Metro Bike Map. Accessed August 2012 at http://www.metro.net/riding_metro/bikes/images/la_bike_map.pdf

Los Angeles River Revitalization Corporation (LARRC). 2011a. Los Angeles River Guide: Fishing. Accessed August 2012 at http://thelariver.com/guide/

———. 2011b. LA River Guide: Walking: Access and Cautions. Accessed August 2012 at http://thelariver.com/guide/walks/access-and-cautions/

———. 2011c. Los Angeles River Guide: Walks. Accessed August 2012 at http://thelariver.com/guide/walks/

———. 2011d. In the Works: A description of projects that are funded and under active development. Accessed September 2012 at http://larivercorp.org/

Public Policy Institute of California. 2000. PPIC Statewide Survey: Special Survey on Californians and the Environment. PPIC in collaboration with The David and Lucile Packard Foundation. June 2000. Accessed July 2012 at http://www.ppic.org/main/allpubs.asp

Santa Monica Mountains Conservancy (SMMC) and) Mountains Recreation Conservation Authority (MRCA). 2007. Your Parks. Accessed August 2012 at http://www.lamountains.com/parks.asp?parkid=20

Southern California Association of Governments (SCAG). 2008. Regional Comprehensive Plan.

Trust for Public Land. 2011. 2011 City Park Facts: Report #1 – Acres of Parkland by City and Agency. Published by the Center for City Park Excellence, The Trust for Public Land. Accessed August 2012 at http://cloud.tpl.org/pubs/ccpe-city-park-facts-2011.pdf

U.S. Census Bureau. 2010. Profile of General Population and Housing Characteristics: 2010. Accessed December 2012 at http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk

(USACE) U.S. Army Corps of Engineers. 15 October 2014. EGM 15-03 Unit Day Values for Recreation for Fiscal Year 2015. CECW-CP Memorandum for Planning Community of Practice. Retrieved online via http://planning.usace.army.mil/toolbox/library/EGMs/EGM15-03.pdf.

———. 2010a. 2005 – 2009 American Community Survey. Census Tract Data. Accessed July 2012 at http://www.factfinder2.census.gov

———. 2010b. 2010 American Community Survey. 1-Yr Estimates. Accessed July 2012 at http://www.factfinder2.census.gov

———. 2011. 2010 Census Data by County, Form SF1. Accessed July 2012 at http://www.factfinder2.census.gov

———. 2012. 2008-2012 American Community Survey, Census Tract Data. Accessed March 2014 at http://factfinder2.census.gov

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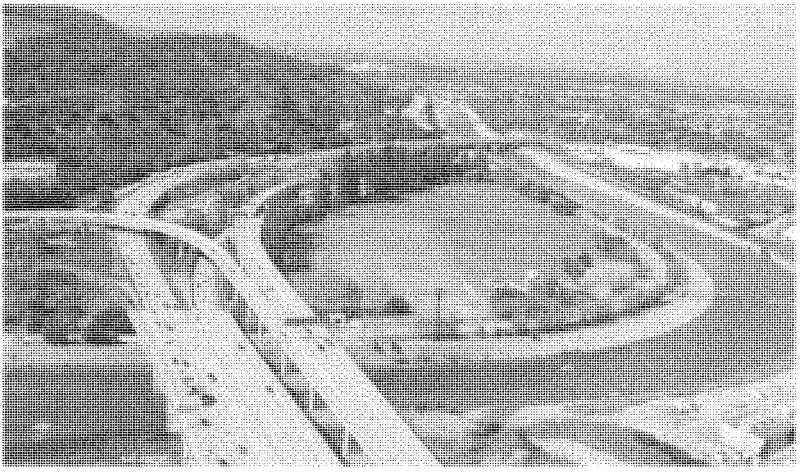
Los Angeles District



Los Angeles River Ecosystem Restoration
Integrated Feasibility Study
Los Angeles County, California

Recreation Analysis

September 2015

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1. USACE Unit Day Value Guidance (EGM 13-03)

1 INTRODUCTION

1.1 RECREATION STUDY AREA

This is the Recreation Analysis report for the Los Angeles River Ecosystem Restoration Feasibility Study Integrated Feasibility Report (IFR). For this analysis, the recreation resource area is the same as the IFR area—defined as being approximately one-half mile buffer on either side of the Los Angeles River (approximately 11 square miles), also known as the ARBOR or Area with Restoration Benefits and Opportunities for Revitalization. The focus is on those recreation resources connected to or otherwise affected by the River. The inventory of larger regional parks and other resources that exist outside this area are beyond the geographic scope of the recreation plan benefit analysis, but are presented below to provide an overview of the regional recreation context along the ARBOR reach.

1.1.1 CURRENT RECREATION USES

Plates 1 through 3 provide an overview of the recreation context along the ARBOR reach. Approved recreation uses of the River in the study area are limited to pedestrian, cyclist, and equestrian trails along the banks. Some areas in the River's watershed have recently been permitted for seasonal fishing or canoeing/kayaking (Sepulveda Basin and a portion of the ARBOR reach—from Fletcher Drive to Barclay Street in Elysian Valley), but these uses are not approved in the rest of the study area. Even in those places users are not often admonished or given citations by the authorities, and unapproved uses do occur, mostly in the soft-bed areas of the River (Los Angeles 2011a). Other activities along the River include bird watching, sightseeing, impromptu performances, small-scale art exhibitions, and tours by local interest groups. There are no areas approved for swimming in the study area, instances of swimming and wading are likely low due to water quality concerns, and local agencies and interest groups typically advise users to stay out of the water (Los Angeles River Revitalization Corporation [LARRC] 2011b). The Los Angeles River Pilot Recreation Zone was opened from Memorial Day in May to Labor Day in September 2013 in the 2.5-mile portion of the River in Elysian Valley, described above. The recreation zone included the river channel and five feet of adjacent riverbank. The public was allowed to walk, fish, and kayak in this zone during the period. The Recreation Zone was renewed in 2014 and 2015.

Small parks along the River's pathways provide an improved pedestrian recreational experience with facilities, such as benches, native habitat, open space areas, interpretive signage, art installations, and some play areas. These parks have been implemented by the city and a combination of other organizations, including local non-profit groups and the State of California—seeking to develop a greenway along the River (Santa Monica Mountains Conservancy and Mountains Recreation Conservation Authority 2007). The Los Angeles River Greenway is a priority of the County of Los Angeles as expressed in its 1996 Los Angeles River Master Plan, the City of Los Angeles via its 2007 Los Angeles River Revitalization Master Plan, the 2012 and 2010 Bicycle Plans of both agencies, respectively, and the Los Angeles River Revitalization Corporation via its "Greenway 2020" campaign initiated in 2013.

The Los Angeles River Bike Path is a Class I Bike Path (off-roadway, paved), and runs along the right bank (facing downstream) of the River from Griffith Park through the Glendale Narrows to Elysian Park (begins in Reach 2 and ends in Reach 7), offering an off-roadway route for pedestrians and cyclists. That portion of the Los Angeles River Bike Path was included in the National Recreational Trail System by the U.S. Department of the Interior in 2012. The existing and future trails on both sides of the River throughout the study area also coincide with the National Park Service's Juan Bautista de Anza National

Historic Trail. Another route between Griffith Park and Elysian Park relies on a combination of bike lanes and bike routes (on-roadway) but does not follow the River, making it a Class III Route, less appropriate for recreation and more of a transportation route. Both of these routes are managed by the Los Angeles County Metropolitan Transportation Authority (Metro), and are included in the City of Los Angeles Bicycle Plan (Metro 2012d).

1.1.2 Existing Trails, Pathways, and Access Roads

The study area contains a mixture of trails, pathways, and access roads which may see some degree of recreation use in the existing condition. Existing trails along the river or those affected by the recreation plan were quantified and categorized via analysis of aerial photographs and available data in geographic information systems (GIS). Plates 4 through 10 summarize the existing features while noting how they will be affected by the proposed recreation plan.

1.1.3 Recreation Supply and Demand

The City of Los Angeles has approximately 24,000 acres of parks, with approximately 16,000 acres of parkland under the jurisdiction of the Department of Recreation and Parks (RAP). Other agencies managing parklands include the Los Angeles Department of Water and Power (LADWP), the Mountains Recreation and Conservation Authority (MRCA), the Santa Monica Mountains Conservancy (SMMC), California State Parks, the Los Angeles County Department of Parks and Recreation (LACDPR) and the Los Angeles County Flood Control District (LACFCD). In all, this equates to a Citywide average of 6.26 acres of park per 1,000 residents (Trust for Public Land 2011). The City of Glendale has 39 developed parks comprising 280 acres, or about 1.4 acres per 1,000 residents (City of Glendale 2012). The City of Burbank operates 27 park facilities covering 155 acres, as well as 500 acres of open space, equating to approximately 6.34 acres of parkland per 1,000 residents (City of Burbank 2010). Including all parks identified in the ARBOR reach presented below, the recreation resource area has an estimated 5,000 acres of parkland, or 38.77 acres per 1,000 residents. This value is high compared to the Citywide average due to the presence of some larger-than-average parks near the study area, such as Griffith Park (the largest park at 4,210 acres) and Elysian Park (575 acres). However, access to these large open space areas has been historically-restricted due to many factors, including infrastructural barriers, such as freeways, streets, rail lines, and prohibited public circulation in/around the River.

Even given the presence of large open spaces like Griffith Park, much of Los Angeles is considered to be park deficient because of distribution and access; this condition is defined as any geographic area that provides less than three acres of green space per 1,000 residents, as prescribed by California law (Green Info Network 2010). In particular, the industrial areas surrounding reaches 7-8 (from the I-5 overpass to Main Street) have the least parkland, with fewer than 3 acres per 1,000 people. Other areas, particularly on the southwest side of Reaches 1-3 (from Pollywog Park to Brazil Street), have greater than 3 acres of parkland per 1,000 residents, which is due to the presence of Griffith Park. In general, access to parks and acres of parkland per 1,000 residents is lowest in areas that have the highest number of families below the poverty line of $47,331 annual income.

According to the Southern California Association of Governments (SCAG), public parks are intended to serve all residents, but not all neighborhoods and people have equal access to these public resources. SCAG calls for a multiagency effort and public transportation to improve access for all to parks throughout Southern California (SCAG 2008). The City Project has been working toward finding resolutions to improve park availability for all neighborhoods, regardless of ethnicity or income level (Garcia et al. 2009).

Residents of Los Angeles place a high priority on the quality of natural and environmental resources. In a study from 2000, 75 percent of those surveyed said that preserving wetlands, rivers, and environmentally sensitive areas would be either "somewhat effective" or "very effective" at improving their quality of life. There is also strong support for protecting cultural resources and for environmental education (Public Policy Institute of California 2000). A notable move forward for public recreation was the California Legislature's passage of Senate Bill 1201 (authored by Senator Kevin De León and signed by Governor Jerry Brown) in 2012, which calls for expanded public access to the River for recreational purposes.

1.2 Recreation Plan Context within Restoration Plan

The recreation plan was formulated cooperatively by USACE and the non-Federal sponsor. The USACE generated GIS shapefiles outlining the basic features of the recreation plan and provided those files for use in development of the recreation plan cost estimate (discussed further in Section 4.1). Two potential recreation plan options were defined, with the second building incrementally on the first, corresponding to ecosystem restoration Alternatives 13 and 20, respectively. Each recreation plan option was developed to be consistent with, and complementary to, its corresponding ecosystem restoration alternative. Both plan options are documented in this appendix.

The recreation plan features are integrated into the ecosystem restoration plan; however, these features are evaluated as separable components of the plan. The features of the recreation plan are designed to capitalize on the areas where substantial ecosystem restoration is proposed. As such, it is assumed that the ecosystem restoration will have taken place when considering the effects of the recreation plan features. For example, the proposed wildlife viewpoints in the recreation plan are dependent upon the ecosystem restoration plan providing the restored area. In this way, the success of the recreation plan is linked to, and affected by, the selected ecosystem restoration plan.

Additionally, all ecosystem restoration plans which call for modification of the channel banks implicitly require that existing top-of-levee access and maintenance roads be replaced to some degree. Per discussion with the study team, it is assumed that the ecosystem restoration plan will include in its design the designation of these top-of-levee or equivalent access roads as multiple-use pathways that may be used for various general recreation activities by the public. It is beyond the scope of this recreation plan analysis to quantify the recreation benefits that these multi-use access roads would provide, as their exact location, length, and type will be determined in future phases of the ecosystem restoration plan design, but their inclusion would be key to providing full connectivity of recreation trails, on both sides of the river, throughout the ARBOR reach. No costs or direct benefits for these access roads associated with the ecosystem restoration plan are included in the recreation cost estimate or recreation benefit calculation.

1.3 Proposed Recreation Features

The objective of the recreation plan is to maintain and improve the quality and quantity of recreation amenities that complement the ecosystem restoration in the ARBOR reach, especially in regard to promoting access and connectivity between both banks of the river and throughout the length of the ARBOR reach. The recreation features will be designed to avoid any negative impacts to the restoration areas.

The recreation plan includes the modification, upgrade, or creation of multi-use trails and related basic amenities (access points, wildlife viewpoints, parking lots, restrooms, signage). The plan also includes

non-motorized multi-use bridges across the River, tributaries, or within large restored areas. This planning level design assumes that signage would include trail markers, wayfinding signage, trail access point markers, and educational/interpretive signage, as appropriate and complementary to the ecosystem restoration features, such as at wildlife viewpoints or in areas of trail through new restoration areas.

Further, some details of trail design and trail access points will be refined during the design phase of the project. One potential refinement to the design includes consideration of Arizona Crossings to facilitate safe access to the recreation and restoration areas. Additionally, future phases of design of the ecosystem restoration plan will consider provision of water access for recreation as a complementary component of the safety/maintenance ramps that will be included in the ecosystem restoration plan design.

The specific listing of features for each of the recreation plan options is summarized in the following subsections.

1.3.1 ALTERNATIVE 13 RECREATION PLAN OPTION FEATURES

The recreation plan option corresponding to ecosystem restoration Alternative 13 includes the following specific features:

- 5.89 miles of new unpaved non-motorized multi-use trail *(to include decomposed granite surface and trail signage)*
- 0.3 miles of new paved multi-use trail *(short extension of current southern end of LA River Bike Path)*
- 1 small bridge/crossing within Taylor Yard
- 1 medium bridge within LATC
- 2 paved parking lots, one at Taylor Yard and one at LATC *(each about 15,000 square feet)*
- 4 restrooms, one at Bette Davis Park, two at Taylor Yard, and one at LATC
- 1 pedestrian underpass at the south end of Taylor Yard
- 24 trail access points throughout the study area *(access points would include grading and planting, signage, stairs, benches, gating, and trash receptacles to provide quality trail access)*
- 6 wildlife viewing points throughout the study area *(viewpoints would include an elevated wood deck with railing, benches, interpretive signage, and trash receptacles to allow users to enjoy high quality viewsheds within the restored ARBOR reach)*
- 4 pedestrian underpasses along the river to support trail connectivity

Plates 4 through 10 display these features. Table 1, below, summarizes the two proposed bridges. Table 2, below, summarizes the proposed changes in trails. As shown in the table, this recreation plan option would result in a 41% increase in accessible trail and multi-use pathways. Including multi-use pathways created by the ecosystem restoration plan, the total increase in accessible trails and pathways would be 51.2%.

Table 1. Proposed Bridges, Alternative 13 Option

ID	*Length (ft)*	*Location*	*Description*
1	150	R6; in Taylor Yard	1 pedestrian bridge within Taylor Yard over restoration area
2	250	R8; LATC	medium pedestrian bridge over restoration area within LATC
Note: See Appendix C – Cost Appendix for detailed backup of the recreation plan option costs summarized in Section 4.1.			

As shown in Table 2 below, 13.07 miles of existing accessible trail would not be modified by the recreation plan. However, there would be 1.12 miles of existing length that would be upgraded to a fully-developed multi-use trail. There would also be 6.19 miles of new trail added in the study area. Lastly, this recreation plan option would convert 0.82 miles of currently inaccessible access road to multi-use trail.

The ecosystem restoration plan would also upgrade 5.28 miles of existing trail, and convert 2.96 miles of currently inaccessible access road to multi-use trail. These changes would result in 29.44 miles of accessible trail and multi-use pathway.

At the current level of design, un-paved trails are assumed to be multiple-use, twelve feet wide, using a decomposed granite surface, and paved trails are assumed to be similar to the existing LA River Bike Path (cost provided by City).

Table 2. Summary of Accessible Trail and Multi-Use Pathway, Alternative 13 Option

Trail Type	*Miles*	*% of Tot With Project Miles*
Existing Trail/Pathway Remaining As-Is	13.07	44.4%
Existing Trail/Pathway Upgraded per Recreation Plan	1.12	3.8%
New Paved and Unpaved Trail/Pathway per Recreation Plan	6.19	21.0%
Inaccessible access road converted to trail per Recreation Plan	0.82	2.8%
Existing Trail Upgraded per Ecosystem Restoration Plan	5.28	17.9%
Inaccessible access road converted to trail per Restoration Plan	2.96	10.1%
TOTAL	**29.44**	100.0%

1.3.2 ALTERNATIVE 20 RECREATION PLAN OPTION FEATURES

The recreation plan option corresponding to ecosystem restoration Alternative 20 includes the following specific features:

- 7.98 miles of new unpaved non-motorized multi-use trail *(to include decomposed granite surface and trail signage)*
- 1.26 miles of new paved multi-use trail *(extension of current southern end of LA River Bike Path)*
- 2 bridges spanning the LA River
- 1 smaller bridge/crossing within Taylor Yard
- 4 small/medium bridges within LATC
- 2 paved parking lots, one at Taylor Yard and one at LATC *(each about 15,000 square feet)*
- 4 restrooms, one at Bette Davis Park, two at Taylor Yard, and one at LATC
- 1 pedestrian underpass at the south end of Taylor Yard
- 28 trail access points throughout the study area *(access paints would include grading and planting, signage, stairs, benches, gating, and trash receptacles to provide quality trail access)*
- 11 wildlife viewing points throughout the study area *(viewpoints would include an elevated wood deck with railing, benches, interpretive signage, and trash receptacles to allow users to enjay high quality viewsheds within the restored ARBOR reach)*
- 6 pedestrian underpasses along the river to support trail connectivity

Plates 11 through 17 display these features. Table 3, below, summarizes the seven proposed bridges. Shaded rows indicate bridges which were also included in Table 1. Table 4, below, summarizes the proposed changes in trails. As shown in the table, this recreation plan option would result in a 58.1%

increase in accessible trail and multi-use pathways. Including multi-use pathways created by the ecosystem restoration plan, the total increase in accessible trails and pathways would be 66.9%.

Table 3. Proposed Bridges, Alternative 20 Option

ID	*Length (ft)*	*Location*	*Description*
1	450	R3; Verdugo Wash	spans LA River on diagonal downstream of Verdugo Wash, connecting the LA River Bike path to the Verdugo Wash confluence on the opposite bank
2	150	R6; in Taylor Yard	1 pedestrian bridge within Taylor Yard over restoration area
3	300	R8; LATC	spans the LA River adjacent to the upstream end of LATC connecting the left and right bank in Reach 8 and providing access to LATC from the right bank
4	25	R8; LATC	small pedestrian bridge over restoration area within LATC
5	100	R8; LATC	medium pedestrian bridge over restoration area within LATC
6	250	R8; LATC	medium pedestrian bridge over restoration area within LATC
7	30	R8; LATC	small pedestrian bridge over restoration area within LATC
Notes: Shaded rows indicate features common to both the Alternative 13 and Alternative 20 recreation plan options. See Appendix C – Cost Appendix for detailed backup of the recreation plan option costs summarized in Section 4.1.			

As shown in Table 4 below, 12.93 miles of existing accessible trail would not be modified by the recreation plan. However, there would be 1.26 miles of existing length that would be upgraded to a fully-developed multi-use trail. There would also be 9.24 miles of new trail added in the study area. Lastly, this recreation plan option would convert 0.82 miles of currently inaccessible access road to multi-use trail.

The ecosystem restoration plan would also upgrade 5.28 miles of existing trail, and convert 2.96 miles of currently inaccessible access road to multi-use trail. These changes would result in 32.49 miles of accessible trail and multi-use pathway.

At the current level of design, un-paved trails are assumed to be multiple-use, twelve feet wide, using a decomposed granite surface, and paved trails are assumed to be similar to the existing LA River Bike Path (cost provided by City).

Table 4. Summary of Accessible Trail and Multi-Use Pathway, Alternative 20 Option

Trail Type	*Miles*	*% of Tot With Project Miles*
Existing Trail/Pathway Remaining As-Is	12.93	39.8%
Existing Trail/Pathway Upgraded per Recreation Plan	1.26	3.9%
New Paved and Unpaved Trail/Pathway per Recreation Plan	9.24	28.4%
Inaccessible access road converted to trail per Recreation Plan	0.82	2.5%
Existing Trail Upgraded per Ecosystem Restoration Plan	5.28	16.3%
Inaccessible access road converted to trail per Restoration Plan	2.96	9.1%
TOTAL	**32.49**	100.0%

1.3.3 BENEFITS OF THE RECREATION PLANS

The two recreation plan options would provide both direct and indirect benefits to recreation participants as well as the communities surrounding the ARBOR reach, albeit to varying amounts. Direct benefits of either recreation plan option would include:

- Improved quality and quantity of trails for multiple user groups along the river
- Increased connectivity of each side of the river's recreation resources
- Increased public safety through better signage and trail development along the river
- Improved viewing and lines of sight along the river, especially in areas of substantial restoration via the ecosystem restoration plan
- Opportunity for interpretive signage and environmental education
- Improved public health by providing opportunities for exercise and psychological respite

In addition to these direct benefits, communities along the ARBOR reach will receive benefits in the form of increased quantity and quality of neighborhood parks. As discussed in the main report, parks provide OSE benefits to communities they serve. The addition of trails and amenities in the restored LATC will benefit the surrounding historically-underserved communities along the downstream end of the ARBOR reach, providing substantial open space in highly-developed neighborhoods which are currently considered park-deficient. Both recreation plan options will also help support the projected RED benefits related to redevelopment in the study area.

The recreation analysis documented in this report evaluates the two recreation plan options in order to estimate net benefits (excess of benefits over cost) of each plan and assess whether the recreation features are economically justified.

2 UNIT DAY VALUE ANALYSIS

The benefits of recreation features are measured through approximation of visitors' willingness to pay for the recreation resource. Willingness-to-pay is assumed to represent the economic value, in dollars, that a visitor places on a recreation resource. Measuring the economic value of the recreation resource without a project and comparing it to the value of the project in place, allows the calculation of net recreation benefits resulting from construction of the recreation plan option being evaluated.

The appropriate valuation methodology was selected based on the guidelines in Appendix E, ER 1105-2-100 Planning Guidance Notebook, dated 22 April 2000. For this study, recreation is incidental to the primary ecosystem restoration purpose; there is no regional model available; the project is not creating specialized recreation activities as defined in the ER; projected increase in visitation is well below the 750,000 threshold requiring more rigorous approaches; and the increase in Federal costs for adding recreation purpose is well below the 10% limit. As such, the Unit Day Value (UDV) method was selected as the appropriate valuation method.

When applying the Unit Day Value methodology, two categories of outdoor recreation visits, general and specialized, may be differentiated for evaluation purposes. "General" refers to a recreation visit involving primarily those activities that are attractive to the majority of outdoor users and that generally require the development and maintenance of convenient access and adequate facilities. "Specialized" refers to a recreation visit involving those activities for which opportunities in general are limited, intensity of use is low, and a high degree of skill, knowledge, and appreciation of the activity by the user may often be involved (USACE 2014). All of the activities at the project site, with and without project, were assumed to fall into the general recreation category.

The unit day value (UDV) method for estimating recreation benefits relies on expert or informed opinion and judgment to approximate the average willingness to pay of users of Federal or Federally assisted recreation resources. By applying a unit day value per visitor, an approximation of project recreation benefits is obtained.

The UDV process includes scoring of the project site using five guidance-defined criteria to yield a point score for the groups of recreation activities at the site. The point score is converted to dollars per visit using tables provided in the UDV guidance (updated annually). The final dollars-per-visit value is the UDV. The UDV is then multiplied by the number of annual visitors to generate an estimate of the annual recreation value at the site. This annual value is then projected over the 50 year period of analysis based on visitation projections for the study area.

This method of annual recreation value estimate is completed twice. First, a valuation is completed for the without project condition. Second, a valuation is completed for the with project condition. The difference between the two estimates is the recreation benefit attributable to the proposed recreation features. The option that returns the greatest excess of benefits over cost (net benefits) is the most desirable from a national economic development perspective. Total benefits may also be compared to the total costs of the recreation features to generate a benefit to cost ratio. The following sections describe the development of visitation estimates and UDV scores.

2.1 VISITATION ESTIMATE VIA TRAILS

Trail visitation was only counted for recreation tied to or in close proximity to the River. For example, use of trails in off-river areas of Griffith Park are not likely to be directly affected by the proposed recreation plan.

Visitation estimates were developed for the without- and with-project conditions. No official, comparable visitor count data were readily available by activity. Inquiries were made with contacts at the Audubon Society, the LA River Equestrian Center, and the Los Angeles Department of Recreation and Parks. The contacts indicated that, while the assumed types of recreation were consistent with their knowledge of the study area, no specific trail counts or total user counts were available for the study area, and that those counts would require a separate data collection effort, determined to be beyond project budget and schedule constraints. The study team identified that following methodology for estimating baseline project visitation.

General trail use was estimated based on published design standards for urban trails in the "Recreation Park and Open Space Standards and Guidelines," by the National Recreation and Parks Association (NRPA 1983). It cites a standard for urban trail use at 90 users per day per mile of trail. This base value was adjusted for weekday/weekend and seasonality, and then applied to a GIS-based estimate of the length of trails in the existing and with-project conditions. Existing trails include trail segments provided by the Local Sponsor in GIS as well as additional areas of trail identified via aerial photographs in GIS. Seasonality weekday/weekend adjustments were based on professional judgment and familiarity with the ARBOR reach. Because inclement weather, which would prevent trail use, is rare in the study area, weekday/weekend use was estimated to have a stronger effect than the season.

As shown in Plates 4 through 17, in order to limit the visitation estimate to those users affected by the River, only trails adjacent to the River or affected directly by proposed recreation plan features were included in the evaluation.

It was qualitatively estimated that the with project condition would experience a higher volume of visitation because of the added amenities of the recreation plan, including the increased access points, parking, restrooms, and connectivity of existing trails in the ARBOR reach. In order to estimate this increase consistent with the methodology in the without project condition, the increase in with project condition was estimated as a function of the additional miles of trail that would be added via the recreation plan and the ecosystem restoration plan. The recreation plan options corresponding to

ecosystem restoration Alternative 13 and ecosystem restoration Alternative 20 provide different quantities of trail, and therefore have differing estimates of visitation.

It was noted that some portion of the with project visitation may be a transfer from other regional recreation areas, but due to lack of area-specific visitation data, there was no basis for quantifying transfers. Qualitatively, the team expects that transfer will not be substantial. For example, new visitors may be residents of the communities around the ARBOR reach which are currently underserved by community parks.

As shown in the tables below, annual visitation for the with project condition was estimated to be 51% higher than in the without project condition for the Alternative 13 option, and 67% higher for the Alternative 20 option, based on the expected increase in accessible trails with the recreation plan and ecosystem restoration features. No estimate of visitation growth from general population growth was included, as this was judged to be a relatively minor effect compared to the increase already described. Based on this methodology, annual visitation is held constant throughout the period of analysis in the with project and without project conditions.

Table 5. Without Project Visitation

Season	*Miles*	*User/Mile*	*Users/Day*	*Days*	*Subtotal Users*
Summer Weekend	19.47	80	1,557.60	26	40,498
Summer Weekday	19.47	65	1,265.55	65	82,261
Fall Weekend	19.47	70	1,362.90	26	35,435
Fall Weekday	19.47	55	1,070.85	65	69,605
Winter Weekend	19.47	70	1,362.90	26	35,435
Winter Weekday	19.47	55	1,070.85	65	69,605
Spring Weekend	19.47	70	1,362.90	26	35,435
Spring Weekday	19.47	55	1,070.85	65	69,605
TOTAL ESTIMATED ANNUAL USE					437,879
Average Users/Day					1,203

Table 6. With Project Visitation, Alternative 13 Option

Season	*Miles*	*User/Mile*	*Users/Day*	*Days*	*Subtotal Users*
Summer Weekend	29.44	80	2,355.20	26	61,235
Summer Weekday	29.44	65	1,913.60	65	124,384
Fall Weekend	29.44	70	2,060.80	26	53,581
Fall Weekday	29.44	55	1,619.20	65	105,248
Winter Weekend	29.44	70	2,060.80	26	53,581
Winter Weekday	29.44	55	1,619.20	65	105,248
Spring Weekend	29.44	70	2,060.80	26	53,581
Spring Weekday	29.44	55	1,619.20	65	105,248
TOTAL ESTIMATED ANNUAL USE					662,106
Average Users/Day					1,819

Table 7. With Project Visitation, Alternative 20 Option

Season	*Miles*	*User/Mile*	*Users/Day*	*Days*	*Subtotal Users*
Summer Weekend	32.49	80	2,599.20	26	67,579
Summer Weekday	32.49	65	2,111.85	65	137,270
Fall Weekend	32.49	70	2,274.30	26	59,132
Fall Weekday	32.49	55	1,786.95	65	116,152
Winter Weekend	32.49	70	2,274.30	26	59,132
Winter Weekday	32.49	55	1,786.95	65	116,152
Spring Weekend	32.49	70	2,274.30	26	59,132
Spring Weekday	32.49	55	1,786.95	65	116,152
TOTAL ESTIMATED ANNUAL USE					730,701
Average Users/Day					2,007

2.2 UDV SCORING/POINT ASSIGNMENT

Per USACE guidance, scores are required for both the without project and with projection condition. Because two recreation plan options were considered, two with project scores were developed, one for each option.

The five UDV scoring criteria from the guidance, for which points are assigned, include the following items:

- Recreation Experience: score increases in proportion to the number of available activities at the site
- Availability of Opportunity: score is based on availability of substitute sites; the fewer the sites in the region that offer comparable recreation experience, the higher the score
- Carrying Capacity: score rates level of facilities at the site to support the activities
- Accessibility: score rates ease of access to the site
- Environmental: rates the aesthetic/environmental quality of the recreation site/activities

Scoring was based on the consideration of general recreation activities that would be affected on those trails along the river in the ARBOR reach. This includes some specific activities, such as equestrian, bird watching, and biking, but also includes more general park-related activities, such as walking/jogging, viewing, picnicking, or general use of outdoor park areas along the River.

The table below summarizes the scores assigned for the Alternative 13 recreation plan option and for the Alternative 20 recreation plan option. In the sections following the table, the rationale is provided for the point assignments according to the five UDV criteria. Because the Alternative 20 recreation plan option builds incrementally on the Alternative 13 recreation plan option, discussion of rationale for point selection integrated. Attachment 1 provides a copy of the USACE guidance which contains the scoring rubric.

Table 8. UDV Score Summary

UDV Criteria	General Recreation		
	Without Project	Alt 13 Option	Alt 20 Option
Recreation Experience	13	16	17
Availability of Opportunity	5	5	5
Carrying Capacity	5	7	10
Accessibility	9	12	14
Environmental	2	7	9
Total Score	**34**	**47**	**5S**

2.2.1 RECREATION EXPERIENCE

Without Project. In the without project condition, this criteria received a score of 13 out of 30 possible points. The project site currently supports the identified general activities, and in the existing condition is a high quality bird watching location, uniquely situated in an urban environment. Per USACE guidance, a high quality activity is defined as an activity which is not common to the region or Nation, and that are usually of high quality. The ARBOR reach is located upstream of a seven-mile stretch of the LA River designated as an Important Bird Area by the National Audubon Society due to high level of use by migrating shorebirds for feeding from July to October.

With Alternative 13 Recreation Plan Option. In the with project condition, this criterion received a score of 16 out of 30 possible points. The number and type of activities remain largely the same as in the without project condition. All activities related to wildlife viewing along the trail will improve substantially in quality by provided designated viewpoints to take advantage of newly restored areas.

Improvement of ecosystem conditions in the ARBOR reach is likely to improve opportunities for bird watching in the ARBOR reach, as well as provide indirect benefits to downstream reaches of the river already included in the Important Bird Area.

Additionally, the restoration of the ARBOR reach may induce participation in additional recreation activities which do not currently exist, or which see very low participation levels. These might include activities such as wildlife viewing, new areas for bird watching, non-motorized boating, environmental education, stewardship training, or even visits to the ARBOR reach specifically to view the ecosystem restoration features.

With Alternative 20 Recreation Plan Option. In the with project condition, this criterion received a score of 17 out of 30 possible points. This recreation plan option would marginally improve the quality of the recreation due to the additional bridges, viewpoints, and trail access points which would further highlight and capitalize on the ecosystem restoration project features.

2.2.2 AVAILABILITY OF OPPORTUNITY

The study team noted that the availability of other substitute recreation resources would likely remain the same between the without and with project conditions. Because the same general types of activities would be available to the same user groups, it was determined that, from a regional perspective, the construction of the recreation plan features would not alter the relative availability of substitute sites. Thus, in both the without project and for both recreation plan options, a score of 5 out of 18 possible points was given. This score reflects that there are several substitute locations which would provide similar recreation activities within one hour, including areas of Griffith Park or Elysian Park not adjacent

to the river. However, these areas would not be perfect substitutes. For example, residents living adjacent to the ARBOR reach are likely to view the River as a community park, rather than a regional one. Additionally, in the with project condition, the newly restored ARBOR reach may become a destination for tourists, environmental educators, artists, and others looking to take advantage of the River's recreation opportunities that were not previously accessible.

2.2.3 CARRYING CAPACITY

Without Project. This criteria received a score of 5 out of 14 possible points. Because the study area already has recreation features, basic facilities already exist to conduct the identified general recreation activities at the site. There is currently very little connectivity, so it may discourage users from exploring.

With Alternative 13 Recreation Plan Option. This criteria received a score of 7 out of 14 possible points. This reflects a change from the "basic" to "adequate" category on the rubric. The proposed features would make substantial improvements toward connecting the left and right bank of the river for recreation purposes, add new trails, viewing points, interpretive signage, and provide additional parking and restroom facilities.

With Alternative 20 Recreation Plan Option. This criteria received a score of 10 out of 14 possible points. This reflects a change from the "adequate" to "optimal" category on the rubric. The additional mile of trail would further increase capacity in the study area. Also the additional bridges, underpasses, and trail access points would substantially improve connectivity both along the banks and across the river.

2.2.4 ACCESSIBILITY

Without Project. This criteria received a score of 9 out of 18 possible points. Because the study area is situated in a highly-urbanized area, the existing road network provides fair access to the site, and there are established road networks within park areas as well. However, trail connectivity and access can be improved, as there are few opportunities for users to cross the River, and many trail lengths are not connected.

With Alternative 13 Recreation Plan Option. This criterion received a score of 12 out of 18 possible points. The additional trails and access points in the proposed recreation plan would substantially increase the connectivity of trail segments along the River, including connecting the left and right bank for trail users. This would constitute a jump from the "fair" to "good" access rating.

With Alternative 20 Recreation Plan Option. This criterion received a score of 14 out of 18 possible points. The additional points were awarded to reflect the increase in accessibility provided by the additional bridges, underpasses, trail lengths, and access points. These additional components were judged to raise the score to the top end of the "good" rating.

2.2.5 ENVIRONMENTAL

Without Project. This criterion received a score of 2 out of 20 possible points. In its present condition, the ARBOR reach is surrounded by a highly-urbanized areas, with commercial and industrial uses, infrastructure barriers, blight, and likely contamination, which lower the quality of the sites.

With Alternative 13 Recreation Plan Option. This criterion received a score of 7 out of 20 possible points. The addition of recreation plan features would bump the score into the "above average" range by improving the amenities within the site, as well as through the addition of wildlife viewpoints and bridges which would highlight restored areas rather than adjacent commercial and industrial areas. The

presence of the new ecosystem restoration features would also greatly improve the aesthetic quality of the site. While there would remain commercial and industrial activity in close proximity to the recreation resource, the effects of these factors would be relatively minor due to improvements within the site that capitalize on the restoration plan features.

With Alternative 20 Recreation Plan Option. This criterion received a score of 9 out of 20 possible points. While still in the "above average' range, this recreation plan option adds a number of bridges and viewpoints which would substantially increase opportunities for viewing the ecosystem restoration treatments associated with Alternative 20. It was judged that these additional features would raise the score, but that the larger urban-industrial setting would keep the rating the "above average" category.

2.3 UNIT DAY VALUE CONVERSION

For the with and without project conditions for both the Alternative 13 and the Alternative 20 plan options, the points were converted to a dollar value based on the FY2015 UDV conversion table in EGM 15-03 (USACE 2014). Scores were interpolated linearly as necessary. The table below shows the point conversion table from the guidance and the dollar values generated for general recreation activities for both the Alternative 13 recreation plan option and the Alternative 20 recreation plan option.

Table 9. FY2014 UDV Conversion Table

General Recreation	
Point Values	Values ($)
0	$3.91
10	$4.64
20	$5.13
30	$5.86
40	$7.32
50	$8.30
60	$9.03
70	$9.52
80	$10.50
90	$11.23
100	$11.72
USACE CECW-CP EGM 15-03 for FY2015	

General Recreation		
Value per Visit ($)		
Without Project	Alt 13 Option	Alt 20 Option
34 pts $6.44	47 $8.01	55 pts $8.67

3 EXPECTED RECREATION BENEFITS

Using the UDV dollar values per visit and visitation estimates generated in the previous sections, recreation values for the without and with project conditions were calculated for both of the recreation plan options. Taking the difference between the with project and the without project, recreation benefits attributable to each option were estimated. The following tables summarize expected recreation benefits in terms of present value and an amortized annual value for each option. Amortization over the period of analysis uses the FY2015 Federal discount rate of 3.375% over a 50-year period of analysis. The analysis estimates amortized annual benefits of $2,479,128 for the Alternative 13 recreation plan option and $3,509,832 for the Alternative 20 recreation plan option.

Table 10. Summary of Recreation Value Calculation, Alternative 13 Option

	Without Project	With Project
Average Annual Visitation	437,879	662,106
Value per Visit*	$6.44	$8.01
Average Annual Recreation Value	$2,821,692	$5,300,821
Average Annual Benefits	**$2,479,128**	
Present Value of Benefits	**$59,483,960**	
* Interpolated value rounded to nearest cent in tables; multiplication results may differ due to rounding		

Table 11. Summary of Recreation Value Calculation, Alternative 20 Option

	Without Project	With Project
Average Annual Visitation	437,879	730,701
Value per Visit*	$6.44	$8.67
Average Annual Recreation Value	$2,821,692	$6,331,524
Average Annual Benefits	**$3,509,832**	
Present Value of Benefits	**$84,214,558**	
* Interpolated value rounded to nearest cent in tables; multiplication results may differ due to rounding		

4 BENEFIT COST ANALYSIS

4.1 CONSTRUCTION COST

Separate construction cost estimates were developed for the proposed recreation features in the Alternative 13 and the Alternative 20 recreation plan options. Costs are presented in FY2015 price level and are consistent with the MCACES cost estimates presented in the Economics Appendix. Detailed cost documentation can be found in the Cost Appendix to the IFR. The following bullets summarize the information in the tables below:

Alternative 13 recreation plan option

- The present value total estimated investment cost for the proposed recreation features is $10,386,000 or $433,000 in amortized annual dollars.
- Operations and maintenance of the recreation plan features adds an additional amortized annual cost of $173,000 or $4,151,000 in present value dollars.
- Total present value project cost is estimated at $14,540,000.

Alternative 20 recreation plan option

- The present value total estimated investment cost for the proposed recreation features is $18,109,000, or $755,000 in amortized annual dollars.
- Operations and maintenance of the recreation plan features adds an additional amortized annual cost of $223,000 or $5,351,000 in present value dollars.
- Total present value project cost is estimated at $23,466,000.

These recreation plan costs do not include LERRDs, as there are no LERRDs costs over and above those required for the ecosystem restoration features. Tables 12 and 13 show the derivation of the annual cost for each option. Interest during construction was calculated separately for the recreation plan to reflect only the construction duration for the recreation features, as the recreation plan is separable project element. The Cost Appendix (Appendix C) provides more detail on the recreation plan option cost estimates, including individual costs and backup components of the recreation plan option for each alternative.

Table 12. Derivation of Costs, Alternative 13 Option

Construction First Cost	$10,353,000
IDC (3.375%)	$33,200
Investment Cost PV	$10,386,000
Annual Investment Cost	$433,000
Annual O&M	$173,000
Total Annual Cost	**$606,000**
Total NPV	**$14,540,000**

Table 13. Derivation of Costs, Alternative 20 Option

Construction First Cost	$18,055,000
IDC (3.375%)	$53,700
Investment Cost PV	$18,109,000
Annual Investment Cost	$755,000
Annual O&M	$223,000
Total Annual Cost	**$978,000**
Total NPV	**$23,466,000**

4.2 Net Recreation Benefits and Benefit to Cost Ratio

For both the Alternative 13 and the Alternative 20 recreation plan options, benefits exceed cost. Annual benefits, annual costs, net benefits, and the benefit-to-cost ratio (BCR) for each of the options are summarized in Table 14, below. Because the BCR for the proposed recreation features is above 1.0 for both options, the recreation features are economically justified. The Alternative 20 recreation plan option provides the greatest net benefits of the two options under evaluation.

Table 14. Benefit-to-Cost Ratio by Alternative Recreation Plan Option

Alternative	Annual Benefits ($)	Annual Costs ($)	Net Benefits ($)	BCR
No Action	$0.00	$0.00	$0.00	0.00
Alternative 13 Recreation Plan Option	$2,479,000	$606,000	$1,873,000	4.09
Alternative 20 Recreation Plan Option	$3,510,000	$978,000	$2,532,000	3.59

4.3 SENSITIVITY ANALYSIS

Visitation

Visitation estimates are typically a source of uncertainty in recreation analyses. Visitation estimates directly affect the benefits of each alternative and the BCR. As discussed in Section 2.1, a key assumption in this analysis was the estimate of existing condition visitation and growth of visitation from the without project to the with project based on additional miles of trails associated with the recreation plan.

- Sensitivity analysis showed that if the without project baseline visitation estimate was not increased at all in the with project, while holding UDV scores the same, both recreation plan options would remain near unity. In this scenario, the Alternative 13 recreation plan option would have a BCR of 1.13 and the Alternative 20 recreation plan option would have a BCR of 0.99.
- Further analysis of sensitivity to visitation was done by reducing the without project baseline visitation and projected with project growth in visitation by the same amount while holding UDV scores constant. In order to drop the Alternative 13 recreation plan BCR below 1.0, baseline and with project visitation would need to be reduced by 76%. For the Alternative 30 recreation plan the reduction would need to be 73%.

Furthermore, visitation is judged to be likely to increase in the with project condition, both in response to the ecosystem restoration, and due to the recreation improvements drawing more visitors. Therefore, the risk of the BCR falling below 1.0 because of visitation uncertainty is judged to be very low for both the Alternative 13 and the Alternative 20 recreation plan options.

UDV Score

Another source of uncertainty in the UDV methodology is the UDV scoring itself. The differential between the without project and the with project UDV scores drives the estimate of recreation benefits from the proposed features. In this analysis, the without project was scored 34 total points, the Alternative 13 option was scored 47 points, and the Alternative 20 option was scored 55 points.

- For the both the Alternative 13 and Alternative 20 recreation plan options, assuming growth of visitation as in the main analysis, a drop in UDV score alone would not be sufficient to drop the BCR below 1.0. For both options, the additional visitation in the with project would add benefits above the cost of the recreation plan even if the score did not change in the with project condition.

Visitation and UDV Score

Combining the visitation uncertainty and the UDV score uncertainty, a more reasonable scenario might be one where with project visitation does not increase as significantly as estimated in the analysis, which estimated a 51 to 67% increase in annual visitation depending on the recreation plan option. Tables 15 and 16 summarize the effects on the BCR if with project visitation increase were instead limited to 10% and the with project UDV score was reduced.

Table 15. Alternative 13 Option Sensitivity Summary

% Growth in Visits versus No Action	With Project Visitation	UDV Score & Value per Visit	Annual Benefits	Annual Cost	Net Benefits	BCR
10%	481,667	47pts; $8.01	$1,034,500	$606,000	$428,500	1.71
10%	481,667	44pts; $7.71	$892,900	$606,000	$287,000	1.47
10%	481,667	40pts; $7.32	$704,100	$606,000	$98,100	1.16
10%	**481,667**	**39pts; $7.17**	**$633,800**	**$606,000**	**$27,800**	**1.05**
10%	481,667	38pts; $6.74	$563,500	$606,000	-$42,500	0.93

Table 16. Alternative 20 Option Sensitivity Summary

% Growth in Visits versus No Action	With Project Visitation	UDV Score & Value per Visit	Annual Benefits	Annual Cost	Net Benefits	BCR
10%	481,667	55pts; $8.67	$1,352,000	$978,000	$374,000	1.38
10%	481,667	50pts; $8.30	$1,176,100	$978,000	$198,100	1.20
10%	481,667	47pts; $8.01	$1,034,500	$978,000	$56,500	1.06
10%	**481,667**	**46pts; $7.91**	**$987,300**	**$978,000**	**$9,300**	**1.01**
10%	481,667	45pts; $7.81	$940,100	$978,000	-$37,800	0.96

Even with visitation growth of just 10%, the UDV scores for the Alternative 13 and the Alternative 20 recreation plan options would need to drop by 9 to 10 points each before the BCRs fell to 1.0. In addition to the strong recreation demand expected form the City and other stakeholders, at a minimum, some increase in visitation would be expected from general population growth and the increased carrying capacity of the site with either recreation plan option. Further the study team judges that there is low risk that the recreation plan would not be economically justified because the proposed recreation features would have a more substantial impacts on the ARBOR reach's recreation value than would be captured by scores of 38 and 45 for the Alternative 13 and Alternative 20 recreation plan options, respectively. Therefore, the study team concludes that there is federal interest in construction of the recreation plan and recommends its inclusion in the project.

4.4 Selected Ecosystem Restoration Plan Option

As documented in the main feasibility report, ecosystem restoration Alternative 20 is selected for recommendation as a locally preferred plan (LPP). As such, the corresponding Alternative 20 recreation plan option is selected as well, and will be carried forward into the pre-construction engineering and design (PED) phase of the study.

The Alternative 20 recreation plan is expected to provide positive net benefits and has an expected benefit cost ratio of 3.59. Between the two recreation plan options evaluated, the Alternative 20 recreation plan provided the largest net recreation benefits. Sensitivity analysis showed that the Alternative 20 option would result in positive net benefits even if visitation grew just 10% above the without project condition and UDV scores used in the analysis were reduced by 9 points. Further, the

Alternative 20 recreation plan option adds additional features considered essential by the project sponsor.

The recommended recreation plan is the optimum recreation plan consistent and compatible with the recommended ecosystem restoration plan features. The plan is comprised of a system of trail improvements, trail connections, and supporting ancillary facilities. These facilities are not separable recreation features but rather parts of the whole trail system plan. A larger plan was not analyzed, because additional features would potentially negatively impact the ecosystem restoration outputs and would not meet Corps guidance for recreation at restoration projects. As demonstrated in this appendix, a smaller trail system plan was developed based upon the NER Plan restoration features. This smaller plan had lower net benefits, offers a reduced number of trail system miles in the study area, provides fewer connections along the river, between trails and the restored areas, and specifically would not include trail linkages that allow visitors to enjoy some of the key restoration features included in the Recommended Plan (Alternative 20) and not in the NER Plan.

5 REFERENCES

Los Angeles River Master Plan. 1996. County of Los Angeles.

Los Angeles River Recreation Zone. 2013. City of Los Angeles Department of Recreation and Parks and the Mountains Recreation and Conservation Authority. http://www.lariverrecreation.org/LA_River_Recreation/home.html

Los Angeles River Revitalization Corporation (LARRC). 2011b. LA River Guide: Walking: Access and Cautions. Accessed August 2012 at http://thelariver.com/guide/walks/access-and-cautions/.

Los Angeles River Revitalization Master Plan. 2007. City of Los Angeles. www.lariver.org

Metropolitan Transit Authority (Metro). 2012d. Bike Metro: Cyclists' Guide: Metro Bike Map. Web. Accessed August 2012. http://www.metro.net/riding_metro/bikes/images/la_bike_map.pdf. Los Angeles County.

National Recreation and Park Association. Published 1983. Recreation Park and Open Space Standards and Guidelines. Edited by Roger A. Lancaster, Director of Research. http://www.prm.nau.edu/prm423/recreation_standards.htm

Santa Monica Mountains Conservancy and Mountains Recreation Conservation Authority. 2007. Your Parks. Accessed August 2012 at http://www.lamountains.com/parks.asp?parkid=20.

Senate Bill 1201, Los Angeles River. 2012. http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201120120SB1201

(USACE) U.S. Army Corps of Engineers. 15 October 2014. EGM 15-03 Unit Day Values for Recreation for Fiscal Year 2015. CECW-CP Memorandum for Planning Community of Practice. Retrieved online via http://planning.usace.army.mil/toolbox/library/EGMs/EGM15-03.pdf.

6 PLATES

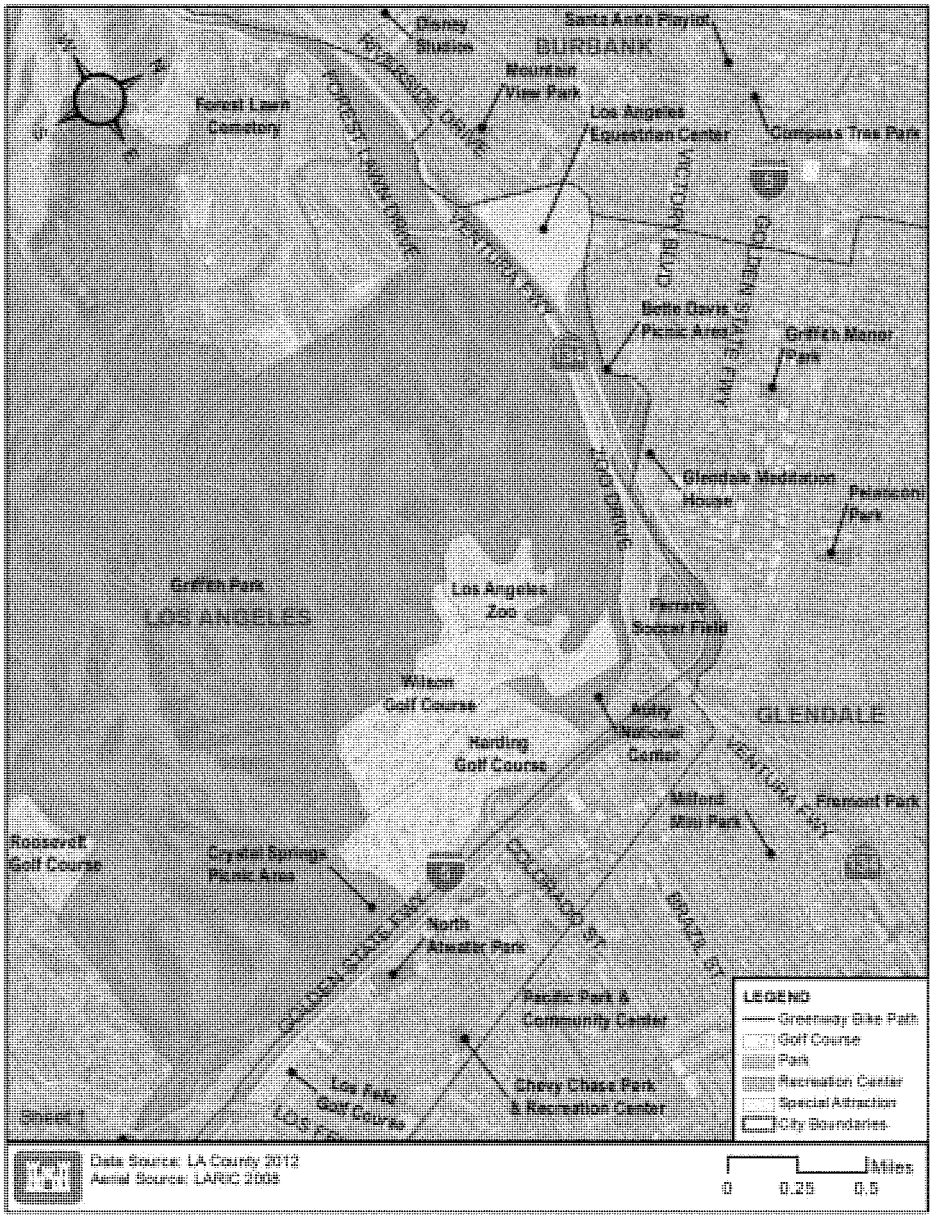

Plate 1. Current Recreation Areas, Reaches 1-3

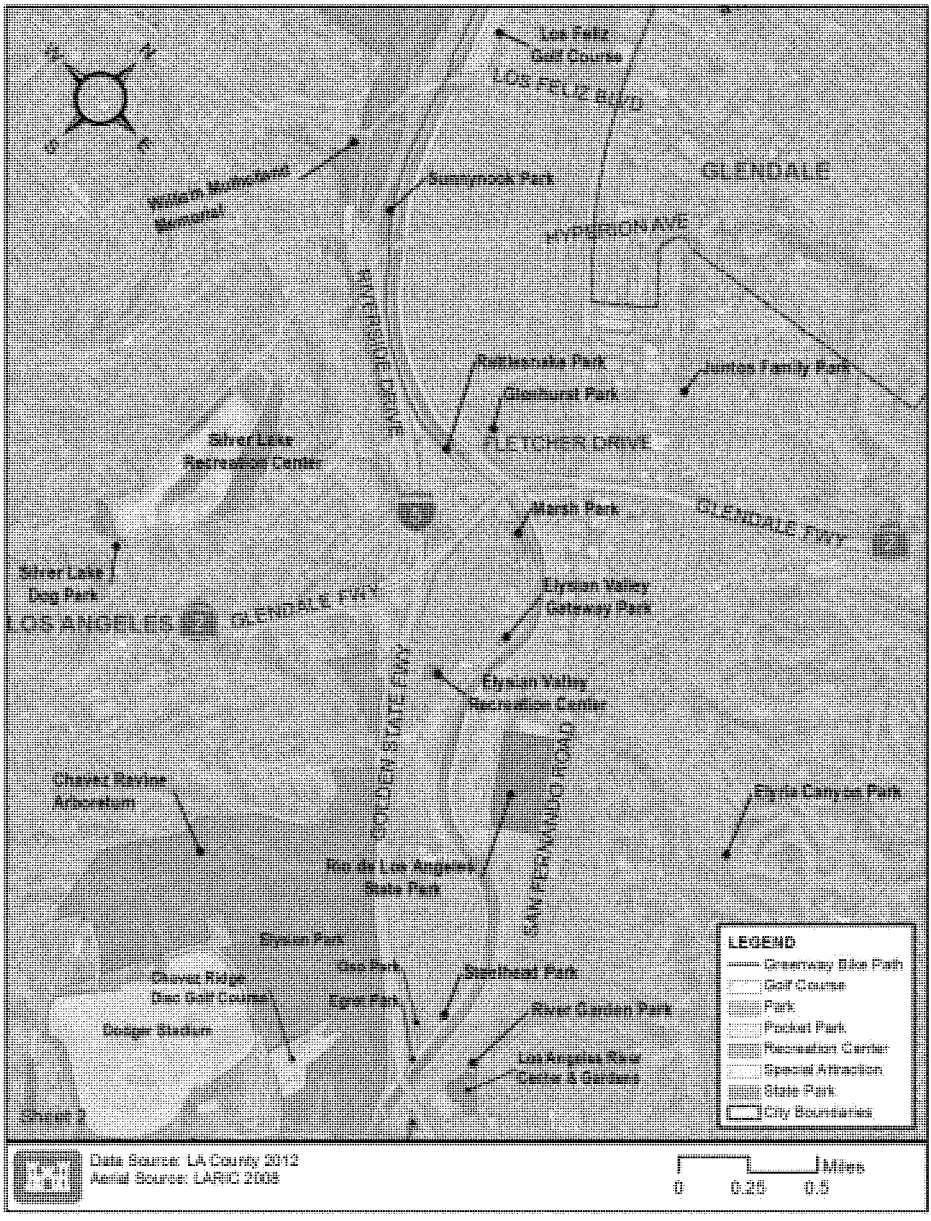

Plate 2. Current Recreation Areas, Reaches 4-6

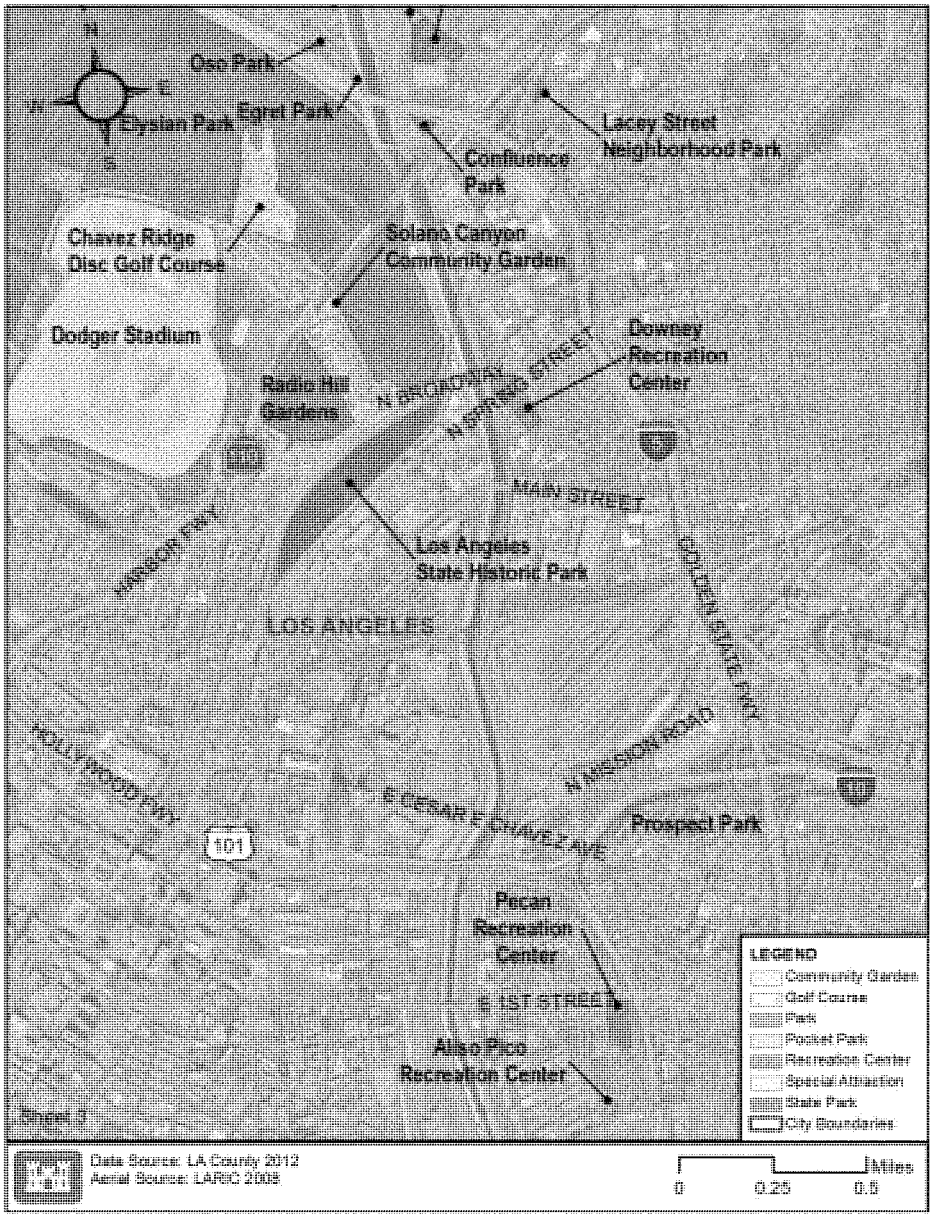

Plate 3. Current Recreation Areas, Reaches 7-8

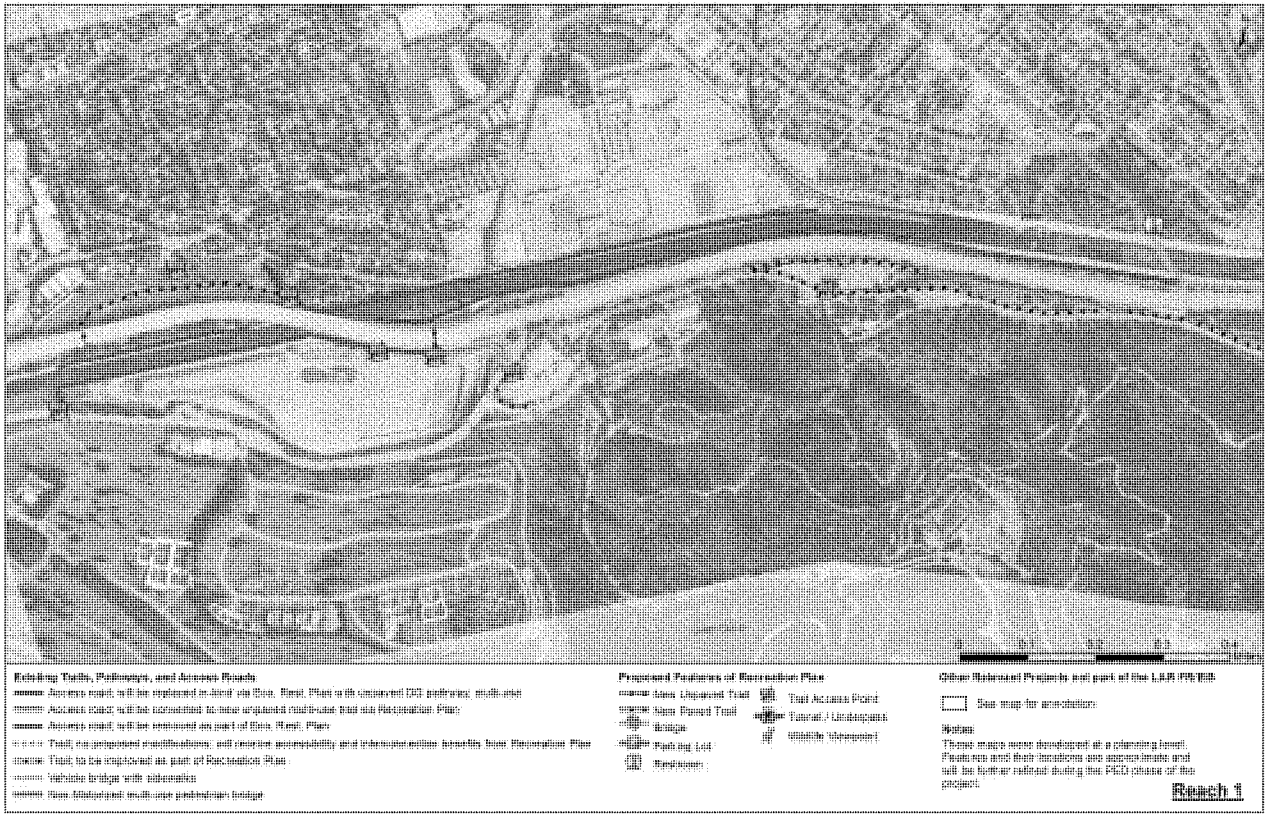

Plate 4. Recreation Plan Reach 1, Alternative 13 Option

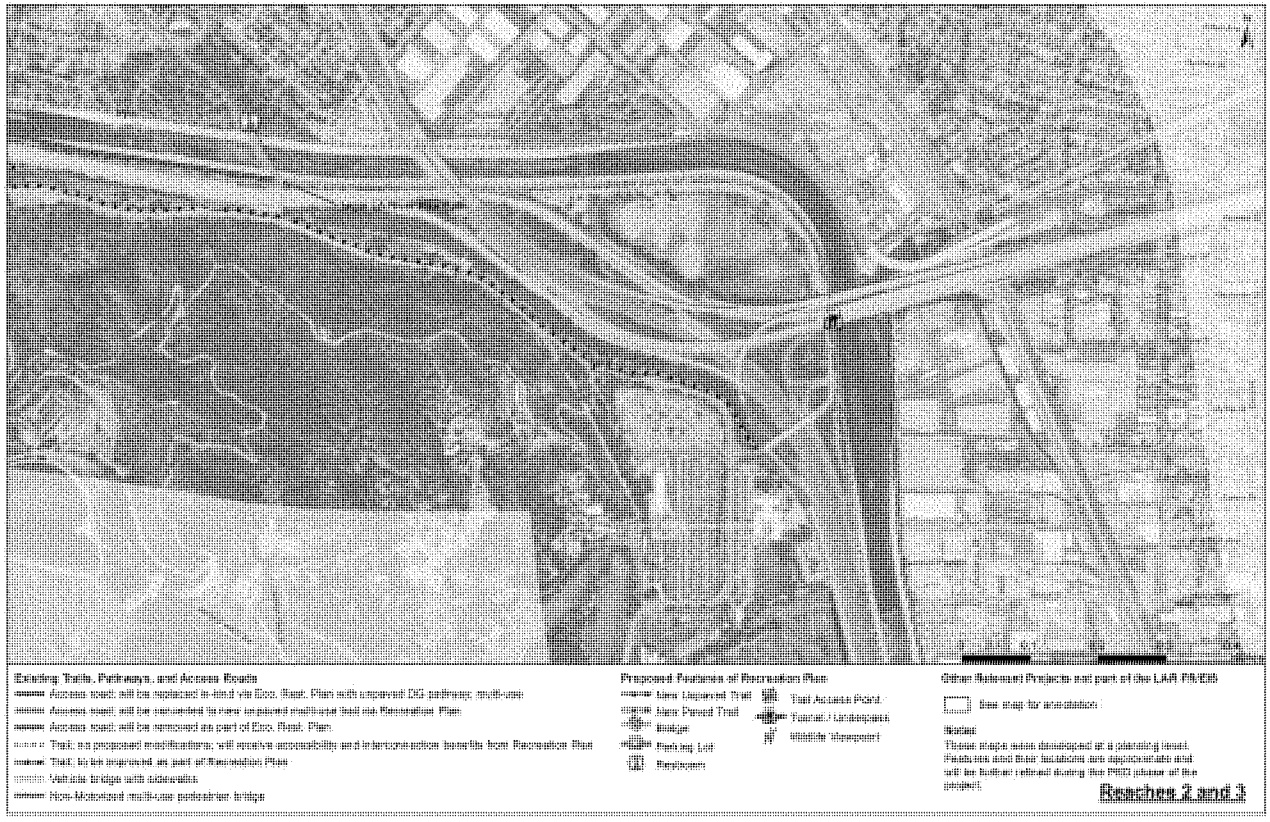

Plate 5. Recreation Plan Reaches 2 and 3, Alternative 13 Option

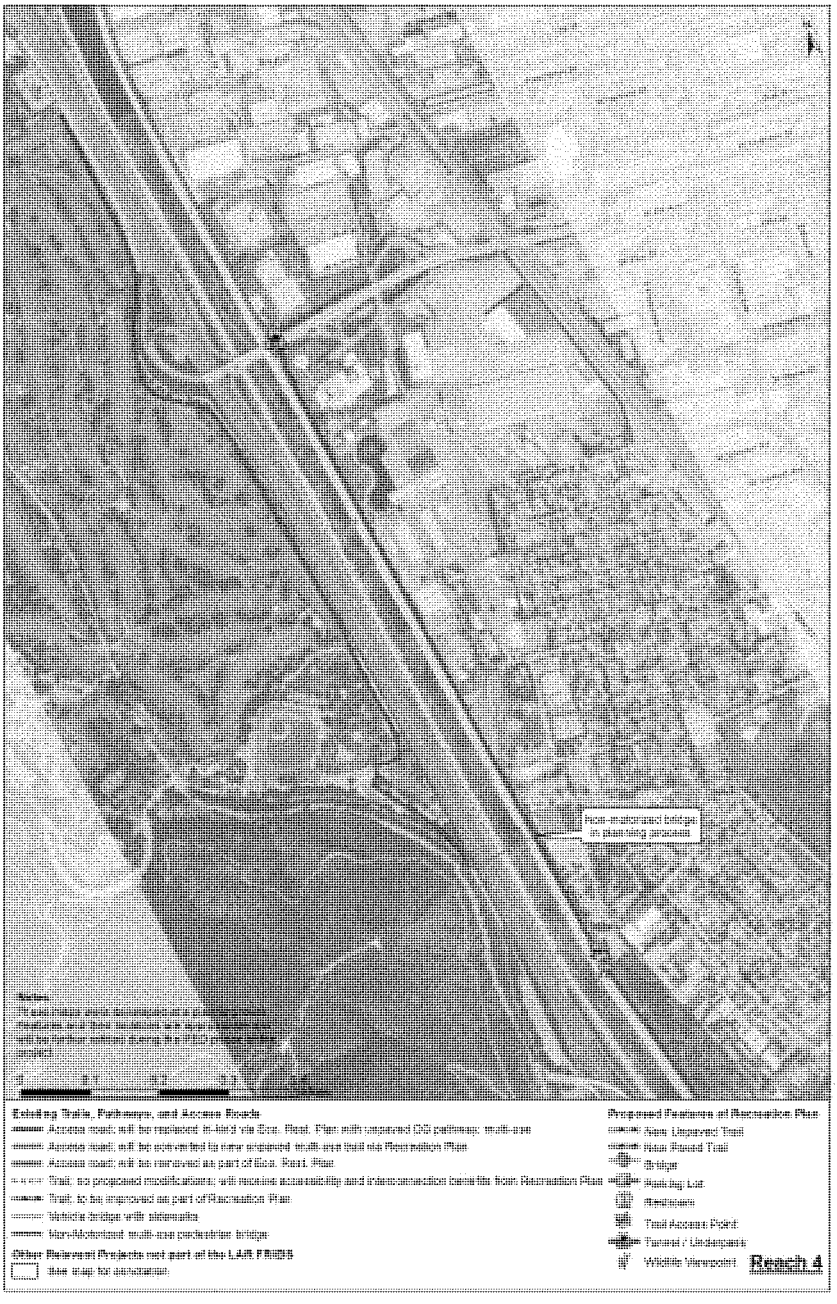

Plate 6. Recreation Plan Reach 4, Alternative 13 Option

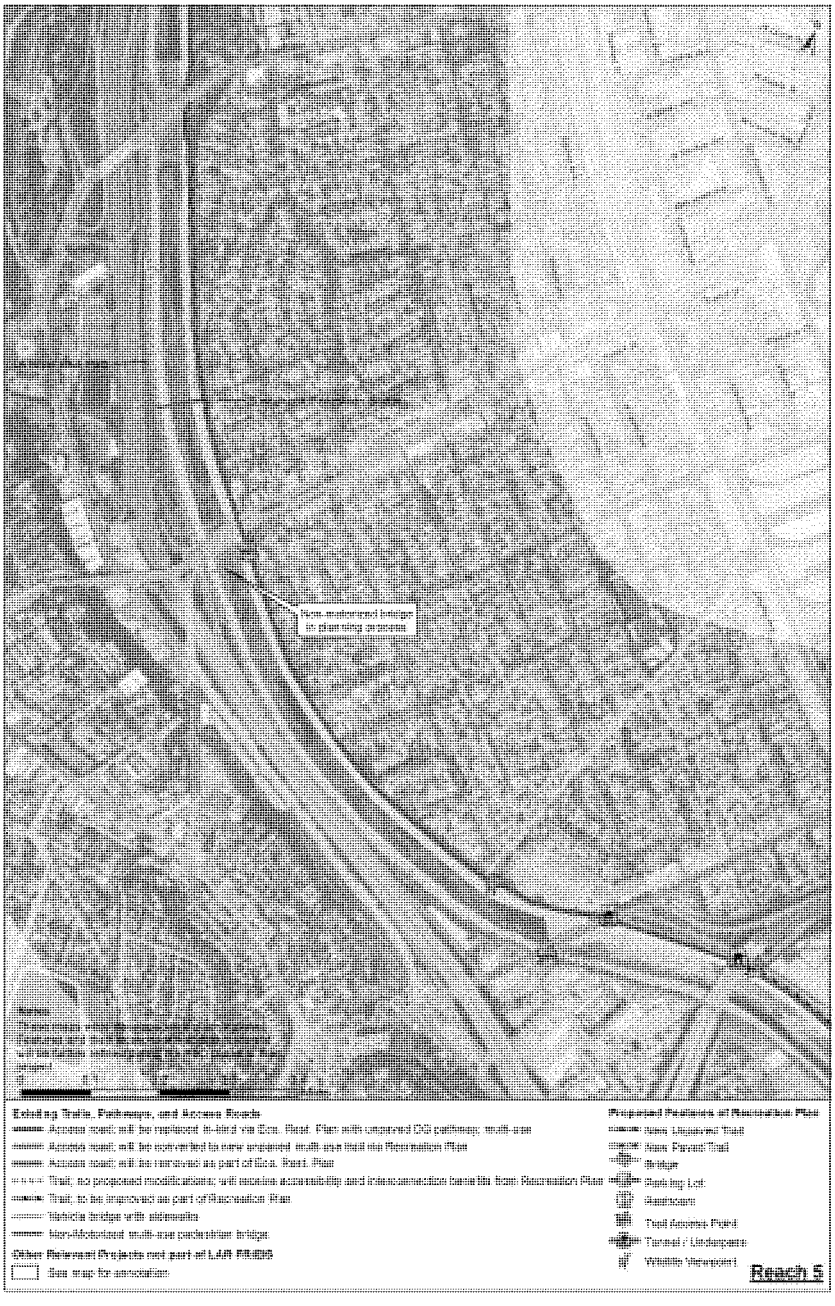

Plate 7. Recreation Plan Reach 5, Alternative 13 Option

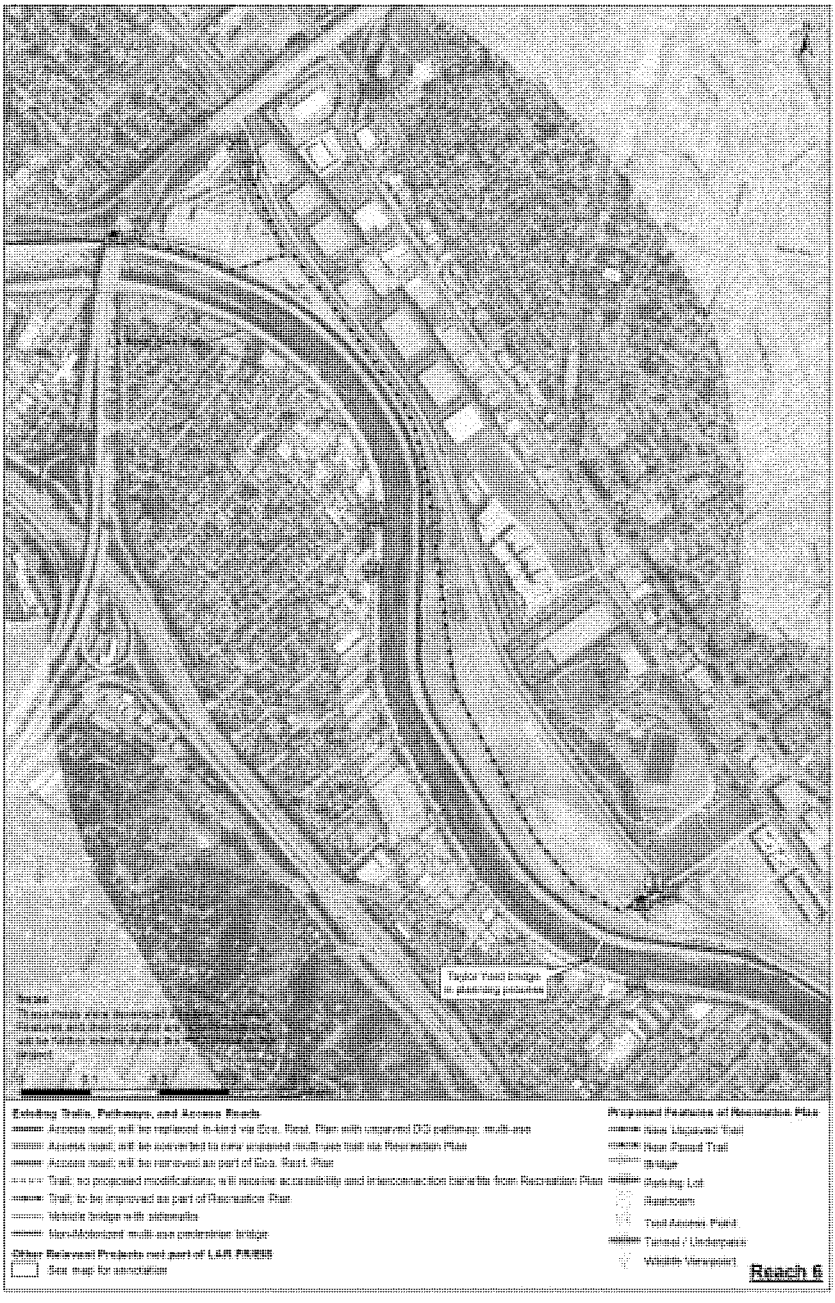

Plate 8. Recreation Plan Reach 6, Alternative 13 Option

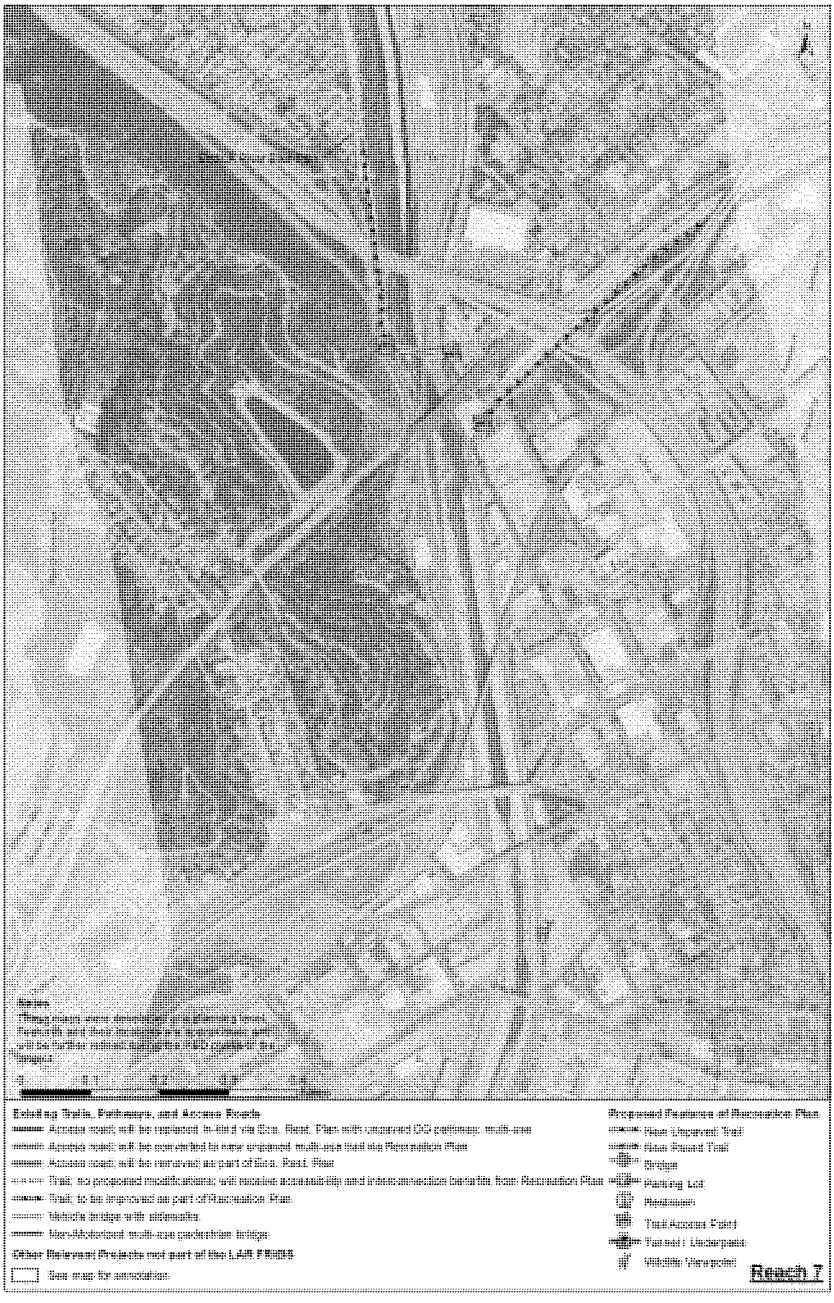

Plate 9. Recreation Plan Reach 7, Alternative 13 Option

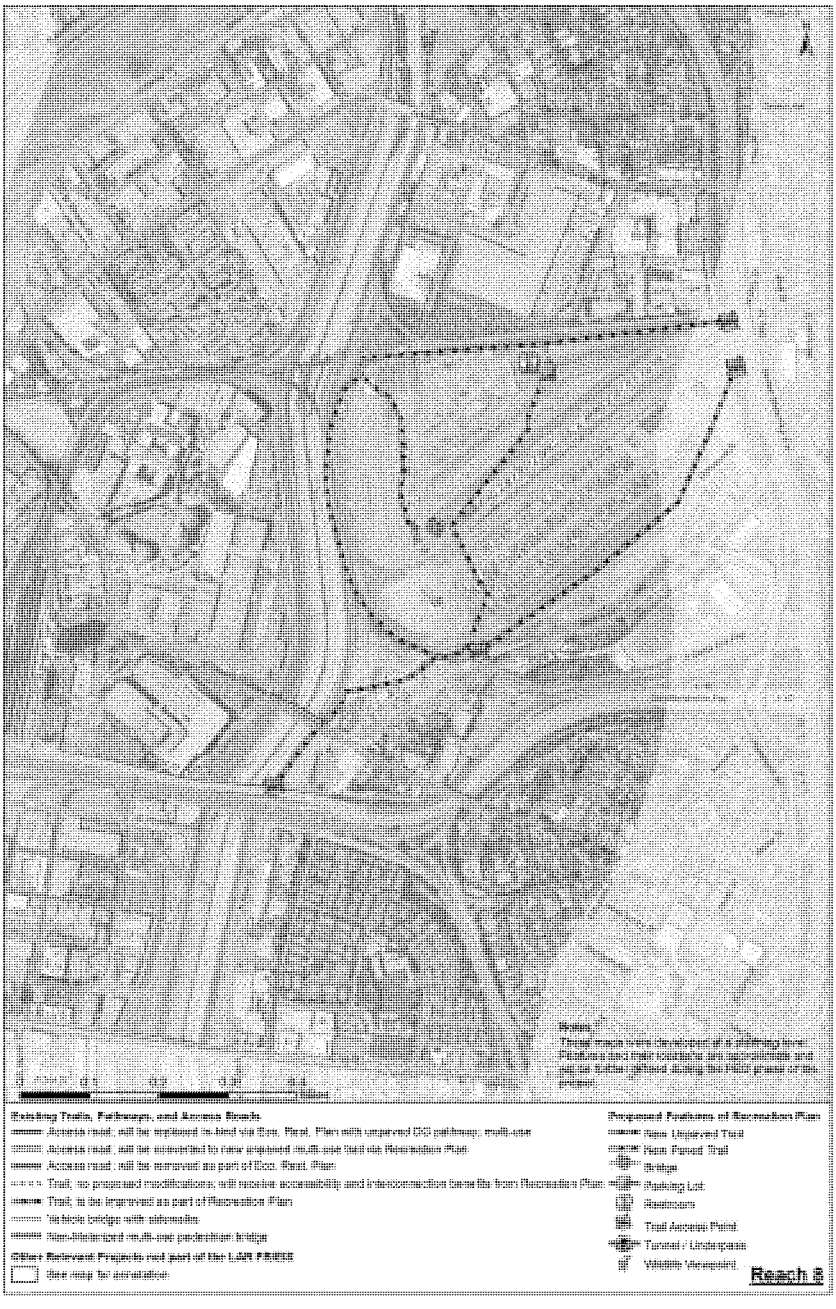

Plate 10. Recreation Plan Reach 8, Alternative 13 Option

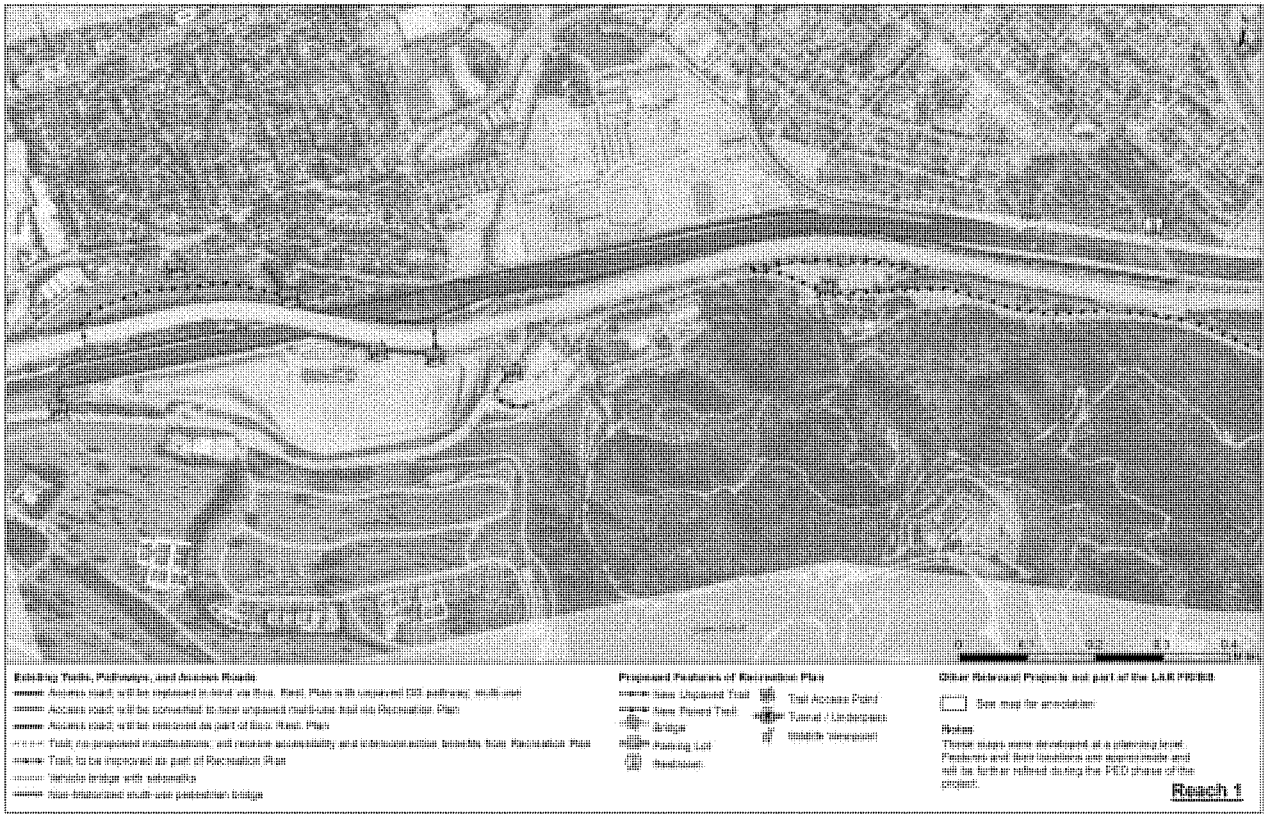

Plate 11. Recreation Plan Reach 1, Alternative 20 Option

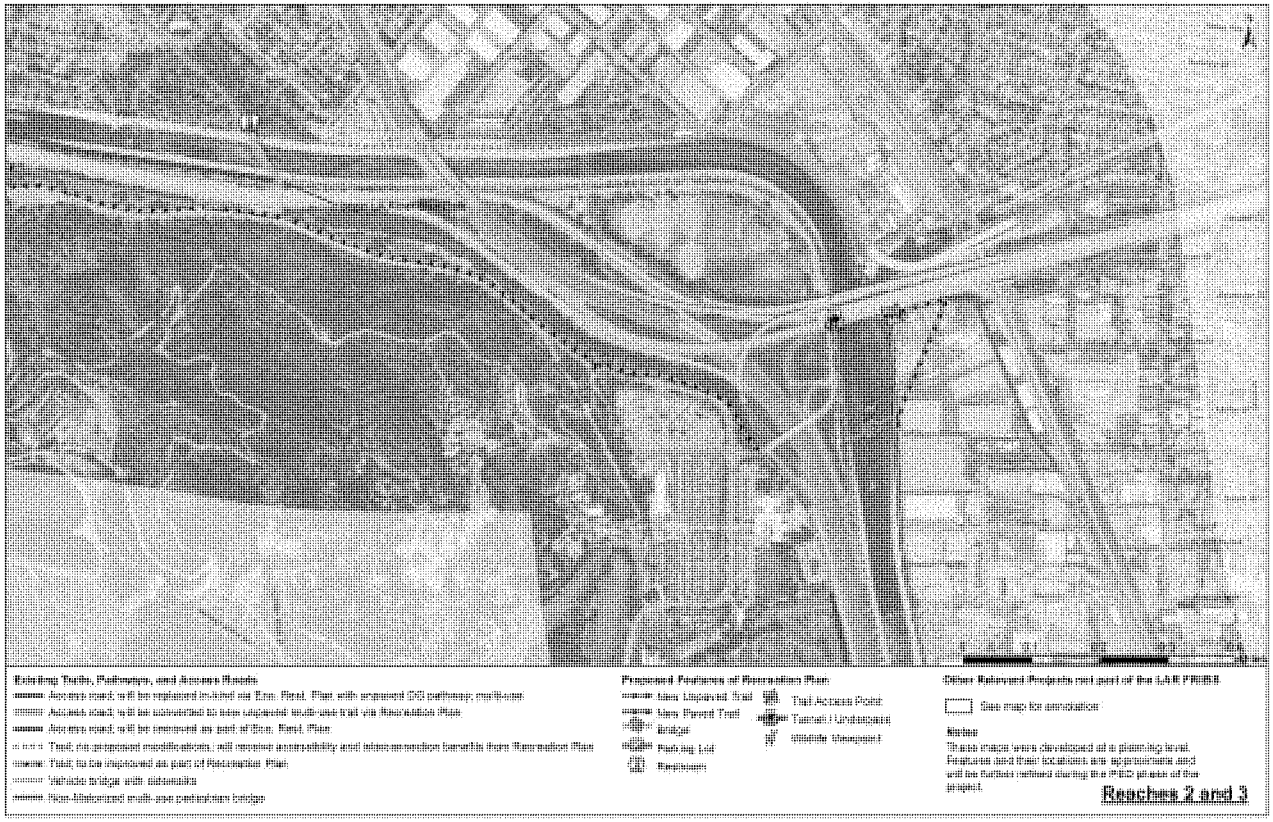

Plate 12. Recreation Plan Reaches 2 and 3, Alternative 20 Option

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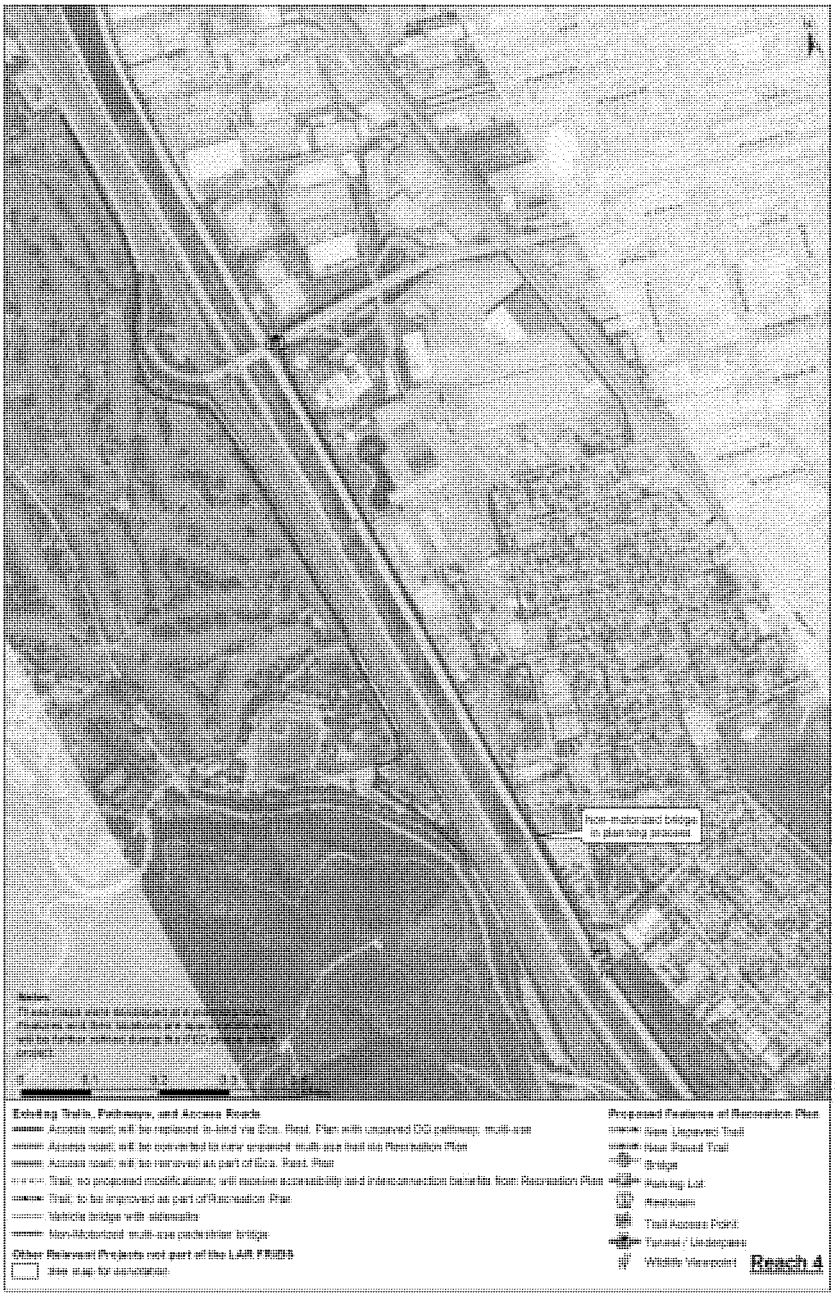

Plate 13. Recreation Plan Reach 4, Alternative 20 Option

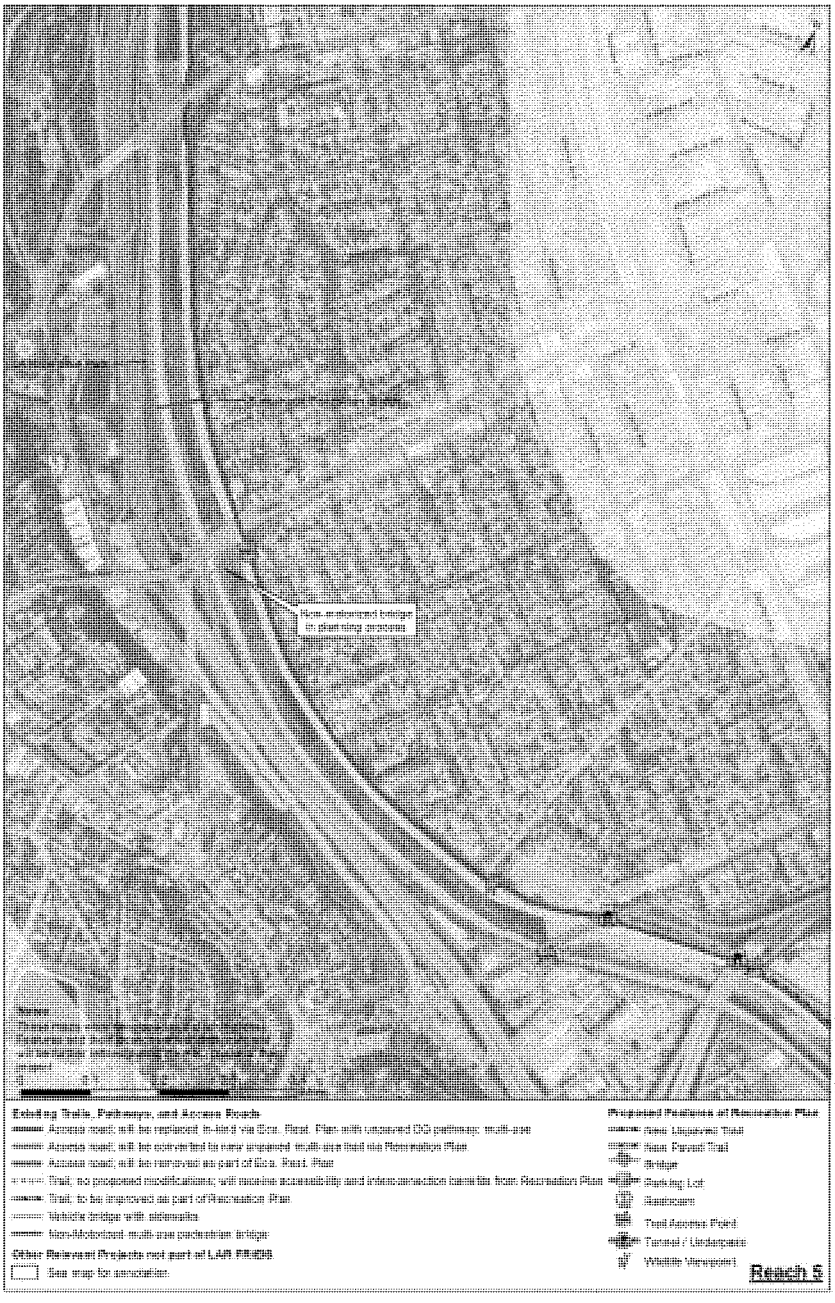

Plate 14. Recreation Plan Reach 5, Alternative 20 Option

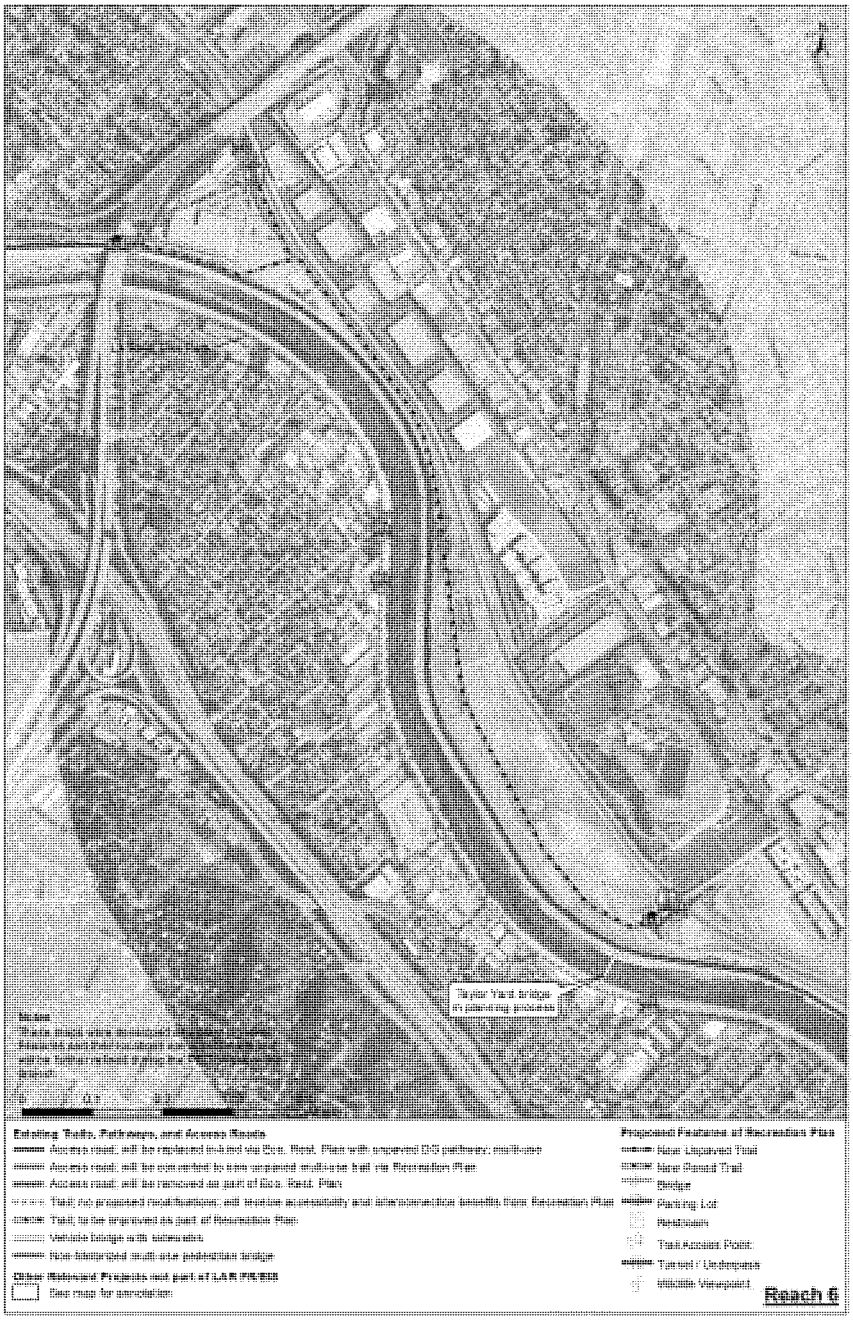

Plate 15. Recreation Plan Reach 6, Alternative 20 Option

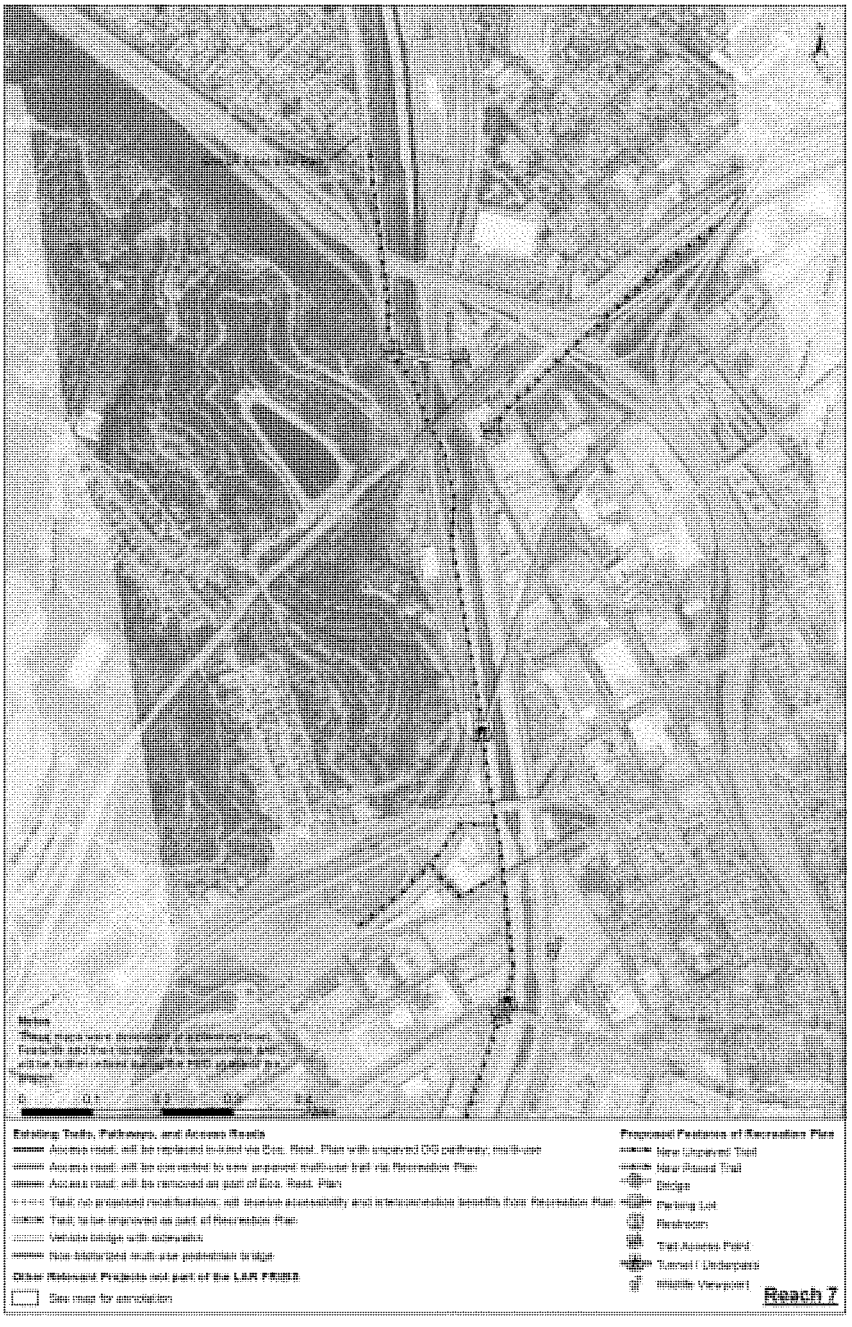

Plate 16. Recreation Plan Reach 7, Alternative 20 Option

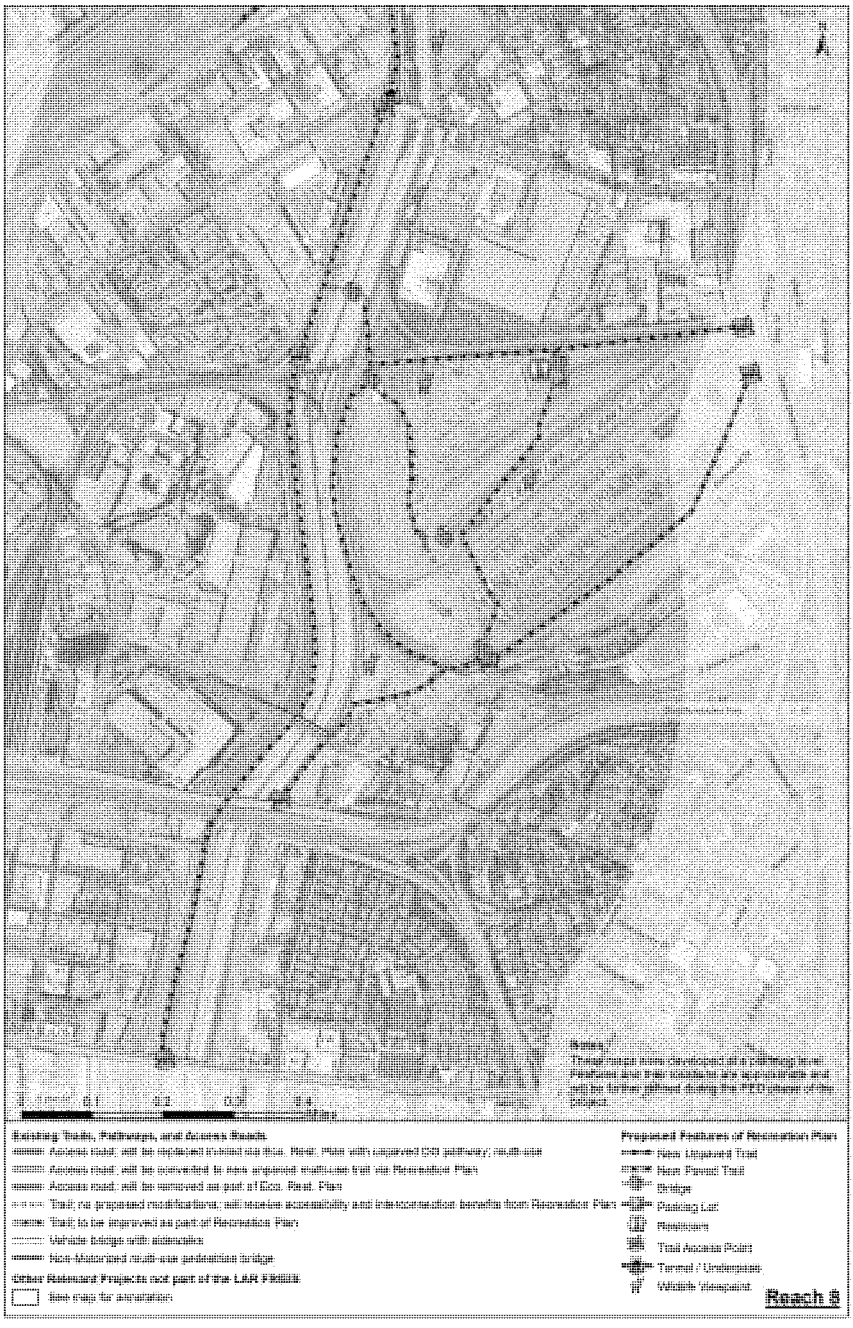

Plate 17. Recreation Plan Reach 8, Alternative 20 Option

Attachment 1 – USACE Unit Day Value Guidance (EGM 15-03) Excerpts

Unit Day Values for Recreation, Fiscal Year 2015

The national economic development (NED) benefit evaluation procedures contained in ER 1105-2-100 (22 Apr 2000), Appendix E, Section VII, include three methods of evaluating the beneficial and adverse NED effects of project recreation: travel cost method (TCM), contingent valuation method (CVM), and unit day value (UDV) method.

The criteria for selecting the appropriate method are described in paragraph E-50b(4) and Figure E-10 of ER 1105-2-100 and in the attached document. If the UDV approach is used, the range of unit day value for FY 2015 studies is:

General Recreation	$ 3.91	$ 11.72
Specialized Recreation	$ 15.87	$ 46.39

If, when using the UDV method, evidence indicates a value outside the published range, use either TCM or CVM to evaluate recreation benefits.

The attached document provides a detailed description of the application of the UDV method. The tables provided in the attachment are constructed as guidance for planners in the selection of unit day values for particular recreation activities. Tables 1 and 2 illustrate a method of assigning a point rating to a particular activity. Point values are assigned based on measurement standards described for the five criteria of activities: recreational experience; availability of opportunity; carrying capacity; accessibility; and environmental quality.

Table 1 covers general recreation, involving relatively intensive development of access and facilities. The specialized recreation category, covered in Table 2, includes such unique experiences as big game hunting, wilderness pack trips, white water canoeing, and other activities generally characterized by more extensive, low density use.

Values provided for FY 2015 may be used to convert points to a UDV dollar amount if the point assignment method is used. The table was adjusted from Table K-3-1, Federal Register Vol. 44, No. 242, p.72962, December 14, 1979, and the subsequent Table VIII-3-1 "Conversion of Points to Dollar Values", Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, March 10, 1983, using the Consumer Price Index (CPI) factors published by the Bureau of Labor Statistics. The CPI basis of Table VIII-3-1 from Principles and Guidelines is July 1, 1982 (CPI value = 97.5). The FY 2015 CPI basis is September, 2014 (CPI value = 238.031).

As a special note of warning, it is important to recognize that all specialized recreation activities claimed will require a regional model or a site-specific study, the results of which would probably not agree with the specialized values in the attached

Encl 1

table. The only exception would be in those specific cases for which the unreliability or infeasibleness of TCM or CVM can be stated convincingly.

Conversion of Points to Dollar Values

Point Values	General Recreation Values (1)	General Fishing and Hunting Values (1)	Specialized Fishing and Hunting Values (2)	Specialized Recreation Values other than Fishing and Hunting (2)
0	$ 3.91	$ 5.62	$ 27.34	$ 15.87
10	$ 4.64	$ 6.35	$ 28.08	$ 16.85
20	$ 5.13	$ 6.84	$ 28.56	$ 18.07
30	$ 5.86	$ 7.57	$ 29.30	$ 19.53
40	$ 7.32	$ 8.30	$ 30.03	$ 20.75
50	$ 8.30	$ 9.03	$ 32.96	$ 23.44
60	$ 9.03	$ 10.01	$ 35.89	$ 25.88
70	$ 9.52	$ 10.50	$ 38.08	$ 31.25
80	$ 10.50	$ 11.23	$ 41.01	$ 36.38
90	$ 11.23	$ 11.47	$ 43.94	$ 41.50
100	$ 11.72	$ 11.72	$ 46.39	$ 46.39

(1) Points from Table 1 in attachment.
(2) Points from Table 2 in attachment.

Encl 2

Unit Day Method

Table 1: Guidelines for Assigning Points for **General Recreation**

Criteria	Judgment factors				
Recreation experience[1] Total Points: 30 Point Value:	Two general activities[2] 0-4	Several general activities 5-10	Several general activities: one high quality value activity[3] 11-16	Several general activities; more than one high quality high activity 17-23	Numerous high quality value activities; some general activities 24-30
Availability of opportunity[4] Total Points: 18 Point Value:	Several within 1 hr. travel time; a few within 30 min. travel time 0-3	Several within 1 hr. travel time; none within 30 min. travel time 4-6	One or two within 1 hr. travel time; none within 45 min. travel time 7-10	None within 1 hr. travel time 11-14	None within 2 hr. travel time 15-18
Carrying capacity[5] Total Points: 14 Point Value:	Minimum facility for development for public health and safety 0-2	Basic facility to conduct activity(ies) 3-5	Adequate facilities to conduct without deterioration of the resource or activity experience 6-8	Optimum facilities to conduct activity at site potential 9-11	Ultimate facilities to achieve intent of selected alternative 12-14

Attachment 5

Table 1: Guidelines for Assigning Points for **General Recreation** (Continued)

Accessibility Total Points: 18 Point Value:	Limited access by any means to site or within site 0-3	Fair access, poor quality roads to site; limited access within site 4-6	Fair access, fair road to site; fair access, good roads within site 7-10	Good access, good roads to site; fair access, good roads within site 11-14	Good access, high standard road to site; good access within site 15-18
Environmental quality Total Points: 20 Point Value:	Low aesthetic factors[6] that significantly lower quality[7] 0-2	Average aesthetic quality; factors exist that lower quality to minor degree 3-6	Above average aesthetic quality; any limiting factors can be reasonably rectified 7-10	High aesthetic quality; no factors exist that lower quality 11-15	Outstanding aesthetic quality; no factors exist that lower quality 16-20

[1]Value for water-oriented activities should be adjusted if significant seasonal water level changes occur.
[2]General activities include those that are common to the region and that are usually of normal quality. This includes picnicking, camping, hiking, riding, cycling, and fishing and hunting of normal quality.
[3]High quality value activities include those that are not common to the region and/or Nation, and that are usually of high quality.
[4]Likelihood of success at fishing and hunting.
[5]Value should be adjusted for overuse.
[6]Major esthetic qualities to be considered include geology and topography, water, and vegetation.
[7]Factors to be considered to lowering quality include air and water pollution, pests, poor climate, and unsightly adjacent areas.

Attachment 6

U.S. Army Corps
of Engineers
Los Angeles District

Los Angeles River Ecosystem Restoration
Integrated Feasibility Study
Los Angeles County, California

Regional Economic Development (RED) and Other Social Effects (OSE) Analysis

April 2015

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1. INTRODUCTION

The purpose of this attachment to the Economic Appendix is to document the analysis of Regional Economic Development (RED) effects and Other Social Effects (OSE) associated with habitat restoration and compatible recreation features along the Los Angeles River (River) within the City of Los Angeles (City) in Los Angeles County, California.

The principal controlling guidance of the analysis comes from the U.S. Army Corps of Engineers' (USACE) *Engineering Regulation (ER) 1105-2-100, Planning Guidance Notebook,* with specific guidance from Appendix D, Economic and Social Considerations. For study area definition, socioeconomic profile, flood risk considerations, recreation resources, and alternatives analysis documentation, see the Economics Appendix.

2. REGIONAL ECONOMIC DEVELOPMENT

The US Water Resources Council's Principles and Guidelines for Water Resources and Related Land Implementation Studies (P&G), which replace the 1972 "Principles and Standards," direct the studies of major water projects by Federal water resources development agencies. A stated purpose of the P&G is to ensure that the formulation and evaluation of water resource studies are done properly and consistently by federal agencies. The federal objective in project planning is to contribute to national economic development (NED) while protecting the environment. NED contributions are increases in the net values of national goods and services outputs, both marketed and non-marketed. A plan, consistent with federal objectives and which maximizes NED benefits, is the "NED plan."

In addition to NED, the P&G include three other accounts: regional economic development (RED), environmental quality (EQ), and other social effects (OSE). Collectively, the four accounts are required to include all significant effects of a plan on the human environment. The RED account includes the regional incidence of NED effects, income transfers, and employment effects. The EQ account shows the non-quantifiable effects of a plan on ecological, cultural, and aesthetic attributes of significant natural and cultural resources. The OSE account displays the effects of a plan on urban and community settings and on life, health, and safety.

The P&G require only that the NED account be developed for the selection of a plan. However, information on the other three accounts, which may bear significantly on selection of a plan, should be included in the alternative assessment.

The RED account shows the effects of plan alternatives on the distribution of regional economic activity in the area where the plan will have significant income and employment effects. All or most of the NED benefits for a plan will typically accrue to the region, and this is also the case for the current project. Effects outside the study region are categorized as "rest of the United States" impacts. The effects on regional income are the sum of 1) the NED income benefits accrued within the region, and 2) transfers from outside the region. Income transfers comprise income from implementation outlays, transfers of economic activities, and indirect and induced effects. Indirect effects are those that result from the changed outputs of goods and services in industries which help meet changes in final products and export demands. Induced effects result from changes in consumer expenditures stimulated by changes in personal income. The effects of

a plan on regional employment parallel those on regional income. Typically, employment impacts of a plan are developed for individual industries at some level of aggregation in order to discern the distributional impacts on business sectors.

2.1 Relation of the RED Account to Other Accounts

RED impacts include, principally, changes in income and employment. However, the nuances of each of those categories may easily overlap with other accounts defined within the P&Gs. As indicated above, NED impacts are also RED impacts if they occur within the region of interest. However, the NED account is to reflect all effects on the national economy and excludes indirect and induced effects because they represent inter-regional transfers of regional economic activity. Conversely, indirect and induced impacts are shown in the RED account, and differences between it and the NED accounts are therefore accounted for as transfers from or to the rest of the nation.

The RED account may also overlap with the OSE account. The OSE account includes urban and community impacts, in particular those on income, population and employment distribution, fiscal conditions, and displacement of people and businesses and farms. A flood event may have social impacts through reduced property values, contaminated drinking water, and greater exposure to biological toxins. All may have regional impacts as typically defined by the RED account, but many may not be quantifiable and thus be included in the OSE account. Others which are measurable may fit into the OSE account and concurrently be an RED impact. For example, people in flooded areas may be unable to live in their homes or commute to work. The inability to live in their homes is an OSE impact, while the inability to commute to work is also an OSE impact, but with RED implications. In the latter case, the outputs of industries will decline if employees are unable to reach their places of employment.

2.2 Study Area RED Analysis

The study area for the RED analysis is the Los Angeles metropolitan area. The metropolitan area is defined by the Office of Management and Budget as the Los Angeles-Long Beach-Santa Ana metropolitan statistical area (MSA), consisting of Los Angeles and Orange counties. Its land area is 4,850 sq. mi (12,562 km^2). At its core, the MSA has the most densely populated urbanized area (the cities of Los Angeles-Long Beach-Santa Ana) in the United States with a population of 12,828,837 as of the 2010 Census. The Census Bureau, based on commuting patterns, defines the Combined Statistical Area (the MSA plus the counties of Ventura, Riverside, and San Bernardino) as home to 18.2 million people, making it the most populous metropolitan area in the western United States and the largest in area in the United States. If the Greater Los Angeles Combined Statistical Area were counted as a country it would have the 15th largest economy in the world in terms of nominal GDP (Gross Domestic Product), placing it just below Australia and above the Netherlands, Turkey, Sweden, Belgium, and Indonesia.[1]

[1] CIA World Factbook. 2009. GDP (Official Exchange Rate), October, 2009.

2.3 Regional Economic Modeling

Many of the RED effects considered in this report are quantified using regional economic models that are based on the principles of input-output (I-O) analysis. I-O analysis represents a means of measuring the flow of commodities and services among industries, institutions, and final consumers within an economy (or study area). I-O models capture all monetary market transactions in an economy, accounting for inter-industry linkages and availability of regionally-produced goods and services. The resulting mathematical formulae allow I-O models to simulate or predict the economic impacts of a change in one or several economic activities on an entire economy.

I-O analyses use three main metrics to measure economic impacts – industry output, value added, and employment. Industry output refers to the value of goods and services produced in a region. Value added consists of four components – employee compensation, proprietor income, other property income, and indirect business tax. Labor income represents the sum of employee compensation and proprietor income. Lastly, employment is measured by the number of full- and part time jobs. For the purposes of this study, the focus is on value added, which represents regional income, and employment, which is consistent with the guidance on RED analysis presented in the P&Gs.

The primary input variable for I-O analysis is the dollar change in purchases of products or services for final use, the "final demand." Final demand changes drive I-O models. Industries respond to meet demands directly or indirectly by supplying goods and services to meet final demand changes. The primary output variables are predicted changes in direct, indirect, and induced economic output, employment, and income for the affected industries within a study area. Direct economic effects refer to the response of a given industry (i.e., changes in output, income, and employment) based on final demand for that industry. Indirect effects refer to changes in output, income, and employment resulting from the iterations of industries purchasing from other industries caused by the direct economic effects. As an example, ecosystem restoration will purchase plants and trees – a direct effect. But to supply these plants and trees the seller would have purchased seeds, soil, fertilizers, containers and other items from other businesses to produce them – these "backward linkages" effects are indirect. Induced economic effects refer to changes in output, income, and employment caused by the expenditures associated with new household income generated by direct and indirect economic effects. The incomes earned by the workers in the industries supplying the goods and services for the direct and indirect products are then spent in other sectors of the economy – for example, retail stores, restaurants, doctor offices, and entertainment. Figure 2.1 shows additional examples of these linkages.

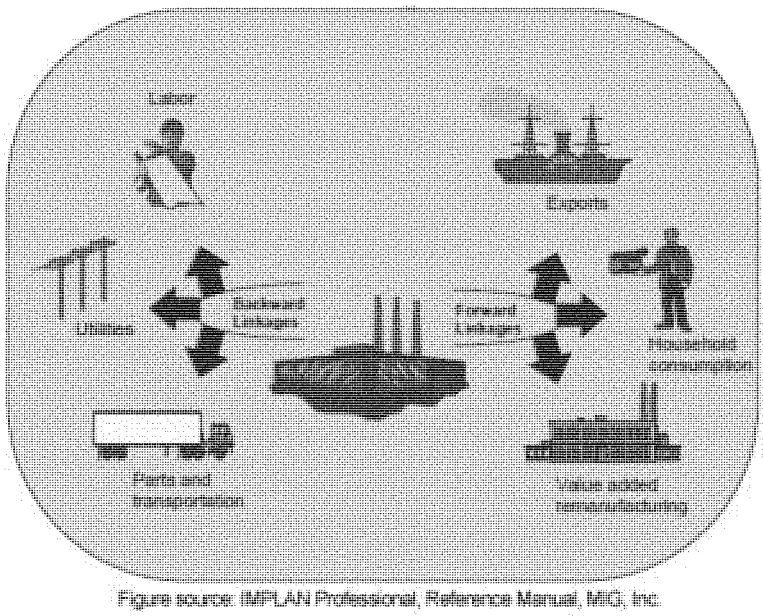

Figure source: IMPLAN Professional, Reference Manual, MIG, Inc.

Figure 2.1 Input-Output Model Linkage Examples

The measurement of direct, indirect, and induced linkages within a regional economy is based on the concept of a multiplier. A multiplier is a single number that quantifies the total economic effect resulting from direct effects. For example, an output multiplier of 1.7 for the planting and forestry sector indicates that every $100,000 of plant sales (the direct output of this industry) supports a total of $170,000 in business sales (like fertilizer, soil, and seeds) throughout the economy (total output of all industries), including the initial $100,000 in plant sales. Several types of multipliers are produced by an I-O model, including output, employment, and income multipliers.

For this study, two I-O models are employed. The first is the Corps RECONS model that is utilized to analyze the economic impacts of project construction expenditures. The Civil Works Regional Economic System (RECONS) Program is a regional economic impact modeling tool that was developed to provide accurate and defendable estimates of regional economic impacts associated with USACE spending. RECONS is the only USACE certified RED model for agency-wide use. This modeling tool automates calculations and generates estimates of jobs and other economic measures such as income and sales associated with USACE's annual Civil Work program spending, as well as that stemming from effects of additional economic activities associated with USACE's core programs (such as water transportation, tourism spending, etc.). RECONS incorporates impact area data, as well as multipliers, direct ratios (jobs to sales, income to sales, etc.), and geographic capture rates that were extracted from the IMPLAN models performed for different USACE projects.

The second model is IMPLAN. IMPLAN (IMpact Analysis for PLANning) is used to estimate regional economic effects of the redevelopment improvements anticipated to occur along the restoration corridor of the project. IMPLAN is a computer-driven system of software and data commonly used to perform economic impact analysis. It was originally developed by the USDA Forest Service (USFS) to assist in land and resource management planning and has been in use since 1979. It is a widely used for economic analyses in Federal, state and local governments, universities, and the private sector. The system is now maintained and marketed by the Minnesota IMPLAN Group, Inc. (MIG), which updates the data annually using information collected at the national, state, county, and local level. The incorporation of IMPLAN to the study is due to RECONS structure being primarily focused on Corps construction projects and isn't as well-suited to measure redevelopment as IMPLAN.

IMPLAN and RECONS are "non-survey" or secondary I-O system, as they do not require primary, survey-based data, which is often difficult and expensive to obtain. National technical relationships among industries form the basis for the model, but are adjustable to account for unique regional conditions. Information on regional economic activity is also incorporated into the models. Changes can be made to data elements to account for regional conditions when better information, such as from primary surveys, is available.

The 2011 IMPLAN dataset was used in the analysis, and no adjustments were made to the regional data or economic model. All input values into IMPLAN were aligned to 2013 dollars employing the 2011 I/O modeling database. The RED analyses are based on the Los Angeles-Long Beach-Santa Ana MSA where impacts are anticipated to occur.

2.4 RED Study Analyses

The RED analysis of the Los Angeles River Ecosystem Restoration Project is divided into three separate levels. The first level is the RED impacts of the construction of the project's alternatives. As noted earlier, this will be accomplished using the Corps' RECONS model. The second level will be redevelopment construction induced by the Corps' ecosystem restoration project. This level of RED benefits will be analyzed using IMPLAN and statistical relationships. The third level will be the analysis of housing and employment generated by the second level's construction. Again, this level will be analyzed using IMPLAN and statistical relationships.

Modeling of the RED impacts of ecosystem restoration expenditures consisted of placement of costs in the standardized account of "*Environment – Construction Activities for Ecosystem*" within the IMPLAN sectors of the RECONS model. The industry sectors considered most appropriate within this account are the following: "*construction of other new nonresidential structures*" and "*support activities for agriculture and forestry*." These contain several related sub-industries within them. Standard default settings for this account were applied for all ecosystem restoration alternatives, which results in a 75/25 percent split between the construction and agriculture/forestry (covering the planting industry) categories, respectively.

2.5 Ecosystem Restoration Alternatives

Brief descriptions of the alternatives under consideration are as follows.

- Alternative 10 – ARBOR Riparian Transitions (ART): The smallest restoration plan focusing on areas upstream and downstream of existing soft-bottomed Glendale Narrows.
- Alternative 13 – ARBOR Corridor Extension (ACE): The plan includes all eight ARBOR reaches, with side channels in key locations and treatments into Downtown LA.
- Alternative 16A – ARBOR Narrows to Downtown (AND): Similar to Alternative 13 the plan includes measures in all eight reaches with channel widening at Verdugo Wash, Arroyo Seco, Cornfield/LA State Historic Park, and LATC.
- Alternative 20A – ARBOR Riparian Integration via Varied Ecological Reintroduction (RIVER): The most extensive plan including measures of Alternative 16 with the addition of marsh creations in the River Glen and Cornfield/LA State Historic Park areas.

The relative contributory acreage provided by these alternatives are indicated in Table 2-1.

Table 2-1 Acreage of Habitat Restoration, by Alternative

Alternative			
10	**13**	**16A**	**20A**
528	588	659	719

Table 2–2 presents costs adjusted to only show first cost without LERRDs. As noted in the table, Alts 16A and 20A contain LERRDs costs for construction of railroad trestles. These are included here because even though they are not cost shared costs, they are an actual construction cost.

Table 2-2 Cost Basis for RED Construction Impacts

	Alt 10	Alt 13	Alt 16A	Alt 20A
Construction	$37,160,342	$82,287,850	$265,844,810	$365,214,471
Mobilization (7.5%)	$2,787,026	$6,171,589	$19,938,361	$27,391,085
Construction First Cost	$39,947,368	$88,459,438	$261,753,170	$363,575,556
Construction Contingency	38.83%	36.01%	37.89%	39.38%
Total Construction Cost	**$55,456,944**	**$120,312,641**	**$360,927,221**	**$506,743,287**
PED/EDC (11%)	$4,394,210	$9,730,538	$31,436,149	$43,186,611
PED/EDC Contingency	24.40%	24.40%	24.40%	24.40%
Total PED/EDC	**$5,466,398**	**$12,104,790**	**$39,106,569**	**$53,724,144**
S&A (6.5%)	$2,596,579	$5,749,864	$18,575,906	$25,519,361
S&A Contingency	26.25%	26.25%	26.25%	26.25%
Total S&A	**$3,278,181**	**$7,259,203**	**$23,452,081**	**$32,218,193**
Total LERRDs*			**$33,134,579**	**$40,461,349**
TOT FIRST COST	**$64,202,000**	**$139,677,000**	**$456,620,000**	**$633,147,000**

**For Alts 16 and 20, LERRDs costs for railroad trestle construction are included. They are included in LERRDs because the cost will not be cost shared, but they do represent a construction cost that should be included in the input to the RED analysis.*

2.5.1 Alternative 10: ARBOR Riparian Transitions (ART)

2.5.1.1 Ecosystem Restoration Project RED Construction Impacts – RECONS

ART's project's construction consists of ecosystem restoration and recreation facilities. Ecosystem restoration construction (excluding LERRDs) is estimated at $64,202,000. Ecosystem restoration construction is estimated to occur over 10 years, an estimate that assumes optimal funding and schedule.

(a) Ecosystem Restoration Construction – RED Impacts

Ecosystem restoration construction is estimated to support overall regional employment of 913 during its development with 529 being directly related to the construction. With the construction period, average annual total employment for ecosystem restoration construction is 1,329. The expenditure to total employment ratio for the project is approximately $48,300 per job or about $121,400 per direct regional employment. Direct regional labor income is estimated at $28,976,000 with total regional labor income at $52,560,000.[2] The results of the RECONS model for ecosystem restoration are displayed in the following tables.

Table 2-3 Project Information

Project Name:	Alternative 10 - ARBOR Riparian Transitions (ART) Construction
Project ID:	3001711
Division:	South Pacific
District:	Los Angeles
Type of Analysis:	Civil Works Budget Analysis
Business Line:	Environmental Stewardship
Work Activity:	Construction Activities for Ecosystem and Habitat Restoration or Improvements

Table 2-4 Economic Impact Regions

Regional Impact Area:	Los Angeles Long Beach Santa Ana CA MSA
Regional Impact Area ID:	24
Counties included	Los Angeles/Orange
State Impact Area:	California
National Impact:	Yes

[2] As discussed above in Section 2.3, *direct* employment/labor income is the first expenditure of money—in the current case that associated with construction and vegetation. These businesses then buy supplies from others, which is *indirect* employment/labor income. Finally, the workers and new employees within both the direct and indirect categories have income changes which they spend, causing induced employment/labor income. The sum of direct, indirect, and induced amounts is the *total* employment/labor income. A higher expenditure to employment ratio (cost per job) is typically the result of only considering the direct category. Both are offered herein.

Table 2-5 Input Assumptions (Spending and LPCs) – Alternative 10: ARBOR Riparian Transitions (ART) Construction

Category	Spending (%)	Spending Amount	Local Purchase Coefficient[3] (LPC) (%)	State LPC (%)	National LPC (%)
Planting and Forestry Activities	25%	$16,050,500	72%	97%	98%
Heavy Construction Activities	75%	$48,151,500	100%	100%	100%
Total[4]	100%	$64,202,000	93%	99%	99%

USACE is planning on expending $64,202,000 on the project. Of this total project expenditure $59,635,000 will be captured within the regional impact area. The rest will be leaked out to the state or the nation. The expenditures made by USACE for various services and products are expected to generate additional economic activity that can be measured in jobs, income, sales and gross regional product as summarized in the following table and includes impacts to the region, the State impact area, and the Nation. Table 2-6 shows the overall economic impacts for this analysis.

Table 2-6 Overall Summary Economic Impacts – Alternative 10: ARBOR Riparian Transitions (ART) Construction

Impact	Impacts Areas	Regional	State	National
Total Spending		$64,202,000	$64,202,000	$64,202,000
Direct Impact				
	Output	$59,635,000	$63,712,000	$63,945,000
	Job	529	625	631
	Labor Income	$28,976,000	$32,199,000	$32,383,000
	GRP	$33,809,000	$36,967,000	$37,148,000
Total Impact				
	Output	$125,936,000	$140,846,000	$184,456,000
	Job	913	1,071	1,329
	Labor Income	$52,560,000	$58,664,000	$71,207,000
	GRP	$73,445,000	$82,032,000	$103,215,000

Table 2-7 reports the total effects over the lifespan of construction. Table 2-7 reports these values on an average annual basis during construction.

[3] Purchase coefficients determine the mix of goods and services purchased with each dollar in their respective sectors at the indicated (local, state, national) level.

[4] Figures represent a weighted average, by industry.

Table 2-7 Overall Economic Impact at Regional Level – Alternative 10: ARBOR Riparian Transitions (ART) Construction

IMPLAN No.	Industry Sector	Sales	Jobs	Labor Income	GRP
	Direct Effects				
19	Support activities for agriculture and forestry	$11,484,000	257	$9,078,000	$8,896,000
36	Construction of other new nonresidential structures	$48,152,000	272	$19,898,000	$24,913,000
	Total Direct Effects	$59,635,000	529	$28,976,000	$33,809,000
	Secondary Effects	$66,301,000	384	$23,584,000	$39,636,000
	Total Effects	$125,936,000	913	$52,560,000	$73,445,000

Table 2-8 Average Annual Economic Impact at Regional Level – Alternative 10: ARBOR Riparian Transitions (ART) Construction

IMPLAN No.	Industry Sector	Sales	Jobs	Labor Income	GRP
	Direct Effects				
19	Support activities for agriculture and forestry	$1,148,400	26	$907,800	$889,600
36	Construction of other new nonresidential structures	$4,815,200	27	$1,989,800	$2,491,300
	Total Direct Effects	$5,963,500	53	$2,897,600	$3,380,900
	Secondary Effects	$6,630,100	38	$2,358,400	$3,963,600
	Total Effects	$12,593,600	91	$5,256,000	$7,344,500

Table 2-9 shows the top ten industries that typically benefit from the types of expenditures made for this project. This analysis was conducted at the national level and thus it cannot be guaranteed that these industries would be present in the regional impact area as analyzed.

Table 2-9 Top Ten Industries Affected by Work Activity– Alternative 10: ARBOR Riparian Transitions (ART) Construction

Rank	Industry	IMPLAN No.	% of Total Employment
1	Construction of other new nonresidential structures	36	34 %
2	Food services and drinking places	413	4 %
3	Architectural, engineering, and related services	369	4 %
4	Real estate establishments	360	2 %
5	Wholesale trade businesses	319	2 %
6	Employment services	382	2 %
7	Offices of physicians, dentists, and other health practitioners	394	1 %
8	Private hospitals	397	1 %
9	Retail Stores - General merchandise	329	1 %
10	Retail Stores - Food and beverage	324	1 %
			53 %

2.5.2 Alternative 13: ARBOR Corridor Extension (ACE)

2.5.2.1 Ecosystem Restoration Project RED Construction Impacts – RECONS

Analysis of Alternative 13 and all others follow the procedures employed for the analysis of Alternative 10. ACE's construction consists of ecosystem restoration and recreation facilities.

Ecosystem restoration construction is estimated at $139,677,000 (excluding LERRD). Construction is assumed to take 10 years for completion.

(a) Ecosystem Restoration Construction – RED Impacts

Ecosystem restoration construction is estimated to support overall regional employment of 1,986 with 1,150 directly related its construction. Again, with a one year construction schedule, average annual regional employment is the same. Overall total employment is estimated at 2,892 with 1,373 being direct employment. The expenditure to total employment ratio for the project is approximately $48,300 per job. At a direct regional employment level this ratio is $121,500-to-1. Direct regional labor income is estimated at $63,040,000 with total regional labor income at $114,350,000. The results of the RECONS model for ecosystem restoration are displayed in the following tables.

Table 2-10 Input Assumptions (Spending and LPCs) – Alternative 13: ARBOR Corridor Extension (ACE) Construction

Category	Spending (%)	Spending Amount	Local LPC (%)	State LPC (%)	National LPC (%)
Planting and Forestry Activities	25%	$34,919,000	72%	97%	98%
Heavy Construction Activities	75%	$104,758,000	100%	100%	100%
Total [5]	100%	$139,677,000	93%	99%	99%

USACE is planning on expending $139,677,000 on the project. Of this total project expenditure $129,741,000 will be captured within the regional impact area. The rest will be leaked out to the state or the nation. The expenditures made by USACE for various services and products are expected to generate additional economic activity in that can be measured in jobs, income, sales and gross regional product as summarized in the following table and includes impacts to the region, the State impact area, and the Nation. Table 2-11 is the overall economic impacts for this analysis.

[5] Figures represent a weighted average, by industry.

Table 2-11 Overall Summary Economic Impacts – Alternative 13: ARBOR Corridor Extension (ACE) Construction

Impact	Impacts Areas	Regional	State	National
Total Spending		$139,677,000	$139,677,000	$139,677,000
Direct Impact				
	Output	$129,741,000	$138,610,000	$139,118,000
	Job	1,150	1,359	1,373
	Labor Income	$63,040,000	$70,051,000	$70,452,000
	GRP	$73,554,000	$80,425,000	$80,818,000
Total Impact				
	Output	$273,986,000	$306,423,000	$401,299,000
	Job	1,986	2,330	2,892
	Labor Income	$114,350,000	$127,629,000	$154,916,000
	GRP	$159,785,000	$178,469,000	$224,553,000

Table 2-12 reports the total effects over the lifespan of construction. On an average annual basis during construction, these effects are estimated in Table 2-13.

Table 2-12 Overall Economic Impact at Regional Level – Alternative 13: ARBOR Corridor Extension (ACE) Construction

IMPLAN No.	Industry Sector	Sales	Jobs	Labor Income	GRP
	Direct Effects				
19	Support activities for agriculture and forestry	$24,983,000	559	$19,750,000	$19,354,000
36	Construction of other new nonresidential structures	$104,758,000	591	$43,290,000	$54,200,000
	Total Direct Effects	$129,741,000	1,150	$63,040,000	$73,554,000
	Secondary Effects	$144,244,000	836	$51,310,000	$86,231,000
	Total Effects	$273,986,000	1,986	$114,350,000	$159,785,000

Table 2-13 Average Annual Economic Impact at Regional Level – Alternative 13: ARBOR Corridor Extension (ACE) Construction

IMPLAN No.	Industry Sector	Sales	Jobs	Labor Income	GRP
	Direct Effects				
19	Support activities for agriculture and forestry	$2,498,300	56	$1,975,000	$1,935,400
36	Construction of other new nonresidential structures	$10,475,800	59	$4,329,000	$5,420,000
	Total Direct Effects	$12,974,100	115	$6,304,000	$7,355,400
	Secondary Effects	$14,424,400	84	$5,131,000	$8,623,100
	Total Effects	$27,398,600	199	$11,435,000	$15,978,500

2.5.3 Alternative 16A: ARBOR Narrows to Downtown (AND)

2.5.3.1 Ecosystem Restoration Project RED Construction Impacts – RECONS

Alternative 16's construction consists of ecosystem restoration and recreation facilities. Ecosystem restoration construction is estimated at $456,620,000. This construction is assumed to take 15 years for completion.

(a) Ecosystem Restoration Construction – RED Impacts

Ecosystem restoration construction is estimated to support overall regional employment of 6,491 during its development. Direct regional construction employment is estimated at 3,759. Overall total employment is estimated at 9,455 with 4,487 being direct. The expenditure to total employment ratio for the project is approximately $48,300 per job and $121,500 at a direct regional job level. A more accurate picture of employment is average annual employment, as a given job may last over several years and is counted each year. Average annual overall regional employment for ecosystem restoration is 2,160 with 1,250 being direct construction employment. Total regional labor income during construction is estimated at $373,823,000 or $124,608,000 per year. The results of the RECONS model for ecosystem restoration are displayed in the following tables.

Table 2-14 Input Assumptions (Spending and LPCs) – Alternative 16A: ARBOR Narrows to Downtown (AND) Constrnction

Category	Spending (%)	Speuding Amount	Local LPC (%)	State LPC (%)	National LPC (%)
Planting and Forestry Activities	25%	$114,155,000	72%	97%	98%
Heavy Construction Activities	75%	$342,465,000	100%	100%	100%
Total[6]	100%	$456,620,000	93%	99%	99%

USACE is planning on expending $456,620,000 on the project. Of this total project expenditure $424,139,000 will be captured within the regional impact area. The rest will be leaked out to the state or the nation. The expenditures made by USACE for various services and products are expected to generate additional economic activity in that can be measured in jobs, income, sales and gross regional product as summarized in the following table and includes impacts to the region, the State impact area, and the Nation. Table 2-15 shows the overall economic impacts for this analysis.

[6] Figures represent a weighted average, by industry.

Table 2-15 Overall Summary Economic Impacts – Alternative 16A: ARBOR Narrows to Downtown (AND) Construction

Impact	Impacts Areas	Regional	State	National
Total Spending		$456,620,000	$456,620,000	$456,620,000
Direct Impact				
	Output	$424,139,000	$453,132,000	$454,793,000
	Job	3,759	4,442	4,487
	Labor Income	$206,085,000	$229,004,000	$230,317,000
	GRP	$240,457,000	$262,918,000	$264,204,000
Total Impact				
	Output	$895,690,000	$1,001,733,000	$1,311,892,000
	Job	6,491	7,616	9,455
	Labor Income	$373,823,000	$417,233,000	$506,438,000
	GRP	$522,357,000	$583,434,000	$734,089,000

Table 2-16 reports the total effects over the lifespan of construction, while Table 2-17 reports the effects on an average annual basis during construction.

Table 2-16 Overall Economic Impact at Regional Level – Alternative 16A: ARBOR Narrows to Downtown (AND) Construction

IMPLAN No.	Industry Sector	Sales	Jobs	Labor Income	GRP
	Direct Effects				
19	Support activities for agriculture and forestry	$81,674,000	1,829	$64,564,000	$63,271,000
36	Construction of other new nonresidential structures	$342,465,000	1,931	$141,521,000	$177,186,000
	Total Direct Effects	$424,139,000	3,759	$206,085,000	$240,457,000
	Secondary Effects	$471,551,000	2,732	$167,738,000	$281,899,000
	Total Effects	$895,690,000	6,491	$373,823,000	$522,357,000

Table 2-17 Average Annual Economic Impact at Regional Level – Alternative 16A: ARBOR Narrows to Downtown (AND) Construction

IMPLAN No.	Industry Sector	Sales	Jobs	Labor Income	GRP
	Direct Effects				
19	Support activities for agriculture and forestry	$5,444,900	122	$4,304,300	$4,218,100
36	Construction of other new nonresidential structures	$22,831,000	129	$9,434,700	$11,812,400
	Total Direct Effects	$28,275,900	251	$13,739,000	$16,030,500
	Secondary Effects	$31,436,700	182	$11,182,500	$18,793,300
	Total Effects	$59,712,700	433	$24,921,500	$34,823,800

2.5.4 Alternative 20A: ARBOR Riparian Integration via Varied Ecological Reintroduction (RIVER)

2.5.4.1 Ecosystem Restoration Project RED Construction Impacts – RECONS

The RIVER's construction consists of ecosystem restoration and recreation facilities. Ecosystem restoration construction is estimated at $633,147,000. Construction is assumed to take 15 years to complete.

(a) Ecosystem Restoration Construction – RED Impacts

Ecosystem restoration construction is estimated to support overall regional employment of 9,001 during its development. Direct regional employment is estimated at 5,213. The cost per total job ratio is approximately $48,300-to-1 or $121,500-to-1 at the direct regional job level. A more accurate picture of employment is average annual employment, as a given job may last over several years and is counted each year. Average annual total regional employment for ecosystem restoration is 3,000. Total regional labor income during the construction period is estimated at $518,341,000 or $172,780,000 per year. The results of the RECONS model for ecosystem restoration are displayed in the following tables.

Table 2-18 Input Assumptions (Spending and LPCs) – Alternative 20A: ARBOR Riparian Integration via Varied Ecological Reintroduction (RIVER) Construction

Category	Spending (%)	Spending Amount	Local LPC (%)	State LPC (%)	National LPC (%)
Planting and Forestry Activities	25%	$158,287,000	72%	97%	98%
Heavy Construction Activities	75%	$474,860,000	100%	100%	100%
Total [7]	100%	$633,147,000	93%	99%	99%

USACE is planning on expending $633,147,000 on the project. Of this total project expenditure $588,108,716 will be captured within the regional impact area. The rest will be leaked out to the state or the nation. The expenditures made by USACE for various services and products are expected to generate additional economic activity in that can be measured in jobs, income, sales and gross regional product as summarized in the following table and includes impacts to the region, the State impact area, and the Nation. Table 2-19 is the overall economic impacts for this analysis.

[7] Figures represent a weighted average, by industry.

Table 2-19 Overall Summary Economic Impacts – Alternative 20A: ARBOR Riparian Integration via Varied Ecological Reintroduction (RIVER) Construction

Impact	Impacts Areas	Regional	State	National
Total Spending		$633,147,000	$633,147,000	$633,147,000
Direct Impact				
	Output	$588,109,000	$628,311,000	$630,613,000
	Job	5,213	6,159	6,222
	Labor Income	$285,756,000	$317,536,000	$319,356,000
	GRP	$333,417,000	$364,561,000	$366,344,000
Total Impact				
	Output	$1,241,959,000	$1,388,997,000	$1,819,063,000
	Job	9,001	10,560	13,110
	Labor Income	$518,341,000	$578,534,000	$702,224,000
	GRP	$724,297,000	$808,987,000	$1,017,884,000

Table 2-20 reports the total effects over the lifespan of construction, while Table 2-21 shows the total effects on an average annual basis during construction.

Table 2-20 Overall Economic Impact at Regional Level – Alternative 20A: ARBOR Riparian Integration via Varied Ecological Reintroduction (RIVER) Construction

IMPLAN No.	Industry Sector	Sales	Jobs	Labor Income	GRP
	Direct Effects				
19	Support activities for agriculture and forestry	$113,248,000	2,535	$89,524,000	$87,731,000
36	Construction of other new nonresidential structures	$474,860,000	2,677	$196,232,000	$245,685,000
	Total Direct Effects	$588,109,000	5,213	$285,756,000	$333,417,000
	Secondary Effects	$653,850,000	3,788	$232,585,000	$390,880,000
	Total Effects	$1,241,959,000	9,001	$518,341,000	$724,297,000

Table 2-21 Average Annual Economic Impact at Regional Level – Alternative 20A: ARBOR Riparian Integration via Varied Ecological Reintroduction (RIVER) Construction

IMPLAN No.	Industry Sector	Sales	Jobs	Labor Income	GRP
	Direct Effects				
19	Support activities for agriculture and forestry	$7,549,900	169	$5,968,300	$5,848,700
36	Construction of other new nonresidential structures	$31,657,300	178	$13,082,100	$16,379,000
	Total Direct Effects	$39,207,300	348	$19,050,400	$22,227,800
	Secondary Effects	$43,590,000	253	$15,505,700	$26,058,700
	Total Effects	$82,797,300	600	$34,556,100	$48,286,500

2.6 Alternatives Summary – RED Benefits of Ecosystem Restoration Construction

Each of the proposed alternatives will produce significant impacts to employment, income and gross regional product (GRP) during their construction periods. Employment gains are estimated to range from 913 to over 9,000 depending upon alternative over their construction lifespans. Incomes derived from construction and its related employment effects would add between $52 million to over $518 million to the regional economy. The regional economy as a whole is anticipated to show growth from $73 million to over $720 million in gross regional product depending upon the alternative. Note that the effects shown are proportional to the size and/or expenditure of the respective alternatives because they share the same RECONS model type and default settings.

Table 2-22 Total Regional Effects of Alternative Construction

	Alt 10: ART	Alt 13: ACE	Alt 16A: AND	Alt 20A: RIVER
Sales	$125,936,000	$273,986,000	$895,690,000	$1,241,959,000
Jobs	913	1,986	6,491	9,001
Labor Income	$52,560,000	$114,350,000	$373,823,000	$518,341,000
GRP	$73,445,000	$159,785,000	$522,357,000	$724,297,000

2.7 Recreation Development

A recreation project has been proposed for the alternatives (see Section 5). The plan complements ecosystem restoration features covering the same geographic extent in all four final alternatives, and as such, the RED impacts of recreation construction do not differ by alternative. The plan is estimated to cost $6,134,000 and will take less than one year to construct. To analyze the regional economic impacts of the plan the Corps' RECONS model was employed. Under RECONS' New Construction in Recreation Areas sector the model estimates 100% of the construction cost will be captured in the local impact area. The overall impacts of recreation construction are as follows.

Table 2-23 Overall Summary Impacts – Recreation Construction

Impact	Impacts Areas	Regional	State	National
Total Spending		$6,134,000	$6,134,000	$6,134,000
Direct Impact				
	Output	$6,134,000	$6,134,000	$6,134,000
	Job	35	35	35
	Labor Income	$2,535,000	$2,535,000	$2,535,000
	GRP	$3,174,000	$3,174,000	$3,174,000
Total Impact				
	Output	$12,958,000	$13,610,000	$17,796,000
	Job	74	78	102
	Labor Income	$4,998,000	$5,139,000	$6,350,000
	GRP	$7,264,000	$7,546,000	$9,592,000

With construction being less than one year, overall regional impacts and annual average regional impacts are the same. The model's estimate of overall regional impacts is as follows.

Table 2-24 Regional/Average Annual Impacts of Recreation Construction

IMPLAN No.	Industry Sector	Sales	Jobs	Labor Income	GRP
	Direct Effects				
36	Construction of other new nonresidential structures	$6,134,000	35	$2,535,000	$3,174,000
	Total Direct Effects	$6,134,000	35	$2,535,000	$3,174,000
	Secondary Effects	$6,824,000	39	$2,463,000	$4,091,000
	Total Effects	$12,958,000	74	$4,998,000	$7,265,000

2.8 RED Benefits From Induced Development

In the preceding sections the analysis focused on what is commonly referred to as backward linkages in I/O modeling terms. A backward linkage is between an industry and its suppliers, or a household and the producers of household goods and services. So for the ecosystem restoration alternatives of the previous sections the analysis focused on their construction demands on their supplying industries and labor market demands. I/O models are well suited to examine these backward linked industry multipliers. However, I/O models are not well-suited to examine what is referred to as forward linkages. A forward linkage is between an industry producing a good or service and the consumers of that good or service. The consumers may be another industry who will add further value to the purchased good in the production of their product. Potential forward linkages to the proposed ecosystem restoration plans are the redevelopment possibilities and economic activity (employment and housing) spurred by the ecosystem restoration in surrounding areas. An important underlying assumption in the analysis is that any existing businesses that are displaced by the redevelopment do so as a result of a free exchange in an open market; that is, conversion of the property would be voluntary due to beneficial economic terms to the existing owner. Thus, the forward linkage in the analysis is for jobs created to supply the projected redevelopment's employment requirements for the workspace created as well as the workforce induced by residential development. This represents new demand that would be generated rather than transferred from another location in the MSA.

To assess how the ecosystem restoration plan could spur economic redevelopment, a qualitative approach utilizing interviews with developers, business groups, and City officials was undertaken. A consistent theme among those interviewed is that the project could alter the development and redevelopment path for the project area. While there is some concern that the project could entice development away from other parts of the city, all agree that the overall net gains would be positive.

The qualitative assessment that the project would be a key environmental and recreational amenity that would positively impact development and property values is also supported and informed by numerous examples and studies of property values and development projects nationwide. One such example is the Rio Salado Ecosystem Restoration Project, the first authorized ecosystem restoration project studied and subsequently constructed by USACE, the City of Phoenix, and the City of Tempe. The project has experienced $500 million dollars in seven square miles of new development since implementation of the restoration project. Another example is the Trinity River Vision Authority's master plan being implemented in Fort Worth to preserve and enhance the river corridor in a multi-purpose context with greenways for

open space, wildlife habitat, trails, neighborhood focal points, and special recreation areas. The Authority reports that developers actively embrace the setting by planning river-centric communities within areas dedicated to flood risk management, ecosystem restoration, and urban revitalization. A significant project partner in the Trinity River Vision is USACE. Further, in a study carried out by Indiana University's Eppley Institute as reported by the Trust for Public Land, 66 percent of property owners living near a former railroad line that was converted into a park for bicycling, skating, and walking felt that it increased the resale value of their property, while only 5 percent felt the opposite....and 64 percent felt the trail made their property easier to sell while 10 percent felt the opposite.

The primary challenge for the project is to maintain a consistent vision for development standards while taking into account changes in the real estate market and the political environment. Cooperation among developers, public officials, business, and community groups will be required which has already been demonstrated considering the representatives currently involved in the project. Officials with the City believe the project itself, along with the associated infrastructure, should provide sufficient incentive to attract the expected commercial, residential, and mixed-use development. Further, redevelopment is assumed to occur in a free market setting. Current owners will freely exchange property rights with developers if the economics of the offers make business sense. Existing vacancy rates in retail, office and industrial locations suggest current businesses, if they desired, could relocate to new locations making business redevelopment and its employment a total RED gain to the economy.

2.8.1 Redevelopment Projections

Redevelopment projections for this study were developed through discussions with the City of Los Angeles staff and the Los Angeles Economic Development Corporation with consideration to the Los Angeles River Revitalization Master Plan (City of Los Angeles 2007a). The Revitalization Master Plan provides both a long-term vision and implementation guidance for revitalizing the River, and as such is referenced in the Water Resources Development Act of 2007 as a source of information with which to help accomplish the current study.[8] Although the Revitalization Master Plan is more extensive than the current study's alternatives, each of the alternatives is consistent with the river changes evaluated in the Revitalization Master Plan. This consistency allows the detailed work of the Master Plan—developed through redevelopment experts, City personnel, and the public—to be a basis of extrapolation for the alternatives.

2.8.1.1 Revitalization Master Plan: Context

The Los Angeles River Revitalization Master Plan identified 20 Opportunity Areas having revitalization potential, as seen in Figure 2.2. Five areas (highlighted in red in the figure) were identified for their considerable potential in demonstrating revitalization and redevelopment. The

[8] Section 4018 of the Water Resources Development Act of 2007, PL 110-114 includes the following language: "prepare a feasibility study...that is consistent with the goals of the Los Angeles River Revitalization Master Plan published by the [C]ity of Los Angeles," and "[i]n preparing the study... use, to the maximum extent practicable...information obtained from the Los Angeles River Revitalization Master Plan."

Canoga Park and Downtown Industrial areas are outside the current study area and are not addressed in this report.

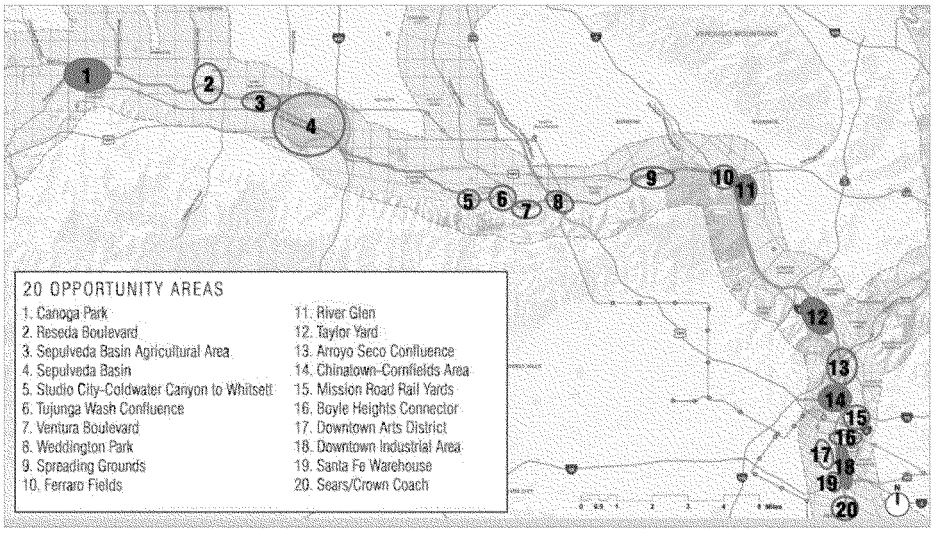

Figure 2.2 Los Angeles River Opportunity Areas

Two areas of the Master Plan, River Glen (area at the confluence with Verdugo Wash) and Chinatown-Cornfields, are of redevelopment interest to this study. Each of these areas consists of older commercial and light industrial buildings, with some public housing within the Chinatown-Cornfields area. The older building stock along with the sites' locations—especially the Chinatown-Cornfields' proximity to downtown and adjacent transportation facilities—are identified by the City as prime redevelopment opportunities for the City's long-term development. Within the Chinatown-Cornfields Opportunity Area, the Revitalization Master Plan projects redevelopment of nearly 5,000 residential units with 1 million square feet of retail & manufacturing and 1.6 million square feet of office space. The projection for the River Glen Opportunity Area is for 600,000 square feet of office/industrial space.

The City's desire and commitment to this redevelopment program is reflected by the creation of the Cornfield Arroyo Seco Specific Plan (CASP)[9] currently under consideration. The CASP was a direct outgrowth of the Revitalization Master Plan and focuses on river and community changes in its place-making recommendations. The Specific Plan calls for rezoning of industrial property for mixed-uses, and the establishment of additional design guidelines to ensure that economic and community development strategies are mutually complementary. The CASP

[9] Cornfield Arroyo Seco Specific Plan, Draft, 2012. City of Los Angeles, Planning Department, August 6, 2012.

boundary includes the Los Angeles River from the confluence with the Arroyo Seco downstream to the Cornfields.

Further, the projected increases in residential development are well-below the expected demand: The maximum residential redevelopment projection within the ARBOR study area represents approximately 900 housing units. The California Department of Finance estimates the population of Los Angeles County to increase by 1.8 million from 2010 to 2060. With a per-household occupancy rate of nearly 3, this population growth would require over 600,000 housing units. The potential for displacement of other development, given the small number of redevelopment in comparison to the overall county requirement, is minimal. Similarly, redevelopment's non-residential estimate is also minimal to the future demand of the county. In comparison to the projected demands of the Revitalization Master Plan the estimated demands are between 20 to 30 percent at the maximum level. Note that these percentages were developed by the study team as reasonable factors, based upon available information, for developing a general estimate of potential redevelopment RED benefits associated with project alternatives.

2.8.1.2 Revitalization Master Plan: Methodology

The economic analysis used in the Revitalization Master Plan was based on projected urban development within each of the Opportunity Areas that would occur as a consequence of river revitalization. This included estimates of new housing units, businesses, and manufacturing areas as an outgrowth of changes in the River. The methodology used included:

Under the without-project condition, the redevelopment areas are expected to exist without much improvement, as they have for decades. Past improvements have mostly been limited to replacement of physically obsolete or damaged structures. Therefore, in the without-project condition, it is expected that over the next several decades a limited number of random structures would be redeveloped in the absence of the project, but that this redevelopment would not significantly alter the evaluation below. It is the proposed project in conjunction with the City's Revitalization Master Plan that provides the backbone for any significant redevelopment efforts in these areas.

The analysis was conducted by several urban development professionals on the Revitalization Master Plan team which included City staff from the Bureau of Engineering and the Planning Department, with input from the Los Angeles Economic Development Corporation. The analysis considered the types of uses, densities, and mix of building types that the market would support. Improvements that were considered as stimuli to economic development included the proposed restoration of the River, associated parks and connections, green streets, and transit improvements. Urban design considerations suggested that neighborhoods would have more mixed uses, be better connected, and be more active and walkable than current conditions. It is important to note that the projected development within the Opportunity Areas is hypothetical and intended to demonstrate only that if economic development is pursued, then new jobs, housing production, new businesses, and tax revenues might result. Any actual agenda for economic development in these Areas is expected to come from a combination of community planning and private initiatives in response to River restoration.

Taking the Chinatown-Cornfields Opportunity Area as an example: The development program was based on a new recreational riverfront anchored by the changes in the River as both an inducement and component to redevelopment. The riverfront village concept was that Main Street would once again become an important mixed-use walking street, with arterials in the area becoming entertainment and shopping destinations with a substantial mix of office and residential uses in dense buildings and towers at key locations, especially along the new riverfront and the habitat and park facilities in the Los Angeles State Historic Park. A destination riverfront with retail and restaurants, cafes, hotels, and opportunities for the arts could emerge. This new destination would likely cause substantial redevelopment connecting the area continuously from the River to Chinatown.

Projections of potential new or redeveloped areas include specific land use quantities for residential units, retail areas, office space, and manufacturing. From this number, the team worked with the Los Angeles Economic Development Corporation and used its own experience on similar projects to develop formulas for estimating the number of jobs, wage-levels, and tax revenues that could result from the specific densities and uses prescribed for each alternative in the Revitalization Master Plan. Table 2-25 displays the results from the Revitalization Master Plan for the two Opportunity Areas, with each Opportunity Area having a higher and lower level estimate of potential development.

Table 2-25 Potential Development Program as Evaluated in the Revitalization Master Plan

Opportunity Area	Residential (units)	Retail (ft^2)	Office (ft^2)	Manufacturing (ft^2)
Chinatown/Cornfields "higher range"	4,665	871,402	1,477,144	241,648
Chinatown/Cornfields "lower range"	3,041	589,584	1,616,073	147,270
River Glen "higher range"	1,085	--	150,742	450,830
River Glen "lower range"	--	--	--	349,207

In examining restoration as an attribute for the current study, the alternatives were examined with respect to the Revitalization Master Plan to compare their potential development to that programmed within the Revitalization Master Plan. None of the restoration alternatives within the current feasibility study are as extensive nor have as widespread channel changes as the River Glen or Chinatown areas depicted in the Revitalization Master Plan. Therefore, discussions with members of the Project Delivery Team took place to reflect a more conservative approach compared to the economic analysis programmed in the Revitalization Master Plan. Factors considered were as follows:

- The channel restoration herein is less extensive than the Revitalization Master Plan, which envisioned a wider channel less constrained by rights-of-way. More rights-of-way allowed additional features such as gateways, promenades, paseos, and other revitalization components to be programmed in the Master Plan. However, these features would not provide incremental habitat benefits and are therefore not part of a Federal project. Even though the City is anticipating these features in the future following the restoration of the River, a more conservative approach is taken when programming future redevelopment in the current RED analysis.

- The River Glen area would likely remain with industrial land uses mixed with commercial land uses, such as found within an industrial park. The effect of a restored river would therefore have a smaller impact on RED benefits compared to the Chinatown-Cornfields area, the latter of which is anticipated to have a larger shopping/entertainment presence. Still, the value of open space is already demonstrated in the River Glen area by some of the businesses that have created "aesthetic space" for their employees. Since the area is expected to continue to evolve into higher density/higher tech uses consolidated closer to San Fernando Road, the amenities of adjacent habitat, open space, and trails are expected to attract higher-skilled employees seeking higher wages, thereby providing higher value associated with the alternatives.

- Ecosystem restoration within the Los Angeles River is only one component of neighborhood revitalization albeit a critical anchor feature around which redevelopment is expected to occur. As shown by other river restoration projects referenced herein, restoration would make a meaningful difference to the region and help leverage overall revitalization within the ARBOR. However, to reflect a conservative approach and the uncertainty of a cause-effect relationship, the development programmed within the Revitalization Master Plan was scaled downward for the RED analysis.

The resulting estimate as described below is that restoration in the River Glen area is projected to influence 10 to 15 percent of the development projected within the Revitalization Master Plan, and 20 to 30 percent of the development projected in the Revitalization Master Plan for the Chinatown-Cornfields area.

2.8.2 River Glen Opportunity Area – Redevelopment Construction

River Glen (Figure 2.3) is characterized by industrial, biomedical, and film/studio-related land uses. Once an area occupied by low-rent businesses, it now is poised to become the premier eco-industrial park in the City.

The River Glen area is approximately 150 acres. It includes three distinct sub-areas that can be defined, based on the quality of building stock and stability of current land use. The most stable of the areas is between Colorado Street and one half-block south of Brazil Street, and is occupied by large employers, such as Baxter, Huntsman Advanced Materials Americas Inc., Quixote Studios, and Kaiser Permanente, which are viewed as long-term and stable job creators for the area.

The second area, between Brazil Street and one-half block south of Doran Street, contains land uses comprising light-industrial and warehouse-type facilities including a vacated Levitz Furniture building, a used car dealership, and the Priority Pak Shipping Facility. Within this area, the dominant pattern is consolidation of multiple parcels into single ownership, resulting in large-format warehouse buildings that wall off the River on its eastern edge.
The third and most susceptible area of potential change is the area's northern boundary, which includes an assortment of metal and paper recycling facilities, and a California Department of Transportation maintenance facility located directly below Interstate 134.

Figure 2.3 River Glen Opportunity Area

Seventy percent of the River Glen area is considered as having redevelopment potential. This area is currently zoned for industrial uses, which could either be modified or maintained with higher density/smaller footprint uses, as mentioned above. Either way, the City recognizes that the area is isolated by aging infrastructure and access, and has underutilized potential for green space and habitat. This provides the impetus for riverly redevelopment at the confluence anchored by a proposed project.

Under Alternative 10 (ART) minor restoration activities take place in the area and as such no change is anticipated to the area's existing development process. The restoration plans of Alternatives 13 (ACE) and 16 (AND) are the same for the River Glen area, with both proposing modest restoration changes to the channel bank. The plan for Alternative 20 (RIVER) proposes the acquisition of recycling yards at the north end of the area to allow for dramatic expansion and greening of the confluence of Verdugo Wash with the River along with the channel bank improvements. This alternative would promote redevelopment of industrial uses within River Glen to a much larger extent.

It is estimated that up to 300,000 square feet of light manufacturing redevelopment in response to restoration may occur during the period of analysis, depending upon alternative–about 5 percent of the total 6.5 million square feet available. In comparison to the LA River Revitalization Plan, the maximum redevelopment is less than 15 percent of the Plan's. This potential redevelopment has a value of $24 million based on a Marshall & Swift construction value of $80 per square foot. The potential for redevelopment by alternative is estimated in Table 2-26.

Table 2-26 River Glen Redevelopment Construction

Alternative	Manufacturing Square Feet	Value
Alt 10: ART	0	$0
Alt 13: ACE	50,000	$4,000,000
Alt 16A: AND	50,000	$4,000,000
Alt 20A: RIVER	300,000	$24,000,000

RED impacts for River Glen redevelopment by alternative as estimated by IMPLAN for the Los Angeles-Orange Counties area are presented below. Total cumulative employment impacts, direct, indirect and induced, over the 50-year redevelopment period are estimated in Table 2-27.

For these alternatives, the investment to total job ratio is approximately $73,000-to-1 and $120,000-to-1 at a direct job ratio. Assuming equal development for each year, annual employment impacts are shown in Table 2-28.

Overall industry and summary cumulative impacts for River Glen redevelopment are shown in Table 2-29. Impacts on an annual basis, assuming a constant annual expenditure during the redevelopment period, are shown in Table 2-30.

Table 2-27 River Glen Redevelopment Construction Employment Impacts by Alternative

Alternative 13: ACE				
Industry	**Direct**	**Indirect**	**Induced**	**Total**
Total	33.2	5.5	15.7	54.5
Agriculture	0.0	0.0	0.0	0.0
Mining	0.0	0.0	0.0	0.0
Construction	33.2	0.1	0.1	33.4
Manufacturing	0.0	0.8	0.3	1.1
TIPU	0.0	0.2	0.5	0.7
Trade	0.0	0.5	3.3	3.8
Service	0.0	3.9	11.4	15.3
Government	0.0	0.0	0.1	0.2

Alternative 16A: AND				
Industry	**Direct**	**Indirect**	**Induced**	**Total**
Total	33.2	5.5	15.7	54.5
Agriculture	0.0	0.0	0.0	0.0
Mining	0.0	0.0	0.0	0.0
Construction	33.2	0.1	0.1	33.4
Manufacturing	0.0	0.8	0.3	1.1
TIPU	0.0	0.2	0.5	0.7
Trade	0.0	0.5	3.3	3.8
Service	0.0	3.9	11.4	15.3
Government	0.0	0.0	0.1	0.2

Alternative 20A: RIVER				
Industry	**Direct**	**Indirect**	**Induced**	**Total**
Total	199.4	33.1	94.2	326.7
Agriculture	0.0	0.0	0.1	0.1
Mining	0.0	0.1	0.1	0.2
Construction	199.4	0.4	0.8	200.6
Manufacturing	0.0	4.6	1.7	6.3
TIPU	0.0	1.4	2.8	4.2
Trade	0.0	2.7	19.9	22.6
Service	0.0	23.5	68.2	91.7
Government	0.0	0.2	0.9	1.1

Table 2-28 River Glen Redevelopment Construction Average Annual Employment Impacts

Alternative	**Direct**	**Indirect**	**Induced**	**Total**
Alt 13: ACE	0.7	0.1	0.3	1.1
Alt 16A: AND	0.7	0.1	0.3	1.1
Alt20A: RIVER	4.0	0.7	1.9	6.5

Table 2-29 River Glen Redevelopment Construction Overall Impacts by Alternative

Alternative 13: ACE				
Impact Type	**Employment**	**Labor Income**	**Value Added[10]**	**Output[11]**
Direct Effect	33.2	$2,464,000	$2,610,000	$4,000,000
Indirect Effect	5.5	$396,000	$597,000	$1,056,000
Induced Effect	15.7	$824,000	$1,452,000	$2,317,000
Total Effect	54.5	$3,684,000	$4,659,000	$7,373,000
Alternative 16A: AND				
Direct Effect	33.2	$2,464,000	$2,610,000	$4,000,000
Indirect Effect	5.5	$396,000	$597,000	$1,056,000
Induced Effect	15.7	$824,000	$1,452,000	$2,317,000
Total Effect	54.5	$3,684,000	$4,659,000	$7,373,000
Alternative 20A: RIVER				
Direct Effect	199.4	$14,785,000	$15,662,000	$24,000,000
Indirect Effect	33.1	$2,375,000	$3,580,000	$6,336,000
Induced Effect	94.2	$4,943,000	$8,709,000	$13,903,000
Total Effect	326.7	$22,103,000	$27,952,000	$44,240,000

RED impacts on an annual basis assuming a constant annual expenditure during the redevelopment period are:

Table 2-30 River Glen Redevelopment Construction Average Annual Impacts Summary by Alternative

Alternative 13: ACE				
Impact Type	**Employment**	**Labor Income**	**Value Added**	**Output**
Direct Effect	0.7	$49,283	$52,208	$80,000
Indirect Effect	0.1	$7,916	$11,934	$21,122
Induced Effect	0.3	$16,477	$29,031	$46,344
Total Effect	1.1	$73,677	$93,173	$147,466
Alternative 16A: AND				
Direct Effect	0.7	$49,283	$52,208	$80,000
Indirect Effect	0.1	$7,916	$11,934	$21,122
Induced Effect	0.3	$16,477	$29,031	$46,344
Total Effect	1.1	$73,677	$93,173	$147,466
Alternative 20A: RIVER				
Direct Effect	4.0	$295,700	$313,246	$480,000
Indirect Effect	0.7	$47,498	$71,604	$126,730
Induced Effect	1.9	$98,862	$174,187	$278,067
Total Effect	6.5	$442,060	$559,038	$884,797

[10] IMPLAN's Value Added is equivalent to RECON's Gross Regional Product (GRP)

[11] IMPLAN's Output is equivalent to RECON's Sales

2.8.2.1 River Glen Redevelopment State and Local Tax Impacts

The previous section discussed the employment, income, and sales gains projected with redevelopment. In addition to these gains, redevelopment construction will generate new state and local taxes since taxes would be paid on these income and sale gains. Over the entire redevelopment period, these taxes are shown in Table 2-31 and Table 2-32 for the three alternatives, according to the IMPLAN model.

Table 2-31 River Glen Redevelopment Construction State & Local Taxes Impacts Alternatives 13-ACE and 16A-AND

Description	Employee Compensation	Proprietor Income	Indirect Business Tax	Households	Corporations
Dividends					
Social Ins Tax- Employee Contribution	$4,000				
Social Ins Tax- Employer Contribution	$6,000				
Indirect Bus Tax: Sales Tax			$74,000		
Indirect Bus Tax: Property Tax			$79,000		
Indirect Bus Tax: Motor Vehicle Lic			$2,000		
Indirect Bus Tax: Severance Tax					
Indirect Bus Tax: Other Taxes			$13,000		
Indirect Bus Tax: S/L NonTaxes			$6,000		
Corporate Profits Tax					$12,000
Personal Tax: Income Tax				$101,000	
Personal Tax: NonTaxes (Fines- Fees				$24,000	
Personal Tax: Motor Vehicle License				$4,000	
Personal Tax: Property Taxes				$2,000	
Personal Tax: Other Tax (Fish/Hunt)				$1,000	
Total State and Local Tax	$10,000		$174,000	$132,000	$12,000

Table 2-32 River Glen Redevelopment Construction State & Local Taxes Impacts Alternative 20A-RIVER

Description	Employee Compensation	Proprietor Income	Indirect Business Tax	Households	Corporations
Dividends					$3,000
Social Ins Tax- Employee Contribution	$22,000				
Social Ins Tax- Employer Contribution	$39,000				
Indirect Bus Tax: Sales Tax			$446,000		
Indirect Bus Tax: Property Tax			$471,000		
Indirect Bus Tax: Motor Vehicle Lic			$10,000		
Indirect Bus Tax: Severance Tax					
Indirect Bus Tax: Other Taxes			$80,000		
Indirect Bus Tax: S/L NonTaxes			$39,000		
Corporate Profits Tax					$72,000
Personal Tax: Income Tax				$604,000	
Personal Tax: NonTaxes (Fines- Fees				$147,000	
Personal Tax: Motor Vehicle License				$27,000	
Personal Tax: Property Taxes				$11,000	
Personal Tax: Other Tax (Fish/Hunt)				$6,000	
Total State and Local Tax	$61,000		$1,046,000	$794,000	$75,000

2.8.3 River Glen Opportunity Area – Long-Term Redevelopment Impacts

The preceding section examined the construction activities of potential redevelopment, but construction is only the initial impact of redevelopment. It follows that the building of retail, office, or industrial facilities is in anticipation of employment within these facilities. Employment in these facilities will produce long-term impacts in the area through the wages employees receive. The following sections will analyze the potential long-term impacts on jobs, wages, and taxes that redevelopment may create.

2.8.3.1 Long-Term Employment, Wages, and Taxes – River Glen Opportunity Area

Each of the alternatives is anticipated to create manufacturing floor space. In a study for the Southern California Association of Governments it is estimated that the average square feet per employee in this sector ranges from 829 to 1,796.[12] For this employment analysis it is assumed that light manufacturing requires 1,000 sq. ft. per employee and that a 5 percent vacancy rate

[12] The Natelson Company, Inc. 2001. Employment Density Study – Summary Report. Prepared for the Southern California Association of Governments.

exists in manufacturing.[13] Like the ground space development, employment growth follows a similar straight-line approach over the 50-year analysis period. The Bureau of Labor Statistics (BLS) reports the average weekly wage rate for manufacturing in Los Angeles County at $1,067 or $55,484 per year.[14] Employment and wage results are shown in the following table.

Table 2-33 River Glen Long-Term Employment & Wages

Alternative	Total Employment	Average Annual Employment	Total of all Wages	Average Annual Wages	NPV of all Wages
Alternative 13: ACE	47.5	24.2	$67,205,000	$1,344,000	$21,562,000
Alternative 16: AND	47.5	24.2	$67,205,000	$1,344,000	$21,562,000
Alternative 20: RIVER	285.0	145.4	$403,230,000	$8,065,000	$129,375,000

The sales tax rate for Los Angeles County and the City of Los Angeles is 9 percent. Of this tax rate, 6.5 percent goes to the State and the remaining 2.5 percent is returned to the county and city. Sales taxes generated from employment, assuming 24 percent of wages are taxable expenditures, are:[15]

Table 2-34 River Glen Long-Term Sales Tax Revenues

	Cumulative			
Alternative	Sales Tax: State	Sales Tax: Local	Average Annual: Local	NPV: Local
Alternative 13: ACE	$1,048,000	$403,000	$8,000	$129,000
Alternative 16A: AND	$1,048,000	$403,000	$8,000	$129,000
Alternative 20A: RIVER	$6,290,000	$2,419,000	$48,000	$776,000

2.8.4 Taylor Yard Opportunity Area

The Taylor Yard opportunity area (Figure 2.4) is within the Elysian Valley and bordered on the northeast by San Fernando Road and southwest by the River and extends from near Arroyo Seco to Fletcher Drive. The area includes the Rio del Los Angeles State Park but along the east side of the river there are many industrial parcels and both freight and Metrolink Railroad tracks and large industrial parcels. The Elysian Valley residential community on the west side is connected to the River with most east/west streets terminating at the River.

An RED analysis was not conducted for this Opportunity Area. The Los Angeles River Revitalization Master Plan states:

The Taylor Yard Opportunity Area demonstrates a significant opportunity for ecosystem restoration on a large scale. Because stakeholders and many community members expressed that this area is inappropriate for more intensive development, and active open space is being incorporated into the Rio de Los Angeles State Park to the east, this Opportunity Area was

[13] Colliers International. 2012. Central Los Angeles Market Report: Industrial. 2nd Quarter.

[14] Bureau of Labor Statistics. 2013. County Employment and Wages – Second Quarter 2012. January 8, 2013. USDL-13-0013.

[15] City of Los Angeles, Department of Public Works. 2007. *Los Angeles River Revitalization Master Plan.* 284 pp.

selected to illustrate the potential for restoration of the River's hydro-ecological functions, and as a showcase for removing the concrete channel walls.

Figure 2.4 Taylor Yard Opportunity Area

The community's desire to keep this area from development is one of the reasons that an analysis was not conducted to evaluate the value of future development. Another reason is that the area of proposed restoration is approximately 1,000 feet away from the main thoroughfare where redevelopment potential exists, with an existing, newly created natural area, park, and school in between that area and the proposed habitat area. Any redevelopment related to the proposed habitat restoration—in light of the just-stated, existing facilities at Taylor Yard—would have an indeterminate cause/effect because the surrounding land uses are already benefiting from some of the adjacent open space and aesthetic amenities. However, even though the evaluation was not conducted, it should still be recognized that the proposed restoration is expected to provide positive benefits. These include increased real estate values, the improved desirability of the neighborhood, and greater redevelopment potential due to the enhanced environment and proximity to additional green space and recreation.

2.8.5 Chinatown–Cornfields Opportunity Area

The Chinatown-Cornfields Opportunity Area (Figure 2.5) boasts grand views of Downtown and the River from its historic bridges. The area is completely cut off from the River because of existing heavy rail lines. The Department of Water and Power facility and the William Mead housing development combine to make up about 40 percent of the entire Opportunity Area of

approximately 210 acres. The remaining 60 percent is composed of a series of light industrial and manufacturing facilities, commercial food warehousing and distribution facilities, and large-vehicle parking lots. Existing building character generally varies from block to block, with small pockets of historically significant and aesthetically beautiful structures interspersed throughout the area. At the area's western edge is the Los Angeles State Historic Park (LASHP); which will provide a catalyst for transforming development along its edge.

Any of the proposed restoration plans in combination with LASHP, Metro Link's Gold Line and its 1.5 mile proximity to the heart of downtown Los Angeles will bring a catalyst of change to this often overlooked area. Redevelopment within this area will certainly occur with the proposed restoration and recreation features of the plan.

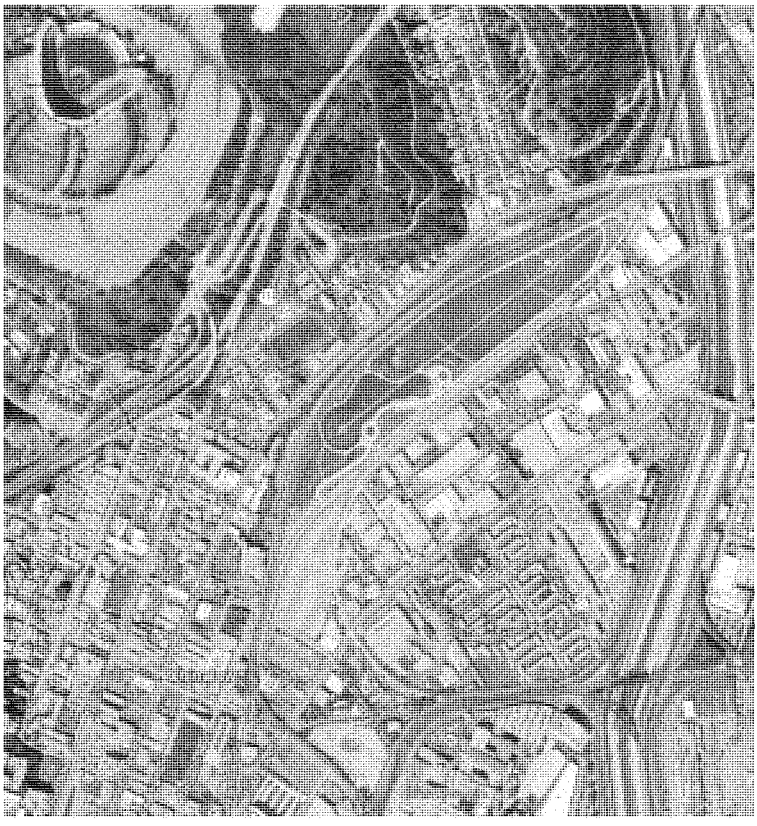

Figure 2.5 Chinatown – Cornfields Opportunity Area

Redevelopment in the Chinatown-Cornfields area will require substantial rezoning of industrial property for mixed-uses, and the establishment of additional design guidelines through the River Improvement Overlay or a Specific Plan to fully garner the benefits of the restoration and

recreation plan. The potential range in redevelopment by alternative is shown in Table 2-35. Ecosystem system restoration plans for 10-ART, 13-ACE, and 16-AND are essentially the same – modest restoration along the river's bank. Thus, redevelopment is estimated at the same level for these plans. For the 20-RIVER plan, restoration increases occur not only along the river's edge but also include the development of a marsh area in the northern area of the site. Redevelopment for the RIVER is estimated to be more extensive than the others for these reasons.

Table 2-35 Chinatown-Cornfields Redevelopment Construction Potential

Chinatown-Cornfields Potential Redevelopment Alternative 10: ART	
Redevelopment Use	**Square Feet (in thousands)**
Residential	281,250
Retail	44,250
Office	111,000
Manufacturing	44,100
Chinatown-Cornfields Potential Redevelopment Alternative 13: ACE	
Residential	281,250
Retail	44,250
Office	111,000
Manufacturing	44,100
Chinatown-Cornfields Potential Redevelopment Alternative 16A: AND	
Residential	281,250
Retail	44,250
Office	111,000
Manufacturing	44,100
Chinatown-Cornfields Potential Redevelopment Alternative 20A: RIVER	
Residential	1,125,000
Retail	177,000
Office	444,000
Manufacturing	44,100

Square footage Marshall & Swift construction estimates are $165/retail, $230/residential, $235/office, and $80/manufacturing. Potential redevelopment values by alternative are indicated in Table 2-36.

Table 2-36 Chinatown-Cornfields Redevelopment Construction Values

Chinatown-Cornfields Redevelopment Valuation Alternative 10: ART	
Redevelopment Use	**Value**
Residential	$64,688,000
Retail	$7,301,000
Office	$26,085,000
Manufacturing	$3,528,000
Total	$101,602,000
Chinatown-Cornfields Redevelopment Valuation Alternative 13: ACE	
Residential	$64,688,000
Retail	$7,301,000
Office	$26,085,000
Manufacturing	$3,528,000
Total	$101,602,000
Chinatown-Cornfields Redevelopment Valuation Alternative 16A: AND	
Residential	$64,688,000
Retail	$7,301,000
Office	$26,085,000
Manufacturing	$3,528,000
Total	$101,602,000
Chinatown-Cornfields Redevelopment Valuation Alternative 20A: RIVER	
Residential	$258,750,000
Retail	$29,205,000
Office	$104,340,000
Manufacturing	$3,528,000
Total	$395,823,000

RED impacts for Chinatown-Cornfields redevelopment by alternative as estimated by IMPLAN for the Los Angeles-Orange Counties area are presented in Table 2-37, which shows total cumulative employment impacts, direct, indirect and induced, over the 50-year redevelopment period.

Table 2-37 Chinatown-Cornfields Redevelopment Construction Cumulative Employment Impacts

Alternatives 10, 13, & 16A				
Industry	**Direct**	**Indirect**	**Induced**	**Total**
Total	675.7	205.4	345.0	1,226.1
Agriculture	0.0	0.1	0.2	0.3
Mining	0.0	1.2	0.2	1.5
Construction	675.7	2.1	2.7	680.5
Manufacturing	0.0	23.1	6.1	29.2
TIPU	0.0	12.7	10.1	22.8
Trade	0.0	63.3	72.8	136.1
Service	0.0	101.7	249.5	351.3
Government	0.0	1.2	3.3	4.4

Alternative 20A				
Industry	**Direct**	**Indirect**	**Induced**	**Total**
Total	2,615.0	807.0	1,338.5	4,760.4
Agriculture	0.0	0.5	0.8	1.3
Mining	0.0	4.8	0.9	5.7
Construction	2,615.0	8.0	10.7	2,633.7
Manufacturing	0.0	90.5	23.6	114.0
TIPU	0.0	50.2	39.3	89.5
Trade	0.0	252.0	282.4	534.4
Service	0.0	396.5	968.1	1,364.6
Government	0.0	4.5	12.7	17.2

The investment to total job ratio for ART, ACE, and AND is approximately $83,000-to-1 and $150,000-to-1 on a direct employment basis. The ratios for the RIVER plan are approximately the same. Annual employment impacts are shown in Table 2-38, which assumes equal development during each year.

Table 2-38 Chinatown-Cornfields Redevelopment Construction Average Annual Employment Impacts

Alternative	**Direct**	**Indirect**	**Induced**	**Total**
Alternatives 10, 13, & 16	13.5	4.1	6.9	24.5
Alternative 20	52.3	16.1	26.8	95.2

The overall industry and summary cumulative impacts for the Chinatown-Cornfields area, as estimated by IMPLAN are presented in Table 2-39.

Table 2-39 Chinatown-Cornfields Redevelopment Construction Cumulative Economic Impacts by Alternative

Overall Impact Summary – Alternatives 10, 13, & 16A				
Impact Type	**Employment**	**Labor Income**	**Value Added**	**Output**
Direct Effect	675.7	$50,265,000	$60,207,000	$101,602,000
Indirect Effect	205.4	$12,622,000	$19,046,000	$33,136,000
Induced Effect	345.0	$18,094,000	$31,879,000	$50,891,000
Total Effect	1,226.1	$80,981,000	$111,132,000	$185,629,000
Overall Impact Summary – Alternative 20A				
Direct Effect	2,615.0	$194,539,000	$233,920,000	$395,823,000
Indirect Effect	807.0	$49,439,000	$74,607,000	$129,749,000
Induced Effect	1,338.5	$70,197,000	$123,674,000	$197,434,000
Total Effect	4,760.4	$314,175,000	$432,201,000	$723,007,000

The impacts on an average annual basis are shown in Table 2-40.

Table 2-40 Chinatown-Cornfields Redevelopment Construction Average Annual Impacts by Alternative

Average Annual Impact Summary – Alternatives 10, 13, & 16A				
Impact Type	**Employment**	**Labor Income**	**Value Added**	**Output**
Direct Effect	13.5	$1,005,000	$1,204,000	$2,032,000
Indirect Effect	4.1	$252,000	$381,000	$663,000
Induced Effect	6.9	$362,000	$638,000	$1,018,000
Total Effect	24.5	$1,620,000	$2,223,000	$3,713,000
Average Annual Impact Summary – Alternative 20A				
Direct Effect	52.3	$3,891,000	$4,678,000	$7,916,000
Indirect Effect	16.1	$989,000	$1,492,000	$2,595,000
Induced Effect	26.8	$1,404,000	$2,473,000	$3,949,000
Total Effect	95.2	$6,284,000	$8,644,000	$14,460,000

2.8.5.1 Chinatown-Cornfields Redevelopment State and Local Tax Impacts

Redevelopment construction will generate state and local taxes. Over the entire redevelopment period, these taxes will amount to the following, according to the IMPLAN model, as shown in Table 2-41 and Table 2-42.

Table 2-41 Chinatown-Cornfields Redevelopment Construction Cumulative State & Local Taxes Impacts – Alternatives 10, 13, and 16A

Description	Employee Compensation	Proprietor Income	Indirect Business Tax	Households	Corporations
Dividends					$16,000
Social Ins Tax- Employee Contribution	$75,000				
Social Ins Tax- Employer Contribution	$133,000				
Indirect Bus Tax: Sales Tax			$2,334,000		
Indirect Bus Tax: Property Tax			$2,469,000		
Indirect Bus Tax: Motor Vehicle Lic			$53,000		
Indirect Bus Tax: Severance Tax			$1,000		
Indirect Bus Tax: Other Taxes			$417,000		
Indirect Bus Tax: S/L NonTaxes			$203,000		
Corporate Profits Tax					$368,000
Personal Tax: Income Tax				$2,223,000	
Personal Tax: Non Taxes (Fines- Fees				$540,000	
Personal Tax: Motor Vehicle License				$99,000	
Personal Tax: Property Taxes				$41,000	
Personal Tax: Other Tax (Fish/Hunt)				$22,000	
Total State and Local Tax	$209,000		$5,476,000	$2,925,000	$383,000

Table 2-42 Chinatown-Cornfields Redevelopment Construction Cumulative State & Local Taxes Impacts - Alternative 20A

Description	Employee Compensation	Proprietor Income	Indirect Business Tax	Households	Corporations
Dividends					$61,000
Social Ins Tax- Employee Contribution	$291,000				
Social Ins Tax- Employer Contribution	$516,000				
Indirect Bus Tax: Sales Tax			$9,139,000		
Indirect Bus Tax: Property Tax			$9,666,000		
Indirect Bus Tax: Motor Vehicle Lic			$209,000		
Indirect Bus Tax: Severance Tax			$5,000		
Indirect Bus Tax: Other Taxes			$1,633,000		
Indirect Bus Tax: S/L NonTaxes			$794,000		
Corporate Profits Tax					$1,440,000
Personal Tax: Income Tax				$8,625,000	
Personal Tax: NonTaxes (Fines- Fees				$2,096,000	
Personal Tax: Motor Vehicle License				$384,000	
Personal Tax: Property Taxes				$158,000	
Personal Tax: Other Tax (Fish/Hunt)				$87,000	
Total State and Local Tax	$807,000		$21,445,000	$11,349,000	$1,501,000

2.8.6 Chinatown–Cornfields Opportunity Area – Long-Term Redevelopment Impacts

2.8.6.1 Long-Term Employment, Wages, and Taxes – Chinatown-Cornfields Opportunity Area

Each of the alternatives is anticipated to create a mixture of floor space. Light manufacturing is assumed to require 1,000 sq. ft. per employee with a yearly wage of $55,484, as previous stated. The U.S. Energy Information Agency (EIA) reports an average of 766 square feet per worker for commercial businesses.[16] BLS reports the average weekly wage rate for retail in Los Angeles County at $826 or $42,952 per year.[17] The vacancy rate among retail establishments is assumed

[16] U.S. Energy Information Agency, Department of Energy. 2001. http://www.eia.gov/emeu/consumptionbriefs/cbecs/pbawebsite/retailserv/retserv_howmanyempl.htm

[17] Bureau of Labor Statistics. 2013. County Employment and Wages – Second Quarter 2012. January 8, 2013. USDL-13-0013.

to be 5 percent.[18] EIA reports office workers have an average of 387 square feet of space. The average weekly wage for office workers is $1,222 ($63,544 annually) according to BLS. Vacancy is estimated at 15 percent within the office sector.[19, 20] The overall average weekly wage rate in Los Angeles County is $1,006 or $52,312 annually as reported by BLS. The jobs-to-housing ratio in the City of Los Angeles is 1.33.[21] Jobs-to-housing ratio is used as an indicator of how jobs-rich or jobs-poor a community is. Generally, a ratio of less than 1-to-1 indicates a jobs-poor area, and a ratio of more than 1-to-1 indicates a jobs-rich area. It is assumed that the residential redevelopment in the Chinatown-Cornfields opportunity area will maintain this jobs-to-housing ratio. The Los Angeles Housing Department reports a vacancy rate of approximately 4 percent for multi-family individually metered housing units based on data from the Los Angeles Department of Water and Power.[22]

Employment and wage results are shown in the following four tables.

Table 2-43 Chinatown-Cornfields Cumulative Long-Term Employment by Sector

Alternative	Residential	Retail	Office	Manufacturing	Total
Alternatives 10, 13, & 16	287.3	54.9	243.8	41.9	627.9
Alternative 20	1149.1	219.5	975.2	41.9	2385.7

Table 2-44 Chinatown-Cornfields Average Annual Long-Term Employment by Sector

Alternative	Residential	Retail	Office	Manufacturing	Total
Alternatives 10, 13, & 16	146.5	28.0	124.3	21.4	320.2
Alternative 20	586.1	112.0	497.3	21.4	1216.7

Table 2-45 Chinatown-Cornfields Cumulative Long-Term Wages by Sector

Alternative	Residential	Retail	Office	Manufacturing	Total
Alternatives 10, 13, & 16	$383,219,000	$60,108,000	$395,044,000	$59,275,000	$897,646,000
Alternative 20	$1,532,876,000	$240,432,000	$1,580,177,000	$59,275,000	$3,412,759,000

Table 2-46 Chinatown-Cornfields Average Annual Wages by Sector

Alternative	Residential	Retail	Office	Manufacturing	Total
Alternatives 10, 13, & 16	$7,664,000	$1,202,000	$7,901,000	$1,185,000	$17,953,000
Alternative 20	$30,658,000	$4,809,000	$31,604,000	$1,185,000	$68,255,000

[18] Colliers International. 2012. Central Los Angeles Market Report: Retail. 3rd Quarter

[19] Daum Commercial Real Estate Services. 2012. Office Los Angeles County. www.daumcommercial.com. Q3.

[20] Los Angeles Business Journal. 2012. *Special Report Real Estate Quarterly*. April 16, 2012.

[21] City of Los Angeles, City Planning Department. 2011." Jordan Downs Specific Plan Draft EIR." September 2011.

[22] City of Los Angeles, Los Angeles Housing Department. 2012. "City of Los Angeles Vacancy Rates Estimate. "June 11 2012

The net present values of the wage streams over the 50-year redevelopment period are shown in Table 2-47.

Table 2-47 Chinatown-Cornfields NPV of Long-Term Wages by Sector

Alternative	Residential	Retail	Office	Manufacturing	Total
Alternatives 10, 13, & 16	$122,954,000	$19,285,000	$126,748,000	$19,018,000	$288,006,000
Alternative 20	$491,817,000	$77,142,000	$506,994,000	$19,018,000	$1,094,971,000

The sales tax rate for Los Angeles County and the City of Los Angeles is 9 percent. Of this tax rate, 6.5 percent goes to the State and the remaining 2.5 percent is returned to the county and city. Sales taxes generated from employment, assuming 24 percent of wages are taxable expenditures, are shown in Table 2-48.

Table 2-48 Chinatown-Cornfields Long-Term Sales Tax Revenues

	Cumulative			
Alternative	Sales Tax: State	Sales Tax: Local	Average Annual: Local	NPV: Local
Alternatives 10, 13, & 16	$14,003,000	$5,386,000	$108,000	$1,728,000
Alternative 20	$53,239,000	$20,477,000	$410,000	$6,570,000

2.9 Regional Economic Development and Economic Impacts Summary

Table 2-49 presents the cumulative regional economic impacts from construction through the study's period of analysis for the alternatives. These results were developed by the study team as reasonable factors, based upon available information, for developing a general estimate of potential redevelopment RED benefits associated with project alternatives.

Table 2-49 Cumulative RED & Economic Impacts of Ecosystem Restoration

Ecosystem Construction Cumulative Impacts				
	10 ART	13 ACE	16A AND	20A RIVER
Jobs	913	1,986	6,491	9,001
Labor Income	$52,560,000	$114,350,000	$373,823,000	$518,341,000
Sales	$125,936,000	$273,986,000	$895,690,000	$1,241,959,000
GRP	$73,445,000	$159,785,000	$522,357,000	$724,297,000
Recreation Construction Cumulative Impacts				
Jobs	74	74	74	74
Labor Income	$4,998,000	$4,998,000	$4,998,000	$4,998,000
Value	$12,958,000	$12,958,000	$12,958,000	$12,958,000
Output	$7,265,000	$7,265,000	$7,265,000	$7,265,000
Redevelopment Construction Cumulative Impacts				
Jobs	1,226	1,281	1,281	5,087
Labor Income	$80,981,000	$84,665,000	$84,665,000	$336,278,000
Value	$111,132,000	$115,791,000	$115,791,000	$460,153,000
Output	$185,630,000	$193,002,000	$193,002,000	$767,247,000
Redevelopment Long-term Economic Activity Cumulative Impacts				
Jobs	628	675	675	2,671
Labor Income	$897,646,000	$964,851,000	$964,851,000	$3,815,989,000
Taxes - Local	$5,386,000	$5,789,000	$5,789,000	$22,896,000

The alternatives are estimated to create 2,200 to 14,100 construction related jobs over the period of analysis. Employment is anticipated to generate labor income ranging from $138 million to $860 million. Regional economic activity from construction is expected to increase by $260 million to nearly $1.5 billion with ecosystem restoration, recreation and redevelopment construction.

The long-term economic impacts of redevelopment are estimated to eventually create permanent employment of 620 to 2,700 jobs. This employment will have a greater impact to the region as these employment opportunities exist throughout the period of analysis. Total labor income from these employment opportunities is estimated to range from nearly $900 million to just under $4 billion depending upon alternative.

The cumulative effects of the construction/redevelopment components over the period of analysis will create between 2,800 to 16,800 jobs with incomes from over $1 billion to nearly $5 billion as shown in Table 2-50.

Table 2-50 Employment and Income Cumulative Impacts

	10 ART	13 ACE	16A AND	20A RIVER
Jobs	2,841	4,016	8,521	16,833
Labor Income	$1,036,185,000	$1,168,864,000	$1,428,337,000	$4,675,606,000

A useful interpretation of the economic impacts is average annual impacts, as construction and redevelopment occur over time. In addition to average annual, net present value is also a method to view impacts that occur over time in current dollars. Ecosystem restoration construction takes place in between 10 and 15 years, whereas the redevelopment components span the 50 years of the analysis. With these time dimensions being so different, combining average annual figures for ecosystem restoration and recreation construction with the redevelopment categories would be misleading. For this reason, the following three tables present average annual impacts separately for ecosystem restoration construction, recreation construction, and redevelopment activities.

Table 2-51 Ecosystem Restoration Construction Impacts – Average Annual

Ecosystem Construction Average Annual Impacts				
	10 ART	13 ACE	16A AND	20A RIVER
Sales	$12,593,600	$27,398,600	$59,712,700	$82,797,300
Jobs	91	199	433	600
Labor Income	$11,435,000	$11,435,000	$24,921,500	$34,556,100
GRP	$7,344,500	$15,978,500	$34,823,800	$48,286,500
Construction Duration	10 years	10 years	15 years	15 years

Table 2-52 Recreation Construction Impacts – Average Annual

Recreation Construction Average Annual Impacts				
	10 ART	13 ACE	16A AND	20A RIVER
Sales	$12,958,000	$12,958,000	$12,958,000	$12,958,000
Jobs	74	74	74	74
Labor Income	$4,998,000	$4,998,000	$4,998,000	$4,998,000
GRP	$7,265,000	$7,265,000	$7,265,000	$7,265,000
Construction Duration	1 year	1 year	1 year	1 year

Table 2-53 Redevelopment Economic Impacts - Average Annual

Redevelopment Construction - Average Annual Impacts				
	10 ART	**13 ACE**	**16A AND**	**20A RIVER**
Jobs	25	26	26	102
Labor Income	$1,620,000	1,693,000	$1,693,000	$6,726,000
Sales	$2,223,000	2,316,000	$2,316,000	$9,203,000
GRP	$3,713,000	3,860,000	$3,860,000	$15,345,000
NPV Income	$36,335,000	$37,988,000	$37,988,000	$150,885,000
Redevelopment Long-term Economic Activity - Average Annual Impacts				
Jobs	320	344	344	1,362
Labor Income	$17,953,000	$19,297,000	$19,297,000	$76,320,000
Taxes	$108,000	$116,000	$116,000	$458,000
NPV Income	$288,006,000	$309,568,000	$309,568,000	$1,224,346,000
Combined Redevelopment Average Annual Impacts				
Jobs	345	370	370	1,464
Labor Income	$19,573,000	$20,990,000	$20,990,000	$83,046,000
NPV Income	$324,341,000	$347,556,000	$347,556,000	$1,375,231,000

3. UPDATED RESULTS FOR THE NATIONAL ECOSYSTEM RESTORATION (NER) AND RECOMMENDED PLAN (LPP)

The analysis documented in previous sections was completed during the alternatives evaluation and comparison phase, based upon planning level alternatives formulation and cost estimates. For consistency with the final NER and recommended plan costs (see Economics Appendix Section 6), the RECONS model was run again to update the estimated RED impacts of construction spending.

Note that redevelopment impacts modeled in IMPLAN were not updated. Because redevelopment effects are a function of the restoration plan components rather than their costs, no substantial changes in the redevelopment effects documented in Section 2.8 are expected. Additionally, the updated NER and Recommended plans aren't expected to result in substantial differences OSE effects compared to those already documented in Section 4.

Updated effects of construction spending are summarized via four tables, as bulleted below:

- Table 3-1: Overall Impacts for NER plan Ecosystem Restoration Construction Spending
- Table 3-2: Overall Impacts for the NER-plan-compatible Recreation Plan
- Table 3-3: Overall Impacts for the Recommended Plan Ecosystem Restoration Construction Spending
- Table 3-4: Overall Impacts for the Recommended-plan-compatible Recreation Plan

These results represent total effect over the duration of construction, not average annual effect. Results are presented in total for quicker comparison to the results shown in Section 2.

3.1 NER Plan

Ecosystem Restoration Construction

The USACE is planning on expending $336,339,000 on the project. Of this total project expenditure $312,413,859 will be captured within the regional impact area. The rest will be leaked out to the state or the nation.

Table 3-1 NER Plan - Ecosystem Construction RED Impacts

Impact Areas / Impacts		Regional	State	National
Total Spending		$336,339,000	$336,339,000	$336,339,000
Direct Impact				
	Output	$312,413,859	$333,770,155	$334,993,047
	Job	2,769.17	3,271.69	3,305.29
	Labor Income	$151,798,611	$168,680,986	$169,647,695
	GRP	$177,116,961	$193,661,261	$194,608,611
Total Impact				
	Output	$659,750,801	$737,860,216	$966,318,565
	Job	4,781.31	5,609.80	6,964.07
	Labor Income	$275,351,761	$307,327,529	$373,034,022
	GRP	$384,759,602	$429,748,303	$540,718,316

Recreation Construction

The USACE is planning on expending $10,377,000 on the project. Of this total project expenditure $10,377,000 will be captured within the regional impact area. The rest will be leaked out to the state or the nation.

Table 3-2 NER Plan - Recreation Construction RED Impacts

Impact Areas / Impacts		Regional	State	National
Total Spending		$10,377,000	$10,377,000	$10,377,000
Direct Impact				
	Output	$10,377,000	$10,377,000	$10,377,000
	Job	58.51	58.51	58.51
	Labor Income	$4,288,202	$4,288,202	$4,288,202
	GRP	$5,368,902	$5,368,902	$5,368,902
Total Impact				
	Output	$21,920,484	$23,023,824	$30,105,589
	Job	125.22	131.57	172.60
	Labor Income	$8,455,129	$8,694,361	$10,741,646
	GRP	$12,289,089	$12,765,131	$16,226,295

3.2 Recommended Plan

Ecosystem Restoration Construction

The USACE is planning on expending $804,017,000 on the project. Of this total project expenditure $746,824,048 will be captured within the regional impact area. The rest will be leaked out to the state or the nation.

Table 3-3 Locally Preferred Plan - Ecosystem Construction RED Impacts

Impact Areas / Impacts		Regional	State	National
Total Spending		$804,017,000	$804,017,000	$804,017,000
Direct Impact				
	Output	$746,824,048	$797,876,186	$800,799,505
	Job	6,619.69	7,820.95	7,901.29
	Labor Income	$362,873,957	$403,231,205	$405,542,119
	GRP	$423,397,369	$462,946,449	$465,211,087
Total Impact				
	Output	$1,577,131,584	$1,763,851,820	$2,309,980,566
	Job	11,429.69	13,410.20	16,647.58
	Labor Income	$658,227,256	$734,665,198	$891,736,300
	GRP	$919,766,251	$1,027,311,555	$1,292,584,917

Recreation Construction

The USACE is planning on expending $18,014,000 on the project. Of this total project expenditure $18,014,000 will be captured within the regional impact area. The rest will be leaked out to the state or the nation.

Table 3-4 Locally Preferred Plan - Recreation Construction RED Impacts

Impact Areas / Impacts		Regional	State	National
Total Spending		$18,014,000	$18,014,000	$18,014,000
Direct Impact				
	Output	$18,014,000	$18,014,000	$18,014,000
	Job	101.57	101.57	101.57
	Labor Income	$7,444,124	$7,444,124	$7,444,124
	GRP	$9,320,169	$9,320,169	$9,320,169
Total Impact				
	Output	$38,052,963	$39,968,311	$52,261,934
	Job	217.37	228.39	299.62
	Labor Income	$14,677,719	$15,093,015	$18,647,009
	GRP	$21,333,299	$22,159,686	$28,168,111

4. OTHER SOCIAL EFFECTS

Since the adoption of the P&G by the Water Resources Council in 1983 and their subsequent incorporation into the USACE water resources policies, there has been a tendency to focus

attention on NED and NER benefit/cost procedures. In the last decade, more focus has also been given to the roles and importance of OSE factors in water resources planning. Newer guidance—principally, EC 1105-2-409, "Planning in a Collaborative Environment" from 2005—places much greater emphasis on the importance of including a broad range of considerations in planning that are to be used to develop appropriate water resources solutions. These include social factors addressed in the OSE account, and addressed herein.

The OSE account describes the potential effects of project alternatives in areas that are not dealt with explicitly in the NER and RED accounts. ER 1105-2-409 states, "[a]ny alternative plan may be selected and recommended for implementation if it has, on balance, net beneficial effects after considering all plan effects, beneficial and adverse, in the four Principles and Guidelines evaluation accounts," of which the OSE is one. The Principles and Guidelines state that the OSE, when included in U.S. Army Corps of Engineers documents, should "display plan effects on social aspects such as community impacts, health and safety, displacement, energy conservation and others."

Social effects in a general sense refer to a concern for how the constituents of life that influence personal and group definitions of satisfaction, well-being, and happiness are affected by some condition or proposed intervention. Well-being is an ensemble concept composed of multiple dimensions. While economic factors are very important in characterizing well-being there are many more factors which come into play. In particular the distribution of resources; the character and richness of personal and community associations; the social vulnerability and resilience of individuals, groups, and communities; and the ability to participate in systems of governance are all elements that help define well-being.

This OSE analysis describes the potential social effects of the alternatives under consideration. The OSE account explores the following categories of effects from the implementation of the alternatives considered. In most cases it is not possible to significantly differentiate between the social effects of the restoration alternatives because the scale of the categories on an overall community level exceeds the scale of differences among the alternatives.

- Displacement/Impacts to Population
- Public Health and Safety
- Displacement/Impacts to Minorities and Special Interest Groups
- Displacement/Impacts to Businesses
- Displacement/Impacts to Agriculture
- Displacement/Impacts to Recreational Areas
- Community Growth
- Project Impacts and Connectivity of the Community
- Community Well-being

There is significant interest and activity along the LA River in the form of numerous small efforts to create pocket parks, improve habitat, increase recreation trails, and filter stormwater runoff. Green spaces facilitate hydrological processes in areas where urban development interferes with the movement, distribution, and quality of water. They also provide social, health,

environmental, and economic benefits, some of which include the promotion of physical activity, filtration of water pollution, increased control of stormwater runoff and flooding, reduced loading on stormwater systems, improved groundwater recharge, provision of wildlife habitat, and reduced need for pollution prevention measures.[23] Similarly, construction of the ecosystem restoration project under consideration has strong potential to deliver significant and meaningful environmental, economic, and social benefits to the region. The feasibility study includes alternative plans that incorporate a suite of habitat types along and within the Los Angeles River, such as wetlands, riparian areas, pool/riffle complexes, and riparian buffers, as well as appropriate recreation features (e.g., trails, signage).

Indeed, a significant social effect documented herein is the health effect of nearby habitat areas and the associated recreational features of ecosystem restoration projects. And while the primary purpose of an ecosystem restoration project along the Los Angeles River is the creation of habitat value, USACE promotes multipurpose project values in that "collaboration is critically important for achieving the missions of the Corps in the 21st century. Solutions to today's problems require reaching out to those with different authorities, perspectives, and resources to solve the various dimensions of these problems."[24] This is true even though funding of USACE projects along typical missions such as ecosystem restoration "makes it harder to work with small communities that typically value recreation."[25] Further, parks and recreation are critical to any multipurpose project even from an economic perspective, as declared by the Mayor of Indianapolis: "Parks…have a tremendous impact on our cities, from increased tourism to enhanced retail to higher property values to environmental mitigation."[26]

In a recent Environmental Science and Technology article the authors report that there is evidence that urban residents living in greener environments may be significantly healthier than those living in environments with less green space, and the presence of water may create even greater health improvements.[27] Most notably for low-income and minority residents, inequitable urban development and the privatization of natural amenities has contributed to environmental injustices in the distribution of green space and water features. Collectively, this can cause disparities in health-related behaviors and obesity.[28] Given the health benefits related to the contact with or use of green space, disadvantaged populations with green space access may obtain some protection from the effects of poverty-related stress, possibly decreasing their

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[23] Heather E. Wright Wendel, Joni A. Downs, and James R. Mihelcic. 2011. "Assessing equitable access to urban green space: the role of engineered water infrastructure". *Environ. Sci. Technol.* 45:6728.

[24] The State of Collaboration in the Corps: A Field Perspective. 2011. From "The Collaborative Capacity Assessment Initiative." Conflict Resolution & Public Participation Center, USACE. 2011-CPC-R-04, May 2011. http://www.iwr.usace.army.mil/Portals/70/docs/iwrreports/2011-CPC-R-04.pdf

[25] Ibid.

[26] Bart Peterson, Mayor of Indianapolis. 2003. In the introduction to "The Excellent City Park System," written by Peter Harnik and published by The Trust for Public Land.

[27] Heather E. Wright Wendel, Joni A. Downs, and James R. Mihelcic. 2011. "Assessing equitable access to urban green space: the role of engineered water infrastructure." *Environ. Sci. Technol.* 45:6728.

[28] Powell, L. M.; Slater, S.; Chaloupka, F. J. 2004. "The relationship between community physical activity settings and race, ethnicity and socioeconomic status." *Evidence-Based Prev. Med.* 1(2), 135–144.

mortality rates relative to similar populations that lack access.[29] For example, people exercising in all types of natural environments experienced enhanced self-esteem and mood, with the presence of water creating the greatest improvements.[30]

This OSE assessment covers not only the standard categories previously mentioned, but it also covers less common areas of social effects as highlighted in the previous paragraph. The primary region of influence (ROI) for the analysis of social effects is the previously defined study area– the approximately 1-mile wide corridor along the River. This ROI area definition extends beyond the potential construction impact area and was chosen based on the assumption that direct social effects associated with the project would be mainly confined to this area.

4.1 Displacement/Impacts to Population

The project location is adjacent to residential, commercial, and industrial land uses that are found along the Los Angeles River channel. The direct effects of construction of the proposed Alternatives 10,13,16, and 20 are not likely to result in any displacement or impacts to population beyond the health and safety concerns outlined below. It is generally assumed that the workers needed for construction will come from the local labor pool. However, labor demands are not anticipated to affect the labor pool as their demands are relatively minor in relation to the labor pool. Thus, construction-related employment is not likely to increase the population to any significant degree within the ROI.

4.2 Public Health and Safety

This section presents a great deal of research literature as evidence of the health costs of obesity and the benefits of exercise at the national, state, and local level. The abundance of information herein is a fraction of the literature that supports the high economic and social health costs of a sedentary lifestyle, and *serves to underline the importance of this facet of OSE benefits related to the project.* Indeed, the challenge of promoting a healthy lifestyle founded on outdoor recreation and the value of natural resources is partly why the America's Great Outdoors (AGO) initiative was begun under President Obama's administration in 2010.[31] A report introducing the AGO initiative states that "[t]he outdoors has increasingly lost its relevance in the lives of our children"...and that "[s]tudies show that access to the outdoors can help reverse the obesity epidemic that has tripled among our children in the last generation. They show that time spent in nature can reduce stress and anxiety, promote learning and personal growth, and foster mental and physical health."[32]

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[29] Mitchell, R.; Popham, F. "Effect of exposure to natural environment on health inequalities: an observational population study." *Lancet.* 2008, 372 (9650), 1655–1660.

[30] Barton, J.; Pretty, J. 2010. "What is the best dose of nature and green exercise for improving mental health? A multi-study analysis." *Environ. Sci. Technol.* 44 (10), 3947–3955.

[31] US Dept. of the Interior, 2011. "America's Great Outdoors: A Promise to Future Generations." A report in collaboration with the USEPA, USDA, and the CEQ. February 2011.

[32] Ibid.

At the current level of analysis, it is impractical to be quantitative about the differences in beneficial effects among the final array primarily because the effects would not greatly vary among the alternatives.

4.2.1 Health Costs

Excessive weight and obesity and their associated health problems have a significant economic impact on the U.S. health care system. Medical costs associated with excessive weight and obesity involve both direct and indirect costs. Direct medical costs may include preventive, diagnostic, and treatment services related to obesity. Indirect costs relate to morbidity and mortality costs. Morbidity costs are defined as the value of income lost from decreased productivity, restricted activity, absenteeism, and bed days. Mortality costs are the value of future income lost by premature death. The medical care costs of obesity in the United States are staggering. In 2008 dollars, these costs totaled about $147 billion.[33] Researchers from the Mayo Clinic, published in the *Journal of Occupational and Environmental Medicine*,[34] found that people who are obese have an extra $1,850 in health costs a year, on average, compared with normal weight people, and for people who are morbidly obese, the costs are even higher: up to $5,500 a year.

The consequences of the country's obesity epidemic expand beyond just personal health. Overweight or obese full-time workers with other chronic health conditions miss 450 million more days of work each year than would healthy workers, costing businesses $153 billion annually in lost productivity, according to a 2011 Gallup poll.[35]

The California Center for Public Health Advocacy (CCPHA) found the total annual estimated cost to California for overweight, obesity and physical inactivity was $41.2 billion – $21.0 billion for overweight and obesity, and $20.2 billion for physical inactivity. Health care costs totaled $20.7 billion and lost productivity costs reached $20.4 billion. Health care costs associated with overweight and obesity were $12.8 billion while health care costs associated with physical inactivity totaled $7.9 billion. Finally, lost productivity costs associated with overweight and obesity were $8.2 billion, and lost productivity costs associated with physical inactivity were $12.3 billion.[36]

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[33] Finkelstein, E., Trogdon, J., Cohen, J. & Dietz, W. 2009. "Annual medical spending attributable to obesity: payer- and service-specific estimates." *Health Affairs* 28(5).

[34] Moriarty, J., Branda M., Olsen, K., Shah, N., Borah, B., Wagie, A., Egginton, J. & Naessens, J. 2012. "The effects of incremental costs of smoking and obesity on health care costs among adults: A 7-year longitudinal study." *Journal of Occupational and Environmental Medicine* Mar; 54(3).

[35] Witters, D. & Agrawal, S. 2011. "Unhealthy U.S. workers' absenteeism costs $153 billion." Internet website: http://www.gallup.com/poll/150026/Unhealthy-Workers-Absenteeism-Costs-153-Billion.aspx.

[36] California Center for Public Health Advocacy. 2006. "The Economic Costs of Overweight, Obesity and Physical Inactivity Among California Adults – 2006." Internet website: http://www.publichealthadvocacy.org/costofobesity.html

4.2.2 Physical Activity and Obesity

Physical activity, essential to overall health, can help control weight, reduce the risk of heart disease and some cancers, strengthen bones and muscles, and improve mental health.[37] The American Planning Association reports that proximity to public parks and tree-lined streets appears to have the greatest impact on the length of the lives of study participants, even when taking into account factors known to affect longevity, such as gender, marital status, income and age.[38] The Centers for Disease Control and Prevention's goal of increasing physical activity among all Americans is supported by key strategies such as creating or enhancing access to places for physical activity, enhancing physical education and activity in schools and physical activity in child care settings, and supporting urban design, land use, and transportation policies.[39,40] The proposed alternatives' features fit well within the context of these strategies since all alternatives provide trails, access points, bridges, parking facilities, and restrooms located at strategic locations. All of these serve to provide easier access to recreation along the River as well as to existing, adjacent parks and facilities, thereby encouraging recreation and exercise.

4.2.2.1 National Statistics

Nationwide, more than 35 percent of U.S. men and women were obese in 2009–2010. There was no significant difference in prevalence between men and women at any age. Overall, adults aged 60 and over were more likely to be obese than younger adults. Among men there was no significant difference in obesity prevalence by age. Among women, however, 42.3 percent of those aged 60 and over were obese compared with 31.9 percent of women aged 20–39 (Figure 4.1).[41] The prevalence of obesity was higher among adolescents than among preschool-aged children (Figure 4.2). The prevalence of obesity was higher among boys than girls (18.6 percent of boys and 15.0 percent of girls were obese).

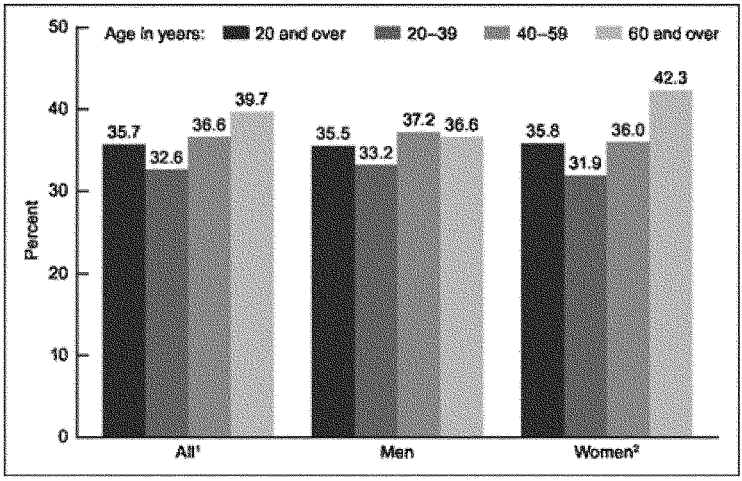
[37] U.S. Department of Health and Human Services. 2008. "Physical activity guidelines for Americans." Hyattsville, MD. U.S. Department of Health and Human Services.

[38] American Planning Association, 2003. "How cities use parks to improve public health, help children learn, create safer neighborhoods." *City Parks Forum Briefing Papers.*

[39] Resources for State and Community Programs. 2010. "CDC's guide to strategies for increasing physical activity in the community." (CD-ROM). Centers for Disease Control and Prevention.

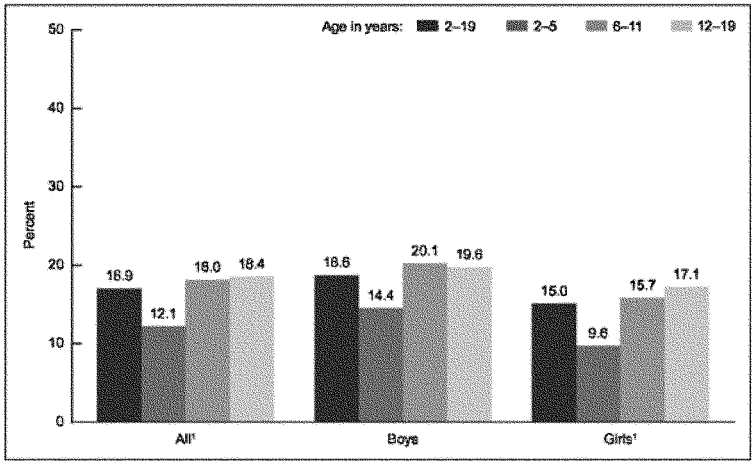
[40] Kahn, E., Ramsey, L., Brownson, R., et al. 2002. "The effectiveness of interventions to increase physical activity: A systematic review." *Am J Prev Med.* 22, (4 suppl).

[41] U.S. Department of Health and Human Services. 2012. "Prevalence of obesity in the United States, 2009-2010." NCHS, Data Brief No. 82. January, 2012.



[1] Significant increasing linear trend by age ($p < 0.01$).
[2] Significant increasing linear trend by age ($p < 0.001$).
NOTE: Estimates were age adjusted by the direct method to the 2000 U.S. Census population using the age groups 20–39, 40–59, and 60 and over.
Source: CDC/NCHS, National Health and Nutrition Examination Survey, 2009–2010

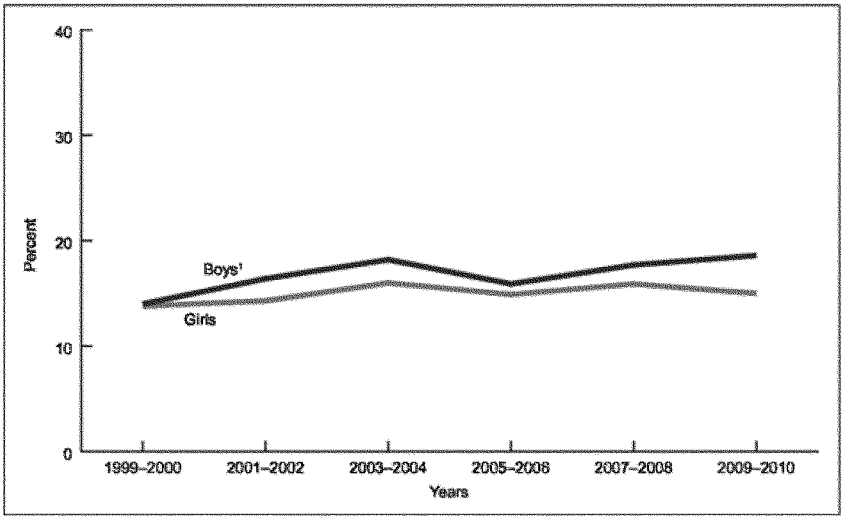
Figure 4.1 Prevalence of Obesity among Adults Aged 20 and Over, by Sex and Age: United States, 2009–2010



[1] Significant increasing linear trend by age ($p < 0.005$).
Source: CDC/NCHS, National Health and Nutrition Examination Survey, 2009–2010.

Figure 4.2 Prevalence of Obesity among Children and Adolescents Aged 2–19, by Sex and Age: United States, 2009–2010

Obesity has been on the rise: In 1999–2000, 27.5 percent of men were obese, and by 2009–2010 the prevalence had increased to 35.5 percent. Among women, 33.4 percent were obese in 1999–2000 with a small change in 2009–2010 (35.8 percent). The prevalence of obesity among boys increased from 14.0 percent in 1999–2000 to 18.6 percent in 2009–2010. There was a small change among girls: the prevalence was 13.8 percent in 1999–2000 and 15.0 percent in 2009–2010 (Figure 4.3).



[1] Significant increasing linear trend 1999–2000 to 2009–2010 ($p < 0.05$).
Source: CDC/NCHS, National Health and Nutrition Examination Survey, 2009–2010.

Figure 4.3 Trends in the Prevalence of Obesity among Children and Adolescents Aged 2–19, by Sex: United States, 1999–2010

The prevalence of these and similar statistics exhibit the growing problem of obesity, nationwide, for which the proposed project features offer beneficial effects regardless of their specific contributory magnitude.

4.2.2.2 California Statistics

In California, despite these now-well-known benefits of physical activity, only 50 percent of California adults engage in the recommended levels of physical activity, and 23.2 percent engage in no leisure-time physical activity, as shown in Table 4-1, according to the Centers for Disease Control and Prevention.

Table 4-1 California: Summary of Physical Activity

	Recommended	Insufficient	Inactive	No-Leisure Time Physical Activity
California	50.0%	37.6%	12.5%	23.2%

Physical activity rates for adults in California by age and gender are shown in Table 4-2.

Table 4-2 California: Recommended Physical Activity - 2007

	18–24	25–34	35–44	45–64	65+
Recommended	64.4%	52.1%	48.7%	47.1%	43.5%
Insufficient	29.8%	37.5%	40.6%	39.5%	36.0%
Inactive	N/A	10.4%	10.7%	13.4%	20.5%
No Leisure-Time Physical Activity*	17.6%	25.2%	25.4%	22.4%	23.9%

	Female	Male
Recommended	48.9%	51.1%
Insufficient	38.6%	36.4%
Inactive	12.5%	12.5%
No Leisure-Time Physical Activity*	24.6%	21.7%

* "Recommended," "Insufficient," and "Inactive" data comprise one measure, and responses should sum to ~100%. "No Leisure-Time Physical Activity" is a separate question, and should not be included with calculations for the recommended, insufficient, or inactive.

Recommended physical activity (meeting the "Healthy People 2010 Objectives") is defined as reported moderate-intensity activities in a usual week (i.e., brisk walking, bicycling, vacuuming, gardening, or anything else that causes small increases in breathing or heart rate) for at least 30 minutes per day, at least 5 days per week; or vigorous-intensity activities in a usual week (i.e., running, aerobics, heavy yard work, or anything else that causes large increases in breathing or heart rate) for at least 20 minutes per day, at least 3 days per week or both. This can be accomplished through lifestyle activities (i.e., household, transportation, or leisure-time activities).

Insufficient physical activity is defined as doing more than 10 minutes total per week of moderate or vigorous-intensity lifestyle activities (i.e., household, transportation, or leisure-time activity), but less than the recommended level of activity.

Inactivity is defined as less than 10 minutes total per week of moderate or vigorous-intensity lifestyle activities (i.e., household, transportation, or leisure-time activity).

No leisure-time physical activity is defined as no reported leisure-time physical activities (i.e., any physical activities or exercises such as running, calisthenics, golf, gardening, or walking) the previous month.

Source: As found in California State Parks. 2005. "The Health and Social Benefits of Recreation." California State Parks. Planning Division. Values updated from the CDC's Behavioral Risk Factor Surveillance System data site: http://www.cdc.gov/brfss/ as accessed in May 2012.

Obesity continues to increase in the state, with a slight dip between 2009 and 2010, as shown in Figure 4.4. Although overall obesity is "down" to roughly 25 percent in 2010 for all Californians, the CDC reports an obesity rate of 30.5 percent for youths between the ages of 10 - 17 in 2007—a rate 7 percent higher than for all Californians.

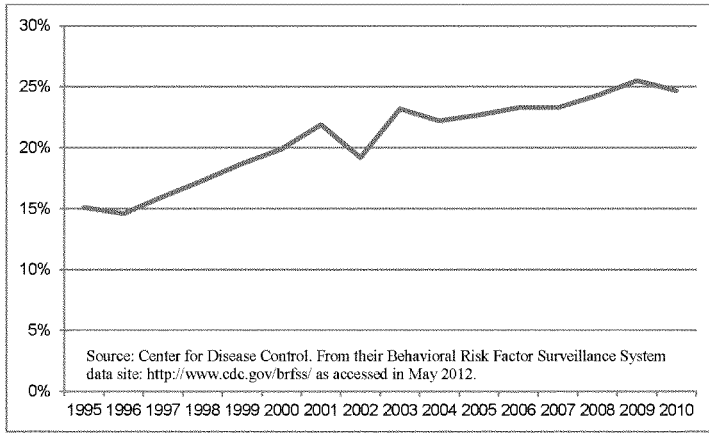


Figure 4.4 California's Overweight and Obesity Annual Rates

More troubling is a recent 2011 report by the UCLA Center for Health Policy Research and California Center for Public Health Advocacy–"*A Patchwork of Progress: Changes in Overweight and Obesity Among California 5th-, 7th-, and 9-th Graders, 2005-2010*"– which indicates 38 percent of 5th, 7th, and 9th graders are overweight or obese. From this report, childhood obesity by ethnicity/race is shown in Figure 4.5 Childhood Obesity.

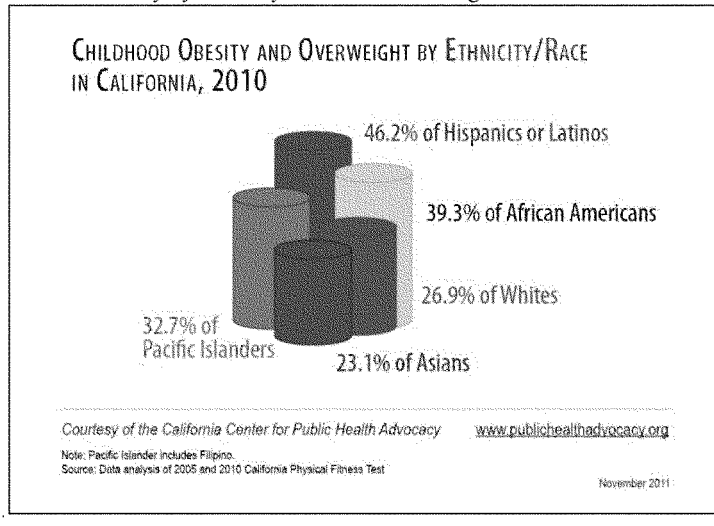


Figure 4.5 Childhood Obesity

The reasons for the correlation between ethnicity and obesity may of course be discussed in the context of culture, income, diet, employment, and a host of environmental justice factors. Among those factors are ample statistics correlating conditions of park-poor neighborhoods within communities that are predominantly Hispanic and African-American. Facilities that provide a greater opportunity and access to recreation opportunities across all of the proposed alternatives, therefore, would serve to help reduce the obesity levels within the ROI.

4.2.2.3 Los Angeles Statistics

The 2005, the CDC's physical activity prevalence statistics for the Los Angeles - Long Beach – Glendale Metropolitan Statistical Area (MSA) indicated that only 45.4 percent of the adult population meets the recommended level of physical activity.

Table 4-3 Physical Activity Prevalence Statistics by Metropolitan Area — SMART BRFSS 2005

	Recommended	Insufficient	Inactive
Los Angeles-Long Beach-Glendale	45.4%	32.4%	13.3%

In a follow-on study in 2008, the CDC reports the level of no leisure-time physical activity for this area's adult population at 25.9 percent.

In 2007 the Department of Public Health and the American Diabetes Association of Los Angeles found that 22 percent of residents suffer from obesity — up from 14.3 percent in 1997.

The issues with overweight/obesity in children are even more severe. After some hope that the obesity/overweight rate with children was stabilizing as evaluated in the Los Angeles County Department of Public Health 2008 report "Los Angeles Health Trends," a subsequent 2010 study conducted by the UCLA Center for Health Policy Research and the California Center for Public Health Advocacy revealed contrary data on the levels of overweight/obesity. The study indicates that while 38 percent of the state's children are overweight or obese, Los Angeles County has both the highest and lowest city rates. City ranges begin as low as 11.3 percent (Manhattan Beach) and climb five-fold to 53 percent for the state's poorest performing city (Huntington Park) with the City of Los Angeles at 45.2 percent and an overall rate for the County at 41.6 percent.

4.2.3 Health Benefits of Exercise Facilities

A landmark report by the U.S. surgeon general found that people who engage in regular physical activity benefit from reduced risk of premature death; reduced risk of coronary heart disease, hypertension, colon cancer, and non-insulin-dependent diabetes; improved maintenance of muscle strength, joint structure, and joint function; reduced body weight and favorable redistribution of body fat; improved physical functioning if they suffer from poor health; and healthier cardiovascular, respiratory, and endocrine systems.[42, 43]

[42] Sherer, Paul M. 2006. "The Benefits of Parks: Why America Needs More City Parks and Open Space." The Trust for Public Land. Reprint of "Parks for People" white paper, published in 2003.

> "Americans can substantially improve their health and quality of life by including moderate amounts of physical activity in their daily lives," the report found. It also found that "health benefits appear to be proportional to the amount of activity; thus, every increase in activity adds some benefit." [44]

The Surgeon General additionally found that physical activity also produces important psychological benefit. It relieves symptoms of depression and anxiety, improves mood, and enhances psychological well-being.[45] Exercise leads to enhanced tranquility and more relief of anxiety and depression when it occurs in natural settings like parks rather than along urban streets.[46]

Exercise significantly reduces the chance for heart problems, according to 43 separate studies conducted by the Centers for Disease Control. Those who do not exercise are twice as likely to have coronary heart disease.[47] A study publishes in the Archives of Internal Medicine indicates the risk of Type II diabetes decreased progressively with increasing levels of physical activity.[48] Women, who exercised regularly in their 20's and had a healthy intake of calcium, decreased by 30 percent their risk of developing osteoporosis in their 70's.[49]

Despite these now well-known benefits of physical activity however only 49 percent of American adults engage in the recommended levels of physical activity, and 24 percent engage in no leisure-time physical activity, according to the Centers for Disease Control and Prevention.[50] The numbers for children and adolescents are similar: only 50 percent of students in grades 9 through 12 engage in moderate to intensive physical activity.[51]

Fortunately, strong evidence shows that people are more likely to exercise when they have access to parks and recreation facilities, thereby reducing obesity and its associated health problems and societal costs. A group of studies reviewed in the American Journal of Preventive

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[43] U.S. Department of Health and Human Services. 1996. "Physical activity and health: A report of the Surgeon General." U.S. Department of Health and Human Services. http://www.cdc.gov/nccdphp/sgr/pdf/sgrfull.pdf.

[44] Ibid.

[45] Ibid.

[46] American Planning Association, 2003. "How Cities Use Parks to Improve Public Health, Help Children Learn, Create Safer Neighborhoods." *City Parks Forum Briefing Papers.*

[47] American Hiking Society (AHS). (n.d.). "A Step in the right direction: The health benefits of hiking and trails." Retrieved from http://atfiles.org/files/pdf/AHShealthben.pdf.

[48] Wannamethee, S.G., Shaper, A.G., & Alberta, K.G.M.M. 2000. "Physical activity, metabolic factors, and the incidence of coronary heart disease and type 2 diabetes." *Archives of Internal Medicine, 160*(14), 2108-2116.

[49] Gorman, Christine. 2002. "Walk, Don't Run: It's Simple, it's cheap, and studies show that walking may be the best exercise for reducing the risk of heart disease, stroke and diabetes." *Time, 159*(3), 82. June, 2012. http://www.time.com/time/covers/1101020121/walking.html

[50] U.S. Department of Health and Human Services, Centers for Disease Control and Prevention. 2012. http://apps.nccd.cdc.gov/PASurveillance/StateSumResult.

[51] U.S. Department of Health and Human Services, Centers for Disease Control and Prevention. 2012. http://apps.nccd.cdc.gov/youthonline/App/Results.

Medicine showed that "creation of or enhanced access to places for physical activity combined with informational outreach" produced a 48.4 percent increase in the frequency of physical activity.[52] The same studies showed that easy access to a place to exercise results in a 5.1 percent median increase in aerobic capacity, along with weight loss, a reduction in body fat, improvements in flexibility, and an increase in perceived energy.[53] Further, a study by the RAND Corporation found that Los Angeles residents who live near parks visit them and exercise more often than people who live greater distances from green spaces.[54] While it may be argued that people with a propensity to exercise will seek to live near parks rather than the proximity to parks *causing* exercise, the fact remains that—either way—more trails, greenways, and parks along the River will result in more exercise among the population.

Unfortunately, residents of many American communities do not have easy access to a park or recreation facility. This is especially true in cities and urban areas, where 80 percent of Americans lived in 2000. Study after study shows that when people cannot reach parks, they often go without exercise. There is a notable scarcity of parks in poor communities. More generally, there is a correlation among poverty, minority status, obesity, ill health, and neighborhood factors that discourage exercise, including the absence of parks and recreation facilities. Indeed, a 2005 University of Southern California study of park access in Los Angeles found that people who live in areas of low income or concentrated poverty and in Latino, African American, and Asian American/Pacific Islander neighborhoods are less likely to have nearby access to parks, playgrounds, and other exercise facilities than people living in largely white neighborhoods.[55,56]

4.2.4 Proposed Alternatives and Public Health

The alternatives' proposed recreational and open space facilities would occur in LA's Council Districts 1, 4, 13 and 14. These districts have some of the lowest parkland to population ratios in the City (Figure 4.6). Note that Council District 4 is third in the ranking due to the inclusion of Griffith Park; however, the current evaluation discounts the recreational use of Griffith Park "on a regular/daily basis" due to its distance from the River and separation by Interstate 5.

Within the principal service territory of the proposed parks, over 11,000 senior citizens (aged 65 and older) and 74,000 adults (aged 18 to 65) reside. The Trust for Public Land in a 2009 study,

[52] Kahn, E., *et al.* 2002. "The effectiveness of interventions to increase physical activity." *American Journal of Preventive Medicine* 22, no. 4S.

[53] Ibid.

[54] Yañez, E. & Muzzy, W. 2005. "Healthy parks and healthy communities: Addressing health disparities and park inequities through public financing of parks, playgrounds, and other physical activity settings." *The Trust for Public Land.*

[55] Wolch, J., Wilson, J. & Fehrenback, J. 2005. "Parks and park funding in Los Angeles: An equity-mapping analysis," *Urban Geography* 26, no. 1.

[56] Pincetl, S., *et al.* 2003. "Toward a sustainable Los Angeles: A 'nature's services' approach." University of Southern California, Center for Sustainable Cities. March, 2003.

"Measuring the Economic Value of a City Park System," has developed a system ("Parks Health Benefits Calculator") to measure the health value of park usage for exercise by adults.

In their study, after identifying the common types of medical problems that are inversely related to physical activity such as heart disease and diabetes, they created the calculator based on studies in seven different states that show an annual $250 cost difference between those who exercise regularly and those who do not. For people over the age of 65, the value is $500 because seniors typically incur two or more times the medical care costs of younger adults.

The key data input is the number of park users who indulge in a sufficient amount of physical activity (at least 30 minutes of moderate to vigorous activity at least three days per week) to make a difference. If it is assumed that the proposed facilities would impact only 10 percent of the adults in the service territory (1,000 seniors and 7,400 adults) the annual health benefit would be $2,400,000, according to the benefit calculator.

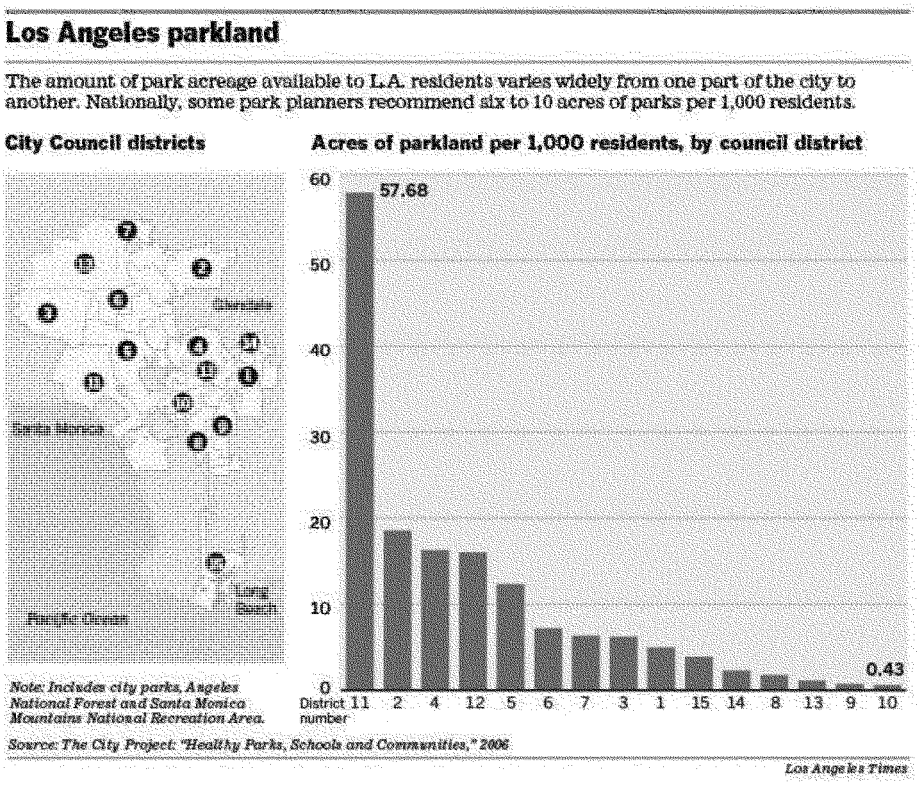

Figure 4.6 Los Angeles Parkland to Population Ratios

As seen in the supporting evidence presented within this section (Section 4.2), inactivity, obesity, and loss of productivity in the workplace contribute to major annual health care cost in California and the Nation, and people who live closer to parks are more likely to participate in physical activity and healthier living. As mentioned above, much of the Los Angeles area is considered to be "park poor" which is defined by California law as any geographic area that provides less than three acres of park per 1,000 residents. [57] Based on this classification, project reaches 7-8 would be considered "park poor" having the lowest amount of parkland per resident in the project area (less than three acres per 1,000 people).

Restoration measures under Alternatives 10, 13, 16A, and 20A would increase accessibility for recreational opportunities in a safe, user-friendly, and accessible setting resulting in a higher frequency of recreation and physical activity use by community members. The recreational facilities common to all alternatives include: trails along the River; bridges that offer accessibility and connectivity to existing, adjacent parks; parking; and access point for trails as well as for kayaking. This is expected to result in a 45% increase in recreation visitation with project, as described in Section 5 and Attachment 1.

Further—beyond the habitat units offered by the restoration measures—the habitat proposed within the alternatives also provide an amenity that would serve to increase the aesthetic enjoyment of recreation along the River by providing an environment conducive to recreation. Linking restoration acreage to public health in this manner results in comparing the acreages of each proposed alternative: Alternative 10 proposes the smallest area of proposed restoration, followed by 13, 16, and 20 with the largest area of proposed restoration. Actual differences in the alternatives based on acreage of restoration may be seen in Table 4-4, indicating increases from one alternative to the next of 13%, 10%, and 4%, respectively.

Table 4-4 Acreage of Habitat Restoration, by Alternative

Alternative			
10	**13**	**16A**	**20a**
528	588	659	719

Restoration measures and associated recreational effects would not only provide obese and at-risk community members with increased opportunities for physical activity and exercise, but would also provide opportunities for healthy and active members of the community who regularly exercise to sustain their health. This would improve the health of the community as a whole by reducing health care costs, increasing productivity, and promoting well-being.

[57] GreenInfo Network. 2010. "Park Poor, Income Poor, and People of Color." Figure presented by the City Project, Los Angeles, CA. Accessed September 2012 at http://www.mapsportal.org/thecityproject/socalmap/LosAngelesCounty.html#.

4.3 Displacement/Impacts to Minorities and Special Interest Groups

Displacements or relocations related to the construction efforts surrounding the project are unlikely due to the construction footprint being on vacant public lands and the limited workforce required for construction.

4.3.1 Proposed Alternatives and Displacement/Impacts to Minorities and Special Interest Groups

Benefits to minorities and special interest groups would be seen in all reaches of the project area post construction. The proposed restoration measures under Alternative 10, 13, 16A, and 20A would provide added trails and linkages to neighboring parks providing recreational activities for hikers, bicycle riders, and equestrian use.

Housing prices would likely appreciate under Alternatives 10, 13, 16A, and 20A, due to the potential of restoration measures to act as a catalyst for the renewal and redevelopment/beautification of adjacent commercial, industrial, business, and residential properties, as discussed above in Section 2.8. Minority and special interest group homeowners would benefit as property values would likely appreciate, while minority renters would be negatively impacted due to rent increases, which could potentially displace minority and special interest group residents.

Alternatives 10, 13, 16A, and 20A vary in the respective implementation acreage of restoration measures; however, each alternative proposes measures in all project reaches (1-8). Therefore, impacts would be similar under each alternative with the slight differences as shown in Table 4-4.

4.4 Displacement/Impacts to Businesses

From an economic perspective, it is assumed that redevelopment would occur in the normal business of free market enterprise. Developers and business owners would agree upon the terms in a free exchange. Existing owners would only transfer ownership if the economic proposition was beneficial. Vacant properties exist throughout the City making relocations possible for the current owner to relocate or build if so desired. The impact areas do not involve residential properties. Thus, the impacts are strictly "business" related.

For Alternative 20, restoration measures and construction staging areas would extend into lands designated as industrial in the Verdugo Wash area of the Northeast Los Angeles Community Plan. Although the construction staging areas represent temporary land uses with less-than significant land use impacts, measures in some alternatives would result in the permanent conversion of industrial uses to a non-industrial use. This would conflict with the designated Industrial Use definition for this site. In addition, active industrial uses are currently in operation within the proposed conversion area. These uses would likely not be able to continue to exist at the site with the restoration measures included in some alternatives, and might require relocation. Further, indirect impacts could occur from the reduction in viable industrial operations adjacent to and in the vicinity of the site. This could result in potentially significant adverse impacts to existing land uses. Still, in the past two decades, the City has supported the conversion of key

river-adjacent parcels that have had industrial, public facility, commercial, and other zoning classifications into publicly-accessible open spaces with ecosystem value. Commitment to this process may be seen by the City Council's adoption of the Los Angeles River Revitalization Master Plan in 2007, which calls for acquisition of key industrially-zoned parcels at the Verdugo Wash confluence, Taylor Yard, the Cornfields, and Arroyo Seco.

The LATC site, located within the Boyle Heights Community Plan Area, would convert industrial container rail yard lands to riparian habitat under Alternatives 10, 13, 16A, and 20A with more extensive restoration measures under Alternative 16A and 20A. These include the creation of freshwater marsh, re-grading of channel banks and revegetation, and the relocation of railroad tracks to trestles to provide hydrologic connections to the river. Proposed restoration features would conflict with the Industrial land use designation, and potentially significant impacts to land use could occur as the current container storage/loading facility would be replaced by habitat areas and trails. New industrial uses may not desire to locate to an area if it has decreased availability and viability for industrial operations. In addition, indirect impacts could result from the decreasing availability of industrial land in the Los Angeles area; this could decrease the viability of industrial and manufacturing businesses from remaining in the area if their operations are limited to increasingly small and potentially isolated parcels of land surrounded by restored riparian and wetland habitat and recreational areas.

Conversion of industrial land within the Boyle Heights Community Plan Area to non-industrial uses would conflict with the industrial land use objectives and policies in the Plan; the objectives include preserving industrial lands for industrial uses, and conserving industry to preserve the tax base for the City and to provide jobs. In addition, policies in the Plan state that the industrial uses north of the San Bernardino freeway and west of the Golden State freeway should be preserved since they are near existing transportation facilities. Therefore, implementation of Alternatives 10, 13, 16A, and 20A would result in potentially significant adverse impacts unless community and political desires help develop mutually-agreeable changes in land use designations that include phasing plans. To this end, as mentioned above in this subsection, past actions by the City indicates a willingness and intent to undertake additional rezoning actions to accommodate the River's ecosystem restoration.

4.4.1 Proposed Alternatives and Displacement/Impacts to Businesses

Benefits to businesses due to the implementation of restoration measures post construction may be seen in areas adjacent to the project footprint due to the previously discussed potential increase in economic benefits derived from increased property values and attractive multi-use development. Though the project area is primarily built out and highly urbanized, restoration measures could stimulate redevelopment and urban renewal. Benefits associated with Alternatives 10, 13, 16A, and 20A would be similar in scope since each Alternative covers all eight reaches. However, direct adverse impacts to businesses within the project footprint—primarily in the LATC areas for all alternatives and in the Verdugo Wash area for Alternative 20—would take place in the proposed habitat areas that would displace those businesses.

4.5 Displacement/Impacts to Agriculture

There are no agricultural activities in the area and no impacts are anticipated.

4.6 Displacement/Impacts to Recreational Areas

Generally, construction will take place on vacant public or industrial lands that are not currently used for recreational purposes. Construction traffic may produce a slight impact on existing travel to existing recreational areas outside of the ROI, but these are considered insignificant.

4.6.1 Proposed Alternatives and Displacement/Impacts to Recreational Areas

Post-construction benefits would include the expansion of project area recreation and improved river corridor trail connectivity between these areas, providing the community increased access and recreational opportunities. From the perspective of actual recreational facilities, the alternatives are the same since there is a single recreation plan for the trails, bridges, access points, parking, and other proposed facilities. But in terms of the additional habitat that offers passive respite and aesthetic amenities during recreational activities, the alternatives would differ based on their respective habitat acreage, as shown in Table 4-4, above, which shows that Alternative 20A proposes the largest restoration acreage, followed by16A, 13, and 10 in decreasing order. Specific improvements and associated increases in recreational use are discussed in Chapter 5.

4.7 Community Growth

Generally, a project is expected to promote growth if it contributes substantially to the population or economics of the ROI area. The project is not expected to significantly contribute economically to the ROI during the construction phase in a direct and indirect manner. Employment benefits are expected to occur in the ROI during construction; however, their impacts in relation to the overall employment within the ROI are small.

The plan is not expected to contribute to any rise in area population, directly or indirectly, during the construction. The ROI is essentially a fully developed urban area. Finally, each municipality or county controls growth in their respective areas through land use and growth policies. Other, more powerful economic considerations also directly influence area growth. Thus, plan construction is not expected to affect community growth, either directly or indirectly, during its construction.

4.7.1 Proposed Alternatives and Community Growth

Although an ecosystem restoration construction project is not expected to contribute to community growth during construction, its existence after construction would create a stimulus for redevelopment as discussed above in Section 2.8. Ecosystem restoration measures proposed under Alternatives 10, 13, 16A, and 20A, in increasing magnitude, respectively, are projected to revitalize commercial, industrial, and residential development in several areas along the Los Angeles River as previously detailed in the RED section of this appendix.

4.8 Project Impacts and Connectivity of the Community

Connectivity is generally defined as the degree to which residents feel a sense of belonging to their neighborhood or municipality. Other important measurements include the level of commitment residents feel to the community and the level of attachment residents have to certain neighbors, groups, or institutions. Generally, these levels are higher as a result of continued association over time. Major impacts to community cohesion are generally caused by displacements to important community businesses, centers of community interactions (churches, community centers, recreation areas) or large tracts of residences. Impacts can also occur through a project separating or dividing individual communities. Finally, visual impacts can affect the quality of adjacent communities, which can sometimes affect community connectivity depending on the severity of the impact.

Any institution that promotes this kind of community cohesion adds value to a neighborhood and, by extension, to the whole city. This human web, which Jane Jacobs termed "social capital,"[58] is strengthened in some cities by parks. From playgrounds to sports fields to park benches to flower gardens, parks offer opportunities for people of all ages to interact, communicate, compete, learn, and grow. Perhaps more significantly, the acts of creating, improving, renewing, or even saving a park can build extraordinary levels of social capital. This is particularly true in a neighborhood suffering from alienation partially due to the lack of public spaces.

Parks satisfy needs for interaction by enticing residents into public spaces with trees, greenery, natural settings, and recreational facilities. In a study conducted at a large public housing development in Chicago, vegetated areas were found to be used by significantly more people and those individuals were more likely to be engaged in social activities than similar areas without vegetation.[59] Social interaction and neighborhood spaces have been identified as key facets of healthy communities supporting social networks, social support, and social integration that have been linked to improvements in both physical and mental health.[60] Sociability may alleviate some forms of mental illness and contribute to a sense of belonging and community. A park brings neighbors together, encourages safer, cleaner neighborhoods and creates a livelier community atmosphere. Parks also help improve a community's image, socioeconomic status and enhance the area's desirability. Perhaps most importantly, parks become a source of community pride and inspiration for further community improvements and revitalization.

4.8.1 Proposed Alternatives and Connectivity of the Community

Alternatives 10, 13, 16A, and 20A would include the restoration of riparian, in-channel, and overbank wetland habitat, and the greening of impervious surfaces throughout all eight reaches of the project area. Moreover, additional trails, access points, parking areas, and bridges are

[58] Jacobs, J. 1961. *The Death and Life of Great American Cities.* New York: Random House. February 1993 [1961].

[59] Sullivan, W., *et al.* 2004. "The fruit of urban nature: Vital neighborhood spaces." *Environment and Behavior*, 39.

[60] Berkmana, L., *et al.* 2000. "From social integration to health: Durkheim in the new millennium."*Social Science and Medicine*, 51.

included in the alternatives. These would provide linkage and connectivity to the restoration areas as well as to existing parks, thereby improving community cohesion. Similar benefits would be seen under all alternatives and would provide a common place for residents of various socio-economic backgrounds to recreate and interact. As shown in the literature cited above, this would help create a sense of community and belonging. In turn, these beneficial social effects would potentially influence the enhancement of surrounding areas to conduct similar activities.

4.9 Community Well-Being

Among the many benefits of nature there are two major mental health benefits that arise from contact with nature. The first is the immediate mental health benefits which help with stress recovery, and the second is the longer-term psychological benefits which help with ongoing health restoration. In terms of immediate mental health benefits, literature shows that stressed individuals often turn to the natural world for relief. Research also shows that trees and woodlands, and contact with nature in general can have a calming effect, helping to reduce stress.[61] Coleman and Iso-Ahola suggest participation in leisure activities provides resources that assist people either to resist the onset of stress reactions or cope with stress before stress has an impact on health.[62] Visual appreciation of natural scenes provides a means to stress recovery. The healing value of hospital gardens or of nature views from hospital windows is a theme present in much literature. Window views of nature have been shown to increase positive feelings, lower stress levels and improve the physical condition of both hospital patients and office employees.[63]

In terms of longer term mental health, nature acts as a restorative environment, providing restoration from mental fatigue. Contact with nature may also help to reduce anger and aggression over the long term. Alternative studies provide a more in depth understanding of how urban nature impacts on psychological well-being. Rhode and Kendle (1994) suggest that urban nature brings emotional benefits (by lowering stress and increasing happiness), cognitive benefits (by reducing mental fatigue) and behavioral benefits (by encouraging adventurous behavior).[64] Contact with urban nature is beneficial to people as it provides an escape from the city, a peaceful retreat to repair emotions and it allows for intellectual learning.

Contact with nature is important for well-being. The benefits that nature brings to human well-being are applicable to both rural and urban settings. The implications of less contact with nature

[61] Palace Road Nature Garden. 2011. "The relationship between nature and human health and well-being in urban areas." Notes on the Royal Commission on Environmental Pollution Study on Urban Environments, Well-being and Health, as found in https://www.facebook.com/notes/palace-road-nature-garden/the-relationship-between-nature-and-human-health-and-well-being-in-urban-areas/158334140891119, March 16, 2011.

[62] Coleman, D. & Iso-Ahola, S. 2001. "Leisure and health: The role of social support and self-determination." *Journal of Leisure Research,* Volume 25, No. 2.

[63] Tarrant, M. 1996. "Attending to past outdoor recreation experiences: Symptom reporting and changes in affect." *Journal of Leisure Research*, *28*(1).

[64] Rohde, C. & Kendle, A. 1994. "Report to English nature-human wellbeing, natural landscapes and wildlife in urban areas: A Review." Department of Horticulture and Landscape and the Research Institute for the Care of the Elderly, Bath: University of Reading, UK.

in urban areas are however more significant. A major study, in English Nature, found that people living in built up areas with access to gardens or green open spaces had a lower prevalence of mental disorder than people in built up areas with no such access.[65]

Many studies refer to the social benefits of urban green space. Urban green space contributes significantly to social inclusion because it is free and access is available to all, it provides a neutral ground for all sectors of society, and it can provide many opportunities for social interaction. Urban nature can be a meeting place for people of all classes and backgrounds and can therefore contribute to the health of society. Research suggests that there is value to be found in social participation in shared green spaces. Nature settings allow for different types of social interactions through activities like recreation and picnicking - activities that strengthen social bonding. Evidence therefore clearly suggests that contact with nature is important for well-being.[66]

Studies have shown that the more webs of human relationships a neighborhood has, the stronger, safer, and more successful it is. Institutions that promote this kind of community cohesion add value to a neighborhood. This social capital is strengthened by parks by offering opportunities for people of all ages to interact, communicate, compete, learn, and grow. [67] The acts of improving, renewing, or even saving a park can build extraordinary levels of social capital. This is particularly true in a neighborhood suffering from alienation partially due to the lack of safe public spaces.

City parks make inner-city neighborhoods more livable. They offer opportunities for recreation and exercise to at-risk and low-income children, youth, and families who might not be able to afford them elsewhere. They also provide places in low-income neighborhoods where people can experience a sense of community. Research shows that residents of neighborhoods with greenery in common spaces are more likely to enjoy stronger social ties than those who live surrounded by barren concrete.[68]

Park and recreation opportunities are essential for strengthening and maintaining a healthy community. Positive impacts are evident throughout the community. Recreation brings neighbors together, encourages safer, cleaner neighborhoods and creates a livelier community atmosphere. Parks and recreational facilities also help improve a community's image, socioeconomic status and enhance the area's desirability. When people move they seek a desirable community. When they retire they also look for a community that will accommodate their special needs. Residents

[65] Palace Road Nature Garden. 2011. "The relationship between nature and human health and well-being in urban areas." Notes on the Royal Commission on Environmental Pollution Study on Urban Environments, Well-being and Health, as found in https://www.facebook.com/notes/palace-road-nature-garden/the-relationship-between-nature-and-human-health-and-well-being-in-urban-areas/158334140891119, March 16, 2011.

[66] Tabbush, P. & O'Brien, E. 2003. "Health and well-being: Trees, woodlands and natural spaces." Forestry Commission, Ediuburgh.

[67] Harnik, P. & Welle, B. 2009. "Measuring the economic value of a city park system." The Trust for Public Land.

[68] Gies, E. 2006. "The health benefits of parks - how parks help keep Americans and their Communities fit and healthy." The Trust for Public Land.

recognize the numerous benefits that well maintained open spaces and recreation facilities can have for a community.[69]

4.9.1 Crime Reduction

Access to public parks and recreational facilities has been strongly linked to reductions in crime and in particular to reduced juvenile delinquency. Recreational facilities keep at-risk youth off the streets, give them a safe environment to interact with their peers, and fill up time within which they could otherwise get into trouble.

Research supports the widely held belief that community involvement in neighborhood parks is correlated with lower levels of crime. The Project on Human Development in Chicago Neighborhoods studied the impact of "collective efficacy," which it defined as "cohesion among neighborhood residents combined with shared expectations for informal social control of public space." The study found that "in neighborhoods where collective efficacy was strong, rates of violence were low, regardless of socio-demographic composition and the amount of disorder observed. Collective efficacy also appears to deter disorder: Where it was strong, observed levels of physical and social disorder were low."[70]

These benefits may be abstract, but they lead to concrete community improvements such as fewer homicides and other violent crime; fewer property crimes, including graffiti; reduced juvenile delinquency; higher educational achievement; lower rates of asthma and teen pregnancy; and better response to the community's needs by central governments because they see a united front.[71]

Residents who live near outdoor greenery are more familiar with their nearby neighbors, socialize more with them, and expressed greater feelings of community and safety than did residents lacking nearby green spaces.[72]

Well-maintained parks and recreation facilities help reduce crime in a community. The presence of park users in and around the facilities is an excellent deterrent. Low crime rates increase property values and help residents feel secure.

4.9.2 Support of Youths and Seniors

Play is the foundation for children's healthy development. The benefits of outdoor play are maximized when developmentally appropriate equipment and materials provided.[73] Preschool

[69] California State Parks. 2005. "The Health and Social Benefits of Recreation." California State Parks. Planning Division.

[70] Gies, E. 2006. "The health benefits of parks - how parks help keep Americans and their Communities fit and healthy." The Trust for Public Land.

[71] Sherer, Paul. 2004. "Park power land & people." The Trust for Public Land. http://www.tpl.org.

[72] American Planning Association. 2003. "How cities use parks to improve public health, help children learn, create safer neighborhoods." City Parks Forum Briefing Papers.

students exposed to a structured intervention program of a physical education demonstrated significantly higher improvement in fundamental locomotion and object control skills than preschool students who were only allowed to have unstructured physical play with limited equipment.[74] Participation in sports and physical activities is positively associated with psychological maturity and identity development for young women.[75] Environments that are nurturing where youth can have a sense of achievement and recognition as well as opportunities for creative expression, physical activity, and social interaction provides the best settings for them to achieve the five development competencies needed to be successful as adults.[76]

For seniors, recreation can enhance active living, helping limit the onset of disease and impairment normally associated with the aging process. Physical activity help the aging population lead independent and satisfied lives helping them remain mobile, flexible and maintaining their cognitive abilities.[77] Recreation activities provide socialization opportunities and help keep seniors active in the community.

Seniors who live alone are often cut off from the community mainstream, losing their purpose for being and retreating into their homes, thus increasing their health risks. It is generally accepted that the risk of depression increases with age.[78] Seniors involved in recreation programs have reduced feelings of alienation and loneliness and increased intergenerational understanding.[79]

4.9.3 Environmental Health

As referenced by Paul Sherer,[80] the U.S. Forest Service calculated that over a 50-year lifetime, one tree generates $31,250 worth of oxygen, provides $62,000 worth of air pollution control, recycles $37,500 worth of water, and controls $31,250 worth of soil erosion. Further, the research scientists of the Pacific Southwest Research Station of the U.S. Department of Agriculture using the i-Tree Streets program estimate a large tree will provide $3,270 in

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[73] Sawyers, Janet K. 1994. "The Preschool Playground." *The Journal of Physical Education, Recreation & Dance. 65*(6). p.32-33. August, 1994.

[74] Ishee, Jimmy H. 2003. "The Influence of Motor Skill Interventions on Disadvantaged Children." *The Journal of Physical Education, Recreation & Dance. 74*(8), p.14. October, 2003.

[75] Shaw, Susan; Klieber, Douglas A.; Caldwell, Linda L. 2001. "Leisure and Identity Formation in Male and Female Adolescents: A Preliminary Examination." *Journal of Leisure Research, 27*(3), 245- 263,

[76] Hudson, Susan D. 1997 "Helping Youth Grow." *The Journal of Physical Education, Recreation & Dance, 68*(9). pp.16-17. Nov/Dec, 1997.

[77] State of California Resources Agency. 2005. "The Health and Social Benefits of Recreation-An Element of the California Outdoor Recreation Planning Program." California State Parks Planning Division.

[78] Chodzko-Zajko, W.J. 1998. "Physical activity and aging: Implications for health and quality of life in older persons." *President's Council on Physical Fitness and Sport Research Digest, 3*(4).

[79] State of California Resources Agency. 2005. "The Health and Social Benefits of Recreation-An Element of the California Outdoor Recreation Planning Program." California State Parks Planning Division.

[80] Sherer, Paul M. 2006. "The Benefits of Parks: Why America Needs More City Parks and Open Space." The Trust for Public Land. Reprint of "Parks for People" white paper, published in 2003.

environmental and other benefits over its lifetime.[81] These researchers also report that 100 large trees will each year remove 7 tons of carbon dioxide, 328 pounds of other air pollutants, and catch 212,000 gallons of rainwater.[82] In addition, they suggest that tree-filled neighborhoods report lower levels of domestic violence, are safer and more sociable, reduce stress of body and mind, and decrease the need for medication, and speed recovery times.[83]

The U.S. Forest Service also completed a relevant study of Los Angeles' existing tree canopy cover for the Million Trees LA Initiative.[84] That study identified locations for additional tree planting and quantified benefits for additional trees. The study found average annual benefits monetized at $38 and $56 per tree planted, depending on tree mortality assumptions. Eighty-one percent of total benefits were aesthetic/other, eight percent were stormwater runoff reduction, six percent energy savings, four percent air quality improvement, and less than one percent atmospheric carbon reduction.

For comparison purposes herein, the assumptions and values from the "Los Angeles 1-Million Tree Canopy Cover Assessment"[85] were applied to the number of potential trees to be planted per alternative. Areas of higher residential densities, commercial, and industrial areas generally have fewer trees and a higher value per tree planted. Therefore, the benefit of $56/tree is used. Table 4-5 includes the annual benefits of trees per alternative.

Table 4-5 Estimated Annual Benefits of Trees per Alternative

	Alt 10-ART	Alt 13-ACE	Alt 16A-AND	Alt 20A-RIVER
Valley Foothills Riparian (acres)	251	273	270	288
Trees/Acre	300	300	300	300
Annual Benefit per Tree	$56	$56	$56	$56
Total Annual Benefit	$4,216,800	$4,586,400	$4,536,000	$4,838,400

4.9.4 Parks and Housing Values

The real estate market consistently demonstrates that many people are willing to pay a larger amount for property located close to parks and open space areas than for a home that does not offer this amenity. The higher value of these residences means that their owners pay higher property taxes. In effect, this represents a "capitalization" of park land into increased property values of proximate land owners.[86] Indeed, parks, greenery, and vegetation in general are

[81] U.S. Department of Agriculture. 2011. "Trees pay us back–in the Southern California Coast Region." May, 2011.

[82] Ibid.

[83] Ibid.

[84] McPherson, E. Gregory; Simpson, James R.; Xiao, Qingfu; Wu, Chunxia.2008. "Los Angeles 1-Million Tree Canopy Cover Assessment." Gen. Tech. Rep. PSW-GTR-207. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. 52 p.

[85] Ibid.

[86] Crompton, J. 2004. "The proximate principle: The impact of parks, open space and water features on residential property values and the property tax base." National Recreatiou and Park Association

typically found associated with higher property values. The researchers from the previous U.S. Forest Study [87] indicate that each large front yard tree adds one percent to the sales price of a house, and large specimen trees can add 10 percent to a property's value. Findings of this type help support the economic development benefits of property located near parkland and trees, and the value placed by society on vegetation, as discussed in the RED section of this appendix.

Repeated studies over the years have confirmed that people prefer to buy homes close to parks, open space, and greenery. One key study looked at the effect of proximity to greenbelts in Boulder, Colorado. The study showed that, other things being equal, there was a $4.20 decrease in the price of residential property for every foot one moved away from the greenbelt, and that the average value of homes next to the greenbelt was 32 percent higher than those 3,200 feet away. A University of Southern California study found that the positive relationship between park proximity and property value holds true in neighborhoods where the residents are mostly immigrants and poor. In a dense urban neighborhood, the value effect of nearby green space can be stronger than lot size itself. The study found that an 11 percent increase in the amount of green space within a radius of 200 to 500 feet from a house leads to an approximate increase of 1.5 percent in the expected sales price of the house, or an additional $3,440 in the median price.[88]

In a 2001 survey conducted for the National Association of Realtors by Public Opinion Strategies, 50 percent of respondents said they would be willing to pay 10 percent more for a house located near a park or other protected open space. In the same survey, 57 percent of respondents said that if they were in the market to buy a new home, they would be more likely to select one neighborhood over another if it was close to parks and open space.[89]

Most people are willing to pay more for a home close to a nice park. Economists call this phenomenon "hedonic value." Hedonic value is affected primarily by two factors: distance from the park and the quality of the park itself. While proximate value can be measured up to 2,000 feet from a large park, most of the value is within the first 500 feet. Moreover, people's desire to live near a park depends on characteristics of the park. Beautiful natural resource parks with great trees, trails, meadows, and gardens are markedly valuable. Other parks with excellent recreational facilities are also desirable. Less attractive or poorly maintained parks are only marginally valuable. Parks with frightening or dangerous aspects can reduce nearby property values.[90] The preponderance of studies has revealed that excellent parks may add 15 percent to

[87] McPherson, E. Gregory; Simpson, James R.; Xiao, Qingfu; Wu, Chunxia.2008. "Los Angeles 1-Million Tree Canopy Cover Assessment." Gen. Tech. Rep. PSW-GTR-207. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. 52 p.

[88] Sherer, Paul M. 2006. "The Benefits of Parks: Why America Needs More City Parks and Open Space." The Trust for Public Land. Reprint of "Parks for People" white paper, published in 2003.

[89] *National Association of Realtors*. 2001, (Press release). "NAR survey shows public support for open space depends on use and cost" April, 2001.

[90] Harnik, P. & Welle, B. 2009. "Measuring the economic value of a city park system." The Trust for Public Land.

the value of a proximate dwelling; on the other hand, problematic parks may subtract 5 percent of home value.[91]

4.9.5 Proposed Alternatives and Community Well-being

The discussion in Section 4.9 suggests that the restoration measures and associated recreational facilities as proposed under Alternatives 10, 13, 16, and 20 would have beneficial impacts to community well-being in the following manner:

- Reduction in short term stress and promotion of long term well-being and restorative psychological effects
- Improvements in community social interactions and community health
- Reduction in crime correlated with increased opportunities for youth to participate in recreation activities and increased community involvement and strength
- Support of youth development and senior citizen health
- Increases in housing values

Restoration measures would include the restoration of riparian, in-channel, and overbank wetland habitat, the greening of impervious surfaces throughout all eight reaches of the project area, and associated recreational trails and paths. Recreation measures would provide open space, trails, linkage to neighborhood parks, parking, and access to the River. Because Alternatives 10, 13, 16, and 20 vary in implementation area and proposed features, alternatives would have similar but scaled qualitative benefits, respectively, in increasing community well-being throughout the project area.

[91] Ibid.

5. REFERENCES

City of Burbank. 2010. City of Burbank: Keep Pace With Technology. Fact Sheet. Accessed August 2012 at http://www.ci.burbank.ca.us/Modules/ShowDocument.aspx?documentid=9636

City of Glendale. 2012. Glendale Quality of Life Indicators: 9.2 Developed Parkland. Accessed August 2012 at http://www.ci.glendale.ca.us/planning/qol/indicators09/9_parks_open_space/developed_parkland.asp

City of Los Angeles. 2007a. Los Angeles River Revitalization Master Plan. Prepared by the City of Los Angeles, Department of Public Works, Bureau of Engineering, River Project Office. May, 2007.

———. 2007b. Programmatic Environmental Impact Report/Environmental Impact Statement for the Los Angeles River Revitalization Master Plan. Prepared by The City of Los Angeles, Department of Public Works, Bureau of Engineering and the U.S. Army Corps of Engineers, Los Angeles District, Planning Division, with technical assistance from Tetra Tech, Inc.

———. 2009. Housing Element of the General Plan, 2006 – 2014. Los Angeles Department of City Planning. Council File No. 08-1933 and No. 08-1933-S1. Internet website: http://cityplanning.lacity.org/HousingInitiatives/HousingElement/Final/HE_Final.pdf

García, R., A. Rawson, M. Yellott, and C. Zaldaña. 2009 Healthy Parks, Schools and Communities for All: Park Development and Community Revitalization. Policy Report for The City Project. Accessed September 2012 at http://www.cityprojectca.org/publications/documents/PolicyReportHealthyParksSchoolsCommunitiesforAllAB31.pdf

GreenInfo Network. 2010. Park Poor, Income Poor, and People of Color. Figure presented by the City Project, Los Angeles, CA. Accessed September 2012 at http://www.mapsportal.org/thecityproject/socalmap/LosAngelesCounty.html#

Los Angeles County Economic Development Corporation (LAEDC). 2012. LAEDC 2012-2013 Economic Forecast and Industry Outlook. February 2012. Accessed December 2012 at http://laedc.org/economic-research-analysis/laedc-reports/

Los Angeles County Metropolitan Transit Authority (Metro). 2012. Bike Metro: Cyclists' Guide: Metro Bike Map. Accessed August 2012 at http://www.metro.net/riding_metro/bikes/images/la_bike_map.pdf

Los Angeles River Revitalization Corporation (LARRC). 2011a. Los Angeles River Guide: Fishing. Accessed August 2012 at http://thelariver.com/guide/

———. 2011b. LA River Guide: Walking: Access and Cautions. Accessed August 2012 at http://thelariver.com/guide/walks/access-and-cautions/

———. 2011c. Los Angeles River Guide: Walks. Accessed August 2012 at http://thelariver.com/guide/walks/

———. 2011d. In the Works: A description of projects that are funded and under active development. Accessed September 2012 at http://larivercorp.org/

Public Policy Institute of California. 2000. PPIC Statewide Survey: Special Survey on Californians and the Environment. PPIC in collaboration with The David and Lucile Packard Foundation. June 2000. Accessed July 2012 at http://www.ppic.org/main/allpubs.asp

Santa Monica Mountains Conservancy (SMMC) and) Mountains Recreation Conservation Authority (MRCA). 2007. Your Parks. Accessed August 2012 at http://www.lamountains.com/parks.asp?parkid=20

Southern California Association of Governments (SCAG). 2008. Regional Comprehensive Plan.

Trust for Public Land. 2011. 2011 City Park Facts: Report #1 – Acres of Parkland by City and Agency. Published by the Center for City Park Excellence, The Trust for Public Land. Accessed August 2012 at http://cloud.tpl.org/pubs/ccpe-city-park-facts-2011.pdf

U.S. Census Bureau. 2010. Profile of General Population and Housing Characteristics: 2010. Accessed December 2012 at http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk

(USACE) U.S. Army Corps of Engineers. 15 October 2014. EGM 15-03 Unit Day Values for Recreation for Fiscal Year 2015. CECW-CP Memorandum for Planning Community of Practice. Retrieved online via http://planning.usace.army.mil/toolbox/library/EGMs/EGM15-03.pdf.

———. 2010a. 2005 – 2009 American Community Survey. Census Tract Data. Accessed July 2012 at http://www.factfinder2.census.gov

———. 2010b. 2010 American Community Survey. 1-Yr Estimates. Accessed July 2012 at http://www.factfinder2.census.gov

———. 2011. 2010 Census Data by County, Form SF1. Accessed July 2012 at http://www.factfinder2.census.gov

———. 2012. 2008-2012 American Community Survey, Census Tract Data. Accessed March 2014 at http://factfinder2.census.gov

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Los Angeles River Ecosystem Restoration Feasibility Study

Final
Cost Appendix

September 2015

LOS ANGELES RIVER ECOSYSTEM RESTORATION FEASIBILITY STUDY
COST APPENDIX

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1. ALTERNATIVE COST ESTIMATES

1.1 Introduction

Section 1 provides the background information for the Los Angeles River Ecosystem Restoration Feasibility Study spreadsheet construction cost estimates, which have been developed for alternative analysis purposes. This analysis was completed in order to select a preferred plan for further analysis. Sections 2 and 3 of this appendix document the assumptions and work completed for the National Ecosystem Restoration (NER) Plan and Locally Preferred Plan (LPP) which were estimated with Micro-Computer Aided Cost Estimating System (MCACES) cost estimating software.

1.1.1 General

The Los Angeles River Ecosystem Restoration Feasibility Study is evaluating ecosystem restoration opportunities on an 11.5-mile long reach of the Los Angeles River (River) located in southern California. This reach, named the Los Angeles River ARBOR (Area with Restoration Benefits and Opportunities for Revitalization) extends from the Headworks area downstream to First Street in downtown Los Angeles. The ARBOR reach includes the Glendale Narrows—one of the few sections of the study area that does not have a hardened river bed—and contains several distinctive sites and connections including the Headworks, Pollywog Park, Bette Davis Park, the Burbank-Western Channel and Glendale River Walk, Griffith Park, Ferraro Fields, Verdugo Wash, Atwater Village, Taylor Yard and the Rio de Los Angeles State Park, the "Cornfields" (Los Angeles State Historic Park), Arroyo Seco, Elysian Park, "Piggyback Yard" (also known as the "Los Angeles Transportation Center (LATC)" as well as "Mission Yard"), and downtown Los Angeles.

Section 1 of this appendix documents the various unit costs and construction assumptions utilized for the Los Angeles River Ecosystem Restoration project alternative cost estimates. For estimating purposes the ARBOR reach was split into eight sub-reaches, and within these eight sub-reaches various restoration measures were estimated. The restoration measures are intended to solve specific problems or help obtain certain planning objectives[1]. From these measures and sub-reaches, various alternatives have been developed for performing the economic alternatives analysis. A summary matrix of costs for each alternative at each sub-reach can be found in Attachment 1.

1.1.2 Purpose

The purpose of this work is to develop preliminary alternative cost estimates – consistent to the conceptual level of design – for the eight sub-reaches of the project in order to perform

[1] Within this appendix, references to restoration, creation, or improvement of "hydrology" and "geomorphology" are intended to refer to restoration, creation, or improvement of a more natural hydrologic regime and a more natural geomorphic character.

an economic alternatives analysis. The costs within this document are not for budgetary purposes and are subject to change.

1.1.3 Design Features

The design features for the sub-reaches are designed at a conceptual level. Features include those components necessary to implement the measures and sub measures described in the associated Design Appendix and main report. Features include concrete demolition; excavation and fill; riprap; grouted riprap; turf reinforcement mats; fencing; clearing and grubbing; reinforced cast-in-place concrete walls, planters, slabs and piers; detention basins; sub-drainage system; railroad bridges and tunneling.

1.1.4 Design Limitations

Designs are based on preliminary, planning-level conceptual designs, and common engineering practices. The development of the hydraulic and geotechnical reports is currently under way, and thus the preliminary designs of this project were developed without this engineering information. Future design phases would be more integrated with the hydraulic information, geotechnical analyses, and vegetation requirements such that the concepts shown and discussed herein would be modified as necessary.

Also due to the limited hydraulic and geotechnical information diversion and control of water not included as line items within the cost estimates. However, these items are anticipated to be fairly uniform across all the alternatives being considered in the economic analysis. Thus, across all alternatives the costs would be similar and would have no discernible impact on the comparison of alternatives, and ultimately the selection of a recommended plan. Once a recommended plan is selected, and further design information is generated, these items will be incorporated into a more detailed cost estimate.

1.2 Basis of Estimate

1.2.1 Basis of Design

Available design documents of the project elements are listed below

- Los Angeles River Feasibility Study Conceptual Design Drawings, Tetra Tech, April 2013
- Los Angeles River Feasibility Study Design Report, Tetra Tech, April 2013
- Los Angeles River As-Built Drawings, Various Dates, USACE

1.2.2 Quantities

The cost estimate is based on project quantity take-offs that have been calculated in accordance with the documents above. A discussion of the quantity calculation process is provided below, and detailed quantity take-offs can be found in Attachment 2.

1.2.2.1 *Demolition Quantities*

The demolition quantities were developed primarily with the aid of existing typical cross section drawings taken from as-built drawings. Each of the typical cross sections corresponds to a specific length of channel. Thus the typical cross section areas and counts were multiplied into the designated length to calculate the required demolition quantities.

1.2.2.2 *Installation Quantities*

The installation quantities were developed in the same fashion as the demolition quantities. New typical cross sections were created for the various sub-reaches and side channels. These cross sections along with the length of the given sub-reaches were used to calculate the construction items required for revitalizing the channel.

1.3 Unit Costs and Assumptions

1.3.1 Unit Cost Development

Unit prices were developed with detailed labor, equipment and material pricing data. Recent vendor quotes for materials and placement were utilized in the development of several unit costs.

1.3.1.1 *Borrow/Disposal Areas and Materials*

Borrow materials are assumed to be available in the greater Los Angeles area. Any borrow material required is assumed to be trucked into the project site.

Any excess earthen material is assumed to be hauled off-site by the contractor to a disposal location. Three landfills that accept clean soils have been located within a 20-mile radius of the project location. These landfills are the Puente Hills Landfill, Scholl Canyon Landfill and Savage Canyon Landfill. Thus, the estimate includes costs for transporting the excess material 20-miles as well as a tipping fee for disposal at the landfills.

1.3.2 Cost Item Assumptions

1.3.2.1 *Excavation Grade Control (All Material Haul)*

This construction cost item accounts for the excavation of material in the existing channel bed. The unit cost includes excavating with the use of hydraulic excavators and assumes all (100%) the material excavated would be hauled off-site for disposal. Front end loaders are assumed to load the trucks for hauling. The trucks are then assumed to travel 20-miles (one way) to a landfill for disposal of the material. A tipping fee is included in the cost as well.

1.3.2.2 *Excavation Grade Control (Medium Material Haul)*

This construction cost item accounts for the excavation of material in the existing channel bed. The unit cost includes excavating with the use of hydraulic excavators and assumes half (50%) the material excavated would be hauled off-site for disposal. Front end loaders are assumed to load the trucks for hauling. The trucks are then assumed to travel 20-miles (one way) to a landfill for disposal of the material. A tipping fee is included in the cost as well.

1.3.2.3 *Excavation Grade Control (Limited Material Haul)*

This construction cost item accounts for the excavation of material in the existing channel bed. The unit cost includes excavating with the use of hydraulic excavators and assumes a limited amount (15%) of the material excavated would be hauled off-site for disposal. Front end loaders are assumed to load the trucks for hauling. The trucks are then assumed to travel 20-miles (one way) to a landfill for disposal of the material. A tipping fee is included in the cost as well.

1.3.2.4 *Grouted Riprap*

This construction cost accounts for the placement of the grouted riprap grade control structures that would be placed within the channel. The unit cost includes all materials (stone and concrete), transportation, and placement required for the structures.

1.3.2.5 *Excavation Embankment Control (All Material Haul)*

This construction cost item accounts for the excavation of materials on the existing slopes of the channel. The unit cost includes excavating with the use of conventional scrapers. The scrapers would also transport the excavated material to a stockpile site and assumes all (100%) the material excavated would be hauled off-site for disposal. Front end loaders are assumed to be used at the stockpile location to load the trucks for hauling. The trucks are then assumed to travel 20-miles (one way) to a landfill for disposal of the material. A tipping fee is included in the cost as well.

1.3.2.6 *Excavation Embankment Control (Medium Material Haul)*

This construction cost item accounts for the excavation of materials on the existing slopes of the channel. The unit cost includes excavating with the use of conventional scrapers. The scrapers would also transport the excavated material to a stockpile site and assumes half (50%) the material would be hauled off-site for disposal. Front end loaders are assumed to be used at the stockpile location. The trucks are then assumed to travel 20-miles (one way) to a landfill for disposal of the material. A tipping fee is included in the cost as well.

1.3.2.7 *Excavation Embankment Control (Limited Material Haul)*

This construction cost item accounts for the excavation of materials on the existing slopes of the channel. The unit cost includes excavating with the use of conventional scrapers. The scrapers would also transport the excavated material to a stockpile site and assumes a limited amount (15%) of the material excavated would be hauled off-site for disposal. Front end loaders are assumed to be used at the stockpile location to load the trucks for hauling. The trucks are then assumed to travel 20-miles (one way) to a landfill for disposal of the material. A tipping fee is included in the cost as well.

1.3.2.8 *Riprap*

This construction cost item accounts for the all the riprap to be placed as erosion protection along the revitalized channel. The unit cost accounts for the purchase of the stone material, transporting the material a distance of approximately 40-miles, and placing the stone with the use of hydraulic excavators.

1.3.2.9 *Grading*

This construction cost item accounts for grading of newly constructed slopes. The unit cost assumes utilizing grader and equipment operator.

1.3.2.10 *Turf Reinforcement Mat*

This construction cost item accounts for the material and placement of the reinforcement mats along designated slopes of the newly constructed channel. The cost for material and placement was provided by capable vendors. This quoted price was used as a sub-contractor bid in the estimate, and thus accrued appropriate sub-bid mark-ups.

1.3.2.11 *Rock at Reinforcement Mat Tie-In*

This construction cost item accounts for the rock required at the tie-in to the slope. The stone for this item is assumed to be purchased from a quarry in the greater Los Angeles region and trucked to the project site. The material would be placed with front end loaders.

1.3.2.12 *Top Soil*

This construction cost item accounts for the top soil that would be placed on top of the turf reinforcement mats. The soil is assumed to be all borrow material, and would need to be trucked to the site. The material is assumed to be placed with front end loaders and compacted.

1.3.2.13 *Vegetation*

This construction item accounts for the placement of vegetation along the channel where necessary. The unit cost accounts for all materials and labor required to place the vegetation. The cost is based on recent estimates of planting costs along channel ways.

1.3.2.14 *Concrete Demolition*

This construction cost item accounts for the demolition of existing concrete slabs, slopes and walls found within the channel. The concrete is assumed to be demolished with the use of a concrete pulverizer and hydraulic excavator. The concrete would then be loaded onto trucks for hauling to a concrete recycling facility. The cost includes the disposal fee at the recycle plant and a 10-mile (one way) haul distance.

1.3.2.15 *Subdrainage System Demolition*

This construction cost item accounts for the demolition of existing subdrainage piping. The excavation required to access the subdrains is assumed to be accounted for in the other excavation items in the estimate. The piping to be removed is assumed to be 12" in diameter.

1.3.2.16 *Chain Link Fence Demolition*

This construction item accounts for the removal of existing fencing that runs along the channel. The fence is assumed to be chain link and would require hauling off site for disposal.

1.3.2.17 *Clearing and Grubbing*

This construction cost item accounts for the clearing and grubbing of the existing channel slopes prior to any earthwork being performed. The crew includes the use of a hydraulic excavator and trucks for removal of material.

1.3.2.18 *6' Chain Link Fence*

This construction cost item accounts for the placement of a 6-foot high chain link fence. The unit cost accounts for all labor, equipment, and material costs required placing the fence.

1.3.2.19 *Aggregate Base Course*

This construction cost item accounts for the placement of an aggregate base layer beneath the required asphalt pavement. The base material is assumed to be purchased and then hauled to the project site from the greater Los Angeles area. The base layer is assumed to be 6-inches in depth, and would be placed with front end loaders and then compacted.

1.3.2.20 *Asphalt Pavement*

This construction cost item accounts for the placement of asphalt roadways. The asphalt layer is assumed to be 6-inches thick, and would be placed on an aggregate base layer, which is accounted for in another unit cost.

1.3.2.21 *Asphalt Demolition*

This construction cost item accounts for the demolition of existing asphalt roadways throughout the project. The asphalt would be demolished, and then loaded onto trucks for hauling off-site. A tipping fee is also included in the unit cost of this item.

1.3.2.22 *Utility Pole Relocations*

An assessment of the utilities within the project extent and the sub-measures for the study area have identified various reaches as having facility/utility relocations. There are numerous high voltage transmission line towers within the study area. The transmission towers are required to be relocated in order to complete many of the construction measures which include planned channel widening, creation of marsh lands and planting of riparian habitat, freshwater marsh creation, railroad trestling, and for removal of existing channel walls for connectivity.

According to the Real Estate Appendix, a preliminary real estate assessment following the guidelines set forth in Real Estate Policy Guidance Letter No. 31 was completed for the transmission tower relocations. Based on the real estate assessment, the transmission towers are of the type eligible for compensation and Los Angeles Department of Water and Power (LADWP) has been identified with a compensable interest in the property in the cases where the LADWP has been identified as the fee owner of the right of way. Further real estate analysis will need to be completed to determine whether LADWP has a compensable interest in the property in reaches 7 and 8. If LADWP is determined to have a compensable interest in the property the cost to relocate the identified utilities should be captured as a LERRD cost and not cost shared under the construction feature accounts.

This cost item accounts for the moving of the large steel transmission towers found throughout the project area. The unit cost was developed based on research into similar construction activities on recent projects. The costs and methodologies from these other projects were incorporated into this unit cost. This utility tower work is considered a relocation component and therefore the costs for these relocations are included under the 02 – Relocations feature account.

The above assumptions were further refined as alternatives were analyzed. Those utility relocations are described in 2.10.2 and 3.10.2.

1.3.2.23 *Compacted Fill (All Borrow Material)*

This construction cost item accounts for fill material to be placed for various structures throughout the project. The unit cost assumes the entire fill amount required (100%) would come from borrow material. Thus, the cost includes the price of the fill material delivered and stockpiled at the project site. It is assumed that the fill would be moved from a stockpile location, placed with a front end loader, and then compacted with a vibratory roller.

1.3.2.24 *Compacted Fill (Medium Borrow Material)*

This construction cost item accounts for fill material to be placed for various structures throughout the project. The unit cost assumes that half the fill amount required (50%) would come from borrow material, and the rest would come from on-site excavated material. The borrow material would need to be purchased, delivered and stockpiled at the project location. It is assumed that the fill would be moved from a stockpile location, placed with a front end loader, and then compacted with a vibratory roller.

1.3.2.25 *Compacted Fill (Limited Borrow Material)*

This construction cost item accounts for fill material to be placed for various structures throughout the project. The unit cost assumes that a portion of the fill amount required (15%) would come from borrow material, and the rest would come from on-site excavated material. The borrow material would need to be purchased, delivered and stockpiled at the project location. It is assumed that the fill would be moved from a stockpile location, placed with a front end loader, and then compacted with a vibratory roller.

1.3.2.26 *Compacted Fill (No Borrow Material)*

This construction cost item accounts for fill material to be placed for various structures throughout the project. The unit cost assumes the entire fill amount required would come from on-site material that has previously been excavated. It is assumed that the fill would be moved from a stockpile location, placed with a front end loader, and then compacted with a vibratory roller.

1.3.2.27 *Sub Drainage System*

This construction item accounts for the placement of the sub drainage system for the reinforced concrete walls. The unit cost includes several items. The drainage piping is assumed to be 12-inch diameter perforated PVC piping. This piping would be placed in the middle of a gravel packing, which would all be encased by geotextile fabric. Weep holes are assumed to be placed approximately every 10-feet along the drainage system.

1.3.2.28 *Demo Grouted Riprap*

This construction item accounts for the removal of the existing grouted riprap found along the channel. The unit cost includes demolishing the grouted stone and loading the material onto trucks. The trucks would transport the material to a proper disposal location.

1.3.2.29 *Riprap Demolition*

This construction item accounts for the removal of the existing riprap found along the current channel. The material would be removed with hydraulic excavators. The removed stone is then assumed to be crushed prior to being loaded and hauled off-site for disposal.

1.3.2.30 *Remove Spalls*

This construction item accounts for the removal of the spalls found in the current channel. The spalls would be removed with the use of hydraulic excavators. The spalls would then be loaded onto trucks for disposal off-site.

1.3.2.31 *Sheet Pile Wall Demolition*

This construction item accounts for the removal of existing sheet pile walls found in several sub-reaches. The sheet piles would be removed with the use of a hydraulic crane crew. No tipping fee has been included as the sheet piles are assumed to provide some salvage value.

1.3.2.32 *Reinforced Concrete Retaining Wall*

This construction item accounts for the placement of a reinforced concrete wall in the locations noted in the typical sections. The unit cost for this item includes costs for the formwork, concrete material, and concrete placement. The concrete is assumed to be pumped into place. An assumption of 150-lbs of reinforcing steel per cubic yard of concrete has been included as well.

1.3.2.33 *Retaining Wall Gravel*

This construction item accounts for the placement of the base material required beneath the retaining wall structures. The unit cost accounts for material and delivery of the gravel, as well as placement with front end loaders.

1.3.2.34 *Reinforced Concrete Planters*

This construction item accounts for the placement of the concrete planters along the channel slope in designated sub-reaches. The planters would be terraced up the slopes and consist of slab portions and vertical wall portions. The unit cost accounts for all formwork, concrete material, placement by pumping, and reinforcing steel required for the planters' construction.

1.3.2.35 *Railroad Bridge*

This construction item accounts for the placement of a new railroad bridge that would be constructed within the channel. The bridges are assumed to be placed on top of concrete caissons. A concrete deck would then be placed prior to installation of the rail line. It is assumed that the bridges are for single rail lines only. The unit cost for this item accounts for all labor, equipment and materials required to place the aforementioned items. The costs for this item are included under the 02 – Relocations feature account.

1.3.2.36 *Impermeable Liner*

This construction item accounts for the placement of the liner in order to create a flood control basin. The unit cost includes all material and placement costs of the liner.

1.3.2.37 *Reinforced Concrete Elevated Slab*

This construction item accounts for the placement of a reinforced concrete elevated slab in the locations noted in the typical sections. The unit cost for this item includes costs for the formwork, concrete material, and concrete placement. The concrete is assumed to be pumped into place. An assumption of 150-lbs of reinforcing steel per cubic yard of concrete has been included as well.

1.3.2.38 *Reinforced Concrete Slab*

This construction item accounts for the placement of a reinforced concrete slab in the locations noted in the typical sections. The unit cost for this item includes costs for the formwork, concrete material, and concrete placement. The concrete is assumed to be pumped into place. An assumption of 150-lbs of reinforcing steel per cubic yard of concrete has been included as well.

1.3.2.39 *Reinforced Concrete Piers*

This construction item accounts for the placement of a reinforced concrete piers in the locations noted in the typical sections. The unit cost for this item includes costs for the formwork, concrete material, and concrete placement. The concrete is assumed to be pumped into place. An assumption of 150-lbs of reinforcing steel per cubic yard of concrete has been included as well.

1.3.2.40 *Underground Basins*

This construction item accounts for the creation of underground basins for water storage. The basins are assumed to be constructed of metal piping. The unit cost includes all material and labor to install the pipes for basin creation.

1.3.2.41 *Storm Drain Daylighting*

This construction item accounts for the placement of a new storm drain, associated piping and 1-acre of vegetation. The unit cost includes purchasing and placing a precast concrete storm drain that has a splitter sending low flows out a 24-inch pipe that would output flows into a wetland area, while high flows would exit the storm drain through a 36" pipe that outputs the flows into the river. The wetland area would be vegetated as well. Costs for the storm drain and piping were provided by vendor quotes.

1.3.2.42 *Four 24' Diameter Tunnels*

This construction item accounts for the drilling and commissioning of four 24-foot diameter tunnels along an 8.2-mile stretch. The unit cost for this item was calculated from a quote provided by capable contractors, whom provided a cost for drilling and constructing one tunnel.

1.4 Price Level

The effective price level date for the alternatives estimates are April 2013. This date applies to all elements of the alternative cost estimates.

1.5 Project Markups and Functional Costs

1.5.1 Escalation

No escalation has been included in the alternative estimates.

1.5.2 Preliminary Alternative Estimates Contingency

Contingencies represent allowances to cover unknowns, uncertainties and/or unanticipated conditions that are not possible to adequately evaluate from the data on hand at the time the cost estimate is prepared but must be represented by a sufficient cost to cover the identified risks. An overall contingency of 25% has been used to cover design changes and uncertainties in quantities and unit prices for the preliminary alternatives analysis.

1.5.3 Real Estate Costs

The costs for this feature were developed by the City of Los Angeles and USACE in August 2013. Costs were developed for each alternative in each sub-reach, and applied appropriately within the alternatives matrix.

1.5.4 Relocation Costs

The total costs for this feature include other costs developed by the USACE in August 2013 as well as the railroad bridge costs estimated within this document. Costs prepared by the USACE were developed in accordance with P.L. 91-646 for businesses that would require relocation and more detailed discussion of the relocation costs is provided in the Real Estate Plan.

1.5.5 Mobilization and Demobilization

Costs for this item were estimated to be 7.5% of construction costs. This item accounts for transporting equipment and crews to the project site, setting up site facilities and staging areas, as well as demobilizing all equipment and crews, removal of staging areas and disassembly of all other field facilities after construction is complete.

1.5.6 Planning, Engineering and Design

Costs for this account were estimated at 11% of construction costs. This account covers the preparation of plans, specifications, and engineering during construction.

1.5.7 Construction Management

Costs for this account were estimated to be 6.5% of construction costs. This account covers construction management during the construction phase.

1.5.8 Operations and Maintenance (O&M)

Costs for this item account for the routine work that is expected to occur each year over the life cycle of the project. Costs were developed for this by using percentages of the original installation cost for each item. A table the overall O&M costs for each sub-reach can be found in Attachment 4.

1.6 Interest During Construction

Interest during construction (IDC) is the opportunity cost of capital, which is an economic cost incurred while construction funds are expended but benefits have not yet begun to accrue. This

value is calculated from the overall costs, the construction duration, and the Federal discount rate (at time of calculation the rate was 3.75%). The IDC values can be found in the alternatives matrix in Attachment 1.

1.7 Annualized Costs

Annualized construction and O&M costs have been calculated within the alternatives matrix spreadsheet. These costs have been annualized over the 50-year life cycle of the project. The assumed Federal discount rate at time of the calculations was 3.75% and this value was used in the computing of the annualized costs.

1.8 Spreadsheet Estimates

Alternative cost estimates have been developed that contain all sub-measures found in each sub-reach. These estimates can be found in Attachment 3. The spreadsheet estimates are split into the eight sub-reaches. Each sub-reach in turn has estimates of each restoration measure that may be constructed in the sub-reach. These spreadsheet estimates are construction costs only and do not contain any of the project markups or functional cost items referenced above.

1.9 Final Array of Alternatives

The nineteen restoration alternatives, listed in Attachment 1, were analyzed as described in the Economics and Plan Formulation Appendix to identify the final array of alternatives. The final array consists of four alternatives that have been renamed to identify the recombination of restoration components. Each of the final array alternatives include a mixture of components taken from the initial nineteen alternatives and the table below includes the alternatives and reaches that compose the final array. The right hand column of the Table 1.1 includes the reaches and lists the preliminary array of nineteen alternatives from which the measures included in the final array originated.

Table 1.1 Final Array of Alternatives Summarized

Final Array Name	Reaches and Alternatives	
10 **ARBOR Riparian Transitions (ART)**	Reach 1 - A11 Reach 2 - A11 Reach 3 - A17 Reach 4 - A16	Reach 5 - A16 Reach 6 - A14 Reach 7 - A9 Reach 8 - A15
13 **ARBOR Corridor Extension (ACE)**	Reach 1 - A11 Reach 2 - A11 Reach 3 - A16 Reach 4 - A16	Reach 5 - A16 Reach 6 - A13 Reach 7 - A12 Reach 8 - A15

16 **ARBOR Narrows to Downtown (AND)**	Reach 1 - A11 Reach 2 - A11 Reach 3 - A16 Reach 4 - A16	Reach 5 - A5 Reach 6 – A13 Reach 7 - A12 Reach 8 - A3
20 **ARBOR Riparian Integration via Varied Ecological Reintroduction (RIVER)**	Reach 1 - A11 Reach 2 - A13 Reach 3 - A18 Reach 4 - A16	Reach 5 - A5 Reach 6 - A13 Reach 7 - A16 Reach 8 - A3

Total first costs (not including O&M, interest during construction, or escalation) for the final array of alternatives are summarized in Table 1.2, and a detailed breakdown of costs can be found in Attachment 5.

1.9.1 Recreation Costs

Recreation costs that were developed for the final array of alternatives are included in Table 1.2. The recreation plan includes modifications, upgrades, and creation of multi-use trails and amenities (access points, wildlife viewpoints, parking lots, restrooms and signage). The plan also includes several non-motorized multi-use bridges that span the river and tributaries.

A detailed discussion of the Recreation plan can be found in Appendix B (Economic Appendix), and detailed cost estimates of the Recreation items can be found in Attachment 6 here within. As described in the Appendix B the recreation plan was refined for Alternatives 13 and 20. The costs for those two recreation plans have been developed in MCACES.

1.9.2 Abbreviated Risk Analysis

An Abbreviated Risk Analysis (ARA) was completed in order to develop the contingencies for the Channels; Planning, Engineering and Design; and Construction Management feature accounts of the four final array alternatives. A single risk register was developed due to the similarity of the construction components between each of the four alternatives. The individual construction element contingencies calculated from the risk register were then pulled out and applied to each alternative's construction costs to generate the weighted construction contingencies seen in Table 1.2. The ARA and the calculated construction contingency spreadsheet can be found in Attachment 7.

Table 1.2 Final Array of Alternatives Cost Estimates by Work Breakdown Structure

Alt 10 - ARBOR Riparian Transitions (ART)

WBS No.	Feature Account	First Costs	Contingency (%)	Total Costs
01	Lands and Damages	$247,425,237	20.00%	$296,910,284
02	Relocations[1]	$11,392,360	20.00%	$13,670,832
09	Channels	$39,947,368	38.83%	$55,456,944
14	Recreation	$4,543,482	35.00%	$6,133,701
30	Planning, Engineering and Design	$6,147,153	24.40%	$7,647,058
31	Construction Management	$3,632,409	26.25%	$4,585,916
			Total Project Cost:	**$384,404,735**

1) Relocation cost and contingency provided by USACE.

Alt 13 - ARBOR Corridor Extension (ACE)

WBS No.	Feature Account	First Costs	Contingency (%)	Total Costs
01	Lands and Damages	$250,048,826	20.00%	$300,058,591
02	Relocations[1]	$11,392,360	20.00%	$13,670,832
09	Channels	$88,459,438	36.01%	$120,312,641
14	Recreation	$4,543,482	35.00%	$6,133,701
30	Planning, Engineering and Design	$11,483,481	24.40%	$14,285,450
31	Construction Management	$6,785,693	26.25%	$8,566,938
			Total Project Cost:	**$463,028,152**

1) Relocation cost and contingency provided by USACE.

Alt 16 - ARBOR Narrows to Downtown (AND)

WBS No.	Feature Account	First Costs	Contingency (%)	Total Costs
01	Lands and Damages	$278,031,210	20.00%	$333,637,452
02	Relocations[1]	$35,422,360	32.14%	$46,805,411
09	Channels	$261,753,170	37.89%	$360,927,221
14	Recreation	$4,543,482	35.00%	$6,133,701
30	Planning, Engineering and Design	$33,189,091	24.40%	$41,287,230
31	Construction Management	$19,611,736	26.25%	$24,759,816
			Total Project Cost:	**$813,550,831**

1) Relocation cost includes costs provided by the USACE and Railroad Bridge construction. Contingency is weighted average of contingencies provided by the USACE and calculated contingency from ARA.

Alt 20 - ARBOR Riparian Integration Via Varied Ecological Reintroduction (RIVER)

WBS No.	Feature Account	First Costs	Contingency (%)	Total Costs
01	Lands and Damages	$352,858,303	20.00%	$423,429,964
02	Relocations[1]	$49,072,002	31.46%	$64,511,752
09	Channels	$363,575,556	39.38%	$506,743,287
14	Recreation	$4,543,482	35.00%	$6,133,701
30	Planning, Engineering and Design	$45,891,014	24.40%	$57,088,422
31	Construction Management	$27,117,418	26.25%	$34,235,740
			Total Project Cost:	**$1,092,142,864**

1) Relocation cost includes costs provided by the USACE and Railroad Bridge construction. Contingency is weighted average of contingencies provided by the USACE and calculated contingency from ARA.

1.10 Alternatives Modification Addendum

Following public review, further analysis was performed that included a more detailed cost analysis using MCACES software, real estate cost updates, and further modified contingencies based upon a full cost risk summary analysis. This analysis identified a more cost effective variation on Alternative 13 (referred to throughout the IFR and Appendices as "Alternative 13v") that is identical to Alternative 13 except for Reach 7, where it includes the reach plan included in Alternative 20 that provides 10 acres of marsh and a connection to the Los Angeles State Historic Park. As described in the IFR, the previously identified NER Plan has been modified to include the substitution of the Reach 7 plan on the basis of the analysis referenced above; Alt 13v is the NER Plan. Because the analysis in this Appendix included analysis of all of the components of Alt 13v, no separate or additional analysis is necessary. For the assessment of Alt 13v for Reaches 1-6 and 8, see the Alternative 13 analysis included in this Appendix. For the assessment of Alt 13v for Reach 7, see the Alternative 20 analysis included in this Appendix.

Subsequent sections of this appendix are based upon Alternative 13v as the NER Plan.

2. MCACES (MII) CONSTRUCTION COST ESTIMATE – NATIONAL ECOSYSTEM RESTORATION PLAN

2.1 Introduction

2.1.1 General

Section 2 of this appendix documents the various unit costs and construction assumptions utilized for the Los Angeles River Ecosystem Restoration project's National Ecosystem Restoration (NER) Plan cost estimate. The NER Plan is Alternative 13v. This alternative incorporates various construction features as discussed below.

2.1.2 Purpose

The purpose of this work is to develop a detailed cost estimate for the Los Angeles River Ecosystem Restoration Project – consistent to the level of design – for the cost and quantities of the project features using Micro-Computer Aided Cost Estimating System (MCACES).

2.1.3 Design Features

The design features for the sub-reaches are designed at a conceptual level. Features for the NER Plan include concrete demolition; excavation and fill; riprap; grouted riprap; turf reinforcement mats; fencing; clearing and grubbing; reinforced cast-in-place concrete; sub-drainage system; asphalt; multi-use trail; trail access points; pedestrian bridges and other recreation components.

2.1.4 Design Limitations

As noted in Section 1 of this appendix, the current designs are based on preliminary, planning-level conceptual designs, and common engineering practices. The design level used to complete the MCACES construction cost estimate has not progressed beyond the level used at the alternatives analysis stage. More detailed assumptions have been developed for key construction items that were not included in the alternatives analysis, which primarily includes diversion and control of water elements.

2.2 Basis of Estimate

2.2.1 Basis of Design

Available design documents of the project elements are listed below

- Los Angeles River Feasibility Study Conceptual Design Drawings, Tetra Tech
- Los Angeles River Feasibility Study Design Report, Tetra Tech
- Los Angeles River As-Built Drawings, Various Dates, USACE

2.2.2 Basis of Quantities

The NER Plan cost estimate is based on the project quantity take-offs that have been calculated in accordance with the documents above. A quantity summary and detailed quantity take-offs that correspond to the MCACES cost estimate are found in Attachment 8, which is for official use only and available upon request.

2.3 Project Schedule

It is estimated that the overall project would take approximately 129 months. The durations used in the NER Plan estimate to determine costs for the contractor to maintain field facilities and provide construction supervision have been taken from the tentative project schedule's construction durations. A simplified tentative project schedule, that includes PED, is presented in Attachment 9. This schedule was developed with the following assumptions:

- Assumed durations for PED and all activities leading up to construction.
- Assumes construction starts at reach 6 and proceeds upstream. Reaches 7 and 8 would be constructed last in order to allow sufficient time for the LATC Relocation work.
- Assumes no in-channel construction from October 15th through April 15th.
- Assumes recreational items in a reach will be completed after all other construction activities are finished at that reach.

2.4 Acquisition Plan

The NER Plan cost estimate is based on five contracts being awarded to separate prime contractors with subcontractors for landscaping, asphalt, fencing and recreation item construction. Four of the contracts would consist of the primary ecosystem restoration construction activities, while the fifth contract would be for the LATC relocation efforts. The prime contractors would be responsible for all the preparatory work, and placing all associated site work as well as overseeing the subcontractors' work. The estimate currently assumes that the project would be let out in an unrestricted bid process and is expected to have a competitive bidding market. Also, no small business contracts are assumed due to the overall size of the project.

2.5 Project Construction

2.5.1 Mobilization/Demobilization

Mobilization and demobilization costs account for the transportation of all construction equipment and personnel to and from the project site. All equipment and labor is assumed to be available in the Los Angeles area.

2.5.2 Staging and Site Access

The project would require multiple staging and access roads throughout the reaches. The cost estimate assumes at least one staging area would be constructed in each reach along with at least

one stretch of access road. The staging areas and access roads are assumed to be cleared and grubbed, graded and have a gravel layer placed over them.

2.5.3 Borrow/Disposal Areas and Materials

All required construction materials are assumed to be available from the greater Los Angeles area. All material quotes include estimated deliver prices to the general project area.

All demolished materials are assumed to be hauled off-site for disposal. Excavated earth material is assumed to be hauled to a disposal site within 20-miles of the project. All asphalt and concrete materials are also assumed to be hauled within 20-miles of the site and disposed at a recycle plant or landfill.

2.5.4 Construction Methodology

- Contract 1 – Reach 6
    - Reach 6: Prior to the construction of the primary restoration measures, several utility towers would be relocated outside of the project footprint. Construction activities in this reach assume placing approximately 2,000-lf of inflatable cofferdams for water control. The inflatable dams are assumed to be used on the natural bottom sections of the channel. This length of cofferdam would require to be moved multiple times in order to complete construction. The construction work would include four restoration measures from the alternatives analysis, as well as construction of recreation components. These items are described below:
        - Measure 21/22 – The existing embankments would be excavated. Once complete a new asphalt access road and chain link fencing would be constructed.
        - Measure 16 – Bioengineering Channel Walls: This would require the placement of turf reinforcement mats along the banks. These mats would require a gravel tie-in section as well as installation of a chain link fence in certain sections to keep the public off the mats.
        - Measure 19 – Bioengineering Channel Walls: This would require the placement of turf reinforcement mats along the banks. These mats would require a gravel tie-in section as well.
        - Measure 17 – Habitat Corridors/Riparian Planting on Banks: The new banks would be vegetated after the other restoration measures are completed. This work is assumed to include placement of shrubs, trees and seeding. The area is also assumed to require temporary irrigation.
        - Recreation: This work is assumed to be completed after all restoration measures are in place. The items in this reach would include new unpaved trails, trail access points, restroom facilities, parking lot, a pedestrian tunnel and a pedestrian bridge.

- Contract 2 – Reaches 3, 4 and 5
    - Reach 5: Construction activities in this reach assume placing an inflatable cofferdam as required for the storm drain construction. This type of cofferdam is assumed to be used due to the natural bottom channel section found in this reach. The construction work would include one restoration measure from the alternatives analysis, as well as construction of recreation components. These items are described below:
        - Measure 2 – Daylight Streams: This work would involve taking the low flow from the existing storm drain into a wetland and return to the river through the storm drain system. Excavation would be required to access the existing storm drain components. The placing of a precast concrete storm drain that has a splitter that would send low flows out a 24-inch pipe that would outlet into a wetland area, while high flows from the existing drain would exit the storm drain through a 36-inch pipe that outlets into the river. The wetland area would be vegetated.
        - Recreation: This work is assumed to be completed after all restoration measures are in place. The items in this reach would include trail access points and wildlife viewpoints.
    - Reach 4: Construction activities in this reach assume placing small k-rail cofferdams for the side channel work and inflatable cofferdams for the in-channel work. The construction activities would include four restoration measures from the alternatives analysis, as well as construction of recreation components. These items are described below:
        - Measure 4 – Grade Adjacent Areas to Lower Elevation Side Channel (G): The existing slopes at side channel G would require excavation. It is assumed that all materials would be hauled off-site for disposal.
        - Measure 10 – Divert Tributary & River Flow into Side Channels (F): The banks alongside channel F would require excavation and riprap placement. It is assumed that all excavated materials would be hauled off-site for disposal.
        - Measure 3/5 – Create Geomorphology and Plant for Freshwater Marsh: This work requires the construction of grade control structures within the existing channel. These grade controls would require excavation, grouted riprap placement and compacted backfill. It is assumed that all the backfill material would come from the excavation work, and any excess material would be hauled off-site for disposal.
        - Measure 2 – Daylight Streams: This work would involve taking the low flow from the existing storm drain into a wetland and return to the river through the storm drain system. Excavation would be required to access the existing storm drain components. The placing of a precast concrete storm drain that has a splitter that would send low flows out a 24-inch pipe that

would outlet into a wetland area, while high flows from the existing drain would exit the storm drain through a 36-inch pipe that outlets into the river. The wetland area would be vegetated.

- Recreation: This work is assumed to be completed after all restoration measures are in place. The items in this reach would include conversion of existing access roads to un-paved multi-use trails, trail access points, and wildlife viewpoints.

- Reach 3: Construction activities in this reach assume placing small k-rail cofferdams for the side channel work and k-rail cofferdam down the center of the channel for the main channel work. The construction activities would include four restoration measures from the alternatives analysis, as well as construction of recreation components. These items are described below:

  - Measure 10 – Divert Tributary & River Flow into Side Channels (E): The banks alongside channel E would require excavation and riprap placement. It is assumed that excavated material required for compacted fill (in measure 3/5) will be stockpiled, and any excess hauled off-site.

  - Measure 3/5 – Create Geomorphology and Plant for Freshwater Marsh: This work requires the construction of grade control structures within the existing channel. These grade controls would require riprap and compacted backfill. It is assumed that all the backfill material would come from the excavation work at this reach, and any excess material would be hauled off-site for disposal.

  - Measure 2 – Daylight Streams: This work would involve taking the low flow from the existing storm drain into a wetland and return to the river through the storm drain system. Excavation would be required to access the existing storm drain components. The placing of a precast concrete storm drain that has a splitter that would send low flows out a 24-inch pipe that would outlet into a wetland area, while high flows from the existing drain would exit the storm drain through a 36-inch pipe that outlets into the river. The wetland area would be vegetated.

  - Measure 17 – Habitat Corridors/Riparian Planting on Banks: This reach would require new vegetation after the other restoration measures are completed. This work is assumed to include placement of shrubs, trees and seeding. The area is also assumed to require temporary irrigation.

  - Recreation: This work is assumed to be completed after all restoration measures are in place. The items in this reach would include conversion of existing access roads to un-paved multi-use trails, new unpaved trails and wildlife viewpoints.

- Contract 3 – Reaches 1 and 2
    - Reach 2: Construction activities in this reach assume all work is outside of the water levels and therefore do not require any dewatering efforts. The construction work would include one restoration measure from the alternatives analysis, as well as construction of recreation components. These items are described below:
        - Measure 17 – Habitat Corridors/Riparian Planting on Banks: This reach would require new vegetation to be placed along the existing banks. This work is assumed to include placement of shrubs, trees and seeding. The area is also assumed to require temporary irrigation.
        - Recreation: This work is assumed to be completed after all restoration measures are in place. The items in this reach would include existing trail improvements, new unpaved trails, trail access points, restroom facilities, and wildlife viewpoints.
    - Reach 1: Construction activities in this reach assume all work is outside of the water levels and therefore do not require any dewatering efforts. The construction work would include one restoration measure from the alternatives analysis, as well as construction of recreation components. These items are described below:
        - Measure 17 – Habitat Corridors/Riparian Planting on Banks: This reach would require new vegetation to be placed along the existing banks. This work is assumed to include placement of shrubs, trees and seeding. The area is also assumed to require temporary irrigation.
        - Recreation: This work is assumed to be completed after all restoration measures are in place. The items in this reach would include existing trail improvements, new unpaved trails and trail access points.
- Contract 4 – Reaches 7 and 8
    - Reach 8: Construction activities in this reach assume placing two k-rail cofferdams. These cofferdams would be used to control flows at the entrance and exit of the side channel into LATC. The construction work would include two restoration measures from the alternatives analysis, as well as construction of recreation components. These items are described below:
        - Measure 6 – Rebuild Geomorphology for Historic Wash (LATC): This area would require excavation and riprap placement. It is assumed that all excavated materials would be hauled off-site for disposal.
        - Measure 17 – Habitat Corridors/Riparian Planting on Banks: The LATC area would be re-vegetated after construction. This work is assumed to include placement of shrubs, trees and seeding. The area is also assumed to require temporary irrigation.

- Recreation: This work is assumed to be completed after all restoration measures are in place. The items in this reach would include new unpaved trails, trail access points, restroom facilities, parking lot and a pedestrian bridge.

- Reach 7: Prior to the construction of the primary restoration measures, several utility towers would be relocated outside of the project footprint. The primary construction activities in this reach assume placing a k-rail cofferdam down the middle of the channel for approximately half the length. One side of the channel would be constructed then, the cofferdam would be shifted such that the other side could be constructed. Then the cofferdam would be moved to the second half of the channel length to complete the work. The construction activities would include five restoration measures from the alternatives analysis, as well as construction of recreation components. These items are described below:

  - Measure 1 – Railroad Trestle: This work would involve the construction of a railroad trestle through this reach. The trestle work assumes only installing items directly associated with the trestle structure and the railroad track components (rails, ballast, ties, etc.). It is assumed that the trestle would be a concrete structure with pilings or caissons constructed to support the elevated deck and rails. This work is considered a relocation effort, and is therefore included under the 02 Account.

  - Measure 27 – Tributary Channels/Widen Channel (Arroyo Seco): The existing reinforced concrete channel wall and chain link fencing would be demolished. The embankment would be excavated as shown in the typical sections. It is assumed that all excavated materials would be hauled off-site for disposal. Once completed, turf reinforcement mats, a new asphalt access road, and chain link fencing would be constructed. Also, the area would be re-vegetated to include the placement of shrubs, trees and seeding. It is assumed that this area would require temporary irrigation.

  - Measure 8 – Corn Field: This area would require excavation. It is assumed that all excavated materials would be hauled off-site for disposal. Once completed, a new impermeable liner, asphalt access road, and chain link fencing would be constructed. Also, this area would be re-vegetated to include the placement of shrubs, trees and seeding. It is assumed that this area would require temporary irrigation.

  - Measure 26 – Terrace Banks: The existing reinforced concrete along the right bank would be demolished. This would involve removing the concrete and chain link fencing. Once completed, reinforced concrete planters, a new asphalt access road, and chain link fencing would be constructed. Also, the area would be re-vegetated to include the placement of shrubs, trees and seeding. It is assumed that this area would require temporary irrigation.

  - Measure 17 – Habitat Corridors/Riparian Planting on Banks: The new banks would be vegetated after all measure work is complete. This work is

assumed to include placement of shrubs, trees and seeding. The area is also assumed to require temporary irrigation.

- Measure 2 – Daylight Streams: This work would involve taking the low flow from the existing storm drain into a wetland and return to the river through the storm drain system. Excavation would be required to access the existing storm drain components. The placing of a precast concrete storm drain that has a splitter that would send low flows out a 24-inch pipe that would outlet into a wetland area, while high flows from the existing drain would exit the storm drain through a 36-inch pipe that outlets into the river. The wetland area would be vegetated.

- Contract 5- LATC Reach 8
  - Construction activities assume that the LATC Intermodal Facility would be replaced in kind at another location. The LATC is located in Reach 8 but the costs for this work are assumed to be under a separate contract that would be completed prior to Reach 8 being constructed. Costs for this work include providing similar infrastructure and operations to rail lines, replacing or removing rubber tires gantry cranes, reconstructing facilities at the new location, which would also include all new structures and security facilities. It is assumed that the NFS would provide this site as part of the LERRDs for the project.

2.5.5 Unusual Conditions

None anticipated to significantly impact the estimate.

2.5.6 Unique Construction Techniques

No unique construction techniques are anticipated to be required.

2.5.7 Equipment/Labor Availability and Distance Traveled

All equipment and labor is assumed to be available in the greater Los Angeles area.

2.6 Effective Dates for Labor, Equipment and Material Pricing

The labor, equipment, and material pricing were developed using the MCACES 2012 English Unit Cost Library, 2014 Los Angeles County Labor Library (see Attachment 10), and the 2011 Equipment Library (Region VII) for the base cost estimates. The index pricing data has been prepared in October 2014 dollars.

The cost estimate has been updated with current quoted fuel prices of $3.36/gal for off-road diesel, $4.11/gal for on-road diesel and $4.01/gal for gasoline in the Los Angeles area.

2.7 Estimated Production Rates

The estimate contains many user created cost items that were developed outside of the MCACES Unit Cost Library. These developed cost items have had crews and production rates created in

order to accurately calculate unit costs. See Attachment 11 for the Estimated Production Rate Calculations for these construction items.

2.8 Direct and Contractor Markups

2.8.1 Direct Markups

The cost estimate includes a 9% sales tax on all material cost items.

2.8.2 Contractor Markups

The prime contractor Job Office Overhead (JOOH) markups are based on calculated percentages currently within MCACES. The JOOH calculations are based on the estimated duration for all construction components. A running percentage has been used in the estimated for the prime contractor Home Office Overhead (HOOH) markup for all contracts. Profit is included for the prime contractors and is calculated using the profit weighted guideline calculation within MCACES. Bonding has also been included for all prime and sub-contractors.

2.9 Project Markups

2.9.1 Escalation

Price levels have been escalated from effective price levels of the construction cost estimate for October 2014 (1Q15) to the mid-points of construction for each contract. The appropriate escalation cost factors for each date and for each feature account have been calculated within the Total Project Cost Summary.

2.9.2 Contingency

An overall 33.8% contingency has been included in the estimate for all the feature accounts except for Lands and Damages and the LATC relocation contract. A separate contingency was developed for these two items, which was based on the incremental costs and general contingencies developed by the entity that completed the cost estimates for those components. A Cost and Schedule Risk Analysis (CSRA) has been performed to support the construction contingency listed above. See Attachment 12 for the full CSRA report for the NER Plan.

2.10 Functional Costs

2.10.1 01 Account – Lands and Damages

The current estimated cost for this account comes from the Real Estate Plan found in Appendix G of the main report. The costs include the real estate required to be purchased as well as business relocation costs. This account also includes incremental costs and other contingencies that have been used as the total contingency for this account within the TPCS.

2.10.2 02 Account – Relocations

The cost for this account includes costs for the relocation of existing utility towers, construction of the railroad trestles, and the relocation of the LATC Intermodal Facility. Only the costs for the

utility towers, trestles, and pipe lines were estimated in MCACES. The LATC facility was estimated as a Class IV estimate outside of MCACES, but input as a lump sum into the estimate for reference. The LATC facility is assumed to be replaced in kind at another location within the Los Angeles basin. The relocation costs for this facility is assumed to be a separate construction contract.

An assessment of the utilities within the project extent and the sub-measures for the study area have identified Reaches 6 and 7 as having facility/utility relocations. In Reach 6 there are five high voltage transmission line towers within the study area where there is planned channel widening, creation of marsh lands and planting of riparian habitat. In order to accomplish the sub-measures the area would need to be graded to a lower elevation and banks would need to be sloped back. In Reach 7, two transmission line towers have been identified as utility relocations. In this reach, the freshwater marsh would be restored and connected under a railroad trestle with the right bank of the river channel terraced.

According to the Real Estate Appendix, a preliminary real estate assessment following the guidelines set forth in Real Estate Policy Guidance Letter No. 31 was completed for the transmission towers in Reach 6 and 7. Based on the real estate assessment, the transmission towers are of the type eligible for compensation and Los Angeles Department of Water and Power (LADWP) has been identified with a compensable interest in the property in the cases where the LADWP has been identified as the fee owner of the right of way. Further real estate analysis will need to be completed to determine whether LADWP has a compensable interest in the property in reach 7. If LADWP is determined to have a compensable interest in the property the cost to relocate the identified utilities should be captured as a LERRD cost and not cost shared under the construction feature accounts.

The cost of relocating the large steel transmission towers found in Reaches 6 and 7 of the project area was developed based on research into similar construction activities on recent projects. The costs and methodologies from these other projects were incorporated into this unit cost. This utility tower work is considered a relocation component and therefore the costs for these relocations are included under the 02 – Relocations feature account.

2.10.3 06 Account – Fish and Wildlife Facilities

Costs for this account are based on the estimated construction costs for all construction activities referenced above that are not accounted for in the 02 or 14 feature accounts. This account was estimated within MCACES software.

2.10.4 06 Account – Fish and Wildlife Facilities (Monitoring & Adaptive Management)

Costs for this account are based on estimated costs for monitoring and adaptive management that has been provided by the Environmental Resource Branch of the Los Angeles District.

2.10.5 14 Account – Recreation

Costs for this account are based on the estimated construction costs for the recreation plan. These components were estimated with the MCACES program.

2.10.6 30 Account – Planning, Engineering and Design

Costs for this account were estimated as percentages of the construction costs for the various feature accounts. This account covers the preparation of plans, specifications, and engineering during construction. The percentages used for contracts one through four were provided and verified by the Los Angeles District's Cost Engineering & Specifications Section, while the PED percentage for the LATC work was estimated by the sub-contractor whom completed the relocation estimate. Table 2.1 provides the various PED percentages used for each feature account within each contract.

Table 2.1 PED Percentages by Contract

Contract	Reaches	WBS Items	PED Percent
1	Reach 6	02, 06, 14	14.5%
2	Reaches 3, 4 & 5	02, 06, 14	14.5%
3	Reaches 1 & 2	02, 06, 14	14.5%
4	Reaches 7 & 8	02, 06, 14	14.5%
5	LATC Relocation	02	3.5%

2.10.7 31 Account – Construction Management

Costs for this account were estimated as percentages of construction costs of the various feature accounts. This cost is assumed to cover construction management during construction. This percentage used for contracts one through seven was provided and verified by the Los Angeles District's Cost Engineering & Specifications Section, while the CM percentage for the LATC work was estimated by the sub-contractor whom completed the relocation estimate. Table 2.2 provides the various CM percentages used for each feature account within each contract.

Table 2.2 CM Percentages by Contract

Contract	Reaches	WBS Items	CM Percent
1	Reach 6	02, 06, 14	6.5%
2	Reaches 3, 4 & 5	02, 06, 14	6.5%
3	Reaches 1 & 2	02, 06, 14	6.5%
4	Reaches 7 & 8	02, 06, 14	6.5%
5	LATC Relocation	02	2.2%

2.11 MCACES Construction Cost Estimate

The construction cost estimate was developed using MCACES 2nd Generation (MII) cost estimating software in accordance with guidance contained in ER 1110-2-1302, Civil Works Cost Engineering. See Attachment 13 for the MCACES construction cost estimate summary output report.

2.12 Total Project Cost Summary (TPCS)

The TPCS was prepared using the latest TPCS Excel spreadsheet provided by the USACE, Walla Walla District. The TPCS incorporates the construction costs developed in the MII, the project markups, and the functional costs. See Attachment 14 for the TPCS spreadsheet.

The TPCS also contains the proposed cost share agreement between the Federal and Non-Federal agencies. The proposed cost share is atypical and more information on the cost share can be found in Chapter 7 of the Integrated Feasibility Report. The cost share agreement shown on the TPCS is estimated based on the following assumptions:

Table 2.3 NER Plan Proposed Cost Share

Feature Account	Federal Percent (%)	Non-Federal Percent (%)
01 – Lands and Damages[1]	0%	100%
02 – Relocations[1]	0%	100%
06 – Fish and Wildlife Facilities[2]	100%	0%
14 – Recreation	50%	50%
30 – Planning, Engineering, & Design (Ecosystem Restoration Only)	100%	0%
30 – Planning, Engineering, & Design (Recreation Only)	50%	50%
31 – Construction Management (Ecosystem Restoration Only)	100%	0%
31 – Construction Management (Recreation Only)	50%	50%
Notes: 1) Non-Federal PED and Construction Management Costs for Ecosystem Restoration are for Relocations and therefore considered part of LERRD's. 2) Federal Administration Cost – Federal administrative costs of LERRD acquisition oversight.		

3. MCACES (MII) CONSTRUCTION COST ESTIMATE – LOCALLY PREFERRED PLAN

3.1 Introduction

3.1.1 General

Section 3 of this appendix documents the various unit costs and construction assumptions utilized for the Los Angeles River Ecosystem Restoration project's locally preferred plan (LPP) cost estimate. The LPP is Alternative 20, ARBOR Riparian Integration via Varied Ecological Reintroduction (RIVER). This alternative incorporates various construction items from each of the eight reaches of the project.

3.1.2 Purpose

The purpose of this work is to develop a detailed cost estimate for the Los Angeles River Ecosystem Restoration Project – consistent to the level of design – for the cost and quantities of the project features using Micro-Computer Aided Cost Estimating System (MCACES).

3.1.3 Design Features

The design features for the sub-reaches are designed at a conceptual level (refer to section 1.3 of this appendix for discussion of individual design feature assumptions). Features for the LPP include concrete demolition; excavation and fill; riprap; grouted riprap; turf reinforcement mats; fencing; clearing and grubbing; reinforced cast-in-place concrete; sub-drainage system; asphalt; multi-use trail; trail access points; railroad trestles; pedestrian bridges and other recreation components.

3.1.4 Design Limitations

As noted in Section 1 of this appendix, the current designs are based on preliminary, planning-level conceptual designs, and common engineering practices. The design level used to complete the MCACES construction cost estimate has not progressed beyond the level used at the alternatives analysis stage. More detailed assumptions have been developed for key construction items that were not included in the alternatives analysis, which primarily includes diversion and control of water elements.

3.2 Basis of Estimate

3.2.1 Basis of Design

Available design documents of the project elements are listed below

- Los Angeles River Feasibility Study Conceptual Design Drawings, Tetra Tech
- Los Angeles River Feasibility Study Design Report, Tetra Tech
- Los Angeles River As-Built Drawings, Various Dates, USACE

3.2.2 Basis of Quantities

The LPP cost estimate is based on the project quantity take-offs that have been calculated in accordance with the documents above. A quantity summary and detailed quantity take-offs that correspond to the LPP MCACES cost estimate are found in Attachment 8.

3.3 Project Schedule

It is estimated that the overall project would take approximately 192 months. The durations used in the LPP estimate to determine costs for the contractor to maintain field facilities and provide construction supervision have been taken from the tentative project schedule's construction durations. A simplified tentative project schedule, that includes PED, is presented in Attachment 9. This schedule was developed with the following assumptions:

- Assumed durations for PED and all activities leading up to construction.
- Assumes no in-channel construction from October 15th through April 15th.
- Assumes recreational items in a reach will be completed after all other construction activities are finished at that reach.

3.4 Acquisition Plan

The LPP cost estimate is based on eight contracts being awarded to separate prime contractors with subcontractors for landscaping, asphalt, fencing, utilities, railroads and recreation item construction. Seven of the contracts would consist of the primary ecosystem restoration construction activities, while the eighth contract would be for the LATC relocation efforts. The prime contractors would be responsible for all the preparatory work, and placing all associated site work as well as overseeing the subcontractors' work. The estimate currently assumes that the project would be let out in an unrestricted bid process and is expected to have a competitive bidding market. Also, no small business contracts are assumed due to the overall size of the project.

3.5 Project Construction

3.5.1 Mobilization/Demobilization

Mobilization and demobilization costs account for the transportation of all construction equipment and personnel to and from the project site. All equipment and labor is assumed to be available in the Los Angeles area.

3.5.2 Staging and Site Access

The project would require multiple staging and access roads throughout the reaches. The cost estimate assumes at least one staging area would be constructed in each reach along with at least one stretch of access road. The staging areas and access roads are assumed to be cleared and grubbed, graded and have a gravel layer placed over them.

3.5.3 Borrow/Disposal Areas and Materials

All required construction materials are assumed to be available from the greater Los Angeles area. All material quotes include estimated deliver prices to the general project area.

All demolished materials are assumed to be hauled off-site for disposal. Excavated earth material is assumed to be hauled to a disposal site within 20-miles of the project. All asphalt and concrete materials are also assumed to be hauled within 20-miles of the site and disposed at a recycle plant or landfill.

3.5.4 Construction Methodology

- Contract 1 – Reach 6
    - Reach 6: Prior to the construction of the primary restoration measures, several utility towers would be relocated outside of the project footprint. The primary construction activities in this reach assume placing approximately 2,000-lf of inflatable cofferdams for water control. The inflatable dams are assumed to be used on the natural bottom sections of the channel. This length of cofferdam would be required to be moved multiple times in order to complete construction. The construction work would include four restoration measures from the alternatives analysis, as well as construction of recreation components. These items are described below:
        - Measure 21/22 – The existing embankments would be excavated. Once completed, a new asphalt access road and chain link fencing would be constructed.
        - Measure 16 – Bioengineering Channel Walls: This would require the placement of turf reinforcement mats along the banks. These mats would require a gravel tie-in section as well as installation of a chain link fence in certain sections to keep the public off the mats.
        - Measure 19 – Bioengineering Channel Walls: This would require the placement of turf reinforcement mats along the banks. These mats would require a gravel tie-in section as well.
        - Measure 17 – Habitat Corridors/Riparian Planting on Banks: The new banks would be vegetated after the other restoration measures are completed. This work is assumed to include placement of shrubs, trees and seeding. The area is also assumed to require temporary irrigation.
        - Recreation: This work is assumed to be completed after all restoration measures are in place. The items in this reach would include new unpaved trails, trail access points, restroom facilities, parking lot, a pedestrian tunnel, a pedestrian bridge, new paved trails, and wildlife viewpoints.

- Contract 2 – Reach 5
    - Reach 5: Construction activities in this reach assume placing an inflatable cofferdam as required for the storm drain construction. This type of cofferdam is assumed to be used due to the natural bottom channel section found in this reach. The construction work would include four restoration measures from the alternatives analysis, as well as construction of recreation components. These items are described below:
        - Measure 2 – Daylight Streams: This work would involve taking the low flow from the existing storm drain into a wetland and return to the river through the storm drain system. Excavation would be required to access the existing storm drain components. The placing of a precast concrete storm drain that has a splitter that would send low flows out a 24-inch pipe that would outlet into a wetland area, while high flows from the existing drain would exit the storm drain through a 36-inch pipe that outlets into the river. The wetland area would be vegetated.
        - Measure 26 – Terrace Banks: The existing reinforced concrete channel slope paving on the left bank would be demolished. This would involve removing the concrete, grouted riprap, spalls, chain link fencing, sheet piles, and asphalt-concrete access road. In addition, the left bank would require excavation as shown in the typical sections. Once completed, a new asphalt access road and concrete planters would be constructed.
        - Measure 27 – Modify Trapezoidal Channel to Vertical Sides: The existing reinforced concrete channel slope paving on the right bank would be demolished. This would involve removing the concrete, grouted riprap, spalls, sheet piles, chain link fencing, and asphalt-concrete access road. In addition, the right bank would require excavation as shown in the typical sections, riprap placement, retaining walls, and compacted backfill. Once completed, a new asphalt access road and chain link fencing would be constructed.
        - Measure 16 – Bioengineer Channel Walls – This reach would require new vegetation to be placed along the existing banks. This work is assumed to include placement of shrubs, trees and seeding. The area is also assumed to require temporary irrigation.
        - Recreation: This work is assumed to be completed after all restoration measures are in place. The items in this reach would include trail access points, wildlife viewpoints, and bridge underpasses.
- Contract 3 – Reach 4
    - Reach 4: Construction activities in this reach assume placing small k-rail cofferdams for the side channel work and inflatable cofferdams for the in-channel work. The construction activities would include four restoration measures from the

alternatives analysis, as well as construction of recreation components. These items are described below:

- Measure 4 – Grade Adjacent Areas to Lower Elevation Side Channel (G): The existing slopes at side channel G would require excavation. It is assumed that all materials would be hauled off-site for disposal.
- Measure 10 – Divert Tributary & River Flow into Side Channels (F): The banks alongside channel F would require excavation and riprap placement. It is assumed that all excavated materials would be hauled off-site for disposal.
- Measure 3/5 – Create Geomorphology and Plant for Freshwater Marsh: This work requires the construction of grade control structures within the existing channel. These grade controls would require excavation, grouted riprap placement and compacted backfill. It is assumed that all the backfill material would come from the excavation work, and any excess material would be hauled off-site for disposal.
- Measure 2 – Daylight Streams: This work would involve taking the low flow from the existing storm drain into a wetland and return to the river through the storm drain system. Excavation would be required to access the existing storm drain components. The placing of a precast concrete storm drain that has a splitter that would send low flows out a 24-inch pipe that would outlet into a wetland area, while high flows from the existing drain would exit the storm drain through a 36-inch pipe that outlets into the river. The wetland area would be vegetated.
- Recreation: This work is assumed to be completed after all restoration measures are in place. The items in this reach would include new unpaved trails, conversion of existing access roads to un-paved multi-use trails, trail access points, wildlife viewpoints, and a bridge underpass.

- Contract 4 – Reach 7
  - Reach 7: Prior to the construction of the primary restoration measures, several utility towers would be relocated outside of the project footprint. The primary construction activities in this reach assume placing a k-rail cofferdam down the middle of the channel for approximately half the length. One side of the channel would be constructed then, the cofferdam would be shifted such that the other side could be constructed. Then the cofferdam would be moved to the second half of the channel length to complete the work. The construction activities would include five restoration measures from the alternatives analysis, as well as construction of recreation components. These items are described below:
    - Measure 1 – Railroad Trestle: This work would involve the construction of a railroad trestle through this reach. The trestle work assumes only installing items directly associated with the trestle structure and the railroad track components (rails, ballast, ties, etc.). It is assumed that the trestle would be

a concrete structure with pilings or caissons constructed to support the elevated deck and rails. This work is considered a relocation effort, and is therefore included under the 02 Account.

- Measure 27 – Tributary Channels/Widen Channel (Arroyo Seco): The existing reinforced concrete channel wall and chain link fencing would be demolished. The embankment would be excavated as shown in the typical sections. It is assumed that all excavated materials would be hauled off-site for disposal. Once completed, turf reinforcement mats, a new asphalt access road, and chain link fencing would be constructed. Also, the area would be re-vegetated to include the placement of shrubs, trees and seeding. It is assumed that this area would require temporary irrigation.

- Measure 8 – Corn Field: This area would require excavation. It is assumed that all excavated materials would be hauled off-site for disposal. Once completed, a new impermeable liner, asphalt access road, and chain link fencing would be constructed. Also, this area would be re-vegetated to include the placement of shrubs, trees and seeding. It is assumed that this area would require temporary irrigation. Baker Street would also be reconstructed to have a precast concrete box culvert placed underneath it.

- Measure 26 – Terrace Banks: The existing reinforced concrete along the right bank would be demolished. This would involve removing the concrete and chain link fencing. Once completed, reinforced concrete planters, a new asphalt access road, and chain link fencing would be constructed. Also, the area would be re-vegetated to include the placement of shrubs, trees and seeding. It is assumed that this area would require temporary irrigation.

- Measure 17 – Habitat Corridors/Riparian Planting on Banks: The new banks would be vegetated after all measure 17 work is complete. This work is assumed to include placement of shrubs, trees and seeding. The area is also assumed to require temporary irrigation.

- Measure 2 – Daylight Streams: This work would involve taking the low flow from the existing storm drain into a wetland and return to the river through the storm drain system. Excavation would be required to access the existing storm drain components. The placing of a precast concrete storm drain that has a splitter that would send low flows out a 24-inch pipe that would outlet into a wetland area, while high flows from the existing drain would exit the storm drain through a 36-inch pipe that outlets into the river. The wetland area would be vegetated.

- Recreation: This work is assumed to be completed after all restoration measures are in place. The items in this reach would include existing trail improvements, new unpaved trails, trail access points, wildlife viewpoints, bridge underpasses, and new paved trails.

- Contract 5 – Reach 3
    - Reach 3: Construction activities in this reach assume placing small k-rail cofferdams for the side channel work and k-rail cofferdam down the center of the channel for the main channel work. The construction activities would include four restoration measures from the alternatives analysis, as well as construction of recreation components. These items are described below:
        - Measure 10 – Divert Tributary & River Flow into Side Channels (E): The banks alongside channel E would require excavation and riprap placement. It is assumed that excavated material required for compacted fill (in measure 3/5) will be stockpiled, and any excess hauled off-site.
        - Measure 3/5 – Create Geomorphology and Plant for Freshwater Marsh: This work requires the construction of grade control structures within the existing channel. These grade controls would require riprap and compacted backfill. It is assumed that all the backfill material would come from the excavation work at this reach, and any excess material would be hauled off-site for disposal.
        - Measure 25 – Tributary Channels – Verdugo Wash: The existing reinforced concrete channel walls would be demolished. This would involve removing the concrete, sub-drainage system, and chain link fencing. The embankment would be excavated as shown in the typical sections. It is assumed that all excavated materials would be hauled off-site for disposal. Once completed, riprap, turf reinforcement mats with gravel tie-in section, a new asphalt access road, topsoil, vegetation and chain link fencing would be constructed.
        - Measure 17 – Habitat Corridors/Riparian Planting on Banks: This reach would require new vegetation after the other restoration measures are completed. This work is assumed to include placement of shrubs, trees and seeding. The area is also assumed to require temporary irrigation.
        - Recreation: This work is assumed to be completed after all restoration measures are in place. The items in this reach would include new unpaved trails, conversion of existing access roads to un-paved multi-use trails, wildlife viewpoints, trail improvements, trail access points, a bridge underpass, and a pedestrian bridge.
- Contract 6 – Reaches 1 and 2
    - Reach 2: Construction activities in this reach assume placing an inflatable cofferdam as required for the storm drain construction. This type of cofferdam is assumed to be used due to the natural bottom channel section found in this reach. The construction work would include three restoration measure from the alternatives analysis, as well as construction of recreation components. These items are described below:

- Measure 27 – Modify Trapezoidal Channel to Vertical Sides: The existing reinforced concrete channel slope paving along the right bank would be demolished. This would involve removing the concrete, grouted riprap, spalls, sheet piles, chain link fencing, and asphalt-concrete access road. In addition, this work requires riprap placement and compacted backfill. A new asphalt access road, retaining walls, sub-drainage system pipe, and chain link fencing would be constructed.

- Measure 16 – Bioengineer Channel Walls: This would require the placement of turf reinforcement mats along the banks. These mats would require a gravel tie-in section as well as installation of a chain link fence in certain sections to keep the public off the mats.

- Measure 17 – Habitat Corridors/Riparian Planting on Banks: This reach would require new vegetation to be placed along the existing banks. This work is assumed to include placement of shrubs, trees and seeding. The area is also assumed to require temporary irrigation.

- Recreation: This work is assumed to be completed after all restoration measures are in place. The items in this reach would include existing trail improvements, new unpaved trails, and restroom facilities.

- Reach 1: Construction activities in this reach assume all work is outside of the water levels and therefore do not require any dewatering efforts. The construction work would include one restoration measure from the alternatives analysis, as well as construction of recreation components. These items are described below:

  - Measure 17 – Habitat Corridors/Riparian Planting on Banks: This reach would require new vegetation to be placed along the existing banks. This work is assumed to include placement of shrubs, trees and seeding. The area is also assumed to require temporary irrigation.

  - Recreation: This work is assumed to be completed after all restoration measures are in place. The items in this reach would include existing trail improvements, new unpaved trails, and trail access points.

- Contract 7 – Reach 8

  - Reach 8: Prior to the primary restoration measures, several utility towers, a 24" VCP line and a 54" concrete sewer line would require relocation. Primary construction activities in this reach assume placing two k-rail cofferdams. These cofferdams would be used to control flows at the entrance and exit of the side channel into LATC. The construction work would include seven restoration measures from the alternatives analysis, as well as construction of recreation components. These items are described below:

    - Measure 1 – Railroad Trestle: This work would involve the construction of a railroad trestle through this reach. The trestle work assumes only installing items directly associated with the trestle structure and the railroad track

components (rails, ballast, ties, etc.). It is assumed that the trestle would be a concrete structure with pilings or caissons constructed to support the elevated deck and rails. This work is considered a relocation effort, and is therefore included under the 02 Account.

- Measure 3 – Create Geomorphology and Plant for Freshwater Marsh: This work requires the construction of grade control structures within the existing channel. These grade controls would require excavation, grouted riprap placement, and compacted backfill. It is assumed that all the backfill material would come from the excavation work, and any excess material would be hauled off-site for disposal. Also, a portion of the channel would be re-vegetated after construction to include the placement of shrubs, trees and seeding. It is assumed that this area would require temporary irrigation.
- Measure 6 – Rebuild Geomorphology for Historic Wash (LATC): This area would require excavation and riprap placement. It is assumed that all excavated materials would be hauled off-site for disposal.
- Measure 10 – Divert Tributary & River Flow into Side Channels (LATC): The banks along the channels would require excavation and riprap placement. It is assumed that all excavated materials would be hauled off-site for disposal.
- Measure 17 – Habitat Corridors/Riparian Planting on Banks: The LATC area would be re-vegetated after construction. This work is assumed to include placement of shrubs, trees and seeding. The area is also assumed to require temporary irrigation.
- Measure 21 – Lower Channel Banks and Provide Setback Levees or Berms: This work requires excavation of the existing embankments and riprap placement. Once completed, a new asphalt access road and chain link fencing would be constructed.
- Measure 26 – Terrace Banks: The existing reinforced concrete channel slope paving and parapet would be demolished along both banks. This would involve removing the concrete, spalls, and chain link fencing. In addition, the embankments would be excavated and riprap would be placed as shown in the typical sections.
- Recreation: This work is assumed to be completed after all restoration measures are in place. The items in this reach would include new unpaved trails, trail access points, restroom facilities, parking lot, pedestrian bridges, and wildlife viewpoints.

- Contract 8- LATC Relocation Contract
  - Construction activities assume that the LATC Intermodal Facility would be replaced in kind at another location. The LATC is located in Reach 8 but the costs for this work are assumed to be under a separate contract that would be completed

prior to Reach 8 being constructed. Costs for this work include providing similar infrastructure and operations to rail lines, replacing or removing rubber tires gantry cranes, reconstructing facilities at the new location, which would also include all new structures and security facilities. It is assumed that the NFS would provide this site as part of the LERRDs for the project.

3.5.5 Unusual Conditions

None anticipated to significantly impact the estimate.

3.5.6 Unique Construction Techniques

No unique construction techniques are anticipated to be required.

3.5.7 Equipment/Labor Availability and Distance Traveled

All equipment and labor is assumed to be available in the greater Los Angeles area.

3.6 Effective Dates for Labor, Equipment and Material Pricing

The labor, equipment, and material pricing were developed using the MCACES 2012 English Unit Cost Library, 2014 Los Angeles County Labor Library (see Attachment 10), and the 2011 Equipment Library (Region VII) for the base cost estimates. The index pricing data has been prepared in October 2014 dollars.

The cost estimate has been updated with current quoted fuel prices of $3.36/gal for off-road diesel, $4.11/gal for on-road diesel and $4.01/gal for gasoline in the Los Angeles area.

3.7 Estimated Production Rates

The estimate contains many user created cost items that were developed outside of the MCACES Unit Cost Library. These developed cost items have had crews and production rates created in order to accurately calculate unit costs. See Attachment 11 for the Estimated Production Rate Calculations for these construction items.

3.8 Direct and Contractor Markups

3.8.1 Direct Markups

The cost estimate includes a 9% sales tax on all material cost items.

3.8.2 Contractor Markups

The prime contractor Job Office Overhead (JOOH) markups are based on calculated percentages currently within MCACES. The JOOH calculations are based on the estimated duration for all construction components. A running percentage has been used in the estimated for the prime contractor Home Office Overhead (HOOH) markup for all contracts. Profit is included for the prime contractors and is calculated using the profit weighted guideline calculation within MCACES. Bonding has also been included for all prime and sub-contractors.

3.9 Project Markups

3.9.1 Escalation

Price levels have been escalated from effective price levels of the construction cost estimate for October 2014 (1Q15) to the mid-points of construction for each contract. The appropriate escalation cost factors for each date and for each feature account have been calculated within the Total Project Cost Summary.

3.9.2 Contingency

An overall 36.8% contingency has been included in the estimate for all the feature accounts except for Lands and Damages and the LATC relocation contract. A separate contingency was developed for these two items, which was based on the incremental costs and general contingencies developed by the entity that completed the cost estimates for those components. A Cost and Schedule Risk Analysis (CSRA) has been performed to support the construction contingency listed above. See Attachment 12 for the full CSRA report for the LPP.

3.10 Functional Costs

3.10.1 01 Account – Lands and Damages

The current estimated cost for this account comes from the Real Estate Plan found in Appendix G of the main report. The costs include the real estate required to be purchased as well as business relocation costs. This account also includes incremental costs and other contingencies that have been used as the total contingency for this account within the TPCS.

3.10.2 02 Account – Relocations

The cost for this account includes costs for the relocation of existing utility towers, construction of the railroad trestles, the relocation of several pipe lines running through the project footprint and the relocation of the LATC Intermodal Facility. Only the costs for the utility towers, trestles, and pipe lines were estimated in MCACES. The LATC facility was estimated as a Class IV estimate outside of MCACES, but input as a lump sum into the estimate for reference. The LATC facility is assumed to be replaced in kind at another location within the Los Angeles basin. The relocation costs for this facility is assumed to be a separate construction contract.

An assessment of the utilities within the project extent and the sub-measures for the study area have identified Reaches 6, 7 and 8 as having facility/utility relocations. In Reach 6 there are five high voltage transmission line towers within the study area where there is planned channel widening, creation of marsh lands and planting of riparian habitat. In order to accomplish the sub-measures the area would need to be graded to a lower elevation and banks would need to be sloped back. In Reach 7, two transmission line towers have been identified as utility relocations. In this reach, the freshwater marsh would be restored and connected under a railroad trestle with the right bank of the river channel terraced. Lastly in Reach 8, five transmission towers have been identified for relocation in order to trestle the rail road tracks and remove the channel wall creating connectivity between the river and the marsh land that would be created at the LATC site.

According to the Real Estate Appendix, a preliminary real estate assessment following the guidelines set forth in Real Estate Policy Guidance Letter No. 31 was completed for the transmission tower in Reach 6, 7 and 8. Based on the real estate assessment, the transmission towers are of the type eligible for compensation and Los Angeles Department of Water and Power (LADWP) has been identified with a compensable interest in the property in the cases where the LADWP has been identified as the fee owner of the right of way. Further real estate analysis will need to be completed to determine whether LADWP has a compensable interest in the property in reaches 7 and 8. If LADWP is determined to have a compensable interest in the property the cost to relocate the identified utilities should be captured as a LERRD cost and not cost shared under the construction feature accounts.

The cost of relocating the large steel transmission towers found in Reaches 6 and 7 of the project area was developed based on research into similar construction activities on recent projects. The costs and methodologies from these other projects were incorporated into the unit cost. This utility tower work is considered a relocation component and therefore the costs for these relocations are included under the 02 – Relocations feature account.

3.10.3 30 Account – Planning, Engineering and Design

Costs for this account were estimated as percentages of the construction costs for the various feature accounts. This account covers the preparation of plans, specifications, and engineering during construction. The percentages used for contracts one through seven were provided and verified by the Los Angeles District's Cost Engineering & Specifications Section, while the PED percentage for the LATC work was estimated by the sub-contractor whom completed the relocation estimate. Table 3.1 provides the various PED percentages used for each feature account within each contract.

Table 3.1 PED Percentages by Contract

Contract	Reaches	WBS Items	PED Percent
1	Reach 6	02, 06, 14	14.5%
2	Reach 5	02, 06, 14	14.5%
3	Reach 4	02, 06, 14	14.5%
4	Reach 7	02, 06, 14	14.5%
5	Reach 3	02, 06, 14	14.5%
6	Reaches 1 & 2	02, 06, 14	14.5%
7	Reach 8	02, 06, 14	14.5%
8	LATC Relocation	02	3.5%

3.10.4 31 Account – Construction Management

Costs for this account were estimated as percentages of construction costs of the various feature accounts. This cost is assumed to cover construction management during construction. This percentage used for contracts one through seven was provided and verified by the Los Angeles District's Cost Engineering & Specifications Section, while the CM percentage for the LATC work was estimated by the sub-contractor whom completed the relocation estimate. Table 3.2 provides the various CM percentages used for each feature account within each contract.

Table 3.2 CM Percentages by Contract

Contract	Reaches	WBS Items	CM Percent
1	Reach 6	02, 06, 14	6.5%
2	Reach 5	02, 06, 14	6.5%
3	Reach 4	02, 06, 14	6.5%
4	Reach 7	02, 06, 14	6.5%
5	Reach 3	02, 06, 14	6.5%
6	Reaches 1 & 2	02, 06, 14	6.5%
7	Reach 8	02, 06, 14	6.5%
8	LATC Relocation	02	2.2%

3.11 MCACES Construction Cost Estimate

The construction cost estimate was developed using MCACES 2nd Generation (MII) cost estimating software in accordance with guidance contained in ER 1110-2-1302, Civil Works Cost Engineering. See Attachment 13 for the MCACES construction cost estimate summary output report for the LPP.

3.12 Total Project Cost Summary (TPCS)

The TPCS was prepared using the latest TPCS Excel spreadsheet provided by the USACE, Walla Walla District. The TPCS incorporates the construction costs developed in the MII, the project markups, and the functional costs. See Attachment 14 for the TPCS spreadsheet for the LPP.

The TPCS also contains the proposed cost share agreement between the Federal and Non-Federal agencies. Per CECW memorandum dated 3 July 2014 it was directed that the reporting officers present two cost sharing options for the LPP. Those cost sharing options are described in detail in Chapter 7 of the Integrated Feasibility Report. The report does not provide a recommendation for cost sharing, any recommendation to deviate from standard cost sharing percentages will require specific statutory language to be authorized.

The Lands and Damages costs shown under the LERRDs in the TPCS include some costs for federal administration, which are not part of LERRDs. Also, a portion of the PED and Construction Management costs relate to Relocations, and are therefore a LERRDs costs. The IFR identifies these specific costs and categorizes them appropriately in cost apportionment tables.

The following tables provide the basis for the two cost sharing options shown on the TPCS.

Table 3.3 LPP Proposed Cost Share – OPTION 1

Feature Account	Federal Percent (%)	Non-Federal Percent (%)
01 – Lands and Damages	0%	100%
01 – Federal Administrative Costs	100%	0%
02 – Relocations	0%	100%
06 – Fish and Wildlife Facilities	NER*	LPP – NER**
14 – Recreation	50%	50%
30 – Planning, Engineering, & Design (Ecosystem Restoration Only)	NER*	LPP – NER**
30 – Planning, Engineering, & Design (Relocations)	0%	100%
30 – Planning, Engineering, & Design (Recreation Only)	50%	50%
31 – Construction Management (Ecosystem Restoration Only)	NER*	LPP – NER**
31 – Construction Management (Relocations)	0%	100%
31 – Construction Management (Recreation Only)	50%	50%
Notes: * Federal sponsors would pay for the cost of the feature account from the NER Plan. ** The Non-Federal sponsors would pay the difference of the current LPP costs minus the NER cost for the given feature account.		

Table 3.4 LPP Proposed Cost Share – OPTION 2

Feature Account	Federal Percent (%)	Non-Federal Percent (%)
01 – Lands and Damages	0%	100%
01 – Federal Administrative Costs	100%	0%
02 – Relocations	0%	100%
06 – Fish and Wildlife Facilities	100%	0%
14 – Recreation	50%	50%
30 – Planning, Engineering, & Design (Ecosystem Restoration Only)	100%	0%
30 – Planning, Engineering, & Design (Relocations)	0%	100%
30 – Planning, Engineering, & Design (Recreation Only)	50%	50%
31 – Construction Management (Ecosystem Restoration Only)	100%	0%
31 – Construction Management (Relocations)	0%	100%
31 – Construction Management (Recreation Only)	50%	50%
Adjustment to Cost Sharing, per Option 2	- 15% of Total Project First Cost for Ecosystem Restoration	+ 15% of Total Project First Cost for Ecosystem Restoration
Notes: For the ecosystem restoration component of the project, the Non-Federal sponsor would be required to provide a cash contribution of 15% of the total project first cost of the LPP ecosystem restoration plan, in addition to providing all LERRDs (including PED and Construction Management costs for Relocations).		

4. REFERENCES

- U.S. Army Corps of Engineers, 1993, *Engineering and Design Cost Engineering Policy and General Requirements, Engineering Regulation 1110-1-1300,* Department of the Army, Washington D.C., 26 March 1993.

- U.S. Army Corps of Engineers, 1999, *Engineering and Design For Civil Works Projects, Engineering Regulation 1110-2-1150,* Department of the Army, Washington D.C., 31 August 1999.

- U.S. Army Corps of Engineers, 2008a, *Civil Works Cost Engineering, Engineering Regulation 1110-2-1302,* Department of the Army, Washington D.C., 15 September 2008.

- U.S. Army Corps of Engineers, 2008b, *Construction Cost Estimating Guide For Civil Works, Engineering Technical Letter 1110-2-573,* Department of the Army, Washington D.C., 30 September 2008.

- U.S. Army Corps of Engineers, 2010, *Civil Works Construction Cost Index System, Engineering Manual 1110-2-1304,* Department of the Army, Washington D.C., 31 March 2014

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Cost Appendix

Attachment 1
Alternatives Matrix of Construction Costs

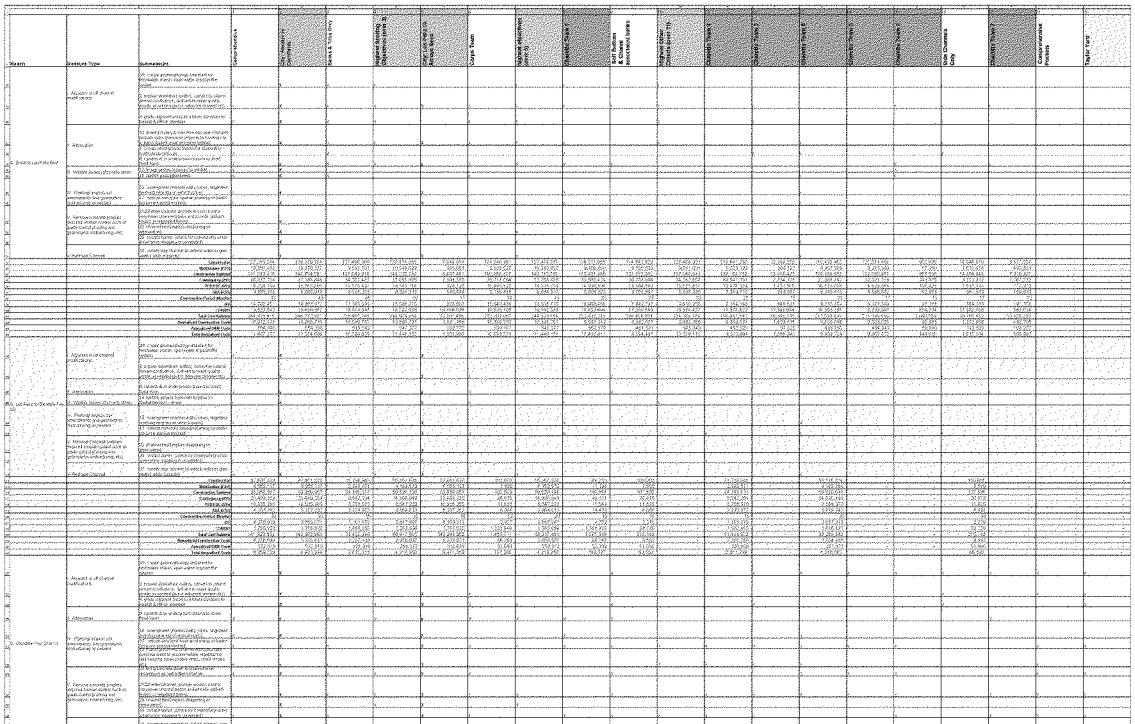
April 2015

LOS ANGELES RIVER CORP ESTIMATE
ALTERNATIVES MATRIX

X: Indicates that the measure is included in the alternative

Y: Preliminary error included cy-nots or basins.

LOS ANGELES RIVER COST ESTIMATE
ALTERNATIVES MATRIX



X: Indicates that the measure is included in the alternative.

y: Preliminary assay included culverts or basins.

LOS ANGELES RIVER COST ESTIMATE
ALTERNATIVES MATRIX

X: Indicates that this measure is included in the alternative

Y: Preliminary since included cul-de-sacs or basins.

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Cost Appendix

Attachment 2
Quantity Take-Offs

April 2015

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Cost Appendix

Attachment 3
Spreadsheet Estimate Summaries

April 2015

LOS ANGELES RIVER FEASIBILITY

SUMMARY OF CONSTRUCTION COSTS

Date: 24-Apr-13

REACH NO.		REACH / SUB-MEASURE DESCRIPTION	UOM	QUANTITY		ANNUAL O&M COST
1		**Pollywog Park/Headworks to Midpoint of Betty Davis Park**				
		Mobilization / Demobilization	LS	1	$	13,840,408
	2	Expose Storm Drain Outlets	LS	1	$	300,000
	3	Create Geomorphology and Plant Freshwater Marsh	LS	1	$	3,602,720
	7	Create Underground Basins for Attenuation	LS	1	$	113,400,000
	10	Divert Tributary & River Flow into Side Channels (A, B, & C)	LS	1	$	17,771,927
	16	Bioengineer Channel Walls	LS	1	$	2,703,283
	17	Habitat Corridors/Riparian Planting on Banks	LS	1	$	1,460,173
	23	Channel Bed	LS	1	$	16,707,980
	25	Tributary Channels - Burbank Channel	LS	1	$	6,767,099
	26	Terrace Banks	LS	1	$	20,888,649
	27	Modify Trapezoidal Channel to Vertical Sides	LS	1	$	936,944
				Total Cost Reach 1:	$	*198,379,183*
2		**Midpoint Betty Davis Park to upstream end of Ferraro Fields**				
		Mobilization / Demobilization	LS	1	$	3,694,944
	2	Expose Storm Drain Outlets	LS	1	$	300,000
	3	Create Geomorphology and Plant Freshwater Marsh	LS	1	$	3,332,465
	9	Culverts or Underground Basins	LS	1	$	10,530,000
	10	Divert Tributary & River Flow into Side Channels (A, B, & C)	LS	1	$	3,959,245
	16	Bioengineer Channel Walls	LS	1	$	935,263
	17	Habitat Corridors/Riparian Planting on Banks	LS	1	$	41,962
	23	Channel Bed	LS	1	$	1,381,401
	26	Terrace Banks	LS	1	$	5,356,628
	27	Modify Trapezoidal Channel to Vertical Sides	LS	1	$	23,428,962
				Total Cost Reach 2:	$	*52,960,871*
3		**Ferraro Fields to Brazil St**				
		Mobilization / Demobilization	LS	1	$	16,182,731
	2	Expose Storm Drain Outlets	LS	1	$	600,000
	3	Create Geomorphology and Plant Freshwater Marsh	LS	1	$	8,030,949
	9	Culverts or Underground Basins	LS	1	$	75,600,000
	10	Divert Tributary & River Flow into Side Channels (E)	LS	1	$	6,239,813
	17	Habitat Corridors/Riparian Planting on Banks	LS	1	$	134,979
	23	Channel Bed	LS	1	$	6,339,819
	25	Tribuary Channels - Verdugo Wash	LS	1	$	47,584,437
	27	Modify Trapezoidal Channel to Vertical Sides	LS	1	$	71,239,755
				Total Cost Reach 3:	$	*231,952,484*

LOS ANGELES RIVER FEASIBILITY

SUMMARY OF CONSTRUCTION COSTS

REACH NO.		REACH / SUB-MEASURE DESCRIPTION	UOM	QUANTITY		ANNUAL O&M COST
4	**Brazil to Los Feliz Blvd**					
		Mobilization / Demobilization	LS	1	$	30,304,227
	2	Expose Storm Drain Outlets	LS	1	$	900,000
	3	Create Geomorphology and Plant Freshwater Marsh	LS	1	$	5,677,607
	4	Grade Adjacent Areas to Lower Elevation (G)	LS	1	$	1,978,350
	9	Culverts or Underground Basins	LS	1	$	265,680,000
	10	Divert Tributary & River Flow into Side Channels (A, B, & C)	LS	1	$	5,290,413
	16	Bioengineer Channel Walls	LS	1	$	501,406
	22	Channel Banks Mainstem/Widen Channel	LS	1	$	9,229,949
	23	Channel Bed	LS	1	$	1,157,000
	26	Terrace Banks	LS	1	$	113,641,639
				Total Cost Reach 4:	$	*434,360,591*
5	**Los Feliz to Glendale Fwy (2)**					
		Mobilization / Demobilization	LS	1	$	6,555,137
	2	Expose Storm Drain Outlets	LS	1	$	100,000
	16	Bioengineer Channel Walls	LS	1	$	149,250
	26	Terrace Banks	LS	1	$	31,784,946
	27	Modify Trapezoidal Channel to Vertical Sides	LS	1	$	55,367,624
				Total Cost Reach 5:	$	*93,956,957*
6	**Glendale Fwy (2) to I-5**					
		Mobilization / Demobilization	LS	1	$	7,645,291
	2	Expose Storm Drain Outlets	LS	1	$	100,000
	4	Grade Adjacent Areas to Lower Elevation (G)	LS	1	$	27,324,195
	9	Culverts or Underground Basins	LS	1	$	14,580,000
	16	Bioengineer Channel Walls	LS	1	$	7,958,437
	17	Habitat Corridors/Riparian Planting on Banks	LS	1	$	924,768
	19	Bioengineer Channel Walls	LS	1	$	1,901,667
	21	Lower Channel Banks and Provide Setback Levees or Berms	LS	1	$	7,615,328
	26	Terrace Banks	LS	1	$	41,532,815
				Total Cost Reach 6:	$	*109,582,501*

LOS ANGELES RIVER FEASIBILITY

SUMMARY OF CONSTRUCTION COSTS

Date: 24-Apr-13

REACH NO.		REACH / SUB-MEASURE DESCRIPTION	UOM	QUANTITY		ANNUAL O&M COST
7	**I-S to Main**					
		Mobilization / Demobilization	LS	1	$	12,560,232
	1	Elevate Railroads on Trestles	LS	1	$	5,000,000
	2	Expose Storm Drain Outlets	LS	1	$	300,000
	3	Create Geomorphology and Plant Freshwater Marsh	LS	1	$	42,681,863
	8	Creation of Wetlands Flood Control Basin (Corn Field)	LS	1	$	3,775,759
	17	Habitat Corridors/Riparian Planting on Banks	LS	1	$	194,299
	21	Lower Channel Banks and Provide Setback Levees or Berms	LS	1	$	20,967,364
	23	Channel Bed	LS	1	$	3,849,481
	27	Tributary Channels/Widen Channel (Arroyo Seco)	LS	1	$	2,660,707
	28	Widen Channel/Cantilever Channel Bank.	LS	1	$	88,040,283
				Total Cost Reach 7:	$	*180,029,987*
8	**Main to First**					
		Mobilization / Demobilization	LS	1	$	27,545,045
	1	Elevate Railroads on Trestles	LS	1	$	24,030,000
	2	Expose Storm Drain Outlets	LS	1	$	200,000
	3	Create Geomorphology and Plant Freshwater Marsh	LS	1	$	9,516,383
	6	Rebuild Geomorphology for Historic Wash (Piggyback Yard)	LS	1	$	11,074,093
	9	Culverts or Undergound Basins	LS	1	$	172,800,000
	10	Divert Tributary & River Flow Into Side Channels (Piggyback Yard	LS	1	$	16,570,920
	16	Bioengineer Channel Walls	LS	1	$	11,957,425
	17	Habitat Corridors/Riparian Planting on Banks	LS	1	$	191,148
	17	Habitat Corridors/Riparian Planting on Banks	LS	1	$	1,006,500
	21	Lower Channel Banks and Provide Setback Levees or Berms	LS	1	$	39,268,638
	23	Channel Bed	LS	1	$	16,114,155
	26	Terrace Banks	LS	1	$	7,875,698
	27	Modify Trapezoidal Channel to Vertical Sides	LS	1	$	11,850,562
	28	Widen Channel/Cantilever Channel Bank.	LS	1	$	45,818,249
				Total Cost Reach 8:	$	*395,818,817*

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Cost Appendix

Attachment 4
Operation and Maintenance Costs

April 2015

ANNUAL O&M COSTS FOR FINAL ARRAY OF ALTERNATIVES

10 ARBOR RIPARIAN TRANSITIONS (ART)

R/A	Sub Measure	Item Description	UOM	Quantity	Unit Cost	Total O&M Cost
R1A11	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 12,410	$ 12,410
R2A11	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 629	$ 629
R3A17	2	Expose Storm Drain Outlets	LS	1	$ 6,000	$ 6,000
R4A16	2	Expose Storm Drain Outlets	LS	1	$ 9,000	$ 9,000
	3/5	Create Geomorphology and Plant Freshwater Marsh	LS	1	$ 47,277	$ 47,277
	4	Grade Adjacent Areas to Lower Elevation (G)	LS	1	$ -	$ -
	10	Divert Tributary & River Flow Into Side Channels (F)	LS	1	$ 36,251	$ 36,251
R5A16	2	Expose Storm Drain Outlets	LS	1	$ 1,000	$ 1,000
R6A14	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 13,872	$ 13,872
	21/22	Lower Channel Banks and Provide Setback Levee or Berms	LS	1	$ 14,311	$ 14,311
R7A9	2	Expose Storm Drain Outlets	LS	1	$ 3,000	$ 3,000
R8A15	6	Rebuild Geomorphology for Historic Wash (Piggyback Yard)	LS	1	$ 32,523	$ 32,523
	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 15,098	$ 15,098
					O&M Subtotal (1):	$ 191,371
					Annual Misc. Inspection and Maintenance per Reach:	$ 50,000
					Total Inspection and Maintenance:	$ 400,000
					Invasive Species Management:	$ 84,000
					O&M Subtotal (2):	$ 675,371
					Contingency:	$ 236,380
					Total Annual O&M Cost:	$ 911,751

13 ARBOR Corridor Extension (ACE)

R/A	Sub Measure	Item Description	UOM	Quantity	Unit Cost	Total Cost
R1A11	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 12,410	$ 12,410
R2A11	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 629	$ 629
R3A16	2	Expose Storm Drain Outlets	LS	1	$ 6,000	$ 6,000
	3/5	Riprap	LS	1	$ 76,763	$ 76,763
	10	Excavation Embankment - Med. Haul Off	LS	1	$ 45,040	$ 45,040
	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 2,025	$ 2,025
R4A16	2	Expose Storm Drain Outlets	LS	1	$ 9,000	$ 9,000
	3/5	Create Geomorphology and Plant Freshwater Marsh	LS	1	$ 47,277	$ 47,277
	4	Excavation Embankment - All Haul Off	LS	1	$ -	$ -
	10	Divert Tributary & River Flow Into Side Channels (F)	LS	1	$ 36,251	$ 36,251
R5A16	2	Expose Storm Drain Outlets	LS	1	$ 1,000	$ 1,000
R6A13	16	Bioengineer Channel Walls	LS	1	$ 123,034	$ 123,034
	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 13,872	$ 13,872
	19	Bioengineer Channel Walls	LS	1	$ 28,525	$ 28,525
	21/22	Lower Channel Banks and Provide Setback Levee or Berms	LS	1	$ 14,311	$ 14,311
R7A12	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 2,914	$ 2,914
	21/22	Lower Channel Banks and Provide Setback Levee or Berms	LS	1	$ 18,003	$ 18,003
R8A15	6	Rebuild Geomorphology for Historic Wash (Piggyback Yard)	LS	1	$ 32,523	$ 32,523
	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 15,098	$ 15,098
					O&M Subtotal (1):	$ 484,676
					Annual Misc. Inspection and Maintenance per Reach:	$ 50,000
					Total Inspection and Maintenance:	$ 400,000
					Invasive Species Management:	$ 84,000
					O&M Subtotal (2):	$ 968,676
					Contingency:	$ 339,037
					Total Annual O&M Cost:	$ 1,307,712

COSTS FOR FINAL ARRAY OF ALTERNATIVES

16 ARBOR Narrows to Downtown (AND)

R/A	Sub Measure	Item Description	UOM	Quantity	Unit Cost	Total Cost
R1A11	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 12,410	$ 12,410
R2A11	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 629	$ 629
R3A16	2	Expose Storm Drain Outlets	LS	1	$ 6,000	$ 6,000
	3/5	Create Geomorphology and Plant Freshwater Marsh	LS	1	$ 76,763	$ 76,763
	10	Divert Tributary & River Flow Into Side Channels (E)	LS	1	$ 45,040	$ 45,040
	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 2,025	$ 2,025
R4A16	2	Expose Storm Drain Outlets	LS	1	$ 9,000	$ 9,000
	3/5	Create Geomorphology and Plant Freshwater Marsh	LS	1	$ 47,277	$ 47,277
	4	Excavation Embankment - All Haul Off	LS	1	$ -	$ -
	10	Divert Tributary & River Flow Into Side Channels (F)	LS	1	$ 36,251	$ 36,251
R5A5	2	Expose Storm Drain Outlets	LS	1	$ 1,000	$ 1,000
	16	Bioengineer Channel Walls	LS	1	$ 2,239	$ 2,239
	26	Terrace Banks	LS	1	$ 270,008	$ 270,008
	27	Modify Trapezoidal Channel to Vertical Sides	LS	1	$ 209,372	$ 209,372
R6A13	16	Bioengineer Channel Walls	LS	1	$ 123,034	$ 123,034
	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 13,872	$ 13,872
	19	Bioengineer Channel Walls	LS	1	$ 28,525	$ 28,525
	21/22	Lower Channel Banks and Provide Setback Levee or Berms	LS	1	$ 14,311	$ 14,311
R7A12	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 2,914	$ 2,914
	21/22	Lower Channel Banks and Provide Setback Levee or Berms	LS	1	$ 18,003	$ 18,003
R8A3	1	Railroad Trestle	LS	1	$ -	$ -
	3/5	Create Geomorphology and Plant Freshwater Marsh	LS	1	$ 83,642	$ 83,642
	6	Rebuild Geomorphology for Historic Wash (Piggyback Yard)	LS	1	$ 32,523	$ 32,523
	10	Divert Tributary & River Flow Into Side Channels (Piggyback Yard)	LS	1	$ 127,429	$ 127,429
	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 15,098	$ 15,098
	21/22	Lower Channel Banks and Provide Setback Levee or Berms	LS	1	$ 67,293	$ 67,293
	26	Terrace Banks	LS	1	$ 32,253	$ 32,253
					O&M Subtotal (1):	$ 1,077,767
					Annual Misc. Inspection and Maintenance per Reach:	$ 50,000
					Total Inspection and Maintenance:	$ 400,000
					Invasive Species Management:	$ 84,000
					O&M Subtotal (2):	$ 1,561,767
					Contingency:	$ 546,618
					Total Annual O&M Cost:	$ 2,108,385

20 ARBOR RIPARIAN INTEGRATION VIA VARIED ECOLOGICAL REINTRODUCTION (RIVER)

R/A	Sub Measure	Item Description	UOM	Quantity	Unit Cost	Total Cost
R1A11	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 12,410	$ 12,410
R2A13	16	Bioengineer Channel Walls	LS	1	$ 3,208	$ 3,208
	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 629	$ 629
	27	Modify Trapezoidal Channel to Vertical Sides	LS	1	$ 97,263	$ 97,263
R3A18	3/5	Create Geomorphology and Plant Freshwater Marsh	LS	1	$ 76,763	$ 76,763
	10	Divert Tributary & River Flow Into Side Channels (E)	LS	1	$ 45,040	$ 45,040
	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 2,025	$ 2,025
	25	Tributary Channels - Verdugo Wash	LS	1	$ 57,265	$ 57,265
R4A16	2	Expose Storm Drain Outlets	LS	1	$ 9,000	$ 9,000
	3/5	Create Geomorphology and Plant Freshwater Marsh	LS	1	$ 47,277	$ 47,277
	4	Excavation Embankment - All Haul Off	LS	1	$ -	$ -
	10	Divert Tributary & River Flow Into Side Channels (F)	LS	1	$ 36,251	$ 36,251
R5A5	2	Expose Storm Drain Outlets	LS	1	$ 1,000	$ 1,000
	16	Bioengineer Channel Walls	LS	1	$ 2,239	$ 2,239
	26	Terrace Banks	LS	1	$ 270,008	$ 270,008
	27	Modify Trapezoidal Channel to Vertical Sides	LS	1	$ 209,372	$ 209,372
R6A13	16	Bioengineer Channel Walls	LS	1	$ 123,034	$ 123,034
	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 13,872	$ 13,872
	19	Bioengineer Channel Walls	LS	1	$ 28,525	$ 28,525
	21/22	Lower Channel Banks and Provide Setback Levee or Berms	LS	1	$ 14,311	$ 14,311
R7A16	1	Railroad Trestle	LS	1	$ -	$ -
	2	Expose Storm Drain Outlets	LS	1	$ 3,000	$ 3,000
	3	Create Geomorphology and Plant Freshwater Marsh	LS	1	$ 181,708	$ 181,708
	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 2,914	$ 2,914
R8A3	1	Railroad Trestle	LS	1	$ -	$ -
	3	Create Geomorphology and Plant Freshwater Marsh	LS	1	$ 83,642	$ 83,642
	6	Rebuild Geomorphology for Historic Wash (Piggyback Yard)	LS	1	$ 32,523	$ 32,523
	10	Divert Tributary & River Flow Into Side Channels (Piggyback Yard)	LS	1	$ 127,429	$ 127,429
	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 15,098	$ 15,098
	21	Lower Channel Banks and Provide Setback Levee or Berms	LS	1	$ 67,293	$ 67,293
	26	Terrace Banks	LS	1	$ 32,253	$ 32,253

O&M Subtotal (1):	$	1,595,350
Annual Misc. Inspection and Maintenance per Reach:	$	50,000
Total Inspection and Maintenance:	$	400,000
Invasive Species Management:	$	84,000
O&M Subtotal (2):	$	2,079,350
Contingency:	$	727,773
Total Annual O&M Cost:	$	2,807,123

O&M COSTS FOR NER AND LPP COST ESTIMATES (BASED ON MCACES CONSTRUCTION COSTS)

13 ARBOR Corridor Extension (ACE)

R/A	Sub Measure	Item Description	UOM	Quantity	Unit Cost	Total Cost
R1A11	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 24,381	$ 24,381
R2A11	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 647	$ 647
R3A16	2	Expose Storm Drain Outlets	LS	1	$ 8,219	$ 8,219
	3/5	Create Geomorphology and Plant Freshwater Marsh	LS	1	$ 70,355	$ 70,355
	10	Divert Tributary & River Flow Into Side Channels	LS	1	$ 41,227	$ 41,227
	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 2,328	$ 2,328
R4A16	2	Expose Storm Drain Outlets	LS	1	$ 14,113	$ 14,113
	3/5	Create Geomorphology and Plant Freshwater Marsh	LS	1	$ 43,303	$ 43,303
	4	Grade Adjacent Areas to Lower Elevation (G)	LS	1	$ -	$ -
	10	Divert Tributary & River Flow Into Side Channels (F)	LS	1	$ 33,516	$ 33,516
R5A16	2	Expose Storm Drain Outlets	LS	1	$ 1,370	$ 1,370
R6A13	16	Bioengineer Channel Walls	LS	1	$ 139,605	$ 139,605
	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 15,776	$ 15,776
	19	Bioengineer Channel Walls	LS	1	$ 31,593	$ 31,593
	21/22	Lower Channel Banks and Provide Setback Levee or Berms	LS	1	$ 18,783	$ 18,783
R7A16	2	Expose Storm Drain Outlets	LS	1	$ 3,938	$ 3,938
	8	Corn Field	LS	1	$ 13,168	$ 13,168
	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 197	$ 197
	26	Terrace Banks	LS	1	$ 3,215	$ 3,215
	27	Lower Channel Banks and Provide Setback Levee or Berms	LS	1	$ 15,621	$ 15,621
R8A15	6	Rebuild Geomorphology for Historic Wash (Piggyback Yard)	LS	1	$ 31,054	$ 31,054
	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 19,477	$ 19,477
					O&M Subtotal (1):	$ 531,887
					Annual Misc. Inspection and Maintenance per Reach:	$ 49,500
					Total Inspection and Maintenance:	$ 396,000
					Invasive Species Management:	$ 84,000
					O&M Subtotal (2):	$ 1,011,887
					Contingency:	$ 354,160
					Total Annual O&M Cost:	$ 1,366,047

20 ARBOR RIPARIAN INTEGRATION VIA VARIED ECOLOGICAL REINTRODUCTION (RIVER)

R/A	Sub Measure	Item Description	UOM	Quantity	Unit Cost	Total Cost
R1A11	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 24,381	$ 24,381
R2A13	16	Bioengineer Channel Walls	LS	1	$ 15,067	$ 15,067
	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 654	$ 654
	27	Modify Trapezoidal Channel to Vertical Sides	LS	1	$ 84,442	$ 84,442
R3A18	3/5	Create Geomorphology and Plant Freshwater Marsh	LS	1	$ 69,136	$ 69,136
	10	Divert Tributary & River Flow Into Side Channels (E)	LS	1	$ 40,513	$ 40,513
	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 2,196	$ 2,196
	25	Tributary Channels - Verdugo Wash	LS	1	$ 58,106	$ 58,106
R4A16	2	Expose Storm Drain Outlets	LS	1	$ 14,113	$ 14,113
	3/5	Create Geomorphology and Plant Freshwater Marsh	LS	1	$ 43,303	$ 43,303
	4	Excavation Embankment - All Haul Off	LS	1	$ -	$ -
	10	Divert Tributary & River Flow Into Side Channels (F)	LS	1	$ 33,516	$ 33,516
R5A5	2	Expose Storm Drain Outlets	LS	1	$ 1,320	$ 1,320
	16	Bioengineer Channel Walls	LS	1	$ 2,440	$ 2,440
	26	Terrace Banks	LS	1	$ 61,817	$ 61,817
	27	Modify Trapezoidal Channel to Vertical Sides	LS	1	$ 204,623	$ 204,623
R6A13	16	Bioengineer Channel Walls	LS	1	$ 139,605	$ 139,605
	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 15,776	$ 15,776
	19	Bioengineer Channel Walls	LS	1	$ 31,593	$ 31,593
	21/22	Lower Channel Banks and Provide Setback Levee or Berms	LS	1	$ 18,783	$ 18,783
R7A16	2	Expose Storm Drain Outlets	LS	1	$ 3,938	$ 3,938
	8	Corn Fileds	LS	1	$ 13,168	$ 13,168
	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 197	$ 197
	26	Terrace Banks	LS	1	$ 3,215	$ 3,215
	27	Tributary Channels/Widen Channel	LS	1	$ 15,621	$ 15,621
R8A3		Utility Relocations	LS	1	$ 24,241	$ 24,241
	3	Create Geomorphology and Plant Freshwater Marsh	LS	1	$ 74,442	$ 74,442
	6	Rebuild Geomorphology for Historic Wash (Piggyback Yard)	LS	1	$ 28,310	$ 28,310
	10	Divert Tributary & River Flow Into Side Channels (Piggyback Yard)	LS	1	$ 110,923	$ 110,923
	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 19,438	$ 19,438
	21	Lower Channel Banks and Provide Setback Levee or Berms	LS	1	$ 67,828	$ 67,828
	26	Terrace Banks	LS	1	$ 5,727	$ 5,727
					O&M Subtotal (1):	$ 1,228,434
					Annual Misc. Inspection and Maintenance per Reach:	$ 49,500
					Total Inspection and Maintenance:	$ 396,000
					Invasive Species Management:	$ 84,000
					O&M Subtotal (2):	$ 1,708,434
					Contingency:	$ 597,952
					Total Annual O&M Cost:	$ 2,306,385

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Cost Appendix

Attachment 5
Cost Breakdown for Final Array of Alternatives

April 2015

COSTS FOR FINAL ARRAY OF ALTERNATIVES

10 ARBOR RIPARIAN TRANSITIONS (ART)

R/A	Sub Measure	Item Description	UOM	Quantity	Unit Cost	Total Cost
R1A11	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 1,460,173	$ 1,460,173
R2A11	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 41,962	$ 41,962
R3A17	2	Expose Storm Drain Outlets	LS	1	$ 600,000	$ 600,000
R4A16	2	Expose Storm Drain Outlets	LS	1	$ 900,000	$ 900,000
	3/5	Create Geomorphology and Plant Freshwater Marsh	LS	1	$ 5,677,607	$ 5,677,607
	4	Grade Adjacent Areas to Lower Elevation (G)	LS	1	$ 1,978,350	$ 1,978,350
	10	Divert Tributary & River Flow Into Side Channels (F)	LS	1	$ 5,290,413	$ 5,290,413
R5A16	2	Expose Storm Drain Outlets	LS	1	$ 100,000	$ 100,000
R6A14	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 924,768	$ 924,768
	21/22	Lower Channel Banks and Provide Setback Levee or Berms	LS	1	$ 7,615,328	$ 7,615,328
R7A9	2	Expose Storm Drain Outlets	LS	1	$ 300,000	$ 300,000
R8A15	6	Rebuild Geomorphology for Historic Wash (Piggyback Yard)	LS	1	$ 11,074,093	$ 11,074,093
	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 1,197,648	$ 1,197,648
					Total Construction Cost:	$ 37,160,342
					Mobilization (7.5%):	$ 2,787,026
					Construction Subtotal:	$ 39,947,368

13 ARBOR Corridor Extension (ACE)

R/A	Sub Measure	Item Description	UOM	Quantity	Unit Cost	Total Cost
R1A11	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 1,460,173	$ 1,460,173
R2A11	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 41,962	$ 41,962
R3A16	2	Expose Storm Drain Outlets	LS	1	$ 600,000	$ 600,000
	3/5	Riprap	LS	1	$ 8,030,949	$ 8,030,949
	10	Excavation Embankment - Med. Haul Off	LS	1	$ 6,239,813	$ 6,239,813
	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 134,979	$ 134,979
R4A16	2	Expose Storm Drain Outlets	LS	1	$ 900,000	$ 900,000
	3/5	Create Geomorphology and Plant Freshwater Marsh	LS	1	$ 5,677,607	$ 5,677,607
	4	Grade Adjacent Areas to Lower Elevation (G)	LS	1	$ 1,978,350	$ 1,978,350
	10	Divert Tributary & River Flow Into Side Channels (F)	LS	1	$ 5,290,413	$ 5,290,413
R5A16	2	Expose Storm Drain Outlets	LS	1	$ 100,000	$ 100,000
R6A13	16	Bioengineer Channel Walls	LS	1	$ 7,958,437	$ 7,958,437
	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 924,768	$ 924,768
	19	Bioengineer Channel Walls	LS	1	$ 1,901,667	$ 1,901,667
	21/22	Lower Channel Banks and Provide Setback Levee or Berms	LS	1	$ 7,615,328	$ 7,615,328
R7A12	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 194,299	$ 194,299
	21/22	Lower Channel Banks and Provide Setback Levee or Berms	LS	1	$ 20,967,364	$ 20,967,364
R8A15	6	Rebuild Geomorphology for Historic Wash (Piggyback Yard)	LS	1	$ 11,074,093	$ 11,074,093
	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 1,197,648	$ 1,197,648
					Total Construction Cost:	$ 82,287,850
					Mobilization (7.5%):	$ 6,171,589
					Construction Subtotal:	$ 88,459,438

COSTS FOR FINAL ARRAY OF ALTERNATIVES

16 ARBOR Narrows to Downtown (AND)

R/A	Sub Measure	Item Description	UOM	Quantity	Unit Cost	Total Cost
R1A11	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 1,460,173	$ 1,460,173
R2A11	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 41,962	$ 41,962
R3A16	2	Expose Storm Drain Outlets	LS	1	$ 600,000	$ 600,000
	3/5	Create Geomorphology and Plant Freshwater Marsh	LS	1	$ 8,030,949	$ 8,030,949
	10	Divert Tributary & River Flow Into Side Channels (E)	LS	1	$ 6,239,813	$ 6,239,813
	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 134,979	$ 134,979
R4A16	2	Expose Storm Drain Outlets	LS	1	$ 900,000	$ 900,000
	3/5	Create Geomorphology and Plant Freshwater Marsh	LS	1	$ 5,677,607	$ 5,677,607
	4	Excavation Embankment - All Haul Off	LS	1	$ 1,978,350	$ 1,978,350
	10	Divert Tributary & River Flow Into Side Channels (F)	LS	1	$ 5,290,413	$ 5,290,413
R5A5	2	Expose Storm Drain Outlets	LS	1	$ 100,000	$ 100,000
	16	Bioengineer Channel Walls	LS	1	$ 149,250	$ 149,250
	26	Terrace Banks	LS	1	$ 31,784,946	$ 31,784,946
	27	Modify Trapezoidal Channel to Vertical Sides	LS	1	$ 55,367,624	$ 55,367,624
R6A13	16	Bioengineer Channel Walls	LS	1	$ 7,958,437	$ 7,958,437
	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 924,768	$ 924,768
	19	Bioengineer Channel Walls	LS	1	$ 1,901,667	$ 1,901,667
	21/22	Lower Channel Banks and Provide Setback Levee or Berms	LS	1	$ 7,615,328	$ 7,615,328
R7A12	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 194,299	$ 194,299
	21/22	Lower Channel Banks and Provide Setback Levee or Berms	LS	1	$ 20,967,364	$ 20,967,364
R8A3	1	Railroad Trestle	LS	1	$ 24,030,000	$ 24,030,000
	3/5	Create Geomorphology and Plant Freshwater Marsh	LS	1	$ 9,516,383	$ 9,516,383
	6	Rebuild Geomorphology for Historic Wash (Piggyback Yard)	LS	1	$ 11,074,093	$ 11,074,093
	10	Divert Tributary & River Flow Into Side Channels (Piggyback Yard)	LS	1	$ 16,570,920	$ 16,570,920
	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 191,148	$ 191,148
	21/22	Lower Channel Banks and Provide Setback Levee or Berms	LS	1	$ 39,268,638	$ 39,268,638
	26	Terrace Banks	LS	1	$ 7,875,698	$ 7,875,698
					Total Construction Cost:	$ 265,844,810
					Mobilization (7.5%):	$ 19,938,361
					Construction Subtotal:	$ 285,783,170

20 ARBOR RIPARIAN INTEGRATION VIA VARIED ECOLOGICAL REINTRODUCTION (RIVER)

R/A	Sub Measure	Item Description	UOM	Quantity	Unit Cost	Total Cost
R1A11	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 1,460,173	$ 1,460,173
R2A13	16	Bioengineer Channel Walls	LS	1	$ 935,263.33	$ 935,263
	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 41,962.12	$ 41,962
	27	Modify Trapezoidal Channel to Vertical Sides	LS	1	$ 23,428,961.66	$ 23,428,962
R3A18	3/5	Create Geomorphology and Plant Freshwater Marsh	LS	1	$ 8,030,949.27	$ 8,030,949
	10	Divert Tributary & River Flow Into Side Channels (E)	LS	1	$ 6,239,812.78	$ 6,239,813
	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 134,978.79	$ 134,979
	25	Tributary Channels - Verdugo Wash	LS	1	$ 47,584,437.48	$ 47,584,437
R4A16	2	Expose Storm Drain Outlets	LS	1	$ 900,000.00	$ 900,000
	3/5	Create Geomorphology and Plant Freshwater Marsh	LS	1	$ 5,677,606.67	$ 5,677,607
	4	Excavation Embankment - All Haul Off	LS	1	$ 1,978,350.00	$ 1,978,350
	10	Divert Tributary & River Flow Into Side Channels (F)	LS	1	$ 5,290,413.33	$ 5,290,413
R5A5	2	Expose Storm Drain Outlets	LS	1	$ 100,000.00	$ 100,000
	16	Bioengineer Channel Walls	LS	1	$ 149,250.00	$ 149,250
	26	Terrace Banks	LS	1	$ 31,784,945.96	$ 31,784,946
	27	Modify Trapezoidal Channel to Vertical Sides	LS	1	$ 55,367,624.42	$ 55,367,624
R6A13	16	Bioengineer Channel Walls	LS	1	$ 7,958,437.33	$ 7,958,437
	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 924,767.70	$ 924,768
	19	Bioengineer Channel Walls	LS	1	$ 1,901,666.67	$ 1,901,667
	21/22	Lower Channel Banks and Provide Setback Levee or Berms	LS	1	$ 7,615,328.19	$ 7,615,328
R7A16	1	Railroad Trestle	LS	1	$ 5,000,000.00	$ 5,000,000
	2	Expose Storm Drain Outlets	LS	1	$ 300,000.00	$ 300,000
	3	Create Geomorphology and Plant Freshwater Marsh	LS	1	$ 42,681,862.55	$ 42,681,863
	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 194,299.05	$ 194,299
R8A3	1	Railroad Trestle	LS	1	$ 24,030,000.00	$ 24,030,000
	3	Create Geomorphology and Plant Freshwater Marsh	LS	1	$ 9,516,383.39	$ 9,516,383
	6	Rebuild Geomorphology for Historic Wash (Piggyback Yard)	LS	1	$ 11,074,093.26	$ 11,074,093
	10	Divert Tributary & River Flow Into Side Channels (Piggyback Yard)	LS	1	$ 16,570,920.19	$ 16,570,920
	17	Habitat/Corridors Riparian Planting on Banks	LS	1	$ 1,197,647.73	$ 1,197,648
	21	Lower Channel Banks and Provide Setback Levee or Berms	LS	1	$ 39,268,637.85	$ 39,268,638
	26	Terrace Banks	LS	1	$ 7,875,698.17	$ 7,875,698

Total Construction Cost:	$	365,214,471
Mobilization (7.5%):	$	27,391,085
Construction Subtotal:	$	392,605,556

Note: The above tables summarize all construction componenets estimated within this report. These summary tables include the railroad trestles, even though they are classified as a relocation, because they were developed with the other construction components. Therefore these tables differ from Table 6-1 in the Feasibility Report.

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Los Angeles River Ecosystem Restoration Feasibility Study

Cost Appendix

Attachment 6
Recreation Cost Estimates

April 2015

LOS ANGELES RIVER FEASIBILITY
RECREATION COMPONENTS

Page: 1 of 1
Date: 23-Jul-13

CONSTRUCTION COST SUMMARY PAGE

ITEM #	ITEM DESCRIPTION	UOM	QUANTITY	UNIT COST	CONTINGENCY	TOTAL CONSTRUCTION COST
REC	**Recreation Construction Costs**					
MOB	Mobilization / Demobilization	LS	1	$ 316,987	35.00%	$ **427,933**
1	Existing Acces Road to Un-Paved Multi Use Trail	LS	1	$ 395,536	35.00%	$ **533,974**
2	Trail Improvement	LS	1	$ 342,258	35.00%	$ **462,049**
3	New Unpaved Trail	LS	1	$ 861,902	35.00%	$ **1,163,568**
4	Parking Lot 1	LS	1	$ 97,400	35.00%	$ **131,490**
5	Parking Lot 2	LS	1	$ 110,288	35.00%	$ **148,888**
6	Restrooms	LS	1	$ 210,000	35.00%	$ **283,500**
7	Trail Access Point	LS	1	$ 95,000	35.00%	$ **128,250**
8	Pedestrian Tunnel	LS	1	$ 107,111	35.00%	$ **144,600**
9	Wildlife Viewpoint	LS	1	$ 57,000	35.00%	$ **76,950**
10	Bridges	LS	1	$ 1,950,000	35.00%	$ **2,632,500**
					Total Construction Cost:	$ **6,133,701**

O&M COST SUMMARY PAGE

ITEM #	ITEM DESCRIPTION	UOM	QUANTITY	UNIT COST	CONTINGENCY	ANNUAL O&M COSTS
REC	**Recreation Construction Costs**					
MOB	Mobilization / Demobilization	YR	1	$ -	35.00%	$ -
1	Existing Acces Road to Un-Paved Multi Use Trail	YR	1	$ 1,077.36	35.00%	$ **1,454**
2	Trail Improvement	YR	1	$ 3,191.00	35.00%	$ **4,308**
3	New Unpaved Trail	YR	1	$ 8,903.65	35.00%	$ **12,020**
4	Parking Lot 1	YR	1	$ 1,043.00	35.00%	$ **1,408**
5	Parking Lot 2	YR	1	$ 1,181.00	35.00%	$ **1,594**
6	Restrooms	YR	1	$ 3,150.00	35.00%	$ **4,253**
7	Trail Access Point	YR	1	$ 674.50	35.00%	$ **911**
8	Pedestrian Tunnel	YR	1	$ 1,226.67	35.00%	$ **1,656**
9	Wildlife Viewpoint	YR	1	$ 1,066.25	35.00%	$ **1,439**
10	Bridges	YR	1	$ 9,750.00	35.00%	$ **13,163**
					ANNUAL O&M:	$ **42,206**

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Los Angeles District

Los Angeles River Ecosystem Restoration Feasibility Study

Cost Appendix

Attachment 7
Abbreviated Risk Analysis

April 2015

Abbreviated Risk Analysis

Los Angeles River
Feasibility (Alternatives)

Meeting Date: 6-Jun-13

PDT Members

Note: PDT involvement is commensurate with project size and involvement.

Lead Planner:	Kathy Bergmann (SPL)
Cost Engineering:	Arnecia Williams (SPL)
Hydrology:	Van Crisostomo (SPL)
Soils, Design, Materials:	Chris Spitzer (SPL)
Geology & Investigations:	Mark McLarty (SPL)
Project Manager:	Ira Artz (Tetra Tech)
Planner:	Scott Estergard (Tetra Tech)
Cost Engineering:	Scott Vose (Tetra Tech)

Abbreviated Risk Analysis

Project (less than $40M): **Los Angeles River**
Project Development Stage: **Feasibility (Alternatives)**
Risk Category: **Moderate Risk: Typical Project or Possible Life Safety**

Total Construction Contract Cost = $ 9,000,000

	CWWBS	Feature of Work	Contract Cost		% Contingency	$ Contingency	Total
	01 LANDS AND DAMAGES	Real Estate	$ 1,000,000		20.00%	$ 200,000	$ 1,200,000.00
1	09 01 CHANNELS	Mobilization - Demobilization	$ 1,000,000		26.44%	$ 264,381	$ 1,264,381.41
2	09 01 CHANNELS	Earthwork	$ 1,000,000		45.78%	$ 457,767	$ 1,457,767.09
3	09 01 CHANNELS	Vegetation & Topsoil	$ 1,000,000		22.80%	$ 228,012	$ 1,228,011.58
4	09 01 CHANNELS	Demolition	$ 1,000,000		24.56%	$ 245,596	$ 1,245,595.58
5	09 01 CHANNELS	Riprap & Grouted Riprap	$ 1,000,000		38.88%	$ 388,781	$ 1,388,780.61
6	09 01 CHANNELS	Turf Reinforcement Mat	$ 1,000,000		24.13%	$ 241,337	$ 1,241,336.55
7	09 01 CHANNELS	Concrete (Walls & Planters)	$ 1,000,000		47.10%	$ 471,045	$ 1,471,045.08
8	09 01 CHANNELS	Asphalt Paving (Inc. Base Course, Fence)	$ 1,000,000		13.44%	$ 134,371	$ 1,134,370.70
9			$ -		0.00%	$ -	$ -
12		**Remaining Construction Items**	**$ 1,000,000**	*12.5%*	32.86%	$ 328,649	$ 1,328,648.56
13	30 PLANNING, ENGINEERING, AND DESIGN	**Planning, Engineering, & Design**	$ 1,000,000		24.40%	$ 244,020	$ 1,244,019.73
14	31 CONSTRUCTION MANAGEMENT	**Construction Management**	$ 1,000,000		26.25%	$ 262,529	$ 1,262,529.13

Totals				
Real Estate	$ 1,000,000	20.00%	$ 200,000	$ 1,200,000.00
Total Construction Estimate	$ 9,000,000	30.67%	$ 2,759,937	$ 11,759,937
Total Planning, Engineering & Design	$ 1,000,000	24.40%	$ 244,020	$ 1,244,020
Total Construction Management	$ 1,000,000	26.25%	$ 262,529	$ 1,262,529
Total	$ 12,000,000		$ 3,466,486	$ 15,466,486

Los Angeles River
Feasibility (Alternatives)
Abbreviated Risk Analysis

Meeting Date: 6-Jun-13

Risk Level

	Negligible	Marginal	Significant	Critical	Crisis
Very Likely	2	3	4	5	5
Likely	1	2	3	4	5
Possible	0	1	2	3	4
Unlikely	0	0	1	2	3

Risk Element	Feature of Work	Concerns Pull Down Tab (ENABLE MACROS THRU TRUST CENTER) (Choose ALL that apply)	Concerns	POT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Likelihood	Impact	Risk Level
Project Scope Growth							
						Max Potential Cost Growth	**75%**
PS-1	Mobilization - Demobilization	• Design confidence?	• Potential for scope growth, added features and quantities? • Design confidence?	Due to low level of design, many aspects in regards to staging areas and site constraints have not been fully developed. These assumptions utilized currently could differ significantly as design progresses and staging constraints are analyzed in detail.	Likely	Significant	3
PS-2	Earthwork	• Water care and diversion fully understood, planned?	• Potential for scope growth, added features and quantities? • Project accomplish intent? • Investigations sufficient to support design assumptions? • Design confidence? • Water care and diversion fully understood, planned?	Primary concerns are that this project is at a low level of design, investigations remain to be completed to finalize design, encountering HTRW's, and no fully developed water control plan has been developed. Based on all these risks, it is likely that at least a few of them could impact the costs, and these risks would significantly impact costs.	Likely	Significant	3
PS-3	Vegetation & Topsoil	• Water care and diversion fully understood, planned?	• Design confidence? • Potential for scope growth, added features and quantities? • Water care and diversion fully understood, planned?	Low level of design is an inherent risk, and there is some chance for the scope to increase. However, the likelihood and impacts are both small as current assumptions are conservative and not likely to incur significant growth.	Possible	Marginal	1
PS-4	Demolition	• Water care and diversion fully understood, planned?	• Investigations sufficient to support design assumptions? • Design confidence? • Water care and diversion fully understood, planned?	Design level is low, and some investigations remain to determine the extent of demolition required. Also, the planters and care of water has not been analyzed in detail. The likelihood of the demo work being affected by scope growth is small, but any increases could add significant costs.	Likely	Marginal	2
PS-5	Riprap & Grouted Riprap	• Water care and diversion fully understood, planned?	• Design confidence? • Potential for scope growth, added features and quantities? • Investigations sufficient to support design assumptions? • Water care and diversion fully understood, planned?	Primary concerns are the low level of design, and the need for additional hydraulic modeling to be completed to finalize design. The modeling could change the current riprap assumptions significantly.	Likely	Significant	3
PS-6	Turf Reinforcement Mat	• Water care and diversion fully understood, planned?	• Design confidence? • Potential for scope growth, added features and quantities? • Project accomplish intent? • Investigations sufficient to support design assumptions? • Water care and diversion fully understood, planned?	Further investigation into calculated and reasonable rest of utilizing the Turf Reinforcement Mats need to be completed. There is a risk that the mat is only for low velocity and small area surface run-off, and that it may be unsuitable for use in this project. Different material could be required by permit impact to cost of ... has been considered to be marginal.	Likely	Marginal	2
PS-7	Concrete (Walls & Planters)	• Water care and diversion fully understood, planned?	• Potential for scope growth, added features and quantities? • Project accomplish intent? • Investigations sufficient to support design assumptions? • Design confidence? • Water care and diversion fully understood, planned?	The concrete structures require further investigations, require further easement and ROW analysis, and are based on conceptual designs. These risks are likely to cause some changes as the project progresses, and impacts to costs could be significant.	Likely	Significant	3
PS-8	Asphalt Paving (Inc. Base Course, Fence)	• Design confidence?	• Potential for scope growth, added features and quantities? • Project accomplish intent? • Investigations sufficient to support design assumptions? • Design confidence?	The level of design is low, but the risks to these items is anticipated to be minor. Scope is not anticipated to grow to an extent that would significantly impact these costs.	Possible	Marginal	1
PS-9	0	• Potential for scope growth, added features and quantities?			Unlikely	Negligible	0
PS-10	0	• Investigations sufficient to support design assumptions?			Unlikely	Negligible	0
PS-11	0	• Potential for scope growth, added features and quantities?			Unlikely	Negligible	0
PS-12	Remaining Construction Items	• Design confidence?	• Design confidence?	No design currently for the storm drains of the new railroad trestles. Scope for these not anticipated to grow, but if did could increase significantly.	Unlikely	Significant	1
PS-13	Planning, Engineering, & Design	• Water care and diversion fully understood, planned?	• Potential for scope growth, added features and quantities? • Project accomplish intent? • Investigations sufficient to support design assumptions? • Design confidence? • Water care and diversion fully understood, planned?	Many investigations remain to be completed in order to finalize the design. If the scope grows in detail then the cost to complete the PED phase would grow as well. However, current assumptions on cost of HTRW have generated large PED costs, thus impacts of future unaccounted for investigations would be marginal.	Very LIKELY	Marginal	3
PS-14	Construction Management	• Water care and diversion fully understood, planned?	• Potential for scope growth, added features and quantities? • Project accomplish intent? • Investigations sufficient to support design assumptions? • Design confidence? • Water care and diversion fully understood, planned?	The primary concern for construction management is the possible encountering of a large area of HTRW. This would create a significant impact on the ... management costs.	Possible	Significant	2

Acquisition Strategy

							Max Potential Cost Growth	30%
AS-1	Mobilization - Demobilization	• Bid schedule developed to reduce quantity risks?	• Contracting plan firmly established? • Ba or small business likely? • Requirement for subcontracting? • Accelerated schedule or harsh weather schedule? • High-risk acquisition limits competition, design/build? • Bid schedule developed to reduce quantity risks?	At this stage of the project no contracting plan has been established. Unit costs take into account use of some sub-contracting for certain aspects of construction. There may be some requirements of Subsmall business, but they probably would not be the prime. Some in channel work may need to be accelerated to avoid rainy seasons, but not a huge risk as many contractors would be capable of working through winter. There is no bid schedule, but detailed quantity take-offs have been developed for current design. So, PDT has concluded that these are all risks, but they are not likely on all occur and impact the costs. The overall impact on costs would be small as well due to the estimate already containing unit costs that account for risks	Possible	Marginal	1
AS-2	Earthwork	• Contracting plan firmly established?	• Contracting plan firmly established? • Ba or small business likely? • Requirement for subcontracting? • Accelerated schedule or harsh weather schedule? • High-risk acquisition limits competition, design/build? • Bid schedule developed to reduce quantity risks?	See discussion in first box above	Possible	Marginal	1
AS-3	Vegetation & Topsoil	• Contracting plan firmly established?	• Contracting plan firmly established? • Ba or small business likely? • Requirement for subcontracting? • Accelerated schedule or harsh weather schedule? • High-risk acquisition limits competition, design/build? • Bid schedule developed to reduce quantity risks?	See discussion in first box above	Possible	Marginal	1
AS-4	Demolition	• Contracting plan firmly established?	• Contracting plan firmly established? • Ba or small business likely? • Requirement for subcontracting? • Accelerated schedule or harsh weather schedule? • High-risk acquisition limits competition, design/build? • Bid schedule developed to reduce quantity risks?	See discussion in first box above	Possible	Marginal	1
AS-5	Riprap & Grouted Riprap	• Contracting plan firmly established?	• Contracting plan firmly established? • Ba or small business likely? • Requirement for subcontracting? • Accelerated schedule or harsh weather schedule? • High-risk acquisition limits competition, design/build? • Bid schedule developed to reduce quantity risks?	See discussion in first box above	Possible	Marginal	1
AS-6	Turf Reinforcement Mat	• Contracting plan firmly established?	• Contracting plan firmly established? • Ba or small business likely? • Requirement for subcontracting? • Accelerated schedule or harsh weather schedule? • High-risk acquisition limits competition, design/build? • Bid schedule developed to reduce quantity risks?	See discussion in first box above	Possible	Marginal	1
AS-7	Concrete (Walls & Planters)	• Contracting plan firmly established?	• Contracting plan firmly established? • Ba or small business likely? • Requirement for subcontracting? • Accelerated schedule or harsh weather schedule? • High-risk acquisition limits competition, design/build? • Bid schedule developed to reduce quantity risks?	See discussion in first box above	Possible	Marginal	1
AS-8	Asphalt Paving (Inc. Base Course, Fence)	• Contracting plan firmly established?	• Contracting plan firmly established? • Ba or small business likely? • Requirement for subcontracting? • Accelerated schedule or harsh weather schedule? • High-risk acquisition limits competition, design/build? • Bid schedule developed to reduce quantity risks?	See discussion in first box above	Possible	Marginal	1
AS-9	0	• Contracting plan firmly established?			Unlikely	Negligible	0
AS-10	0	• Contracting plan firmly established?			Unlikely	Negligible	0
AS-11	0	• Contracting plan firmly established?			Unlikely	Negligible	0
AS-12	Remaining Construction Items	• Contracting plan firmly established?	• Contracting plan firmly established? • Ba or small business likely? • Requirement for subcontracting? • Accelerated schedule or harsh weather schedule? • High-risk acquisition limits competition, design/build? • Bid schedule developed to reduce quantity risks?	See discussion in first box above	Possible	Marginal	1
AS-13	Planning, Engineering, & Design	• Contracting plan firmly established?	• Contracting plan firmly established? • Ba or small business likely? • Requirement for subcontracting? • Accelerated schedule or harsh weather schedule? • High-risk acquisition limits competition, design/build? • Bid schedule developed to reduce quantity risks?	See discussion in first box above	Possible	Marginal	1
AS-14	Construction Management	• Contracting plan firmly established?	• Contracting plan firmly established? • Ba or small business likely? • Requirement for subcontracting? • Accelerated schedule or harsh weather schedule? • High-risk acquisition limits competition, design/build? • Bid schedule developed to reduce quantity risks?	See discussion in first box above	Possible	Marginal	1

Construction Elements

					Max Potential Cost Growth		25%
CE-1	Mobilization - Demobilization	• Potential for construction modification and claims?	No significant risks anticipated	No specialty equipment or contractors should be required for this project.	Unlikely	Negligible	0
CE-2	Earthwork	• Potential for construction modification and claims?	• Accelerated schedule or harsh weather schedule? • High risk or complex construction elements, site access, in-water? • Water care and diversion plan? • Potential for construction modification and claims?	The primary risks concerning the earthwork are the unanticipated groundwater occurrence, re-use of excavated material for structure foundations (must have good moisture for re-use), lack of water care plan and/or neglecting HTRW. These risks are likely to occur at some point during the construction of this project, and the cost impact would be significant.	Likely	Significant	3
CE-3	Vegetation & Topsoil	• Water care and diversion plan?	• Accelerated schedule or harsh weather schedule? • Water care and diversion plan?	These construction items are not risky themselves. The lack of a water care plan, or possible accelerated schedule could pose a small risk. Cost impacts would not be significant those as these are pretty typical items with accurate unit costs being used.	Possible	Marginal	1
CE-4	Demolition	• Potential for construction modification and claims?	• High risk or complex construction elements, site access, in-water? • Water care and diversion plan? • Potential for construction modification and claims?	Site accessibility could be difficult as no detailed analysis has been done into this aspect. The same can be said about the water care and diversion. Also, unanticipated structures could be found during construction or at a further design phase. These risks are possible to occur, but due to size of the bulks in quantity development, current costs/quantities, are not anticipated to be impacted greatly.	Possible	Marginal	1
CE-5	Riprap & Grouted Riprap	• Water care and diversion plan?	• High risk or complex construction elements, site access, in-water? • Water care and diversion plan?	Site accessibility could be difficult as no detailed analysis has been completed. Also the water care and diversion plan has not been determined either. These risks would most likely impact other areas of construction prior to the start of the riprap placement. This it is unlikely that the risks would occur, and impacts would be negligible	Unlikely	Negligible	0
CE-6	Turf Reinforcement Mat	• Potential for construction modification and claims?	• High risk or complex construction elements, site access, in-water? • Special equipment or subcontractors needed? • Potential for construction modification and claims?	Turf reinforcement mat placement would probably be performed by company providing the material. Lack of expertise with material may lead to problems during design, which in turn could lead to mods. Risk is likely, and impact to cost should not be large, as material quote was provided by supplier for project.	Possible	Negligible	0
CE-7	Concrete (Walls & Planters)	• Potential for construction modification and claims?	• High risk or complex construction elements, site access, in-water? • Water care and diversion plan? • Potential for construction modification and claims?	This work requires the large scale placement of large concrete retaining walls and concrete planter boxes. A project of this scale has not really been completed for these items. Thus any design errors could lead to construction mods. The placement could be risky as well, due to the size, and need for everything to line up properly. These risks are likely to occur at some point throughout the project, and costs for this would be significantly impacted.	Likely	Significant	3
CE-8	Asphalt Paving (inc. Base Course, Fence)	• Accelerated schedule or harsh weather schedule?	No significant risks anticipated	This work is all very straight forward and no risks are expected to occur or impact costs in a significant way.	Unlikely	Negligible	0
CE-9	0	• Accelerated schedule or harsh weather schedule?			Unlikely	Negligible	0
CE-10	0	• Accelerated schedule or harsh weather schedule?			Unlikely	Negligible	0
CE-11	0	• Accelerated schedule or harsh weather schedule?			Unlikely	Negligible	0
CE-12	Remaining Construction Items	• Special equipment or subcontractors needed?	• High risk or complex construction elements, site access, in-water? • Unique construction methods? • Special equipment or subcontractors needed?	Construction of the remaining items is where difficult construction lies. The talented contractors would need to be heavily involved and special contractor would be likely. Cost estimate assumed a sub- for this work, and has conservative unit costs. Therefore impact would be marginal, but risk of all sorts of something not going as planned.	Likely	Marginal	2
CE-13	Planning, Engineering, & Design	• Potential for construction modification and claims?	• High risk or complex construction elements, site access, in-water? • Water care and diversion plan? • Potential for construction modification and claims?	Designs will need to be very detailed in order for the large scale structures to be constructed properly. Extra time and oversight may be required, but current PED cost should be more than adequate to complete the design work. Thus no impacts to costs are assumed.	Unlikely	Negligible	0
CE-14	Construction Management	• Potential for construction modification and claims?	• High risk or complex construction elements, site access, in-water? • Water care and diversion plan? • Potential for construction modification and claims?	Assumed CM rates could differ from actual if some of the mods mentioned above occur. Primarily if there are mods to the contract, there could be need for more management costs. However, the risk would not be significant to overall CM costs as current CM costs are quite high.	Possible	Marginal	1

Quantities for Current Scope

					Max Potential Cost Growth		20%
Q-1	Mobilization - Demobilization	• Quality control check applied?	No significant risks anticipated.	Mob/Demob costs are not based on any quantity calculations, and therefore have no likelihood of risks and no impacts to costs.	Unlikely	Negligible	0
Q-2	Earthwork	• Sufficient investigations to develop quantities?	• Level of confidence based on design and assumptions? • Sufficient investigations to develop quantities?	Earthwork quantities were calculated based on using one typical cross section per reach. This allows for plenty of room for changes as design progresses and more details are available. Also, investigations remain that could alter the quantity development as well. Changes to these quantities are likely to occur, and any growth in quantities would cause significant changes to costs.	Likely	Significant	3
Q-3	Vegetation & Topsoil	• Sufficient investigations to develop quantities?	• Level of confidence based on design and assumptions? • Sufficient investigations to develop quantities?	Vegetation areas were calculated based on using one typical cross section per reach. The areas are likley to change as design is refined. However, the areas are not anticipated to increase much and thus impact is assumed to be marginal.	Likely	Marginal	2
Q-4	Demolition	• Sufficient investigations to develop quantities?	• Level of confidence based on design and assumptions? • Sufficient investigations to develop quantities?	Demo quantities were calculated based on typical cross sections found in the as-built drawings. These cross sections were compared with aerials to determine lengths for quantity development. As design progresses quantities are not anticipated to increase greatly since current quantities were conservatively calculated. Thus impacts would be marginal.	Possible	Marginal	1
Q-5	Riprap & Grouted Riprap	• Sufficient investigations to develop quantities?	• Level of confidence based on design and assumptions? • Sufficient investigations to develop quantities?	The hydraulic modeling has not been finalized for this project, and thus the quantity of riprap currently assumed could change once the modeling is completed. There is a chance that more rock could be needed, and increases in this quantity would cause significant increases in costs.	Likely	Significant	3
Q-6	Turf Reinforcement Mat	• Level of confidence based on design and assumptions?	• Level of confidence based on design and assumptions?	Due to the low level of design, a single cross section per reach was used to calculate quantities for this. Increases to the amount of mats required is not anticipated to occur as conservative assumptions were already used. Any increases in quantity would impact the overall cost of this item significantly though.	Unlikely	Significant	1
Q-7	Concrete (Walls & Planters)	• Sufficient investigations to develop quantities?	• Level of confidence based on design and assumptions? • Sufficient investigations to develop quantities?	The current quantity calculations were based off one cross section per reach. Once further detailed designs are completed, and hydraulic modeling finished, the quantities would likely change. However, quantities are anticipated to change as the project progresses. Impacts to costs would be significant if the quantities increased.	Likely	Significant	3
Q-8	Asphalt Paving (Inc. Base Course, Fence)	• Sufficient investigations to develop quantities?	• Level of confidence based on design and assumptions?	Changes to the quantities for these items are not anticipated to change significantly. If they did change, costs would only be affected marginally.	Unlikely	Marginal	0
Q-9	0	• Level of confidence based on design and assumptions?			Unlikely	Negligible	0
Q-10	0	• Level of confidence based on design and assumptions?			Unlikely	Negligible	0
Q-11	0	• Level of confidence based on design and assumptions?			Unlikely	Negligible	0
Q-12	Remaining Construction Items	• Appropriate methods applied to calculate quantities?	• Level of confidence based on design and assumptions? • Appropriate methods applied to calculate quantities?	Detailed quantity take-offs have not been developed for the the storm drains or the railroad trestles as no design exists currently. General assumptions were used and are likely to change, which could have a significant impact on costs.	Likely	Significant	3
Q-13	Planning, Engineering, & Design	• Sufficient investigations to develop quantities?	• Appropriate methods applied to calculate quantities? • Level of confidence based on design and assumptions? • Sufficient investigations to develop quantities?	Design level is very low at this time. Many investigations still remain to be order to accurately calculate quantities. However, current PED value should have adequate funds to account for any issues that arise for quantity development. Thus no impact to costs is assumed to occur either.	Unlikely	Negligible	0
Q-14	Construction Management	• Level of confidence based on design and assumptions?	No significant risks anticipated.	CM is not anticipated to affected by risks to the quantities of the project.	Unlikely	Negligible	0

Specialty Fabrication or Equipment

					Max Potential Cost Growth		75%
FE-1	Mobilization - Demobilization	• Risk of specialty equipment functioning first time? Test?	No significant risks anticipated	This construction feature does no require specialty fabrication or equipment and thus no risks are anticipated	Unlikely	Negligible	0
FE-2	Earthwork	• Unusual parts, material or equipment manufactured or installed?	No significant risks anticipated	This construction feature does no require specialty fabrication or equipment and thus no risks are anticipated	Unlikely	Negligible	0
FE-3	Vegetation & Topsoil	• Unusual parts, material or equipment manufactured or installed?	No significant risks anticipated	This construction feature does no require specialty fabrication or equipment and thus no risks are anticipated	Unlikely	Negligible	0
FE-4	Demolition	• Unusual parts, material or equipment manufactured or installed?	No significant risks anticipated	This construction feature does no require specialty fabrication or equipment and thus no risks are anticipated	Unlikely	Negligible	0
FE-5	Riprap & Grouted Riprap	• Unusual parts, material or equipment manufactured or installed?	No significant risks anticipated	This construction feature does no require specialty fabrication or equipment and thus no risks are anticipated	Unlikely	Negligible	0
FE-6	Turf Reinforcement Mat	• Risk of specialty equipment functioning first time? Test?	• Unusual parts, material or equipment manufactured or installed? • Confidence in suppliers' ability? • Risk of specialty equipment functioning first time? Test?	There is a risk of the turf reinforcement not being sufficient to withstand the flows that may occur in the channel. Also, the supplier would most likely be a sub to the prime for installation of the material, which may be a risk in terms of methodologies. The supplier has been involved throughout this project so far, and has assured that the material is adequate for this project, so currently not likely to occur. But significant cost impacts could be accrued if is shown that the material is not adequate.	Possible	Significant	2
FE-7	Concrete (Walls & Planters)	• Ability to reasonably transport?	• Unusual parts, material or equipment manufactured or installed? • Confidence in suppliers' ability? • Ability to reasonably transport?	Precast planters may have some risks. These structures will be very large and may have difficulty in being manufactured and transported to project site. Also, each piece would need to be approved for placement. The region should have a supplier capable, but risk remains possible, and impact would be significant if no supplier is found and/or transportation becomes a problem.	Possible	Significant	2
FE-8	Asphalt Paving (Inc. Base Course, Fence)	• Unusual parts, material or equipment manufactured or installed?	No significant risks anticipated	This construction feature does no require specialty fabrication or equipment and thus no risks are anticipated	Unlikely	Negligible	0
FE-9	0	• Unusual parts, material or equipment manufactured or installed?			Unlikely	Negligible	0
FE-10	0	• Unusual parts, material or equipment manufactured or installed?			Unlikely	Negligible	0
FE-11	0	• Unusual parts, material or equipment manufactured or installed?			Unlikely	Negligible	0
FE-12	Remaining Construction Items	• Ability to reasonably transport?	• Unusual parts, material or equipment manufactured or installed? • Confidence in contractor's ability to install? • Ability to reasonably transport?	Some prefabricated items may be required for the railroad trestle installation. The trestles are large structures and a risk could be the difficulty in making sure the materials arrive on site on schedule. Sub-contractor used should be capable of handling this and thus the risk is not likely but the impact could be large if things get delayed or fabrication can't be completed on time.	Possible	Significant	2
FE-13	Planning, Engineering, & Design	• Unusual parts, material or equipment manufactured or installed?	• Unusual parts, material or equipment manufactured or installed?	New and different types of materials and construction elements, such as the Pyramat and planter boxes, can cause difficulty during the PED phase. There is a possible chance of these increasing PED costs, however that cost is assumed to be negligible due to the amount of the PED value being used.	Possible	Negligible	0
FE-14	Construction Management	• Ability to reasonably transport?	• Unusual parts, material or equipment manufactured or installed? • Ability to reasonably transport?	Primary risk is the capability of the contractors to keep the transportation of the materials to the site on schedule (especially the planters). If materials are not provided on schedule significant impact to costs may be accrued.	Possible	Significant	2

Cost Estimate Assumptions

							Max Potential Cost Growth	35%
CT-1	Mobilization - Demobilization	• Site accessibility, transport delays, congestion?	• Site accessibility, transport delays, congestion?	Site accessibility and staging areas have not been fully developed. However, current mob/demob assumption results in large mob/demob costs as it is a percentage of construction. Therefore mob/demob is not anticipated to have much of an impact even if further analysis results in accessibility problems	Possible	Marginal	1
CT-2	Earthwork	• Site accessibility, transport delays, congestion?	• Reliability and number of key quotes? • Assumptions regarding crew, productivity, overtime? • Site accessibility, transport delays, congestion?	Large volumes of excavated material will be required to be disposed of off-site. The capability of the contractor to be able to find adequate disposal locations that would accept the large volumes could be difficult. Also, traffic could be a major risk to trucks transporting the material. These risks were factored in some for unit cost development, but at time of construction could vary significantly.	Likely	Significant	3
CT-3	Vegetation & Topsoil	• Lack confidence on critical cost items?	• Lack confidence on critical cost items?	No vegetation plan has been developed. Thus, the unit cost used was developed from analyzing other local projects cost estimates. Actual cost for vegetation could be different depending on future design. Also, amounts of irrigation required could cause cost increases. However, conservative unit cost was used and assumptions are likely to change but impact would be marginal.	Likely	Marginal	2
CT-4	Demolition	• Reliability and number of key quotes?	• Assumptions regarding crew, productivity, overtime? • Site accessibility, transport delays, congestion? • Reliability and number of key quotes?	With no site access plan, demolition of existing structures could be more difficult to access than assumed. Tipping fees were obtained for materials being demolished, but these could be different at time of construction. These risks are not anticipated to be likely, but could have significant impacts.	Possible	Significant	2
CT-5	Riprap & Grouted Riprap	• Site accessibility, transport delays, congestion?	• Reliability and number of key quotes? • Assumptions regarding crew, productivity, overtime? • Site accessibility, transport delays, congestion?	Large volumes of stone would be required, and thus would heavily depend on the material and trucking costs. If these costs are different at time of construction, which is likely, then there would be significant impacts to costs.	Likely	Significant	3
CT-6	Turf Reinforcement Mat	• Reliability and number of key quotes?	• Reliability and number of key quotes?	Cost quote for material and placement of the material was obtained. Sub-contractor markups were applied as well, due to the assumption that the material supplier would also install. Quote used was in line with other projects the material was used, and therefore is unlikely to change.	Unlikely	Marginal	0
CT-7	Concrete (Walls & Planters)	• Site accessibility, transport delays, congestion?	• Site accessibility, transport delays, congestion?	Transporting the concrete material, and planter boxes could be problematic due to traffic concerns. This shouldn't cause to many delays but could be significant if it does occur.	Possible	Significant	2
CT-8	Asphalt Paving (Inc. Base Course, Fence)	• Reliability and number of key quotes?	No significant risks anticipated	This work is very typical in this area, and no significant risks are likely to occur. Unit costs are in line with this work in the area and not anticipated to change.	Unlikely	Negligible	0
CT-9	0	• Reliability and number of key quotes?			Unlikely	Negligible	0
CT-10	0	• Reliability and number of key quotes?			Unlikely	Negligible	0
CT-11	0	• Reliability and number of key quotes?			Unlikely	Negligible	0
CT-12	Remaining Construction Items	• Lack confidence on critical cost items?	• Lack confidence on critical cost items?	No design exists for the storm drain daylighting at the railroad trestles. Conservative unit costs were used for each of these items however. Costs are likely to be different, but due to the conservative unit costs used impacts would be marginal.	Likely	Marginal	2
CT-13	Planning, Engineering, & Design	• Lack confidence on critical cost items?	• Lack confidence on critical cost items?	Current percentage used for PED is probably conservative due the overall project costs, which generate large PED costs. Thus the likelihood of it increasing is minimal, and the impact would be marginal if it did increase.	Unlikely	Marginal	0
CT-14	Construction Management	• Lack confidence on critical cost items?	• Lack confidence on critical cost items?	Current CM percentage used is conservative, due to the overall project costs, which generates large CM costs. However, some of the risks outlined above may cause increases to CM. These risks are not likely to occur and could cause marginal increases here.	Possible	Marginal	1

External Project Risks

						Max Potential Cost Growth	40%
EX-1	Mobilization - Demobilization	• Potential for market volatility impacting competition, pricing?	• Potential for severe adverse weather? • Political influences, lack of support, obstacles? • Unanticipated inflations in fuel, key materials? • Potential for market volatility impacting competition, pricing?	There are several external risks that could delay the project and/or impact the overall costs. One risk is in regard to the interactions between all the agencies that would be involved in this project. Getting all the agencies on the same page could be a cause for concern moving forward. Also dealing with the overall scale of the project and all the multiple stakholders is a risk as well. Weather is not anticipated to be a likely risk, but could impact the costs if something drastic occurred. Lastly, inflation in fuel and some materials would impact costs. Overall, these are not likely to occur, but most likely would be an impact to schedule and only marginal to costs.	Possible	Marginal	1
EX-2	Earthwork	• Potential for severe adverse weather?	• Potential for severe adverse weather? • Political influences, lack of support, obstacles? • Unanticipated inflations in fuel, key materials? • Potential for market volatility impacting competition, pricing?	See discussion in first box above.	Possible	Marginal	1
EX-3	Vegetation & Topsoil	• Potential for severe adverse weather?	• Potential for severe adverse weather? • Political influences, lack of support, obstacles? • Unanticipated inflations in fuel, key materials? • Potential for market volatility impacting competition, pricing?	See discussion in first box above.	Possible	Marginal	1
EX-4	Demolition	• Potential for severe adverse weather?	• Potential for severe adverse weather? • Political influences, lack of support, obstacles? • Unanticipated inflations in fuel, key materials? • Potential for market volatility impacting competition, pricing?	See discussion in first box above.	Possible	Marginal	1
EX-5	Riprap & Grouted Riprap	• Potential for severe adverse weather?	• Potential for severe adverse weather? • Political influences, lack of support, obstacles? • Unanticipated inflations in fuel, key materials? • Potential for market volatility impacting competition, pricing?	See discussion in first box above.	Possible	Marginal	1
EX-6	Turf Reinforcement Mat	• Potential for severe adverse weather?	• Potential for severe adverse weather? • Political influences, lack of support, obstacles? • Unanticipated inflations in fuel, key materials? • Potential for market volatility impacting competition, pricing?	See discussion in first box above.	Possible	Marginal	1
EX-7	Concrete (Walls & Planters)	• Potential for severe adverse weather?	• Potential for severe adverse weather? • Political influences, lack of support, obstacles? • Unanticipated inflations in fuel, key materials? • Potential for market volatility impacting competition, pricing?	See discussion in first box above.	Possible	Marginal	1
EX-8	Asphalt Paving (Inc. Base Course, Fence)	• Potential for severe adverse weather?	• Potential for severe adverse weather? • Political influences, lack of support, obstacles? • Unanticipated inflations in fuel, key materials? • Potential for market volatility impacting competition, pricing?	See discussion in first box above.	Possible	Marginal	1
EX-9	0	• Potential for severe adverse weather?			Unlikely	Negligible	0
EX-10	0	• Potential for severe adverse weather?			Unlikely	Negligible	0
EX-11	0	• Potential for severe adverse weather?			Unlikely	Negligible	0
EX-12	Remaining Construction Items	• Potential for severe adverse weather?	• Potential for severe adverse weather? • Political influences, lack of support, obstacles? • Unanticipated inflations in fuel, key materials? • Potential for market volatility impacting competition, pricing?	See discussion in first box above.	Possible	Marginal	1
EX-13	Planning, Engineering, & Design	• Potential for severe adverse weather?	• Potential for severe adverse weather? • Political influences, lack of support, obstacles? • Unanticipated inflations in fuel, key materials? • Potential for market volatility impacting competition, pricing?	See discussion in first box above.	Possible	Marginal	1
EX-14	Construction Management	• Potential for severe adverse weather?	• Potential for severe adverse weather? • Political influences, lack of support, obstacles? • Unanticipated inflations in fuel, key materials? • Potential for market volatility impacting competition, pricing?	See discussion in first box above.	Possible	Marginal	1

Los Angeles River
Feasibility (Alternatives)
Abbreviated Risk Analysis

Typical Risk Elements	Potential Risk Areas													
	Mobilization - Demobilization	Earthwork	Vegetation & Topsoil	Demolition	Riprap & Grouted Riprap	Turf Reinforcement Mat	Concrete (Walls & Planters)	Asphalt Paving (Inc. Base Course, Fe	0	0	0	Remaining Construction Ite	Planning, Engineering, & Design	Construction Management
Project Scope Growth	3	3	1	2	3	2	3	1	-	-	-	1	3	2
Acquisition Strategy	1	1	1	1	1	1	1	1	-	-	-	1	1	1
Construction Elements	-	3	1	1	-	-	3	-	-	-	-	2	-	1
Quantities for Current Scope	-	3	2	1	3	1	3	-	-	-	-	3	-	-
Specialty Fabrication or Equipment	-	-	-	-	-	2	2	-	-	-	-	2	-	2
Cost Estimate Assumptions	1	3	2	2	3	-	2	-	-	-	-	2	-	1
External Project Risks	1	1	1	1	1	1	1	1	-	-	-	1	1	1

Construction Contingencies by Alternative

ALT 10 - ARBOR Riparian Transitions (ART)

Features	Construction Cost	Contingency	Total Cost
Mobilization - Demobilization	$ 2,787,026	26.44%	$ 3,523,915
Earthwork	$ 19,169,720	45.78%	$ 27,945,617
Vegetation & Topsoil	$ 3,624,550	22.80%	$ 4,450,948
Demolition	$ -	24.56%	$ -
Riprap & Grouted Riprap	$ 11,283,850	38.88%	$ 15,671,010
Turf Reinforcement Mat	$ -	24.13%	$ -
Concrete (Walls & Planters)	$ -	47.10%	$ -
Asphalt Paving (Inc. Base Course, Fence)	$ 1,182,222	13.44%	$ 1,341,113
Remaining Construction Items	$ 1,900,000	32.86%	$ 2,524,340
Total Construction Costs	***$ 39,947,368***	***38.83%***	***$ 55,456,944***

ALT 13 - ARBOR Corridor Extension (ACE)

Features	Construction Cost	Contingency	Total Cost
Mobilization - Demobilization	$ 6,171,589	26.44%	$ 7,803,357
Earthwork	$ 32,734,957	45.78%	$ 47,721,020
Vegetation & Topsoil	$ 3,953,828	22.80%	$ 4,855,301
Demolition	$ 8,360,013	24.56%	$ 10,413,232
Riprap & Grouted Riprap	$ 23,109,490	38.88%	$ 32,094,459
Turf Reinforcement Mat	$ 9,494,344	24.13%	$ 11,785,329
Concrete (Walls & Planters)	$ -	47.10%	$ -
Asphalt Paving (Inc. Base Course, Fence)	$ 2,669,458	13.44%	$ 3,028,233
Remaining Construction Items	$ 1,965,760	32.86%	$ 2,611,709
Total Construction Costs	***$ 88,459,438***	***36.01%***	***$ 120,312,641***

ALT 16 - ARBOR Narrows to Downtown (AND)

Features	Construction Cost	Contingency	Total Cost
Mobilization - Demobilization	$ 19,938,361	26.44%	$ 25,210,063
Earthwork	$ 81,865,448	45.78%	$ 119,343,449
Vegetation & Topsoil	$ 3,872,911	22.80%	$ 4,755,935
Demolition	$ 30,050,117	24.56%	$ 37,430,426
Riprap & Grouted Riprap	$ 60,223,646	38.88%	$ 83,638,599
Turf Reinforcement Mat	$ 9,494,344	24.13%	$ 11,785,329
Concrete (Walls & Planters)	$ 46,625,927	47.10%	$ 68,586,739
Asphalt Paving (Inc. Base Course, Fence)	$ 7,616,160	13.44%	$ 8,639,772
Remaining Construction Items	$ 26,096,257	32.86%	$ 34,671,487
Total Construction Costs	***$ 285,783,170***	***37.89%***	***$ 394,061,800***

ALT 20 - ARBOR Riparian Integration Via Varied Ecol. Reintroduction (RIVER)

Features	Construction Cost	Contingency	Total Cost
Mobilization - Demobilization	$ 27,391,085	26.44%	$ 34,633,288
Earthwork	$ 113,775,573	45.78%	$ 165,862,031
Vegetation & Topsoil	$ 5,603,018	22.80%	$ 6,880,507
Demolition	$ 25,234,156	24.56%	$ 31,431,665
Riprap & Grouted Riprap	$ 76,784,594	38.88%	$ 106,638,445
Turf Reinforcement Mat	$ 11,815,774	24.13%	$ 14,666,920
Concrete (Walls & Planters)	$ 93,075,780	47.10%	$ 136,914,473
Asphalt Paving (Inc. Base Course, Fence)	$ 7,925,902	13.44%	$ 8,991,143
Remaining Construction Items	$ 30,999,672	32.86%	$ 41,186,164
Total Construction Costs	***$ 392,605,556***	***39.38%***	***$ 547,204,636***

PED Contingency:	24.40%
CM Contingency:	26.25%

US Army Corps
of Engineers®
Los Angeles District

Los Angeles River Ecosystem Restoration Feasibility Study

Cost Appendix

Attachment 8
MCACES Cost Estimate
Detailed Quantity Take-Offs

April 2015

US Army Corps
of Engineers®
Los Angeles District

Los Angeles River Ecosystem Restoration Feasibility Study

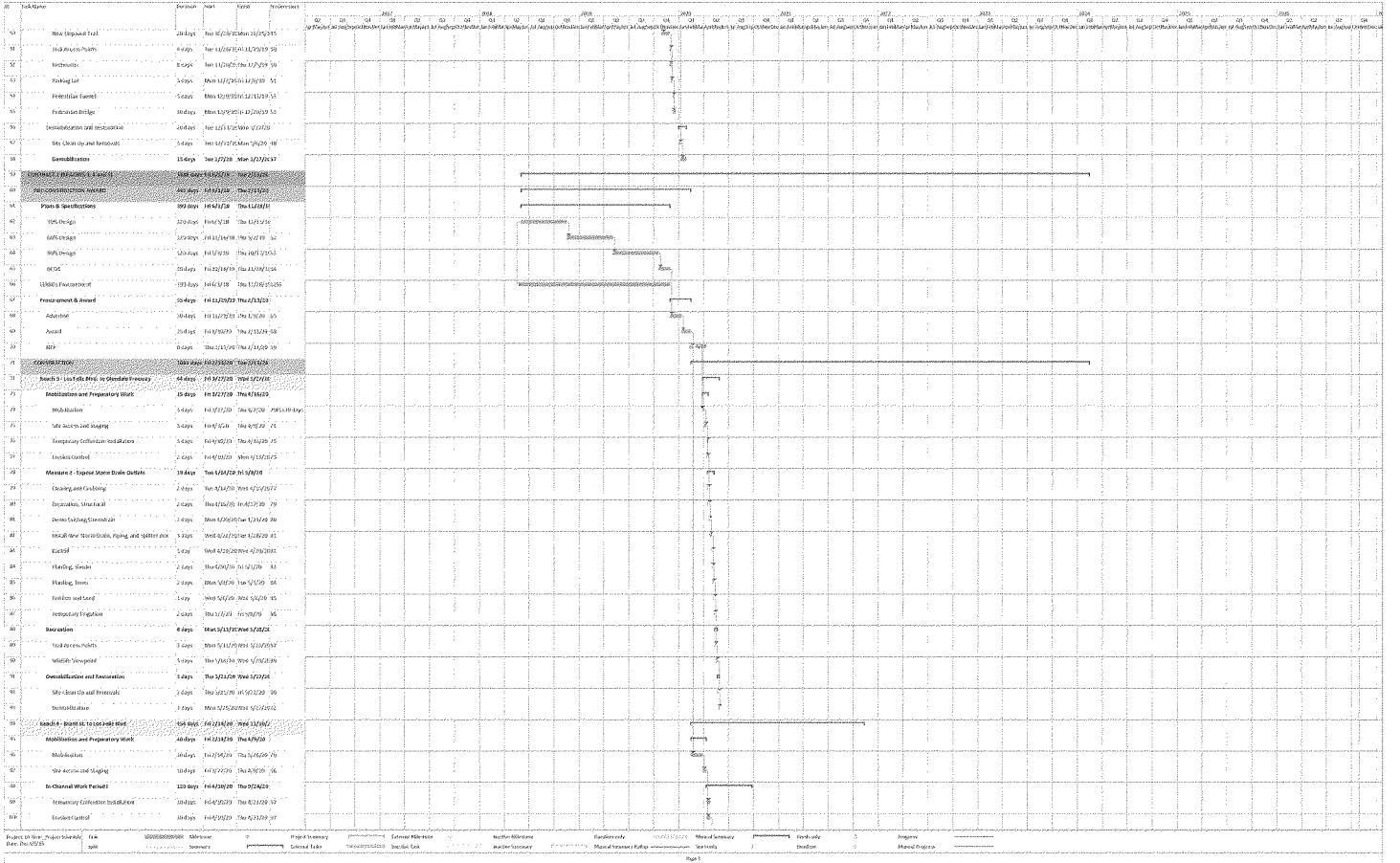
Cost Appendix

Attachment 9
Tentative Project Schedule

April 2015

NATIONAL ECOSYSTEM RESTORATION PLAN – ALTERNATIVE 13v

TENTATIVE PROJECT SCHEDULE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Finish
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Milestone
Summary
Project Summary
External Tasks
External Milestone
Inactive Task
Inactive Milestone
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Duration-only
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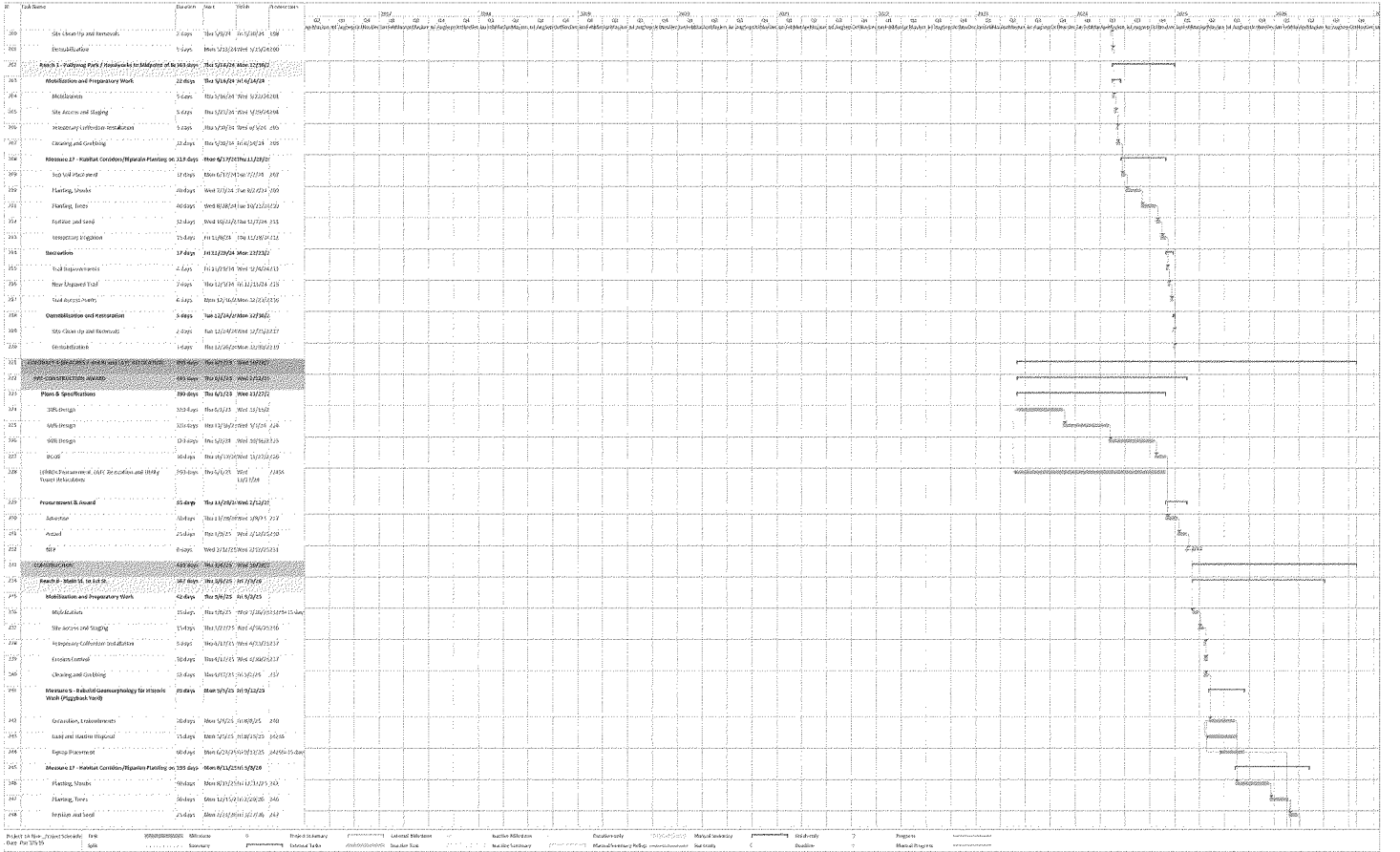
Manual Summary
Start-only
Finish-only
Deadline
Progress
Manual Progress
Page 3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Milestone
Summary
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Manual Summary
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Deadline
Progress
Manual Progress
Page 1

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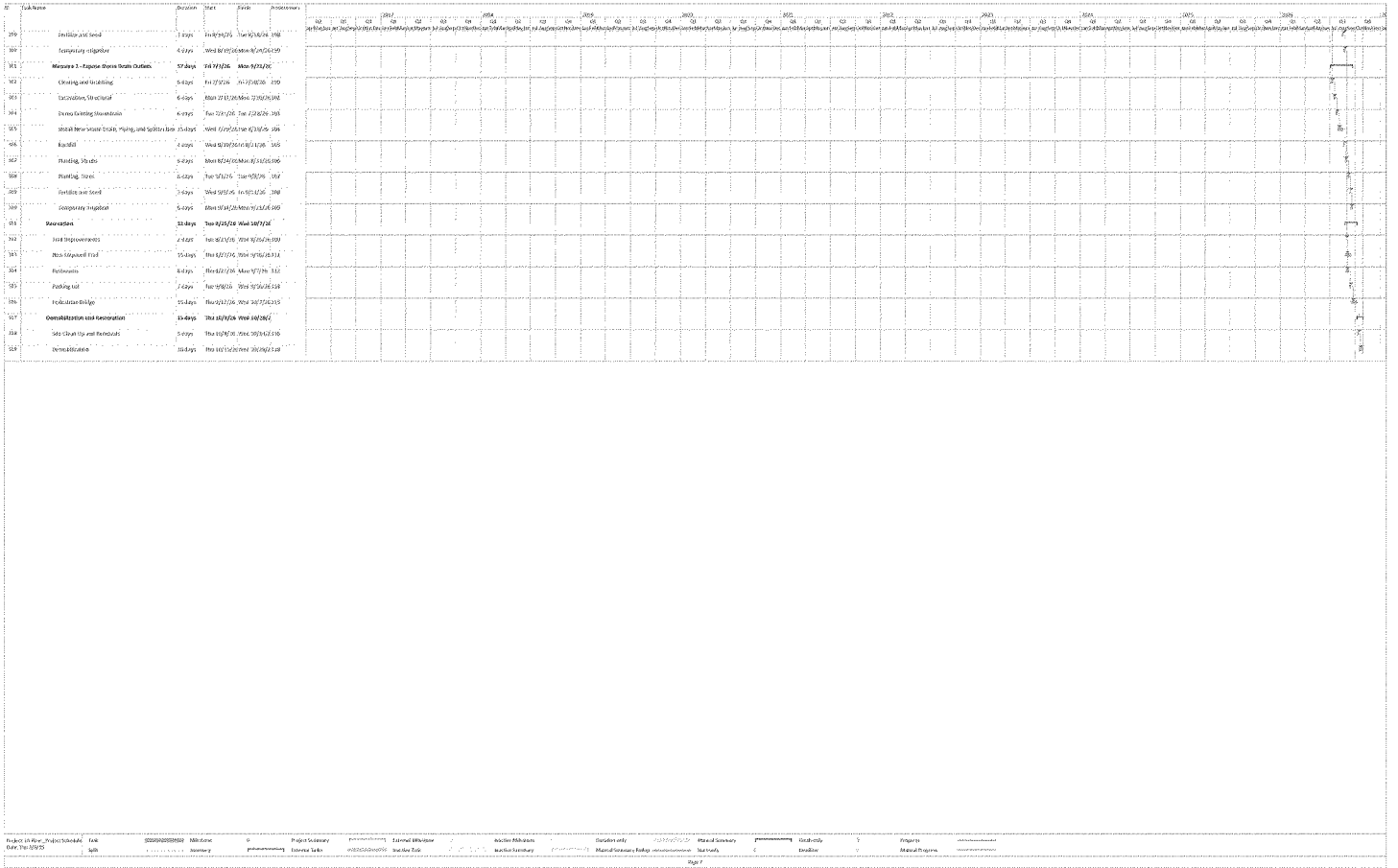
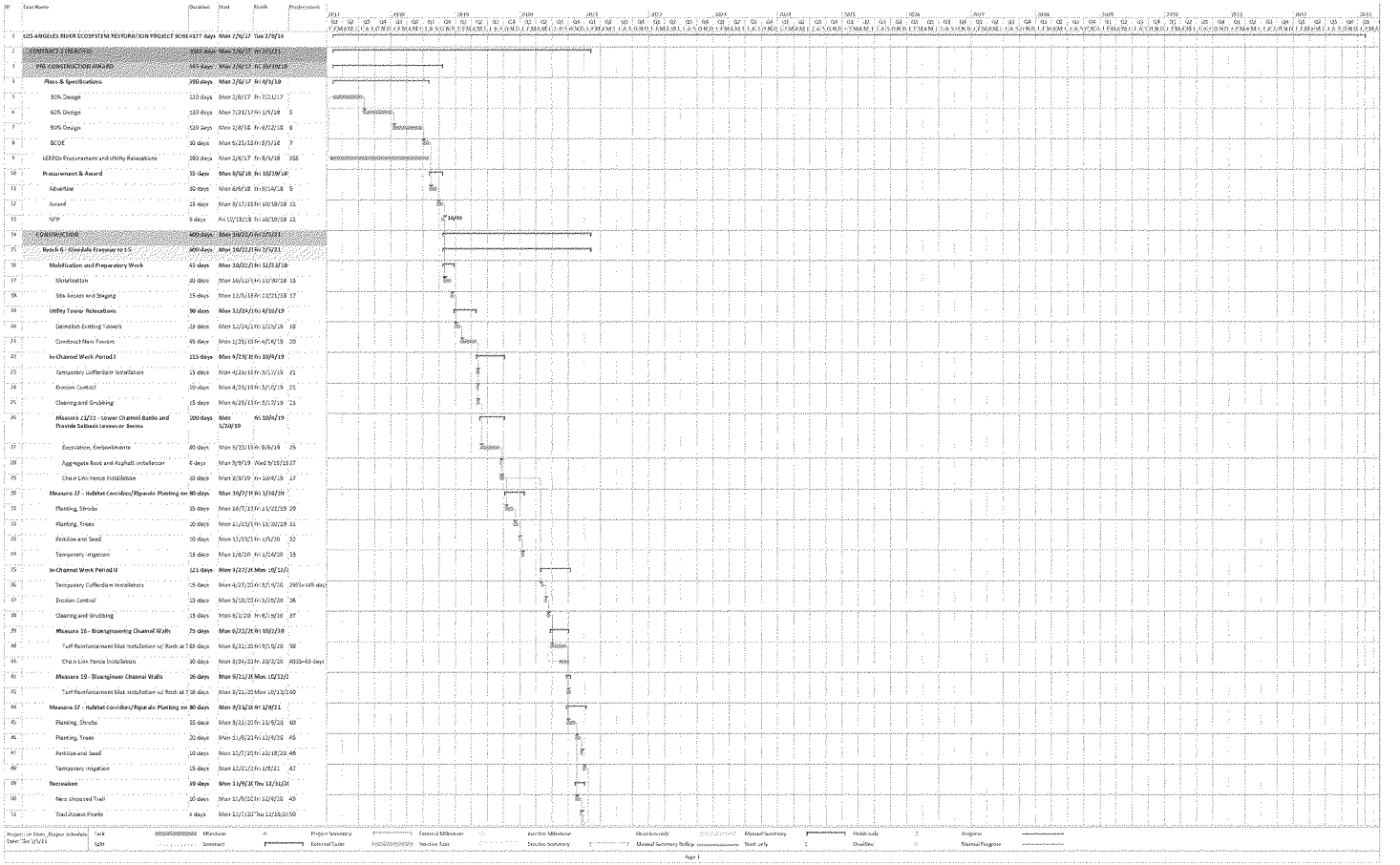


ID	Task Name	Duration	Start	Finish	Predecessors
159	Fertilize and Seed	1 days	Fri 9/19/25	Tue 9/16/26	158
160	Temporary Irrigation	4 days	Wed 8/19/26	Mon 8/24/26	159
161	**Measure 1 - Expose Storm Drain Outlets**	**57 days**	**Fri 7/3/26**	**Mon 9/21/26**	
162	Clearing and Grubbing	5 days	Fri 7/3/26	Thu 7/9/26	139
163	Excavation, Structural	6 days	Mon 7/13/26	Mon 7/20/26	162
164	Demo Existing Foundation	4 days	Tue 7/21/26	Tue 7/28/26	163
165	Install New Storm Drain, Piping, and Splitter Box	15 days	Wed 7/29/26	Tue 8/18/26	164
166	Backfill	2 days	Wed 8/19/26	Thu 8/20/26	165
167	Plumbing, Stubs	5 days	Mon 8/24/26	Mon 8/31/26	166
168	Plumbing, Risers	5 days	Tue 9/1/26	Tue 9/8/26	167
169	Portable Unit Secure	3 days	Wed 9/9/26	Fri 9/11/26	168
170	Temporary Irrigation	5 days	Mon 9/14/26	Mon 9/21/26	169
171	**Recreation**	**32 days**	**Tue 8/25/26**	**Wed 10/7/26**	
172	Trail Improvements	4 days	Tue 8/25/26	Wed 9/30/26	169
173	Play Equipment Pad	15 days	Thu 8/27/26	Wed 9/16/26	171
174	Restrooms	8 days	Thu 8/27/26	Mon 9/7/26	171
175	Parking Lot	7 days	Tue 9/8/26	Wed 9/16/26	174
176	Pedestrian Bridge	15 days	Thu 9/17/26	Wed 10/7/26	175
177	**Demobilization and Revegetation**	**15 days**	**Thu 10/8/26**	**Wed 10/28/26**	
178	Site Clean Up and Removals	5 days	Thu 10/8/26	Wed 10/14/26	176
179	Demobilization	10 days	Thu 10/15/26	Wed 10/28/26	178

LOCALLY PREFERRED PLAN – ALTERNATIVE 20

TENTATIVE PROJECT SCHEDULE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Task Name
Duration
Start
Finish
Predecessors
1 LOS ANGELES RIVER ECOSYSTEM RESTORATION PROJECT SCHE 4177 days Mon 2/6/17 Tue 2/28/33
2 CONTRACT 1 (LEGACY) 965 days Mon 1/6/14 Fri 3/5/21
3 PPR CONSTRUCTION AWARD 445 days Mon 2/6/17 Fri 10/19/18
4 Plans & Specifications 390 days Mon 2/6/17 Fri 6/8/18
5 30% Design 120 days Mon 2/6/17 Fri 7/21/17
6 60% Design 120 days Mon 7/24/17 Fri 1/5/18 5
7 90% Design 120 days Mon 1/8/18 Fri 6/22/18 6
8 BCOE 10 days Mon 6/25/18 Fri 8/3/18 7
9 LERRDs Procurement and Utility Relocations 180 days Mon 2/6/17 Fri 9/3/18 355
10 Procurement & Award 53 days Mon 8/6/18 Fri 10/19/18
11 Advertise 30 days Mon 8/6/18 Fri 9/14/18 9
12 Award 15 days Mon 9/17/18 Fri 10/5/18 11
13 NTP 9 days Fri 10/12/18 Fri 10/19/18 12
14 CONSTRUCTION 400 days Mon 10/22/18 Fri 3/5/21
15 Reach 6 - Glendale Freeway to I-5 400 days Mon 10/22/18 Fri 3/5/21
16 Mobilization and Preparatory Work 45 days Mon 10/22/18 Fri 12/21/18
17 Mobilization 30 days Mon 10/22/18 Fri 11/30/18 13
18 Site Access and Staging 15 days Mon 12/3/18 Fri 12/21/18 17
19 Utility Tower Relocations 50 days Mon 12/24/18 Fri 3/1/19
20 Demolish Existing Towers 10 days Mon 12/24/18 Fri 1/25/19 18
21 Construct New Towers 65 days Mon 1/28/19 Fri 4/26/19 20
22 In-Channel Work Period I 115 days Mon 9/23/19 Fri 3/6/19
23 Temporary Coffer Dam Installation 15 days Mon 4/29/19 Fri 5/17/19 21
24 Erosion Control 10 days Mon 4/29/19 Fri 5/10/19 21
25 Cleaning and Grubbing 15 days Mon 4/29/19 Fri 5/17/19 23
26 Measure J1/J2 - Lower Channel Banks and Provide Setback Levees or Berms 100 days Mon 5/20/19 Fri 10/4/19
27 Excavation, Embankments 80 days Mon 5/20/19 Fri 9/6/19
28 Aggregate Base and Asphalt Installation 5 days Mon 9/9/19 Wed 9/18/19 27
29 Chain Link Fence Installation 10 days Mon 9/30/19 Fri 10/4/19 27
30 Measure J7 - Habitat Corridor/Riparian Planting on 80 days Mon 10/7/19 Fri 1/24/20
31 Planting, Shrubs 35 days Mon 10/7/19 Fri 11/22/19 29
32 Planting, Trees 20 days Mon 11/25/19 Fri 12/20/19 31
33 Fertilize and Seed 10 days Mon 12/23/19 Fri 1/3/20 32
34 Temporary Irrigation 15 days Mon 1/6/20 Fri 1/24/20 33
35 In-Channel Work Period II 121 days Mon 9/21/20 Mon 3/1/21
36 Temporary Coffer Dam Installation 15 days Mon 4/27/20 Fri 5/15/20 2W3+145 days
37 Erosion Control 10 days Mon 5/18/20 Fri 5/29/20 36
38 Cleaning and Grubbing 15 days Mon 5/1/20 Fri 6/19/20 37
39 Measure J6 - Bioengineering Channel Walls 75 days Mon 6/22/20 Fri 10/2/20
40 Turf Reinforcement Mat Installation w/ Rock at T 65 days Mon 8/22/20 Fri 11/6/20 39
41 Chain Link Fence Installation 10 days Mon 8/24/20 Fri 9/4/20 4016+40 days
42 Measure J9 - Bioengineer Channel Walls 16 days Mon 9/21/20 Mon 10/12/20
43 Turf Reinforcement Mat Installation w/ Rock at T 16 days Mon 9/21/20 Mon 10/12/20 40
44 Measure J7 - Habitat Corridor/Riparian Planting on 30 days Mon 9/14/20 Fri 1/8/21
45 Planting, Shrubs 35 days Mon 9/21/20 Fri 11/6/20 40
46 Planting, Trees 20 days Mon 11/9/20 Fri 12/4/20 45
47 Fertilize and Seed 10 days Mon 12/7/20 Fri 12/18/20 46
48 Temporary Irrigation 15 days Mon 12/21/20 Fri 1/8/21 47
49 Recreation 39 days Mon 11/9/20 Thu 11/21/20
50 New Unpaved Trail 10 days Mon 11/9/20 Fri 11/20/20 45
51 Trail Access Points 4 days Mon 11/7/20 Thu 11/10/20 50
2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033
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Date: Tue 3/1/11
Task
Split
Milestone
Summary
Project Summary
External Tasks
External Milestone
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
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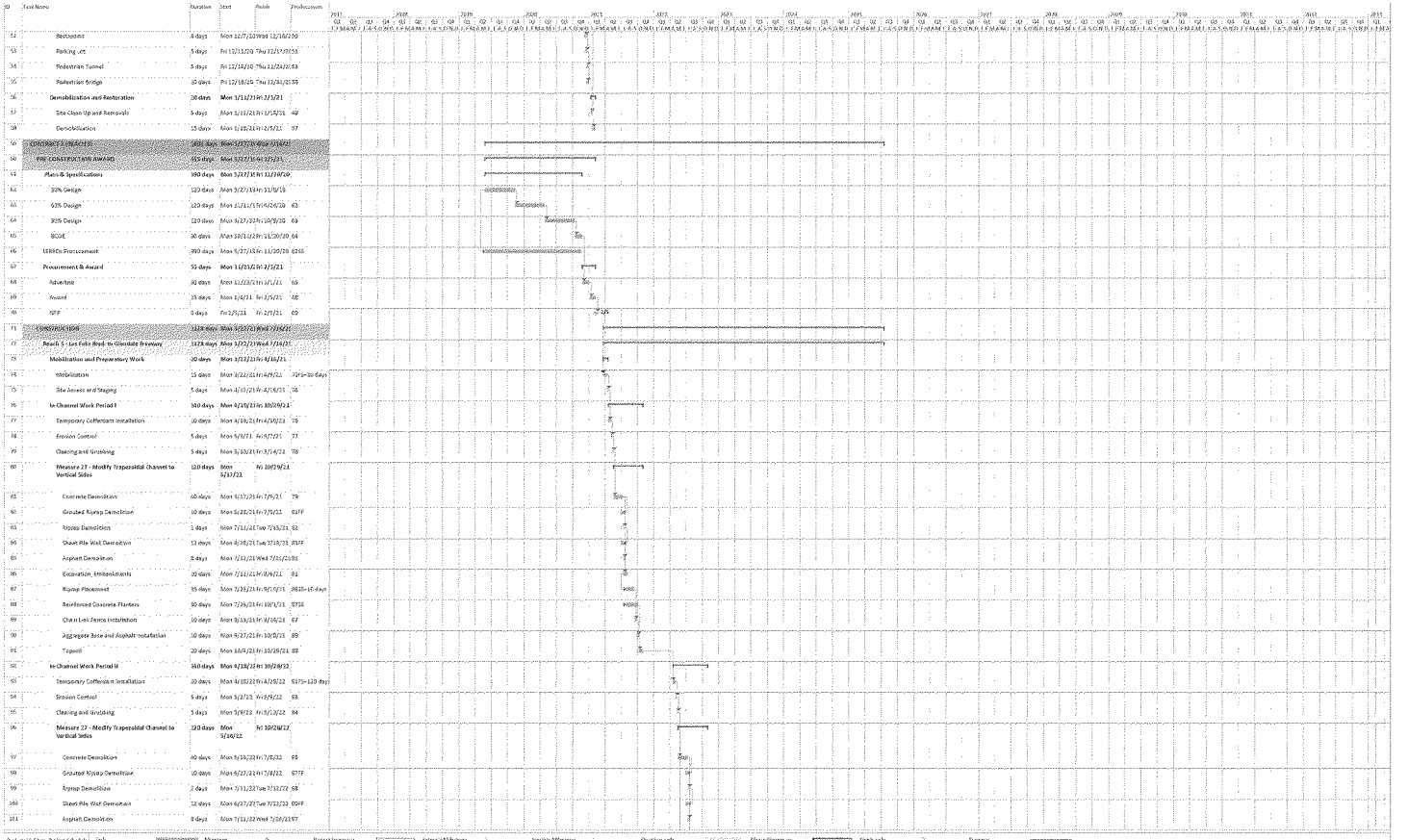
Start-only
Finish-only
Deadline
Progress
Manual Progress
Page 1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Finish
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Parking Lot
Pedestrian Tunnel
Pedestrian Bridge
Demobilization and Restoration
Site Clean Up and Removals
Demobilization
CONTRACT ONE ACTS
PRE-CONSTRUCTION AWARD
Plans & Specifications
30% Design
60% Design
90% Design
BCOE
USACE Procurement
Procurement & Award
Advertise
Award
NTP
CONSTRUCTION
Reach 5 - Las Felix Road to Glendale Freeway
Mobilization and Preparatory Work
Mobilization
Site Access and Staging
In-Channel Work Period I
Temporary Cofferdam Installation
Erosion Control
Clearing and Grubbing
Measure 27 - Modify Trapezoidal Channel to Vertical Sides
Concrete Demolition
Grouted Riprap Demolition
Riprap Demolition
Sheet Pile Wall Demolition
Asphalt Demolition
Excavation, Embankments
Riprap Placement
Reinforced Concrete Planters
Chain Link Fence Installation
Aggregate Base and Asphalt Installation
Topsoil
In-Channel Work Period II
Temporary Cofferdam Installation
Erosion Control
Clearing and Grubbing
Measure 27 - Modify Trapezoidal Channel to Vertical Sides
Concrete Demolition
Grouted Riprap Demolition
Riprap Demolition
Sheet Pile Wall Demolition
Asphalt Demolition
Project: LA Rivers_Project Schedule
Date: Thu 3/5/15
Task
Split
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Summary
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External Tasks
External Milestone
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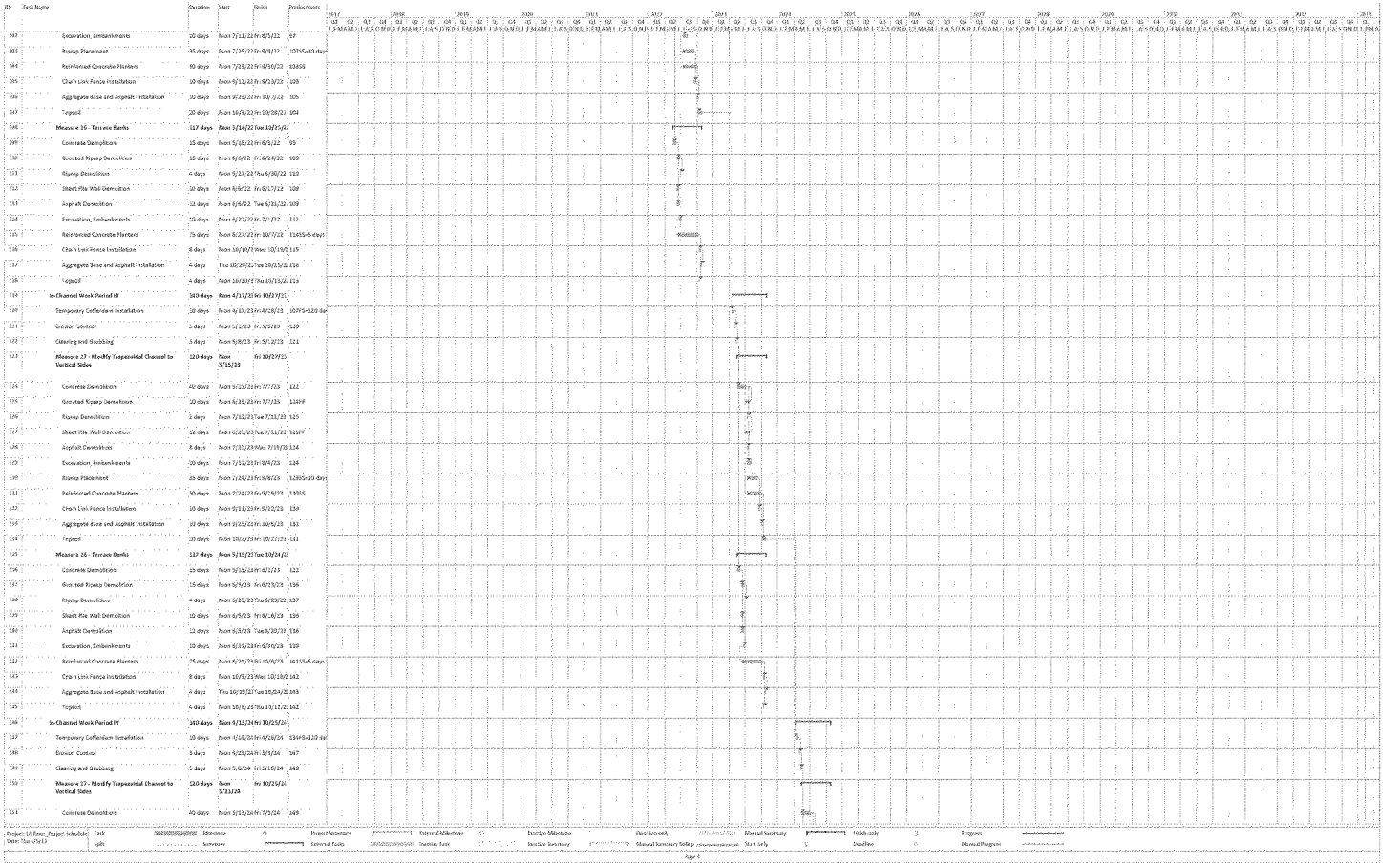
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2023
2024
2025
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2031
2032
2033
Excavation, Embankments 10 days Mon 7/11/22 Fri 8/5/22 97
Riprap Placement 35 days Mon 7/25/22 Fri 9/9/22 100SS+10 days
Reinforced Concrete Planters 90 days Mon 7/25/22 Fri 10/28/22 104SS
Chain Link Fence Installation 10 days Mon 9/12/22 Fri 9/23/22 103
Aggregate Base and Asphalt Installation 10 days Mon 9/26/22 Fri 10/7/22 105
Topsoil 20 days Mon 10/10/22 Fri 10/28/22 104
Measure 26 - Terrace Banks 117 days Mon 3/14/22 Tue 8/30/22
Concrete Demolition 15 days Mon 5/16/22 Fri 6/3/22 95
Grouted Riprap Demolition 16 days Mon 6/6/22 Fri 6/24/22 109
Riprap Demolition 4 days Mon 6/27/22 Thu 6/30/22 110
Sheet Pile Wall Demolition 10 days Mon 6/6/22 Fri 6/17/22 109
Asphalt Demolition 12 days Mon 6/6/22 Tue 6/21/22 109
Excavation, Embankments 10 days Mon 6/20/22 Fri 7/1/22 111
Reinforced Concrete Planters 75 days Mon 6/27/22 Fri 10/7/22 114SS+5 days
Chain Link Fence Installation 8 days Mon 10/10/22 Wed 10/19/22 115
Aggregate Base and Asphalt Installation 4 days Thu 10/20/22 Tue 10/25/22 116
Topsoil 4 days Mon 10/10/22 Thu 10/13/22 115
In-Channel Work Period III 140 days Mon 4/17/23 Fri 10/27/23
Temporary Cofferdam Installation 10 days Mon 4/17/23 Fri 4/28/23 107FS-120 days
Erosion Control 5 days Mon 5/1/23 Fri 5/5/23 120
Clearing and Grubbing 5 days Mon 5/8/23 Fri 5/12/23 121
Measure 27 - Modify Trapezoidal Channel to Vertical Sides 120 days Mon 5/15/23 Fri 10/27/23
Concrete Demolition 40 days Mon 5/15/23 Fri 7/7/23 122
Grouted Riprap Demolition 20 days Mon 6/26/23 Fri 7/7/23 124FF
Riprap Demolition 5 days Mon 7/10/23 Tue 7/11/23 125
Sheet Pile Wall Demolition 14 days Mon 6/26/23 Tue 7/11/23 124FF
Asphalt Demolition 8 days Mon 7/10/23 Wed 7/19/23 124
Excavation, Embankments 20 days Mon 7/10/23 Fri 8/4/23 124
Riprap Placement 35 days Mon 7/24/23 Fri 9/8/23 128SS+20 days
Reinforced Concrete Planters 90 days Mon 7/24/23 Fri 9/29/23 130SS
Chain Link Fence Installation 10 days Mon 9/11/23 Fri 9/22/23 129
Aggregate Base and Asphalt Installation 10 days Mon 9/25/23 Fri 10/6/23 131
Topsoil 10 days Mon 10/9/23 Fri 10/27/23 131
Measure 26 - Terrace Banks 117 days Mon 9/25/23 Tue 10/24/23
Concrete Demolition 15 days Mon 9/25/23 Fri 10/13/23 122
Grouted Riprap Demolition 15 days Mon 9/9/23 Fri 9/29/23 136
Riprap Demolition 4 days Mon 9/25/23 Thu 9/28/23 137
Sheet Pile Wall Demolition 10 days Mon 9/9/23 Fri 9/22/23 135
Asphalt Demolition 12 days Mon 9/11/23 Tue 9/26/23 136
Excavation, Embankments 10 days Mon 9/11/23 Fri 9/22/23 139
Reinforced Concrete Planters 75 days Mon 9/25/23 Fri 10/6/23 141SS+5 days
Chain Link Fence Installation 8 days Mon 10/9/23 Wed 10/18/23 142
Aggregate Base and Asphalt Installation 4 days Thu 10/19/23 Tue 10/24/23 143
Topsoil 4 days Mon 10/9/23 Thu 10/12/23 142
In-Channel Work Period IV 140 days Mon 9/15/24 Fri 10/25/24
Temporary Cofferdam Installation 10 days Mon 4/15/24 Fri 4/26/24 134FS-120 days
Erosion Control 5 days Mon 4/29/24 Fri 5/3/24 147
Clearing and Grubbing 5 days Mon 5/6/24 Fri 5/10/24 148
Measure 27 - Modify Trapezoidal Channel to Vertical Sides 120 days Mon 5/13/24 Fri 10/25/24
Concrete Demolition 40 days Mon 5/13/24 Fri 7/5/24 149
Project: LA River_Project Schedule1
Date: Thu 1/5/23
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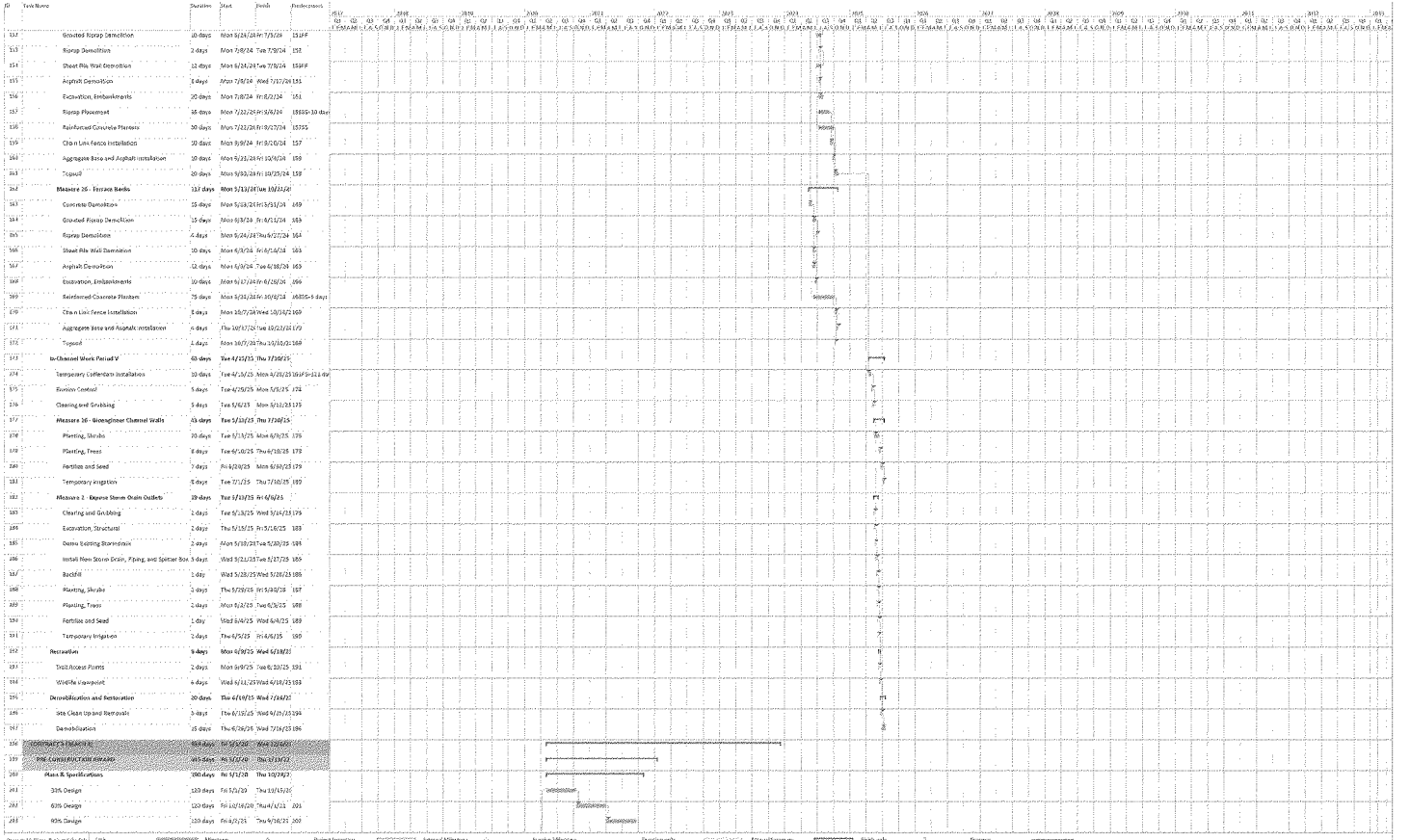
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2019
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2022
2023
2024
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2030
2031
2032
2033
Project: 10 Rivers_Project Schedule
Date: Thu 5/1/25
Task
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Milestone
Summary
Project Summary
External Tasks
External Milestone
Inactive Task
Inactive Milestone
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Start-only
Finish-only
Progress
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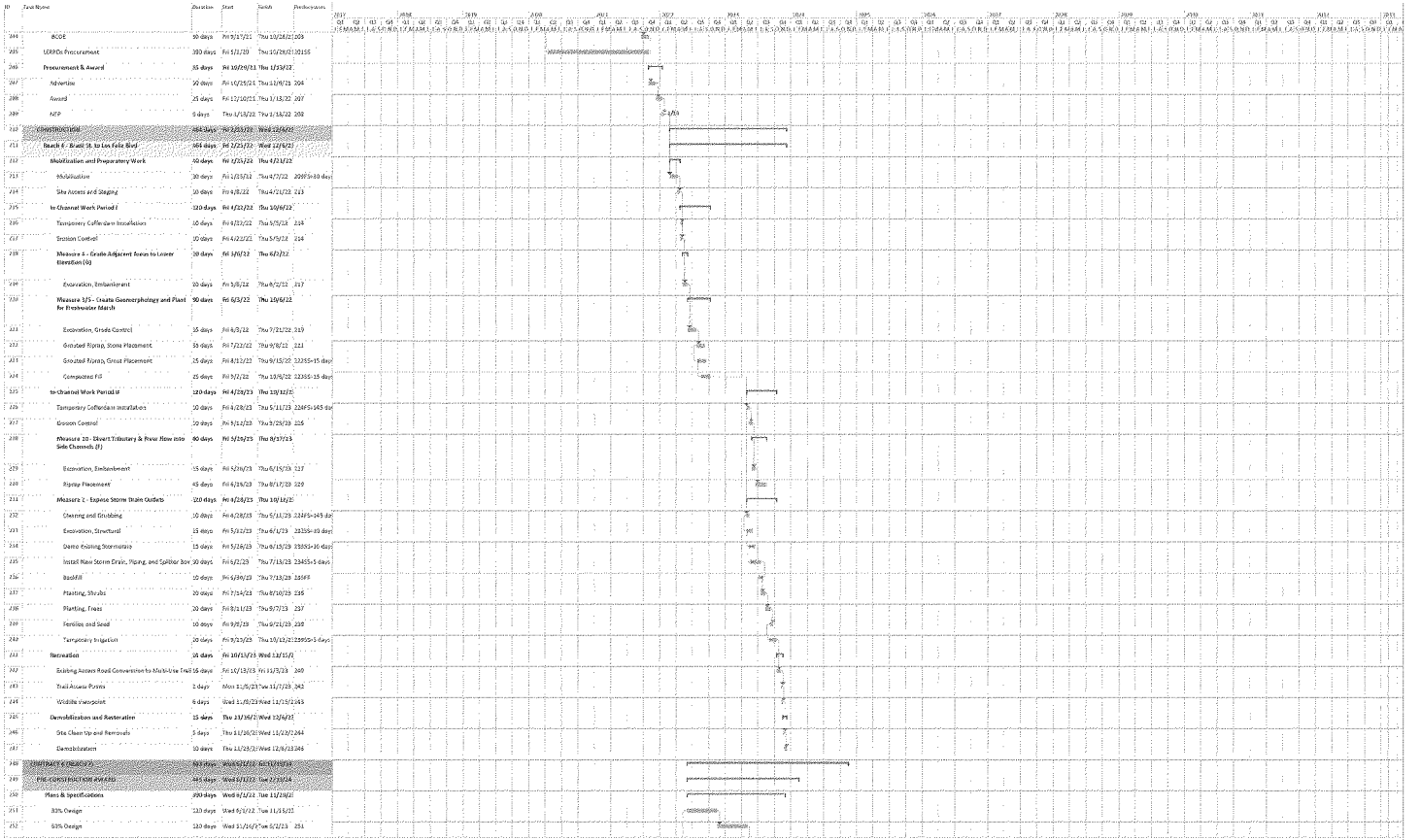
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BCDE 90 days Fri 9/17/21 Thu 10/28/21 209
LERPDs Procurement 180 days Fri 5/1/20 Thu 10/28/21 10155
Procurement & Award 55 days Fri 10/29/21 Thu 1/13/22
Advertise 50 days Fri 10/29/21 Thu 12/9/21 204
Award 25 days Fri 12/10/21 Thu 1/13/22 207
NTP 0 days Thu 1/13/22 Thu 1/13/22 208
CONSTRUCTION 464 days Fri 2/25/22 Wed 12/6/23
Reach 6 - Brazil St. to Los Feliz Blvd 464 days Fri 2/25/22 Wed 12/6/23
Mobilization and Preparatory Work 40 days Fri 2/25/22 Thu 4/21/22
Mobilization 30 days Fri 2/25/22 Thu 4/7/22 209FS+30 days
Site Access and Staging 10 days Fri 4/8/22 Thu 4/21/22 213
In-Channel Work Period I 120 days Fri 4/22/22 Thu 10/6/22
Temporary Cofferdam Installation 10 days Fri 4/22/22 Thu 5/5/22 214
Erosion Control 10 days Fri 4/22/22 Thu 5/5/22 214
Measure 4 - Grade Adjacent Areas to Lower Elevation (4)
Excavation, Embankment 10 days Fri 5/6/22 Thu 5/19/22 217
Measure 3/5 - Create Geomorphology and Plant for Freshwater Marsh 90 days Fri 5/6/22 Thu 10/6/22
Excavation, Grade Control 15 days Fri 6/3/22 Thu 7/21/22 219
Grouted Riprap, Stone Placement 55 days Fri 7/22/22 Thu 9/8/22 221
Grouted Riprap, Grout Placement 25 days Fri 8/12/22 Thu 9/15/22 222SS+15 days
Compacted Fill 25 days Fri 9/2/22 Thu 10/6/22 223SS+15 days
In-Channel Work Period II 120 days Fri 4/28/23 Thu 10/12/23
Temporary Cofferdam Installation 10 days Fri 4/28/23 Thu 5/11/23 224FS+145 days
Erosion Control 10 days Fri 5/12/23 Thu 5/25/23 226
Measure 10 - Divert Tributary & Pond Flow into Side Channels (I)
Excavation, Embankment 15 days Fri 5/26/23 Thu 6/15/23 227
Riprap Placement 45 days Fri 6/16/23 Thu 8/17/23 229
Measure 2 - Expose Storm Drain Outlets 120 days Fri 4/28/23 Thu 10/12/23
Clearing and Grubbing 10 days Fri 4/28/23 Thu 5/11/23 224FS+145 days
Excavation, Structural 15 days Fri 5/12/23 Thu 6/1/23 232SS+10 days
Demo Existing Stormdrain 15 days Fri 5/26/23 Thu 6/15/23 232SS+30 days
Install New Storm Drain, Piping, and Splitter Box 30 days Fri 6/2/23 Thu 7/13/23 234SS+5 days
Backfill 10 days Fri 6/30/23 Thu 7/13/23 235FF
Planting, Shrubs 20 days Fri 7/14/23 Thu 8/10/23 236
Planting, Trees 20 days Fri 8/11/23 Thu 9/7/23 237
Fertilize and Seed 10 days Fri 9/8/23 Thu 9/21/23 238
Temporary Irrigation 20 days Fri 9/15/23 Thu 10/12/23 239SS+5 days
Restoration 16 days Fri 10/13/23 Wed 11/1/23
Existing Access Road Conversion to Multi-Use Trail 16 days Fri 10/13/23 Fri 11/3/23 240
Trail Access Points 2 days Mon 11/6/23 Tue 11/7/23 242
Wildlife Viewpoint 6 days Wed 11/8/23 Wed 11/15/23 243
Demobilization and Restoration 15 days Thu 11/16/23 Wed 12/6/23
Site Clean Up and Removals 5 days Thu 11/16/23 Wed 11/22/23 244
Demobilization 10 days Thu 11/23/23 Wed 12/6/23 246
CONTRACT CLOSEOUT 464 days Wed 6/21/23 Fri 3/15/24
PRE-CONSTRUCTION ACTIVITIES 464 days Wed 6/1/22 Tue 2/13/24
Plans & Specifications 250 days Wed 6/1/22 Tue 11/7/23
30% Design 120 days Wed 6/1/22 Tue 11/15/22
60% Design 120 days Wed 11/16/22 Tue 5/2/23 251
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Date: Thu 1/5/23
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Finish-only
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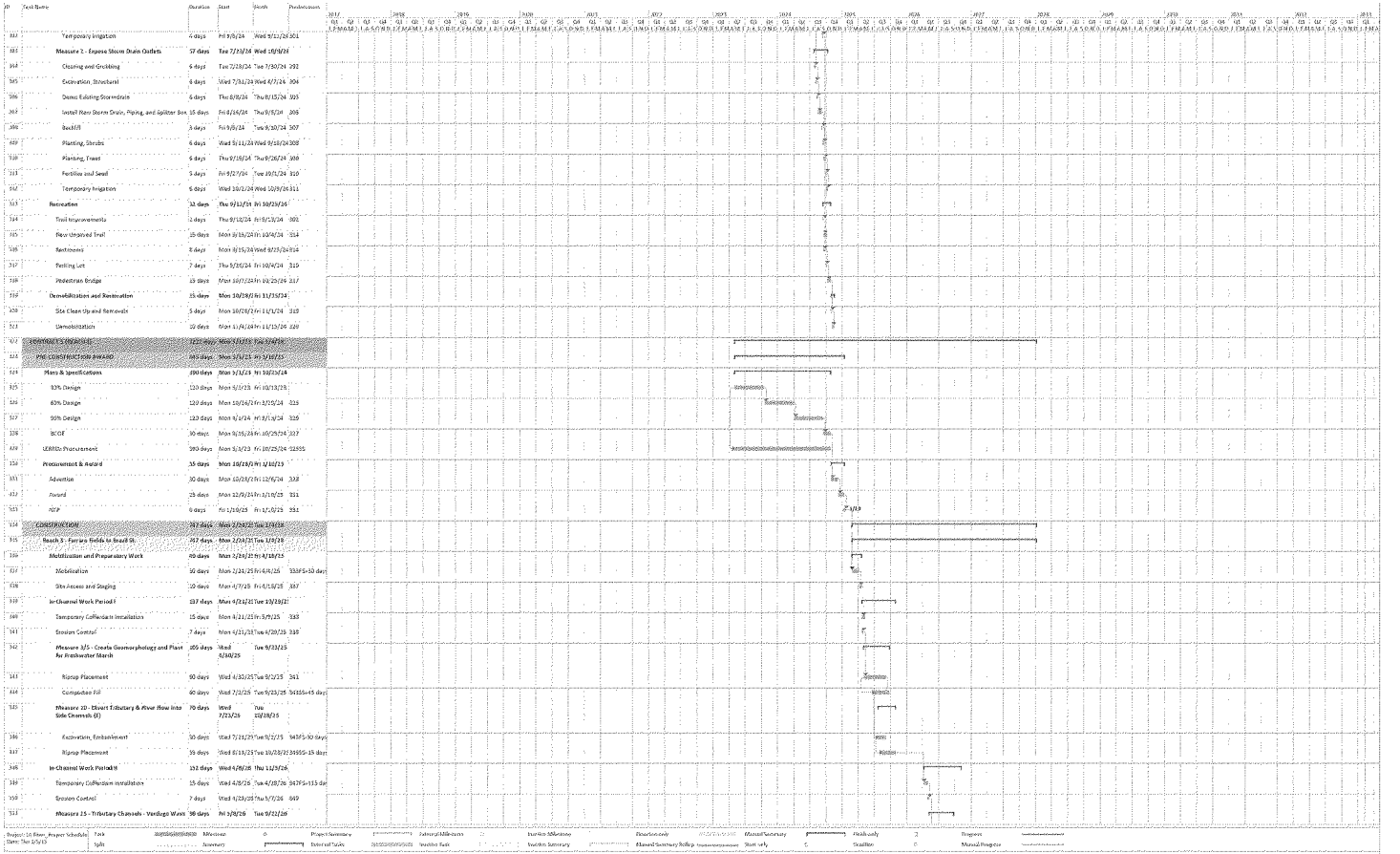
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2022
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2024
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2027
2028
2029
2030
2031
2032
2033
Temporary Irrigation
4 days
Fri 9/6/24
Wed 9/11/24
301
Measure 2 - Expose Storm Drain Outlets
57 days
Tue 7/23/24
Wed 10/9/24
Clearing and Grubbing
4 days
Tue 7/23/24
Tue 7/30/24
292
Excavation, Structural
4 days
Wed 7/31/24
Wed 8/7/24
304
Demo Existing Stormdrain
4 days
Thu 8/8/24
Thu 8/15/24
305
Install New Storm Drain, Piping, and Splitter Box
15 days
Fri 8/16/24
Thu 9/5/24
306
Backfill
3 days
Fri 9/6/24
Tue 9/10/24
307
Planting, Shrubs
6 days
Wed 9/11/24
Wed 9/18/24
308
Planting, Trees
6 days
Thu 9/19/24
Thu 9/26/24
309
Fertilize and Seed
5 days
Fri 9/27/24
Tue 10/1/24
310
Temporary Irrigation
6 days
Wed 10/2/24
Wed 10/9/24
311
Recreation
11 days
Thu 9/12/24
Fri 10/25/24
Trail Improvements
2 days
Thu 9/12/24
Fri 9/13/24
301
New Unpaved Trail
15 days
Mon 9/16/24
Fri 10/4/24
314
Restrooms
8 days
Mon 9/16/24
Wed 9/25/24
314
Parking Lot
7 days
Thu 9/26/24
Fri 10/4/24
315
Pedestrian Bridge
15 days
Mon 10/7/24
Fri 10/25/24
317
Demobilization and Restoration
15 days
Mon 10/28/24
Fri 11/15/24
Site Clean Up and Removals
5 days
Mon 10/28/24
Fri 11/1/24
319
Demobilization
10 days
Mon 11/4/24
Fri 11/15/24
320
CONTRACT DOCUMENTS
121 days
Mon 11/1/23
Tue 3/26/24
PRE CONSTRUCTION AWARD
165 days
Mon 3/1/23
Fri 10/27/23
Plans & Specifications
190 days
Mon 3/1/23
Fri 10/27/23
30% Design
120 days
Mon 3/1/23
Fri 10/13/23
60% Design
120 days
Mon 10/16/23
Fri 3/15/24
328
90% Design
120 days
Mon 4/1/24
Fri 9/13/24
326
BCOE
30 days
Mon 9/16/24
Fri 10/25/24
327
LERRDs Procurement
180 days
Mon 3/1/23
Fri 10/27/23
51655
Procurement & Award
35 days
Mon 10/28/24
Fri 12/13/24
Advertise
30 days
Mon 10/28/24
Fri 12/6/24
332
Award
25 days
Mon 12/9/24
Fri 1/10/25
331
NTP
0 days
Fri 1/10/25
Fri 1/10/25
331
CONSTRUCTION
917 days
Mon 7/24/23
Tue 1/6/26
Reach 3 - Farrars Fields to Beadle St.
917 days
Mon 7/24/23
Tue 1/6/26
Mobilization and Preparatory Work
60 days
Mon 2/24/25
Fri 5/16/25
Mobilization
50 days
Mon 2/24/25
Fri 5/2/25
333FS-10 days
Site Access and Staging
10 days
Mon 4/7/25
Fri 4/18/25
337
In-Channel Work Period I
137 days
Mon 9/15/25
Tue 3/31/26
Temporary Cofferdam Installation
15 days
Mon 9/15/25
Fri 10/3/25
338
Erosion Control
7 days
Mon 4/21/25
Tue 4/29/25
338
Measure 3/5 - Create Geomorphology and Plant for Freshwater Marsh
169 days
Wed 8/20/25
Tue 3/31/26
Riprap Placement
90 days
Wed 4/30/25
Tue 9/2/25
341
Compaction Fill
60 days
Wed 7/2/25
Tue 9/23/25
34355+45 days
Measure 10 - Divert Tributary & River Flow into Side Channels (E)
70 days
Wed 7/23/25
Tue 10/28/25
Excavation, Embankment
50 days
Wed 7/23/25
Tue 9/2/25
343FS-30 days
Riprap Placement
35 days
Wed 8/13/25
Tue 10/28/25
34655+15 days
In-Channel Work Period II
152 days
Wed 4/8/26
Thu 11/5/26
Temporary Cofferdam Installation
15 days
Wed 4/8/26
Tue 4/28/26
347FS+115 da
Erosion Control
7 days
Wed 9/23/26
Thu 5/7/26
349
Measure 15 - Tributary Channels - Verdugo Wash
96 days
Fri 3/6/26
Tue 8/11/26
Project: LA River_Project Schedule
Date: Thu 3/6/25
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Inactive Task
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Deadline
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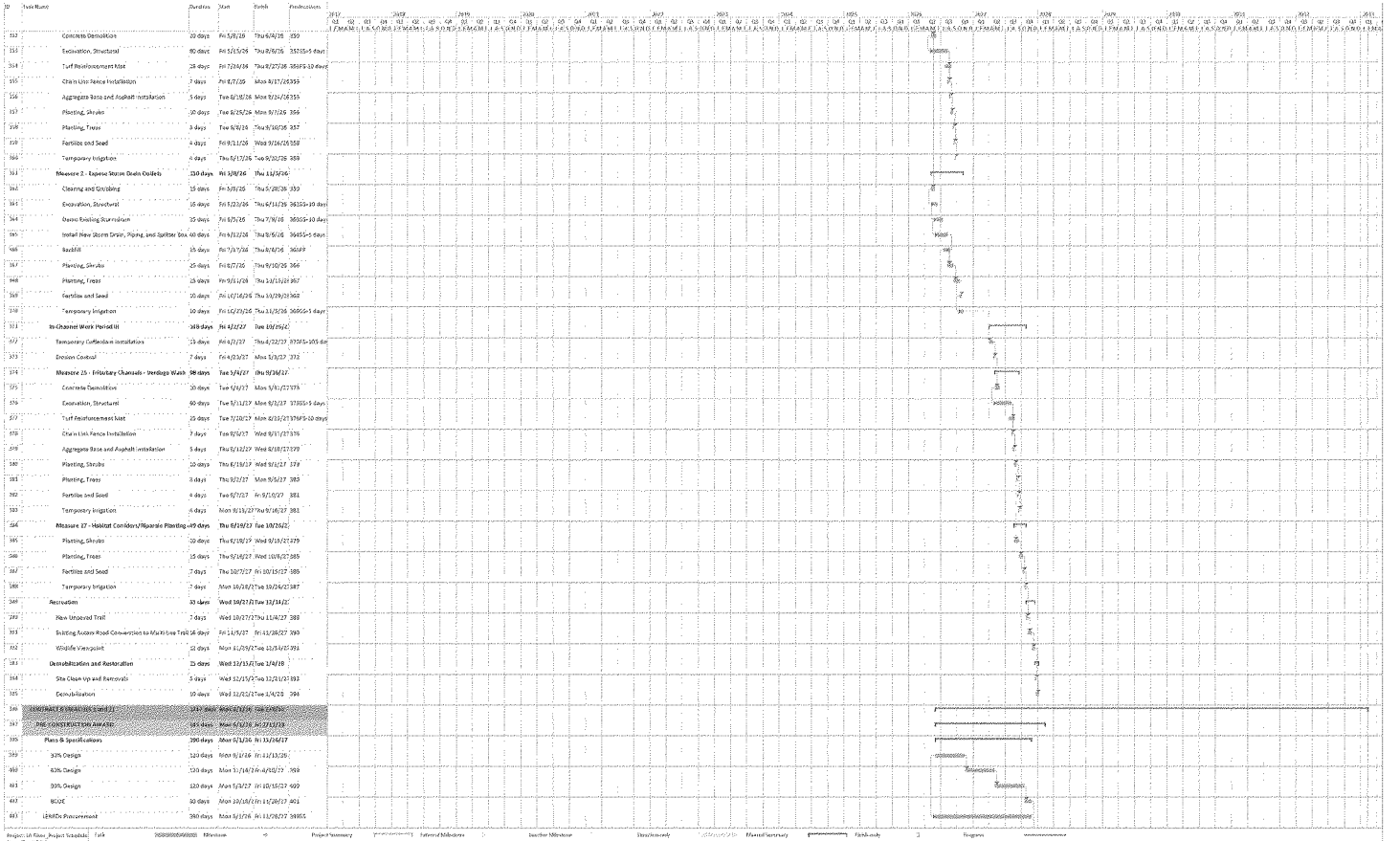
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Manual Task
Manual Summary Rollup
Manual Summary
Start-only
Deadline
Progress
Manual Progress
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ID
Task Name
Duration
Start
Finish
Predecessors
404 Procurement & Award 55 days Mon 11/19/18 Fri 2/1/19
405 Advertise 30 days Mon 11/26/18 Fri 1/4/19 402
406 Award 15 days Mon 1/28/19 Fri 2/1/19 405
407 NTP 0 days Fri 2/1/19 Fri 2/1/19 406
408 CONSTRUCTION 966 days Mon 3/26/18 Mon 9/13/21
409 Reach 2 - Glendale Freeway to I-5 966 days Mon 3/26/18 Mon 9/13/21
410 Mobilization and Preparatory Work 30 days Mon 3/26/18 Fri 4/27/18
411 Mobilization 15 days Mon 3/26/18 Fri 4/7/18 407FS-15 days
412 Site Access and Staging 10 days Mon 4/16/18 Fri 4/27/18 411
413 Clearing and Grubbing 5 days Mon 4/24/18 Fri 4/28/18 412
414 In-Channel Work Period 1 129 days Mon 5/1/18 Thu 10/25/18
415 Temporary Cofferdam Installation 10 days Mon 5/1/18 Fri 5/11/18 413
416 Erosion Control 5 days Mon 5/15/18 Fri 5/18/18 415
417 Measure 17 - Modify Trapezoidal Channel to Vertical Sides 183 days Mon 5/21/18 Thu 10/25/18
418 Concrete Demolition 10 days Mon 5/21/18 Fri 6/1/18 416
419 Grouted Riprap Demolition 12 days Mon 6/4/18 Tue 6/20/18 418
420 Riprap Demolition 10 days Wed 6/21/18 Tue 7/4/18 419
421 Sheet Pile Wall Demolition 12 days Mon 6/4/18 Tue 6/20/18 418
422 Chain Link Fence Installation 3 days Wed 6/21/18 Tue 6/27/18 421
423 Asphalt Demolition 7 days Wed 6/20/18 Thu 7/5/18 421
424 Riprap Placement 25 days Wed 7/4/18 Tue 8/7/18 422
425 Compacted Fill 20 days Wed 7/11/18 Tue 8/7/18 424FS+5 days
426 Reinforced Concrete Planters 30 days Wed 8/8/18 Tue 10/1/18 425
427 Chain Link Fence Installation 15 days Wed 9/12/18 Tue 10/2/18 426FF
428 Aggregate Base and Asphalt Installation 7 days Wed 10/10/18 Thu 10/18/18 427
429 In-Channel Work Period 2 38 days Fri 3/30/19 Tue 6/18/19
430 Temporary Cofferdam Installation 10 days Fri 3/30/19 Thu 4/11/19 428FS-150 days
431 Erosion Control 5 days Fri 4/5/19 Thu 4/11/19 430
432 Measure 16 - Bioengineered Channel Walls 29 days Fri 4/26/19 Thu 5/30/19
433 Turf Reinforcement Mats 20 days Fri 4/26/19 Thu 5/23/19 431
434 Measure 17 - Habitat Corridors/Riparian Planting on Banks 23 days Fri 5/10/19 Tue 6/11/19
435 Planting, Shrubs 10 days Fri 5/10/19 Thu 5/23/19 433
436 Planting, Trees 5 days Fri 5/31/19 Thu 6/6/19 435
437 Fertilize and Seed 2 days Mon 6/10/19 Tue 6/11/19 436
438 Temporary Irrigation 5 days Wed 6/12/19 Tue 6/18/19 437
439 Recreation 31 days Mon 6/10/19 Mon 7/22/19
440 Trail Improvements 1 days Mon 6/10/19 Tue 6/11/19 436
441 New Unpaved Trail 10 days Wed 6/12/19 Tue 7/2/19 440
442 Trail Access Points 1 day Wed 7/3/19 Wed 7/3/19 441
443 Restrooms 8 days Wed 7/4/19 Fri 7/12/19 441
444 Wildlife Viewpoint 5 days Mon 7/15/19 Mon 7/22/19 443
445 Demobilization and Restoration 15 days Tue 7/16/19 Mon 8/5/19
446 Site Clean Up and Removals 5 days Tue 7/16/19 Mon 7/22/19 444
447 Demobilization 10 days Tue 7/23/19 Mon 8/5/19 446
448 Reach 1 - Pollyana Park / Headworks to Mouth of Bi 174 days Mon 3/26/18 Wed 11/14/18
449 Mobilization and Preparatory Work 22 days Mon 3/26/18 Tue 4/24/18
450 Mobilization 5 days Mon 3/26/18 Fri 3/30/18 411SS
451 Site Access and Staging 5 days Mon 3/27/18 Fri 3/31/18 450
452 Temporary Cofferdam Installation 5 days Mon 4/9/18 Fri 4/13/18 451
453 Clearing and Grubbing 12 days Mon 4/9/18 Tue 4/24/18 451
Project: LA River_Project Schedule
Date: Thu 3/9/17
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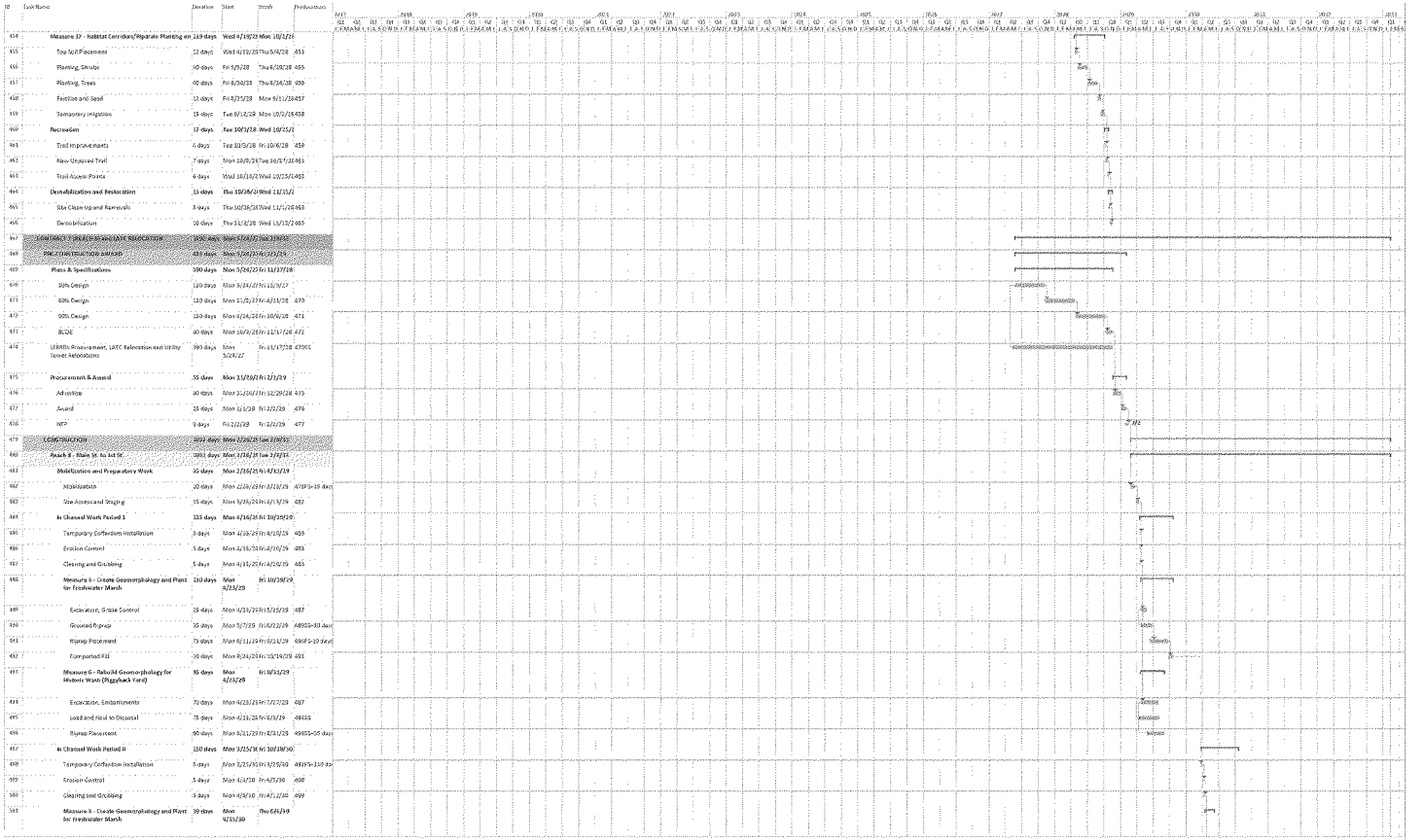
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Finish
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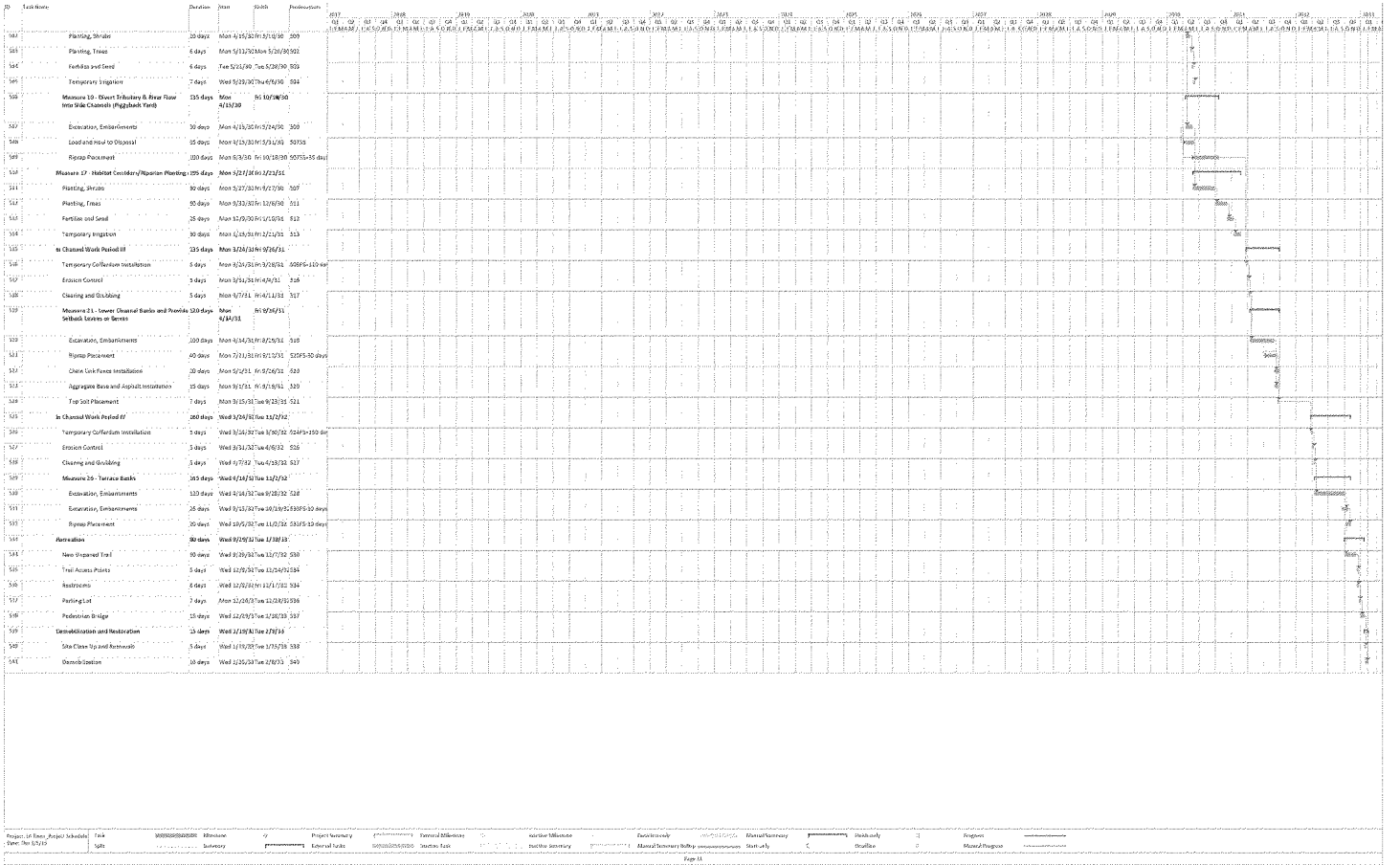
Measure 17 - Habitat Corridors/Riparian Planting on 110 days Wed 4/19/28 Mon 10/1/28
Top Soil Placement 12 days Wed 4/19/28 Thu 5/4/28 453
Planting, Shrubs 40 days Fri 5/5/28 Thu 6/29/28 455
Planting, Trees 40 days Fri 6/30/28 Thu 8/24/28 456
Fertilize and Seed 12 days Fri 8/25/28 Mon 9/11/28 457
Temporary Irrigation 15 days Tue 8/12/28 Mon 10/2/28 458
Recreation 17 days Tue 10/3/28 Wed 10/25/28
Trail Improvements 4 days Tue 10/3/28 Fri 10/6/28 459
New Unpaved Trail 7 days Mon 10/9/28 Tue 10/17/28 461
Trail Access Points 6 days Wed 10/18/28 Wed 10/25/28 463
Demobilization and Restoration 15 days Thu 10/26/28 Wed 11/15/28
Site Clean Up and Removals 5 days Thu 10/26/28 Wed 11/1/28 463
Demobilization 10 days Thu 11/2/28 Wed 11/15/28 465
CONTRACT 1 (REACH 5) and LATE RELOCATION 1000 days Mon 5/28/27 Tue 3/19/30
PRECONSTRUCTION (MBSD) 615 days Mon 5/24/27 Fri 1/31/30
Plans & Specifications 390 days Mon 5/24/27 Fri 11/17/28
90% Design 120 days Mon 5/24/27 Fri 11/4/27
60% Design 120 days Mon 11/5/27 Fri 4/21/28 470
90% Design 120 days Mon 4/24/28 Fri 10/6/28 471
BCOE 90 days Mon 10/9/28 Fri 11/17/28 472
LERRDs Procurement, LRTC Relocation and Utility Cover Relocations 780 days Mon 5/24/27 Fri 11/17/28 47365
Procurement & Award 55 days Mon 11/26/29 Fri 2/1/29
Advertise 30 days Mon 11/26/29 Fri 12/29/28 473
Award 15 days Mon 1/1/29 Fri 1/19/29 474
NTP 9 days Fri 1/19/29 Fri 2/1/29 477
CONSTRUCTION 1011 days Mon 1/16/28 Tue 2/9/32
Reach 8 - River St. to Int 90 1011 days Mon 1/16/28 Tue 2/9/32
Mobilization and Preparatory Work 35 days Mon 2/26/29 Fri 4/13/29
Mobilization 20 days Mon 2/26/29 Fri 3/23/29 478FS+10 days
Site Access and Staging 15 days Mon 3/26/29 Fri 4/13/29 482
In Channel Work Period 1 115 days Mon 4/16/29 Fri 10/26/29
Temporary Cofferdam Installation 5 days Mon 4/16/29 Fri 4/20/29 484
Erosion Control 5 days Mon 4/16/29 Fri 4/20/29 483
Clearing and Grubbing 5 days Mon 4/16/29 Fri 4/20/29 485
Measure 5 - Create Geomorphology and Plant for Freshwater Marsh 130 days Mon 4/23/29 Fri 10/19/29
Excavation, Grade Control 25 days Mon 4/23/29 Fri 5/25/29 487
Grouted Riprap 35 days Mon 5/7/29 Fri 6/22/29 489FS+10 days
Riprap Placement 75 days Mon 6/11/29 Fri 9/21/29 496FS-10 days
Compacted Fill 20 days Mon 8/26/29 Fri 9/19/29 491
Measure 6 - Rebuild Geomorphology for Historic Wash (Piggyback Fan#) 95 days Mon 4/23/29 Fri 8/31/29
Excavation, Embankments 70 days Mon 4/23/29 Fri 7/27/29 487
Load and Haul to Disposal 75 days Mon 4/23/29 Fri 8/3/29 498SS
Riprap Placement 30 days Mon 8/21/29 Fri 9/28/29 498FS-55 days
In Channel Work Period II 150 days Mon 3/25/30 Fri 10/10/30
Temporary Cofferdam Installation 5 days Mon 3/25/30 Fri 3/29/30 493FS+110 days
Erosion Control 5 days Mon 4/1/30 Fri 4/5/30 498
Clearing and Grubbing 5 days Mon 4/8/30 Fri 4/12/30 499
Measure 3 - Create Geomorphology and Plant for Freshwater Marsh 99 days Mon 4/15/30 Thu 8/28/30
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
Project: LP Basin_Project Schedule
Date: Thu 1/9/25
Task
Split
Milestone
Summary
Project Summary
External Tasks
External Milestone
Inactive Task
Inactive Milestone
Inactive Summary
Deliverable
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
Duration-only
Progress
Manual Progress
Page 10


ID
Task Name
Duration
Start
Finish
Predecessors
Planting, Shrubs
Planting, Trees
Fertilize and Seed
Temporary Irrigation
Measure 10 - Divert Tributary & River Flow into Side Channels (Piggyback Yard)
Excavation, Embankments
Load and Haul to Disposal
Riprap Placement
Measure 17 - Habitat Corridors/Riparian Planting
Planting, Shrubs
Planting, Trees
Fertilize and Seed
Temporary Irrigation
In Channel Work Period III
Temporary Cofferdam Installation
Erosion Control
Clearing and Grubbing
Measure 21 - Lower Channel Banks and Provide Setback Levees or Berms
Excavation, Embankments
Riprap Placement
Chain Link Fence Installation
Aggregate Base and Asphalt Installation
Top Soil Placement
In Channel Work Period IV
Temporary Cofferdam Installation
Erosion Control
Clearing and Grubbing
Measure 26 - Terrace Banks
Excavation, Embankments
Excavation, Embankments
Riprap Placement
Recreation
New Unpaved Trail
Trail Access Points
Restrooms
Parking Lot
Pedestrian Bridge
Demobilization and Restoration
Site Clean Up and Removal
Demobilization
Project: LF River_Project Schedule
Date: Thu 1/5/17
Task
Split
Milestone
Summary
External Tasks
Project Summary
Inactive Task
External Milestone
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
Deadline
Progress
Manual Progress
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US Army Corps
of Engineers®
Los Angeles District

Los Angeles River Ecosystem Restoration Feasibility Study

Cost Appendix

Attachment 10
Labor Rates

April 2015

General Decision Number: CA140033 03/14/2014 CA33

Superseded General Decision Number: CA20130033

State: California

Construction Types: Building, Heavy (Heavy and Dredging) and Highway

County: Los Angeles County in California.

BUILDING CONSTRUCTION PROJECTS; DREDGING PROJECTS (does not include hopper dredge work); HEAVY CONSTRUCTION PROJECTS (does not include water well drilling); HIGHWAY CONSTRUCTION PROJECTS

Modification Number	Publication Date
0	01/03/2014
1	01/10/2014
2	01/24/2014
3	01/31/2014
4	02/21/2014
5	03/14/2014

ASBE0005-002 07/01/2013

	Rates	Fringes
Asbestos Workers/Insulator (Includes the application of all insulating materials, protective coverings, coatings, and finishes to all types of mechanical systems)	$ 34.51	18.55
Fire Stop Technician (Application of Firestopping Materials for wall openings and penetrations in walls, floors, ceilings and curtain walls)	$ 24.34	16.09

ASBE0005-004 06/24/2013

	Rates	Fringes
Asbestos Removal worker/hazardous material handler (Includes preparation, wetting, stripping, removal, scrapping, vacuuming, bagging and disposing of all insulation materials from mechanical systems, whether they contain asbestos or not)	$ 16.95	10.23

BOIL0092-003 10/01/2012

	Rates	Fringes

BOILERMAKER.....$ 41.17 28.27

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* BRCA0004-007 05/01/2013

	Rates	Fringes
BRICKLAYER; MARBLE SETTER	$ 37.16	12.85

*The wage scale for prevailing wage projects performed in Blythe, China lake, Death Valley, Fort Irwin, Twenty-Nine Palms, Needles and 1-15 corridor (Barstow to the Nevada State Line) will be Three Dollars ($3.00) above the standard San Bernardino/Riverside County hourly wage rate

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BRCA0018-004 06/01/2012

	Rates	Fringes
MARBLE FINISHER	$ 27.04	10.66
TILE FINISHER	$ 22.37	9.19
TILE LAYER	$ 33.55	13.55

BRCA0018-010 09/01/2011

	Rates	Fringes
TERRAZZO FINISHER	$ 26.59	9.62
TERRAZZO WORKER/SETTER	$ 33.63	10.46

CARP0409-001 07/01/2010

	Rates	Fringes
CARPENTER		
(1) Carpenter, Cabinet Installer, Insulation Installer, Hardwood Floor Worker and acoustical installer	$ 37.35	11.08
(2) Millwright	$ 37.85	11.08
(3) Piledrivermen/Derrick Bargeman, Bridge or Dock Carpenter, Heavy Framer, Rock Bargeman or Scowman, Rockslinger, Shingler (Commercial)	$ 37.48	11.08
(4) Pneumatic Nailer, Power Stapler	$ 37.60	11.08
(5) Sawfiler	$ 37.44	11.08
(6) Scaffold Builder	$ 28.55	11.08
(7) Table Power Saw Operator	$ 37.45	11.08

FOOTNOTE: Work of forming in the construction of open cut sewers or storm drains, on operations in which horizontal lagging is used in conjunction with steel H-Beams driven or placed in pre- drilled holes, for that portion of a lagged trench against which concrete is poured, namely, as a

substitute for back forms (which work is performed by piledrivers): $0.13 per hour additional.

CARP0409-002 07/01/2008

	Rates	Fringes
Diver		
(1) Wet	$ 663.68	9.82
(2) Standby	$ 331.84	9.82
(3) Tender	$ 323.84	9.82
(4) Assistant Tender	$ 299.84	9.82

Amounts in "Rates' column are per day

CARP0409-005 07/01/2010

	Rates	Fringes
Drywall		
DRYWALL INSTALLER/LATHER	$ 37.35	11.08
STOCKER/SCRAPPER	$ 10.00	6.67

CARP0409-008 08/01/2010

	Rates	Fringes
Modular Furniture Installer	$ 17.00	7.41

ELEC0011-004 01/27/2014

	Rates	Fringes
ELECTRICIAN (INSIDE ELECTRICAL WORK)		
Journeyman Electrician	$ 39.45	24.80
ELECTRICIAN (INTELLIGENT TRANSPORTATION SYSTEMS Street Lighting, Traffic Signals, CCTV,and Underground Systems)		
Journeyman Transportation Electrician	$ 39.20	25.04
Technician	$ 29.40	24.75

FOOT NOTE:
CABLE SPLICER & INSTRUMENT PERSON: Recieve 5% additional per hour above Journeyman Electrician basic hourly rate.
TUNNEL WORK: 10% additional per hour.

SCOPE OF WORK - TRANSPORTATION SYSTEMS

ELECTRICIAN:
Installation of street lights and traffic signals,including electrical circuitry, programmable controllers, pedestal-mounted electrical meter enclosures and laying of pre-assembled multi-conductor cable in ducts, layout of electrical systems and communication installation, including proper position of trench depths and radius at duct banks, location for man

holes, pull boxes, street lights and traffic signals.
Installation of underground ducts for electrical,telephone,
cable television and communication systems.
Pulling,termination and
splicing of traffic signal and street lighting conductors and
electrical systems including interconnect,detector loop,
fiber optic cable and video/cable.

TECHNICIAN:
Distribution of material at job site, manual excavation and
backfill, installation of system conduits and raceways for
electrical, telephone, cable television and communication
systems. Pulling, terminating and splicing of traffic signal
and street lighting conductors and electrical systems
including interconnect, detector loop, fiber optic cable
and video/data.

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* ELEC0011-005 11/25/2013

COMMUNICATIONS & SYSTEMS WORK (excludes any work on Intelligent Transportation Systems or CCTV highway systems)

	Rates	Fringes
Communications System		
Installer	$ 27.75	12.36
Technician	$ 29.55	12.42

SCOPE OF WORK The work covered shall include the
installation, testing, service and maintenance, of the
following systems that utilize the transmission and/or
transference of voice, sound, vision and digital for
commercial, education, security and entertainment purposes
for TV monitoring and surveillance, background foreground
music, intercom and telephone interconnect, inventory
control systems, microwave transmission, multi-media,
multiplex, nurse call system, radio page, school intercom
and sound, burglar alarms and low voltage master clock
systems.

A. Communication systems that transmit or receive information
and/or control systems that are intrinsic to the above
listed systems SCADA (Supervisory control/data acquisition
PCM (Pulse code modulation) Inventory control systems
Digital data systems Broadband & baseband and carriers
Point of sale systems VSAT data systems Data communication
systems RF and remote control systems Fiber optic data
systems

B. Sound and Voice Transmission/Transference Systems
Background-Foreground Music Intercom and Telephone
Interconnect Systems Sound and Musical Entertainment
Systems Nurse Call Systems Radio Page Systems School
Intercom and Sound Systems Burglar Alarm Systems
Low-Voltage Master Clock Systems Multi-Media/Multiplex
Systems Telephone Systems RF Systems and Antennas and Wave
Guide

C. *Fire Alarm Systems-installation, wire pulling and testing.

D. Television and Video Systems Television Monitoring and Surveillance Systems Video Security Systems Video Entertainment Systems Video Educational Systems CATV and CCTV

E. Security Systems, Perimeter Security Systems, Vibration Sensor Systems
Sonar/Infrared Monitoring Equipment, Access Control Systems, Card Access Systems

*Fire Alarm Systems
1. Fire Alarms-In Raceways: Wire and cable pulling in raceways performed at the current electrician wage rate and fringe benefits.
2. Fire Alarms-Open Wire Systems: installed by the Technician.

ELEC1245-001 06/01/2013

	Rates	Fringes
LINE CONSTRUCTION		
(1) Lineman; Cable splicer	$ 50.30	15.00
(2) Equipment specialist (operates crawler tractors, commercial motor vehicles, backhoes, trenchers, cranes (50 tons and below), overhead & underground distribution line equipment)	$ 40.17	14.56
(3) Groundman	$ 30.73	13.48
(4) Powderman	$ 44.91	13.48

HOLIDAYS: New Year's Day, M.L. King Day, Memorial Day, Independence Day, Labor Day, Veterans Day, Thanksgiving Day and day after Thanksgiving, Christmas Day

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ELEV0018-001 01/01/2014

	Rates	Fringes
ELEVATOR MECHANIC	$ 49.03	26.785

FOOTNOTE:
PAID VACATION: Employer contributes 8% of regular hourly rate as vacation pay credit for employees with more than 5 years of service, and 6% for 6 months to 5 years of service. PAID HOLIDAYS: New Years Day, Memorial Day, Independence Day, Labor Day, Veterans Day, Thanksgiving Day, Friday after Thanksgiving, and Christmas Day.

ENGI0012-003 08/26/2013

	Rates	Fringes

OPERATOR: Power Equipment
(All Other Work)

GROUP 1	$ 38.20	21.10
GROUP 2	$ 38.98	21.10
GROUP 3	$ 39.27	21.10
GROUP 4	$ 40.76	21.10
GROUP 5	$ 41.86	21.10
GROUP 6	$ 40.98	21.10
GROUP 8	$ 41.09	21.10
GROUP 9	$ 42.19	21.10
GROUP 10	$ 41.21	21.10
GROUP 11	$ 42.31	21.10
GROUP 12	$ 41.38	21.10
GROUP 13	$ 41.48	21.10
GROUP 14	$ 41.51	21.10
GROUP 15	$ 41.59	21.10
GROUP 16	$ 41.71	21.10
GROUP 17	$ 41.88	21.10
GROUP 18	$ 41.98	21.10
GROUP 19	$ 42.09	21.10
GROUP 20	$ 42.21	21.10
GROUP 21	$ 42.38	21.10
GROUP 22	$ 42.48	21.10
GROUP 23	$ 42.59	21.10
GROUP 24	$ 42.71	21.10
GROUP 25	$ 42.88	21.10

OPERATOR: Power Equipment
(Cranes, Piledriving &
Hoisting)

GROUP 1	$ 39.55	21.10
GROUP 2	$ 40.33	21.10
GROUP 3	$ 40.62	21.10
GROUP 4	$ 40.76	21.10
GROUP 5	$ 40.98	21.10
GROUP 6	$ 41.09	21.10
GROUP 7	$ 41.21	21.10
GROUP 8	$ 41.38	21.10
GROUP 9	$ 41.55	21.10
GROUP 10	$ 42.55	21.10
GROUP 11	$ 43.55	21.10
GROUP 12	$ 44.55	21.10
GROUP 13	$ 45.55	21.10

OPERATOR: Power Equipment
(Tunnel Work)

GROUP 1	$ 40.05	21.10
GROUP 2	$ 40.83	21.10
GROUP 3	$ 41.12	21.10
GROUP 4	$ 41.26	21.10
GROUP 5	$ 41.48	21.10
GROUP 6	$ 41.59	21.10
GROUP 7	$ 41.71	21.10

PREMIUM PAY:
$3.75 per hour shall be paid on all Power Equipment Operator work on the followng Military Bases: China Lake Naval Reserve, Vandenberg AFB, Point Arguello, Seely Naval Base, Fort Irwin, Nebo Annex Marine Base, Marine Corp Logistics Base Yermo, Edwards AFB, 29 Palms Marine Base and Camp Pendleton

Workers required to suit up and work in a hazardous material environment: $2.00 per hour additional. Combination mixer and compressor operator on gunite work shall be classified as a concrete mobile mixer operator.

SEE ZONE DEFINITIONS AFTER CLASSIFICATIONS

POWER EQUIPMENT OPERATORS CLASSIFICATIONS

GROUP 1: Bargeman; Brakeman; Compressor operator; Ditch Witch, with seat or similar type equipment; Elevator operator-inside; Engineer Oiler; Forklift operator (includes loed, lull or similar types under 5 tons; Generator operator; Generator, pump or compressor plant operator; Pump operator; Signalman; Switchman

GROUP 2: Asphalt-rubber plant operator (nurse tank operator); Concrete mixer operator-skip type; Conveyor operator; Fireman; Forklift operator (includes loed, lull or similar types over 5 tons; Hydrostatic pump operator; oiler crusher (asphalt or concrete plant); Petromat laydown machine; PJU side dum jack; Screening and conveyor machine operator (or similar types); Skiploader (wheel type up to 3/4 yd. without attachment); Tar pot fireman; Temporary heating plant operator; Trenching machine oiler

GROUP 3: Asphalt-rubber blend operator; Bobcat or similar type (Skid steer); Equipment greaser (rack); Ford Ferguson (with dragtype attachments); Helicopter radioman (ground); Stationary pipe wrapping and cleaning machine operator

GROUP 4: Asphalt plant fireman; Backhoe operator (mini-max or similar type); Boring machine operator; Boxman or mixerman (asphalt or concrete); Chip spreading machine operator; Concrete cleaning decontamination machine operator; Concrete Pump Operator (small portable); Drilling machine operator, small auger types (Texoma super economatic or similar types - Hughes 100 or 200 or similar types - drilling depth of 30' maximum); Equipment greaser (grease truck); Guard rail post driver operator; Highline cableway signalman; Hydra-hammer-aero stomper; Micro Tunneling (above ground tunnel); Power concrete curing machine operator; Power concrete saw operator; Power-driven jumbo form setter operator; Power sweeper operator; Rock Wheel Saw/Trencher; Roller operator (compacting); Screed operator (asphalt or concrete); Trenching machine operator (up to 6 ft.); Vacuum or much truck

GROUP 5: Equipment Greaser (Grease Truck/Multi Shift).

GROUP 6: Articulating material hauler; Asphalt plant engineer; Batch plant operator; Bit sharpener; Concrete joint machine operator (canal and similar type); Concrete planer operator; Dandy digger; Deck engine operator; Derrickman (oilfield type); Drilling machine operator, bucket or auger types (Calweld 100 bucket or similar types - Watson 1000 auger or similar types - Texoma 330, 500 or 600 auger or similar types - drilling depth of 45' maximum); Drilling machine operator; Hydrographic seeder

machine operator (straw, pulp or seed), Jackson track maintainer, or similar type; Kalamazoo Switch tamper, or similar type; Machine tool operator; Maginnis internal full slab vibrator, Mechanical berm, curb or gutter(concrete or asphalt); Mechanical finisher operator (concrete, Clary-Johnson-Bidwell or similar); Micro tunnel system (below ground); Pavement breaker operator (truck mounted); Road oil mixing machine operator; Roller operator (asphalt or finish), rubber-tired earth moving equipment (single engine, up to and including 25 yds. struck); Self-propelled tar pipelining machine operator; Skiploader operator (crawler and wheel type, over 3/4 yd. and up to and including 1-1/2 yds.); Slip form pump operator (power driven hydraulic lifting device for concrete forms); Tractor operator-bulldozer, tamper-scraper (single engine, up to 100 h.p. flywheel and similar types, up to and including D-5 and similar types); Tugger hoist operator (1 drum); Ultra high pressure waterjet cutting tool system operator; Vacuum blasting machine operator

GROUP 8: Asphalt or concrete spreading operator (tamping or finishing); Asphalt paving machine operator (Barber Greene or similar type); Asphalt-rubber distribution operator; Backhoe operator (up to and including 3/4 yd.), small ford, Case or similar; Cast-in-place pipe laying machine operator; Combination mixer and compressor operator (gunite work); Compactor operator (self-propelled); Concrete mixer operator (paving); Crushing plant operator; Drill Doctor; Drilling machine operator, Bucket or auger types (Calweld 150 bucket or similar types - Watson 1500, 2000 2500 auger or similar types - Texoma 700, 800 auger or similar types - drilling depth of 60' maximum); Elevating grader operator; Grade checker; Gradall operator; Grouting machine operator; Heavy-duty repairman; Heavy equipment robotics operator; Kalamazoo balliste regulator or similar type; Kolman belt loader and similar type; Le Tourneau blob compactor or similar type; Loader operator (Athey, Euclid, Sierra and similar types); Mobark Chipper or similar; Ozzie padder or similar types; P.C. slot saw; Pneumatic concrete placing machine operator (Hackley-Presswell or similar type); Pumpcrete gun operator; Rock Drill or similar types; Rotary drill operator (excluding caisson type); Rubber-tired earth-moving equipment operator (single engine, caterpillar, Euclid, Athey Wagon and similar types with any and all attachments over 25 yds. up to and including 50 cu. yds. struck); Rubber-tired earth-moving equipment operator (multiple engine up to and including 25 yds. struck); Rubber-tired scraper operator (self-loading paddle wheel type-John Deere, 1040 and similar single unit); Self-propelled curb and gutter machine operator; Shuttle buggy; Skiploader operator (crawler and wheel type over 1-1/2 yds. up to and including 6-1/2 yds.); Soil remediation plant operator; Surface heaters and planer operator; Tractor compressor drill combination operator; Tractor operator (any type larger than D-5 - 100 flywheel h.p. and over, or similar-bulldozer, tamper, scraper and push tractor single engine); Tractor operator (boom attachments), Traveling pipe wrapping, cleaning and bendng machine operator; Trenching machine operator (over 6 ft. depth capacity, manufacturer's rating); trenching Machine with Road Miner

attachment (over 6 ft depth capacity): Ultra high pressure waterjet cutting tool system mechanic; Water pull (compaction) operator

GROUP 9: Heavy Duty Repairman

GROUP 10: Drilling machine operator, Bucket or auger types (Calweld 200 B bucket or similar types-Watson 3000 or 5000 auger or similar types-Texoma 900 auger or similar types-drilling depth of 105' maximum); Dual drum mixer, dynamic compactor LDC350 (or similar types); Monorail locomotive operator (diesel, gas or electric); Motor patrol-blade operator (single engine); Multiple engine tractor operator (Euclid and similar type-except Quad 9 cat.); Rubber-tired earth-moving equipment operator (single engine, over 50 yds. struck); Pneumatic pipe ramming tool and similar types; Prestressed wrapping machine operator; Rubber-tired earth-moving equipment operator (single engine, over 50 yds. struck); Rubber tired earth moving equipment operator (multiple engine, Euclid, caterpillar and similar over 25 yds. and up to 50 yds. struck), Tower crane repairman; Tractor loader operator (crawler and wheel type over 6-1/2 yds.); Woods mixer operator (and similar Pugmill equipment)

GROUP 11: Heavy Duty Repairman - Welder Combination, Welder - Certified.

GROUP 12: Auto grader operator; Automatic slip form operator; Drilling machine operator, bucket or auger types (Calweld, auger 200 CA or similar types - Watson, auger 6000 or similar types - Hughes Super Duty, auger 200 or similar types - drilling depth of 175' maximum); Hoe ram or similar with compressor; Mass excavator operator less tha 750 cu. yards; Mechanical finishing machine operator; Mobile form traveler operator; Motor patrol operator (multi-engine); Pipe mobile machine operator; Rubber-tired earth- moving equipment operator (multiple engine, Euclid, Caterpillar and similar type, over 50 cu. yds. struck); Rubber-tired self- loading scraper operator (paddle-wheel-auger type self-loading - two (2) or more units)

GROUP 13: Rubber-tired earth-moving equipment operator operating equipment with push-pull system (single engine, up to and including 25 yds. struck)

GROUP 14: Canal liner operator; Canal trimmer operator; Remote- control earth-moving equipment operator (operating a second piece of equipment: $1.00 per hour additional); Wheel excavator operator (over 750 cu. yds.)

GROUP 15: Rubber-tired earth-moving equipment operator, operating equipment with push-pull system (single engine, Caterpillar, Euclid, Athey Wagon and similar types with any and all attachments over 25 yds. and up to and including 50 yds. struck); Rubber-tired earth-moving equipment operator, operating equipment with push-pull system (multiple engine-up to and including 25 yds. struck)

GROUP 16: Rubber-tired earth-moving equipment operator,

operating equipment with push-pull system (single engine, over 50 yds. struck); Rubber-tired earth-moving equipment operator, operating equipment with push-pull system (multiple engine, Euclid, Caterpillar and similar, over 25 yds. and up to 50 yds. struck)

GROUP 17: Rubber-tired earth-moving equipment operator, operating equipment with push-pull system (multiple engine, Euclid, Caterpillar and similar, over 50 cu. yds. struck); Tandem tractor operator (operating crawler type tractors in tandem - Quad 9 and similar type)

GROUP 18: Rubber-tired earth-moving equipment operator, operating in tandem (scrapers, belly dumps and similar types in any combination, excluding compaction units - single engine, up to and including 25 yds. struck)

GROUP 19: Rotex concrete belt operator (or similar types); Rubber-tired earth-moving equipment operator, operating in tandem (scrapers, belly dumps and similar types in any combination, excluding compaction units - single engine, Caterpillar, Euclid, Athey Wagon and similar types with any and all attachments over 25 yds.and up to and including 50 cu. yds. struck); Rubber-tired earth-moving equipment operator, operating in tandem (scrapers, belly dumps and similar types in any combination, excluding compaction units - multiple engine, up to and including 25 yds. struck)

GROUP 20: Rubber-tired earth-moving equipment operator, operating in tandem (scrapers, belly dumps and similar types in any combination, excluding compaction units - single engine, over 50 yds. struck); Rubber-tired earth-moving equipment operator, operating in tandem (scrapers, belly dumps, and similar types in any combination, excluding compaction units - multiple engine, Euclid, Caterpillar and similar, over 25 yds. and up to 50 yds. struck)

GROUP 21: Rubber-tired earth-moving equipment operator, operating in tandem (scrapers, belly dumps and similar types in any combination, excluding compaction units - multiple engine, Euclid, Caterpillar and similar type, over 50 cu. yds. struck)

GROUP 22: Rubber-tired earth-moving equipment operator, operating equipment with the tandem push-pull system (single engine, up to and including 25 yds. struck)

GROUP 23: Rubber-tired earth-moving equipment operator, operating equipment with the tandem push-pull system (single engine, Caterpillar, Euclid, Athey Wagon and similar types with any and all attachments over 25 yds. and up to and including 50 yds. struck); Rubber-tired earth-moving equipment operator, operating with the tandem push-pull system (multiple engine, up to and including 25 yds. struck)

GROUP 24: Rubber-tired earth-moving equipment operator, operating equipment with the tandem push-pull system (single engine, over 50 yds. struck); Rubber-tired

earth-moving equipment operator, operating equipment with the tandem push-pull system (multiple engine, Euclid, Caterpillar and similar, over 25 yds. and up to 50 yds. struck)

GROUP 25: Concrete pump operator-truck mounted; Rubber-tired earth-moving equipment operator, operating equipment with the tandem push-pull system (multiple engine, Euclid, Caterpillar and similar type, over 50 cu. yds. struck)

CRANES, PILEDRIVING AND HOISTING EQUIPMENT CLASSIFICATIONS

GROUP 1: Engineer oiler; Fork lift operator (includes loed, lull or similar types)

GROUP 2: Truck crane oiler

GROUP 3: A-frame or winch truck operator; Ross carrier operator (jobsite)

GROUP 4: Bridge-type unloader and turntable operator; Helicopter hoist operator

GROUP 5: Hydraulic boom truck; Stinger crane (Austin-Western or similar type); Tugger hoist operator (1 drum)

GROUP 6: Bridge crane operator; Cretor crane operator; Hoist operator (Chicago boom and similar type); Lift mobile operator; Lift slab machine operator (Vagtborg and similar types); Material hoist and/or manlift operator; Polar gantry crane operator; Self Climbing scaffold (or similar type); Shovel, backhoe, dragline, clamshell operator (over 3/4 yd. and up to 5 cu. yds. mrc); Tugger hoist operator

GROUP 7: Pedestal crane operator; Shovel, backhoe, dragline, clamshell operator (over 5 cu. yds. mrc); Tower crane repair; Tugger hoist operator (3 drum)

GROUP 8: Crane operator (up to and including 25 ton capacity); Crawler transporter operator; Derrick barge operator (up to and including 25 ton capacity); Hoist operator, stiff legs, Guy derrick or similar type (up to and including 25 ton capacity); Shovel, backhoe, dragline, clamshell operator (over 7 cu. yds., M.R.C.)

GROUP 9: Crane operator (over 25 tons and up to and including 50 tons mrc); Derrick barge operator (over 25 tons up to and including 50 tons mrc); Highline cableway operator; Hoist operator, stiff legs, Guy derrick or similar type (over 25 tons up to and including 50 tons mrc); K-crane operator; Polar crane operator; Self erecting tower crane operator maximum lifting capacity ten tons

GROUP 10: Crane operator (over 50 tons and up to and including 100 tons mrc); Derrick barge operator (over 50 tons up to and including 100 tons mrc); Hoist operator, stiff legs, Guy derrick or similar type (over 50 tons up to and including 100 tons mrc), Mobile tower crane operator (over 50 tons, up to and including 100 tons M.R.C.); Tower crane operator and tower gantry

GROUP 11: Crane operator (over 100 tons and up to and including 200 tons mrc); Derrick barge operator (over 100 tons up to and including 200 tons mrc); Hoist operator, stiff legs, Guy derrick or similar type (over 100 tons up to and including 200 tons mrc); Mobile tower crane operator (over 100 tons up to and including 200 tons mrc)

GROUP 12: Crane operator (over 200 tons up to and including 300 tons mrc); Derrick barge operator (over 200 tons up to and including 300 tons mrc); Hoist operator, stiff legs, Guy derrick or similar type (over 200 tons, up to and including 300 tons mrc); Mobile tower crane operator (over 200 tons, up to and including 300 tons mrc)

GROUP 13: Crane operator (over 300 tons); Derrick barge operator (over 300 tons); Helicopter pilot; Hoist operator, stiff legs, Guy derrick or similar type (over 300 tons); Mobile tower crane operator (over 300 tons)

TUNNEL CLASSIFICATIONS

GROUP 1: Skiploader (wheel type up to 3/4 yd. without attachment)

GROUP 2: Power-driven jumbo form setter operator

GROUP 3: Dinkey locomotive or motorperson (up to and including 10 tons)

GROUP 4: Bit sharpener; Equipment greaser (grease truck); Slip form pump operator (power-driven hydraulic lifting device for concrete forms); Tugger hoist operator (1 drum); Tunnel locomotive operator (over 10 and up to and including 30 tons)

GROUP 5: Backhoe operator (up to and including 3/4 yd.); Small Ford, Case or similar; Drill doctor; Grouting machine operator; Heading shield operator; Heavy-duty repairperson; Loader operator (Athey, Euclid, Sierra and similar types); Mucking machine operator (1/4 yd., rubber-tired, rail or track type); Pneumatic concrete placing machine operator (Hackley-Presswell or similar type); Pneumatic heading shield (tunnel); Pumpcrete gun operator; Tractor compressor drill combination operator; Tugger hoist operator (2 drum); Tunnel locomotive operator (over 30 tons)

GROUP 6: Heavy Duty Repairman

GROUP 7: Tunnel mole boring machine operator

ENGINEERS ZONES

$1.00 additional per hour for all of IMPERIAL County and the portions of KERN, RIVERSIDE & SAN BERNARDINO Counties as defined below:

That area within the following Boundary: Begin in San Bernardino County, approximately 3 miles NE of the intersection of I-15 and the California State line at that point which is

the NW corner of Section 1, T17N,m R14E, San Bernardino Meridian. Continue W in a straight line to that point which is the SW corner of the northwest quarter of Section 6, T27S, R42E, Mt. Diablo Meridian. Continue North to the intersection with the Inyo County Boundary at that point which is the NE corner of the western half of the northern quarter of Section 6, T25S, R42E, MDM. Continue W along the Inyo and San Bernardino County boundary until the intersection with Kern County, as that point which is the SE corner of Section 34, T24S, R40E, MDM. Continue W along the Inyo and Kern County boundary until the intersection with Tulare County, at that point which is the SW corner of the SE quarter of Section 32, T24S, R37E, MDM. Continue W along the Kern and Tulare County boundary, until that point which is the NW corner of T25S, R32E, MDM. Continue S following R32E lines to the NW corner of T31S, R32E, MDM. Continue W to the NW corner of T31S, R31E, MDM. Continue S to the SW corner of T32S, R31E, MDM. Continue W to SW corner of SE quarter of Section 34, T32S, R30E, MDM. Continue S to SW corner of T11N, R17W, SBM. Continue E along south boundary of T11N, SBM to SW corner of T11N, R7W, SBM. Continue S to SW corner of T9N, R7W, SBM. Continue E along south boundary of T9N, SBM to SW corner of T9N, R1E, SBM. Continue S along west boundary of R1E, SMB to Riverside County line at the SW corner of T1S, R1E, SBM. Continue E along south boundary of T1s, SBM (Riverside County Line) to SW corner of T1S, R10E, SBM. Continue S along west boundary of R10E, SBM to Imperial County line at the SW corner of T8S, R10E, SBM. Continue W along Imperial and Riverside county line to NW corner of T9S, R9E, SBM. Continue S along the boundary between Imperial and San Diego Counties, along the west edge of R9E, SBM to the south boundary of Imperial County/California state line. Follow the California state line west to Arizona state line, then north to Nevada state line, then continuing NW back to start at the point which is the NW corner of Section 1, T17N, R14E, SBM

$1.00 additional per hour for portions of SAN LUIS OBISPO, KERN, SANTA BARBARA & VENTURA as defined below:

That area within the following Boundary: Begin approximately 5 miles north of the community of Cholame, on the Monterey County and San Luis Obispo County boundary at the NW corner of T25S, R16E, Mt. Diablo Meridian. Continue south along the west side of R16E to the SW corner of T30S, R16E, MDM. Continue E to SW corner of T30S, R17E, MDM. Continue S to SW corner of T31S, R17E, MDM. Continue E to SW corner of T31S, R18E, MDM. Continue S along West side of R18E, MDM as it crosses into San Bernardino Meridian numbering area and becomes R30W. Follow the west side of R30W, SBM to the SW corner of T9N, R30W, SBM. Continue E along the south edge of T9N, SBM to the Santa Barbara County and Ventura County boundary at that point whch is the SW corner of Section 34.T9N, R24W, SBM, continue S along the Ventura County line to that point which is the SW corner of the SE quarter of Section 32, T7N, R24W, SBM. Continue E along the south edge of T7N, SBM to the SE corner to T7N, R21W, SBM. Continue N along East side of R21W, SBM to Ventura County and Kern County boundary at the NE corner of T8N, R21W. Continue W along the Ventura County and Kern County boundary to the SE corner of T9N, R21W. Continue North along the East edge of R21W, SBM to the NE corner of T12N, R21W, SBM. Continue

West along the north edge of T12N, SBM to the SE corner of T32S, R21E, MDM. [T12N SBM is a think strip between T11N SBM and T32S MDM]. Continue North along the East side of R21E, MDM to the Kings County and Kern County border at the NE corner of T25S, R21E, MDM, continue West along the Kings County and Kern County Boundary until the intersection of San Luis Obispo County. Continue west along the Kings County and San Luis Obispo County boundary until the intersection with Monterey County. Continue West along the Monterey County and San Luis Obispo County boundary to the beginning point at the NW corner of T25S, R16E, MDM.

$2.00 additional per hour for INYO and MONO Counties and the Northern portion of SAN BERNARDINO County as defined below:

That area within the following Boundary: Begin at the intersection of the northern boundary of Mono County and the California state line at the point which is the center of Section 17, T10N, R22E, Mt. Diablo Meridian. Continue S then SE along the entire western boundary of Mono County, until it reaches Inyo County at the point which is the NE corner of the Western half of the NW quarter of Section 2, T8S, R29E, MDM. Continue SSE along the entire western boundary of Inyo County, until the intersection with Kern County at the point which is the SW corner of the SE 1/4 of Section 32, T24S, R37E, MDM. Continue E along the Inyo and Kern County boundary until the intersection with San Bernardino County at that point which is the SE corner of section 34, T24S, R40E, MDM. Continue E along the Inyo and San Bernardino County boundary until the point which is the NE corner of the Western half of the NW quarter of Section 6, T25S, R42E, MDM. Continue S to that point which is the SW corner of the NW quarter of Section 6, T27S, R42E, MDM. Continue E in a straight line to the California and Nevada state border at the point which is the NW corner of Section 1, T17N, R14E, San Bernardino Meridian. Then continue NW along the state line to the starting point, which is the center of Section 18, T10N, R22E, MDM.

REMAINING AREA NOT DEFINED ABOVE RECIEVES BASE RATE

ENGI0012-004 08/05/2013

	Rates	Fringes
OPERATOR: Power Equipment (DREDGING)		
(1) Leverman	$ 47.70	21.20
(2) Dredge dozer	$ 41.73	21.20
(3) Deckmate	$ 41.62	21.20
(4) Winch operator (stern winch on dredge)	$ 41.07	21.20
(5) Fireman-Oiler, Deckhand, Bargeman, Leveehand	$ 40.53	21.20
(6) Barge Mate	$ 41.14	21.20

IRON0377-002 07/01/2013

	Rates	Fringes
Ironworkers:		
Fence Erector	$ 26.58	17.74
Ornamental, Reinforcing and Structural	$ 33.00	26.30

PREMIUM PAY:

$6.00 additional per hour at the following locations:

China Lake Naval Test Station, Chocolate Mountains Naval Reserve-Niland,
Edwards AFB, Fort Irwin Military Station, Fort Irwin Training Center-Goldstone, San Clemente Island, San Nicholas Island, Susanville Federal Prison, 29 Palms - Marine Corps, U.S. Marine Base - Barstow, U.S. Naval Air Facility - Sealey, Vandenberg AFB

$4.00 additional per hour at the following locations:

Army Defense Language Institute - Monterey, Fallon Air Base, Naval Post Graduate School - Monterey, Yermo Marine Corps Logistics Center

$2.00 additional per hour at the following locations:

Port Hueneme, Port Mugu, U.S. Coast Guard Station - Two Rock

LABO0300-001 07/01/2013

	Rates	Fringes
Brick Tender	$ 28.37	15.78

LABO0300-003 07/01/2013

	Rates	Fringes
LABORER (TUNNEL)		
GROUP 1	$ 34.84	16.02
GROUP 2	$ 35.16	16.02
GROUP 3	$ 35.62	16.02
GROUP 4	$ 36.31	16.02
LABORER		
GROUP 1	$ 28.99	16.02
GROUP 2	$ 29.54	16.02
GROUP 3	$ 30.09	16.02
GROUP 4	$ 31.64	16.02
GROUP 5	$ 31.99	16.02

LABORER CLASSIFICATIONS

GROUP 1: Cleaning and handling of panel forms; Concrete screeding for rough strike-off; Concrete, water curing; Demolition laborer, the cleaning of brick if performed by a worker performing any other phase of demolition work, and the cleaning of lumber; Fire watcher, limber, brush loader,

piler and debris handler; Flag person; Gas, oil and/or water pipeline laborer; Laborer, asphalt-rubber material loader; Laborer, general or construction; Laborer, general clean-up; Laborer, landscaping; Laborer, jetting; Laborer, temporary water and air lines; Material hose operator (walls, slabs, floors and decks); Plugging, filling of shee bolt holes; Dry packing of concrete; Railroad maintenance, repair track person and road beds; Streetcar and railroad construction track laborers; Rigging and signaling; Scaler; Slip form raiser; Tar and mortar; Tool crib or tool house laborer; Traffic control by any method; Window cleaner; Wire mesh pulling - all concrete pouring operations

GROUP 2: Asphalt shoveler; Cement dumper (on 1 yd. or larger mixer and handling bulk cement); Cesspool digger and installer; Chucktender; Chute handler, pouring concrete, the handling of the chute from readymix trucks, such as walls, slabs, decks, floors, foundation, footings, curbs, gutters and sidewalks; Concrete curer, impervious membrane and form oiler; Cutting torch operator (demolition); Fine grader, highways and street paving, airport, runways and similar type heavy construction; Gas, oil and/or water pipeline wrapper - pot tender and form person; Guinea chaser; Headerboard person - asphalt; Laborer, packing rod steel and pans; Membrane vapor barrier installer; Power broom sweeper (small); Riprap stonepaver, placing stone or wet sacked concrete; Roto scraper and tiller; Sandblaster (pot tender); Septic tank digger and installer(lead); Tank scaler and cleaner; Tree climber, faller, chain saw operator, Pittsburgh chipper and similar type brush shredder; Underground laborer, including caisson bellower

GROUP 3: Buggymobile person; Concrete cutting torch; Concrete pile cutter; Driller, jackhammer, 2-1/2 ft. drill steel or longer; Dri-pak-it machine; Gas, oil and/or water pipeline wrapper, 6-in. pipe and over, by any method, inside and out; High scaler (including drilling of same); Hydro seeder and similar type; Impact wrench multi-plate; Kettle person, pot person and workers applying asphalt, lay-kold, creosote, lime caustic and similar type materials ("applying" means applying, dipping, brushing or handling of such materials for pipe wrapping and waterproofing); Operator of pneumatic, gas, electric tools, vibrating machine, pavement breaker, air blasting, come-alongs, and similar mechanical tools not separately classified herein; Pipelayer's backup person, coating, grouting, making of joints, sealing, caulking, diapering and including rubber gasket joints, pointing and any and all other services; Rock slinger; Rotary scarifier or multiple head concrete chipping scarifier; Steel headerboard and guideline setter; Tamper, Barko, Wacker and similar type; Trenching machine, hand-propelled

GROUP 4: Asphalt raker, lute person, ironer, asphalt dump person, and asphalt spreader boxes (all types); Concrete core cutter (walls, floors or ceilings), grinder or sander; Concrete saw person, cutting walls or flat work, scoring old or new concrete; Cribber, shorer, lagging, sheeting and trench bracing, hand-guided lagging hammer; Head rock slinger; Laborer, asphalt- rubber distributor boot person;

Laser beam in connection with laborers' work; Oversize concrete vibrator operator, 70 lbs. and over; Pipelayer performing all services in the laying and installation of pipe from the point of receiving pipe in the ditch until completion of operation, including any and all forms of tubular material, whether pipe, metallic or non-metallic, conduit and any other stationary type of tubular device used for the conveying of any substance or element, whether water, sewage, solid gas, air, or other product whatsoever and without regard to the nature of material from which the tubular material is fabricated; No-joint pipe and stripping of same; Prefabricated manhole installer; Sandblaster (nozzle person), water blasting, Porta Shot-Blast

GROUP 5: Blaster powder, all work of loading holes, placing and blasting of all powder and explosives of whatever type, regardless of method used for such loading and placing; Driller: All power drills, excluding jackhammer, whether core, diamond, wagon, track, multiple unit, and any and all other types of mechanical drills without regard to the form of motive power; Toxic waste removal

TUNNEL LABORER CLASSIFICATIONS

GROUP 1: Batch plant laborer; Bull gang mucker, track person; Changehouse person; Concrete crew, including rodder and spreader; Dump person; Dump person (outside); Swamper (brake person and switch person on tunnel work); Tunnel materials handling person

GROUP 2: Chucktender, cabletender; Loading and unloading agitator cars; Nipper; Pot tender, using mastic or other materials (for example, but not by way of limitation, shotcrete, etc.); Vibrator person, jack hammer, pneumatic tools (except driller)

GROUP 3: Blaster, driller, powder person; Chemical grout jet person; Cherry picker person; Grout gun person; Grout mixer person; Grout pump person; Jackleg miner; Jumbo person; Kemper and other pneumatic concrete placer operator; Miner, tunnel (hand or machine); Nozzle person; Operating of troweling and/or grouting machines; Powder person (primer house); Primer person; Sandblaster; Shotcrete person; Steel form raiser and setter; Timber person, retimber person, wood or steel; Tunnel Concrete finisher

GROUP 4: Diamond driller; Sandblaster; Shaft and raise work

LABO0300-005 01/01/2014

	Rates	Fringes
Asbestos Removal Laborer.....	$ 28.00	15.25

SCOPE OF WORK: Includes site mobilization, initial site cleanup, site preparation, removal of asbestos-containing material and toxic waste, encapsulation, enclosure and disposal of asbestos- containing materials and toxic waste by hand or with equipment or machinery; scaffolding,

fabrication of temporary wooden barriers and assembly of decontamination stations.

LABO0345-001 07/01/2013

	Rates	Fringes
LABORER (GUNITE)		
GROUP 1	$ 33.04	17.86
GROUP 2	$ 32.09	17.86
GROUP 3	$ 28.55	17.86

FOOTNOTE: GUNITE PREMIUM PAY: Workers working from a Bosn'n's Chair or suspended from a rope or cable shall receive 40 cents per hour above the foregoing applicable classification rates. Workers doing gunite and/or shotcrete work in a tunnel shall receive 35 cents per hour above the foregoing applicable classification rates, paid on a portal-to-portal basis. Any work performed on, in or above any smoke stack, silo, storage elevator or similar type of structure, when such structure is in excess of 75'-0" above base level and which work must be performed in whole or in part more than 75'-0" above base level, that work performed above the 75'-0" level shall be compensated for at 35 cents per hour above the applicable classification wage rate.

GUNITE LABORER CLASSIFICATIONS

GROUP 1: Rodmen, Nozzlemen

GROUP 2: Gunmen

GROUP 3: Reboundmen

LABO1184-001 07/01/2013

	Rates	Fringes
Laborers: (HORIZONTAL DIRECTIONAL DRILLING)		
(1) Drilling Crew Laborer	$ 30.11	11.83
(2) Vehicle Operator/Hauler	$ 30.28	11.83
(3) Horizontal Directional Drill Operator	$ 32.13	11.83
(4) Electronic Tracking Locator	$ 34.13	11.83
Laborers: (STRIPING/SLURRY SEAL)		
GROUP 1	$ 31.06	14.53
GROUP 2	$ 32.36	14.53
GROUP 3	$ 34.37	14.53
GROUP 4	$ 36.11	14.53

LABORERS - STRIPING CLASSIFICATIONS

GROUP 1: Protective coating, pavement sealing, including repair and filling of cracks by any method on any surface

in parking lots, game courts and playgrounds; carstops; operation of all related machinery and equipment; equipment repair technician

GROUP 2: Traffic surface abrasive blaster; pot tender - removal of all traffic lines and markings by any method (sandblasting, waterblasting, grinding, etc.) and preparation of surface for coatings. Traffic control person: controlling and directing traffic through both conventional and moving lane closures; operation of all related machinery and equipment

GROUP 3: Traffic delineating device applicator: Layout and application of pavement markers, delineating signs, rumble and traffic bars, adhesives, guide markers, other traffic delineating devices including traffic control. This category includes all traffic related surface preparation (sandblasting, waterblasting, grinding) as part of the application process. Traffic protective delineating system installer: removes, relocates, installs, permanently affixed roadside and parking delineation barricades, fencing, cable anchor, guard rail, reference signs, monument markers; operation of all related machinery and equipment; power broom sweeper

GROUP 4: Striper: layout and application of traffic stripes and markings; hot thermo plastic; tape traffic stripes and markings, including traffic control; operation of all related machinery and equipment

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LABO1414-001 08/07/2013

	Rates	Fringes
LABORER		
PLASTER CLEAN-UP LABORER	$ 27.45	16.36
PLASTER TENDER	$ 30.00	16.36

Work on a swing stage scaffold: $1.00 per hour additional.

PAIN0036-001 01/01/2014

	Rates	Fringes
Painters: (Including Lead Abatement)		
(1) Repaint (excludes San Diego County)	$ 26.49	11.73
(2) All Other Work	$ 29.82	11.73

REPAINT of any previously painted structure. Exceptions: work involving the aerospace industry, breweries, commercial recreational facilities, hotels which operate commercial establishments as part of hotel service, and sports facilities.

PAIN0036-006 01/01/2014

	Rates	Fringes
DRYWALL FINISHER/TAPER		
Antelope Valley North of the following Boundary: Kern County Line to Hwy. #5, South of Hwy. #5 to Hwy. N2, East on N2 to Palmdale Blvd., to Hsy. #14, South to Hwy. #18, East to Hwy. #395	$ 29.83	15.41
Remainder of Los Angeles County	$ 34.03	15.41

PAIN0036-015 02/01/2014

	Rates	Fringes
GLAZIER	$ 38.95	22.08

FOOTNOTE: Additional $1.25 per hour for work in a condor, from the third (3rd) floor and up Additional $1.25 per hour for work on the outside of the building from a swing stage or any suspended contrivance, from the ground up

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* PAIN1247-002 01/01/2014

	Rates	Fringes
SOFT FLOOR LAYER	$ 29.85	12.56

PLAS0200-009 08/07/2013

	Rates	Fringes
PLASTERER	$ 36.11	13.13

PLAS0500-002 07/01/2013

	Rates	Fringes
CEMENT MASON/CONCRETE FINISHER	$ 30.85	21.00

PLUM0016-001 07/01/2013

	Rates	Fringes
PLUMBER/PIPEFITTER		
Plumber and Pipefitter All other work except work on new additions and remodeling of bars, restaurant, stores and commercial buildings not to exceed 5,000 sq. ft. of floor space and work on strip malls, light commercial, tenant improvement and remodel		

work.....$ 43.60 20.16
Work ONLY on new additions and remodeling of bars, restaurant, stores and commercial buildings not to exceed 5,000 sq. ft. of floor space.....$ 42.26 19.18
Work ONLY on strip malls, light commercial, tenant improvement and remodel work.....$ 34.11 17.51

PLUM0345-001 01/01/2014

	Rates	Fringes
PLUMBER		
Landscape/Irrigation Fitter	$ 28.56	19.55
Sewer & Storm Drain Work....	$ 32.50	17.23

ROOF0036-002 08/01/2012

	Rates	Fringes
ROOFER	$ 34.65	11.38

FOOTNOTE: Pitch premium: Work on which employees are exposed to pitch fumes or required to handle pitch, pitch base or pitch impregnated products, or any material containing coal tar pitch, the entire roofing crew shall receive $1.75 per hour "pitch premium" pay.

SFCA0669-013 07/01/2013

DOES NOT INCLUDE THE CITY OF POMONA, CATALINA ISLAND, AND THAT PART OF LOS ANGELES COUNTY WITHIN 25 MILES OF THE CITY LIMITS OF LOS ANGELES:

	Rates	Fringes
SPRINKLER FITTER	$ 34.19	19.37

SFCA0709-005 01/01/2014

THE CITY OF POMOMA, CATALINA ISLAND, AND THAT PART OF LOS ANGELES COUNTY WITHIN 25 MILES OF THE CITY LIMITS OF LOS ANGELES:

	Rates	Fringes
SPRINKLER FITTER (Fire)	$ 40.61	24.02

SHEE0105-002 01/01/2014

LOS ANGELES (South of a straight line between gorman and Big Pines including Catalina Island)

	Rates	Fringes
SHEET METAL WORKER		
(1) Light Commercial: Work on general sheet metal and heating and AC up to 4000 sq ft	$ 24.47	8.65
(2) Modernization : Excluding New Construction - Under 5000 sq. ft. Does not include modification, upgrades, energy management, or conservation improvements of central heating and AC equpment	$ 40.79	22.88

SHEE0105-003 01/01/2014

LOS ANGELES (South of a straight line drawn between Gorman and Big Pines)and Catalina Island, INYO, KERN (Northeast part, East of Hwy 395), MONO ORANGE, RIVERSIDE, AND SAN BERNARDINO COUNTIES

	Rates	Fringes
SHEET METAL WORKER		
(1) Commercial - New Construction and Remodel work	$ 40.79	22.88
(2) Industrial work including air pollution control systems, noise abatement, hand rails, guard rails, excluding aritechtural sheet metal work, excluding A-C, heating, ventilating systems for human comfort	$ 40.79	22.88

SHEE0105-004 01/01/2014

KERN (Excluding portion East of Hwy 395) & LOS ANGELES (North of a straight line drawn between Gorman and Big Pines including Cities of Lancaster and Palmdale) COUNTIES

	Rates	Fringes
SHEET METAL WORKER	$ 31.08	22.64

TEAM0011-002 07/01/2013

	Rates	Fringes
TRUCK DRIVER		
GROUP 1	$ 27.59	22.69
GROUP 2	$ 27.74	22.69
GROUP 3	$ 27.87	22.69

GROUP 4	$ 28.06	22.69
GROUP 5	$ 28.09	22.69
GROUP 6	$ 28.12	22.69
GROUP 7	$ 28.37	22.69
GROUP 8	$ 28.62	22.69
GROUP 9	$ 28.82	22.69
GROUP 10	$ 29.12	22.69
GROUP 11	$ 29.62	22.69
GROUP 12	$ 30.05	22.69

WORK ON ALL MILITARY BASES:
PREMIUM PAY: $3.00 per hour additional.
[29 palms Marine Base, Camp Roberts, China Lake, Edwards AFB, El Centro Naval Facility, Fort Irwin, Marine Corps Logistics Base at Nebo & Yermo, Mountain Warfare Training Center, Bridgeport, Point Arguello, Point Conception, Vandenberg AFB]

TRUCK DRIVERS CLASSIFICATIONS

GROUP 1: Truck driver

GROUP 2: Driver of vehicle or combination of vehicles - 2 axles; Traffic control pilot car excluding moving heavy equipment permit load; Truck mounted broom

GROUP 3: Driver of vehicle or combination of vehicles - 3 axles; Boot person; Cement mason distribution truck; Fuel truck driver; Water truck - 2 axle; Dump truck, less than 16 yds. water level; Erosion control driver

GROUP 4: Driver of transit mix truck, under 3 yds.; Dumpcrete truck, less than 6-1/2 yds. water level

GROUP 5: Water truck, 3 or more axles; Truck greaser and tire person ($0.50 additional for tire person); Pipeline and utility working truck driver, including winch truck and plastic fusion, limited to pipeline and utility work; Slurry truck driver

GROUP 6: Transit mix truck, 3 yds. or more; Dumpcrete truck, 6-1/2 yds. water level and over; Vehicle or combination of vehicles - 4 or more axles; Oil spreader truck; Dump truck, 16 yds. to 25 yds. water level

GROUP 7: A Frame, Swedish crane or similar; Forklift driver; Ross carrier driver

GROUP 8: Dump truck, 25 yds. to 49 yds. water level; Truck repair person; Water pull - single engine; Welder

GROUP 9: Truck repair person/welder; Low bed driver, 9 axles or over

GROUP 10: Dump truck - 50 yds. or more water level; Water pull - single engine with attachment

GROUP 11: Water pull - twin engine; Water pull - twin engine

with attachments; Winch truck driver - $1.25 additional
when operating winch or similar special attachments

GROUP 12: Boom Truck 17K and above

WELDERS - Receive rate prescribed for craft performing
operation to which welding is incidental.

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Unlisted classifications needed for work not included within
the scope of the classifications listed may be added after
award only as provided in the labor standards contract clauses
(29CFR 5.5 (a) (1) (ii)).

The body of each wage determination lists the classification
and wage rates that have been found to be prevailing for the
cited type(s) of construction in the area covered by the wage
determination. The classifications are listed in alphabetical
order of "identifiers" that indicate whether the particular
rate is union or non-union.

Union Identifiers

An identifier enclosed in dotted lines beginning with
characters other than "SU" denotes that the union
classification and rate have found to be prevailing for that
classification. Example: PLUM0198-005 07/01/2011. The first
four letters , PLUM, indicate the international union and the
four-digit number, 0198, that follows indicates the local union
number or district council number where applicable , i.e.,
Plumbers Local 0198. The next number, 005 in the example, is
an internal number used in processing the wage determination.
The date, 07/01/2011, following these characters is the
effective date of the most current negotiated rate/collective
bargaining agreement which would be July 1, 2011 in the above
example.

Union prevailing wage rates will be updated to reflect any
changes in the collective bargaining agreements governing the
rates.

0000/9999: weighted union wage rates will be published annually
each January.

Non-Union Identifiers

Classifications listed under an "SU" identifier were derived
from survey data by computing average rates and are not union
rates; however, the data used in computing these rates may

include both union and non-union data. Example: SULA2004-007 5/13/2010. SU indicates the rates are not union majority rates, LA indicates the State of Louisiana; 2004 is the year of the survey; and 007 is an internal number used in producing the wage determination. A 1993 or later date, 5/13/2010, indicates the classifications and rates under that identifier were issued as a General Wage Determination on that date.

Survey wage rates will remain in effect and will not change until a new survey is conducted.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

* an existing published wage determination
* a survey underlying a wage determination
* a Wage and Hour Division letter setting forth a position on a wage determination matter
* a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour Regional Office for the area in which the survey was conducted because those Regional Offices have responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative

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Los Angeles District

Los Angeles River Ecosystem Restoration Feasibility Study

Cost Appendix

Attachment 11
Estimated Production Rates

April 2015

TITLE: Los Angeles River Ecosystem Restoration
SUBJECT: Output Rates for Excavation
MADE BY: SKV JOB NO.: T26313
CHECKED BY: DATE: 3/24/2014

Sheet No. 1 of 2

CSI TASK:

CHANNEL BANK EXCAVATION

CREW: *Excavation Crew [2-cy Hydraul. Exc.]* — 2 crew members
1 Equip. Oper. Heavy
1 Oiler
1 Hydraul. Excavator, 2-cy Bucket

PRODUCTION

2.0 cy bucket
0.85 % fill
55 min/hr
1.00 cycle/min

94 cy/crew hr →

EXCAVATION, EMBANKMENTS

CREW: *Excavation Crew [scraper]* — 2 crew members
1 Equip. Oper. Heavy
1 Oiler
1 28-cy Scraper

PRODUCTION

28.0 cy bucket
0.85 % fill
55 min/hr
0.15 cycle/min

196 cy/crew hr →

EXCAVATION, SPALLS

CREW: *Excavation Crew [2-cy Hydraul. Exc.]* — 2 crew members
1 Equip. Oper. Heavy
1 Oiler
1 Hydraul. Excavator, 2-cy Bucket

PRODUCTION

2.0 cy bucket
0.85 % fill
55 min/hr
0.90 cycle/min

84 cy/crew hr →

TITLE:	Los Angeles River Ecosystem Restoration	
SUBJECT:	Output Rates for Excavation	
MADE BY:	SKV	JOB NO.: T26313
CHECKED BY:		DATE: 3/24/2014

Sheet No. 2 of 2

EXCAVATION, STORM DRAIN

CREW: *Excavation Crew [2-cy Hydraul. Exc.]* — 2 crew members

1 Equip. Oper. Heavy
1 Oiler
1 Hydraul. Excavator, 2-cy Bucket

PRODUCTION

2.0 cy bucket
0.85 % fill
55 min/hr
0.70 cycle/min

65 cy/crew hr

EXCAVATE BASE LAYER [Staging/Access Areas]

CREW: *Staging/Access Excavation Crew* — 1.5 crew members

1 Equip. Oper. Heavy
0.5 Laborer
1 Hydraul. Excavator, 2-cy Bucket

PRODUCTION

2.0 cy bucket
0.85 % fill
55 min/hr
1.00 cycle/min

94 cy/crew hr

1043

TITLE:	Los Angeles River Ecosystem Restoration		
SUBJECT:	Output Rates for Excavation		
MADE BY:	SKV	JOB NO.:	T26313
CHECKED BY:		DATE:	3/24/2014

Sheet No. 1 of 2

CSI TASK:

LOAD AND HAUL TO DISPOSAL
[3-cy Loader, 20-cy Dump Truck, 20 Mile Haul, 35-mph Avg.]

CREW NAME: *Excavate, Load and Haul Crew* — 18 crew members

1 Eq. Oper. Heavy
1 Oilers
16 Truck Driver, Heavy
1 Front End Loader, 3-cy Bucket
16 12-cy Dump Trucks

OVERALL PRODUCTION RATE → 255 cy/crew hr

LOADING

SUB-CREW: Loading Crew — 2 crew members

1 Equip. Oper. Heavy
1 Oiler
1 Front End Loader, 3-cy Bucket

PRODUCTION

3 cy bucket
0.85 % fill
50 min/hr
2.00 cycle/min

255 cy/crew hr → 255 cy/crew hr

1.00 crews/equipment members to match overall production rate

1.00 total number of crews needed

TITLE:	Los Angeles River Ecosystem Restoration		
SUBJECT:	Output Rates for Excavation		
MADE BY:	SKV	JOB NO.:	T26313
CHECKED BY:		DATE:	3/24/2014

HAUL TO DISPOSAL SITE

SUB-CREW: Truck Haul Crew — 1 crew members

1 Truck Driver, Heavy
1 20-cy Dump Truck

PRODUCTION

20	cy truck
0.95	% fill
4.7	min. for loading
20	mi. to disposal location
35	mph haul speed
2.4	min. dump time
55	min/hr

QUANTITY PER TRUCK 19.0 cy/truck

DURATION OF HAULING 1.38 hr

13.8 cy/hr →

16.00 Number of truck crews required to have little or no back up on route

1045

TITLE:	Los Angeles River Ecosystem Restoration		
SUBJECT:	Output Rates for Fill and Compact From Stockpile		
MADE BY:	SKV	JOB NO.:	T26313
CHECKED BY:		DATE:	3/24/2014

Sheet No. 1 of 2

CSI TASK:

FILL AND COMPACT FROM STOCKPILE
[300-ft Haul , 3-cy Bucket, Vibro Compacted, with 3,000-gal Water Truck]

CREW NAME: *Fill and Compact from Stockpile Crew* — 5 crew members

- 3 Eq. Oper. Med.
- 1 Laborers
- 1 Truck Driver, Heavy
- 1 Dozer
- 1 Front End Loader 3-cy Bucket
- 1 Vibratory Roller
- 1 Dozer
- 1 Water Truck, 3000-gal

OVERALL PRODUCTION RATE → 102 cy/crew hr

FILL FROM STOCKPILE

SUB-CREW: Fill From Stockpile Crew — 3 crew members

- 2 Eq. Oper. Med.
- 0.5 Laborer
- 1 Dozer
- 1 Front End Loader, 3-cy Bucket

PRODUCTION

- 3 cy bucket (avg.)
- 0.85 % fill
- 50 min/hr
- 0.80 cycle/min

→ 102 cy/crew hr

COMPACT FILL

SUB-CREW: Compaction Crew — 1.5 crew members

- 0.5 laborer
- 1 Equip. Oper. Medium
- 1 Vibratory Roller

PRODUCTION 0.24 min/cy → 250 cy/hr

0.41 crews/equipment members to match overall production rate

1.00 total number of crews needed

TITLE:	Los Angeles River Ecosystem Restoration	
SUBJECT:	Output Rates for Fill and Compact From Stockpile	
MADE BY:	SKV	JOB NO.: T26313
CHECKED BY:		DATE: 3/24/2014

WATER TRUCK

SUB-CREW:

Water Truck Crew — 1 crew members
1 Truck Driver, Heavy
1 Water Truck, 3000-gal

PRODUCTION 0.48 min/cy → 125 cy/hr

0.82 crews/equipment members to match overall production rate

1.00 total number of crews needed

TITLE:	Los Angeles River Ecosystem Restoration		
SUBJECT:	Output Rates for Topsoil Placement		
MADE BY:	SKV	JOB NO.:	T26313
CHECKED BY:		DATE:	3/24/2014

Sheet No. 1 of 2

CSI TASK:

TOP SOIL, PLACEMENT

CREW NAME: *Fill and Compact from Stockpile Crew* — 5 crew members

- 3 Eq. Oper. Med.
- 1 Laborers
- 1 Truck Driver, Heavy
- 1 Dozer
- 1 Front End Loader 3-cy Bucket
- 1 Vibratory Roller
- 1 Dozer
- 2 Water Truck, 3000-gal

OVERALL PRODUCTION RATE → 159 cy/crew hr

FILL FROM STOCKPILE

SUB-CREW: Fill From Stockpile Crew — 3 crew members

- 2 Eq. Oper. Med.
- 0.5 Laborer
- 1 Dozer
- 1 Front End Loader, 3-cy Bucket

PRODUCTION

- 3 cy bucket (avg.)
- 0.85 % fill
- 50 min/hr
- 1.25 cycle/min

→ 159 cy/crew hr

COMPACT FILL

SUB-CREW: Compaction Crew — 1.5 crew members

- 0.5 laborer
- 1 Equip. Oper. Medium
- 1 Vibratory Roller

PRODUCTION 0.24 min/cy → 250 cy/hr

0.64 crews/equipment members to match overall production rate

1.00 total number of crews needed

TITLE:	Los Angeles River Ecosystem Restoration	
SUBJECT:	Output Rates for Topsoil Placement	
MADE BY:	SKV	JOB NO.: T26313
CHECKED BY:		DATE: 3/24/2014

WATER TRUCK

SUB-CREW: Water Truck Crew — 1 crew members

1 Truck Driver, Heavy
1 Water Truck, 3000-gal

PRODUCTION 0.48 min/cy → 125 cy/hr

1.28 crews/equipment members to match overall production rate

2.00 total number of crews needed

TITLE: Los Angeles River Ecosystem Restoration
SUBJECT: Output Rates for Stone Placement
MADE BY: SKV JOB NO.: T26313
CHECKED BY: DATE: 3/24/2014

Sheet No. 1 of 2

CSI TASK:

AGGREGATE BASE, PLACEMENT

CREW: *Aggregate Base Crew* — 5 crew members

3 Equip. Oper. Medium
1 Labor Foreman
1 Laborer
1 Front End Loader, 3-cy Bucket
1 Vibratory Roller
1 Grader

3 cy bucket
0.90 % fill
55 min/hr
0.75 cycle/min

OVERALL PRODUCTION RATE → 111 cy/hr

RIPRAP PLACEMENT

CREW: *Rip Rap Placement Crew* — 5 crew members

1 Equip. Oper. Heavy
1 Oiler
1 Labore Foreman
2 Laborers
1 3-cy Hydraul. Excavator

3 cy bucket
0.60 % fill
50 min/hr
0.33 cycle/min

OVERALL PRODUCTION RATE → 30 cy/hr

TIE-IN STONE, PLACEMENT

CREW: *Tie-In Stone Crew* — 5 crew members

1 Equip. Oper. Heavy
1 Oiler
1 Labore Foreman
2 Laborers
1 1.5-cy Hydraul. Excavator

1.5 cy bucket
0.75 % fill
50 min/hr
0.60 cycle/min

OVERALL PRODUCTION RATE → 34 cy/hr

TITLE:	Los Angeles River Ecosystem Restoration		
SUBJECT:	Output Rates for Stone Placement		
MADE BY:	SKV	JOB NO.:	T26313
CHECKED BY:		DATE:	3/24/2014

CSI TASK:

DECOMPOSED GRANITE, PLACEMENT

CREW:

Decomposed Granite Crew — 6 crew members

2 Equip. Oper. Medium
1 Truck Driver, Heavy
1 Labor Foreman
2 Laborers
1 Front End Loader, 3-cy Bucket
1 Drum Roller
1 Water Truck

3	cy bucket
0.75	% fill
50	min/hr
0.28	cycle/min
9.0	in. thick

OVERALL PRODUCTION RATE → **1114 sf/hr**

TITLE:	Los Angeles River Ecosystem Restoration		
SUBJECT:	Output Rates for Demolition Items		
MADE BY:	SKV	JOB NO.:	T26313
CHECKED BY:		DATE:	3/24/2014

Sheet No. 1 of 1

CSI TASK:

DEMO CONCRETE, REINFORCED

CREW: *Concrete Demo Crew* — 5 crew members

1 Labor Foreman
2 Laborers
1 Equip. Oper. Light
1 Equip. Oper. Med.
1 2.5-cy Hydraul. Excavator
1 3.5-cy Front End Loader

30.00 min/cy

OVERALL PRODUCTION RATE **2.0 cy/hr**

DEMO ASPHALT, ACCESS ROAD

CREW: *Concrete Demo Crew* — 5 crew members

1 Labor Foreman
2 Laborers
1 Equip. Oper. Light
1 Equip. Oper. Med.
1 2.5-cy Hydraul. Excavator
1 3.5-cy Front End Loader

24.00 min/cy

OVERALL PRODUCTION RATE **2.5 cy/hr**

CHAIN LINK FENCE, DEMOLITION

CREW: *Concrete Demo Crew* — 3 crew members

2 Laborers
1 Equip. Oper. Light
1 Backhoe

1.20 min/lf

OVERALL PRODUCTION RATE **50.0 lf/hr**

TITLE:	Los Angeles River Ecosystem Restoration		
SUBJECT:	Output Rates for Loading and Hauling Concrete		
MADE BY:	SKV	JOB NO.:	T26313
CHECKED BY:		DATE:	3/24/2014

Sheet No. 1 of 2

CSI TASK:

CONCRETE LOAD AND HAUL
16-cy Dump Truck, 10-mile Haul, 35-mph Avg.

CREW:	*Concrete Load and Haul Crew*	6 crew members
	1 Equip. Oper. Heavy	
	1 Oiler	
	4 Truck Driver, Heavy	
	1 Front End Loader, 3-cy Bucket	
	4 12-cy Dump Truck	

OVERALL PRODUCTION RATE → 75 cy/crew hr

LOADING

SUB-CREW:	Loading Crew	2 crew members
	1 Equip. Oper. Heavy	
	1 Oiler	
	1 Front End Loader, 3-cy Bucket	

PRODUCTION

3	cy bucket
0.50	% fill
50	min/hr
1.00	cycle/min
75	cy/crew hr

→ 75 cy/crew hr

1053

TITLE:	Los Angeles River Ecosystem Restoration		
SUBJECT:	Output Rates for Loading and Hauling Concrete		
MADE BY:	SKV	JOB NO.:	T26313
CHECKED BY:		DATE:	3/24/2014

HAUL TO DISPOSAL SITE

SUB-CREW: Truck Haul Crew — 1 crew members

1 Truck Driver, Heavy
1 16-cy Dump Truck

PRODUCTION

16	cy truck
0.80	% fill
12.8	min. for loading
10	mi. to disposal location
35	mph haul speed
6.4	min. dump time
55	min/hr

QUANTITY PER TRUCK 12.8 cy/truck

DURATION OF HAULING 0.97 hr

13.2 cy/hr →

4.00 Number of truck crews required to have little or no back up on route

TITLE:	Los Angeles River Ecosystem Restoration		
SUBJECT:	Output Rates for Clearing and Grubbing		
MADE BY:	SKV	JOB NO.:	T26313
CHECKED BY:		DATE:	3/24/2014

Sheet No. 1 of 1

CSI TASK:

CLEARING AND GRUBBING
[Medium Brush Including Trees]

CREW:	*Clear and Grub Crew*	3 crew members
	2 Laborer	
	1 Equip. Oper. Medium	
	1 Dozer with Land Clearing Equip.	
PRODUCTION	480.00 min/acre	
OVERALL PRODUCTION RATE		0.125 acre/hr

CLEARING AND GRUBBING
[For Trails]

CREW:	*Clear and Grub Crew*	3 crew members
	2 Laborer	
	1 Equip. Oper. Medium	
	1 Dozer with Land Clearing Equip.	
PRODUCTION	0.25 min/sy	
OVERALL PRODUCTION RATE		2160 sf/hr

1055

TITLE: Los Angeles River Ecosystem Restoration
SUBJECT: Output Rates for Fill and Compact From Stockpile
MADE BY: SKV JOB NO.: T26313
CHECKED BY: DATE: 3/24/2014

Sheet No. 1 of 1

CSI TASK:

TOP SOIL PLACEMENT

CREW NAME: *Fill and Compact from Stockpile Crew* — 5 crew members

2 Eq. Oper. Med.
2 Laborers
1 Truck Driver, Heavy
1 Dozer
1 Front End Loader 6-cy Bucket
1 Dozer
2 Water Truck, 3000-gal

OVERALL PRODUCTION RATE → 159 cy/crew hr

FILL FROM STOCKPILE

SUB-CREW: Fill From Stockpile Crew — 3 crew members

2 Eq. Oper. Med.
2 Laborer
1 Dozer
1 Front End Loader, 3-cy Bucket

PRODUCTION

3 cy bucket (avg.)
0.85 % fill
50 min/hr
1.25 cycle/min

→ 159 cy/crew hr

WATER TRUCK

SUB-CREW: Water Truck Crew — 1 crew members

1 Truck Driver, Heavy
1 Water Truck, 3000-gal

PRODUCTION 0.48 min/cy → 125 cy/hr

1.28 crews/equipment members to match overall production rate

2.00 total number of crews needed

TITLE:	Los Angeles River Ecosystem Restoration		
SUBJECT:	Output Rates for Vegetation		
MADE BY:	SKV	JOB NO.:	T26313
CHECKED BY:		DATE:	3/24/2014

Sheet No. 1 of 1

CSI TASK:

SHRUBS

CREW:	Planting Crew 2 Laborers	2 crew members
PRODUCTION	5.00 min/ea per person	
OVERALL PRODUCTION RATE		24 ea/hr

TREES

CREW:	Planting Crew 2 Laborers 1 Pickup Truck	2 crew members
PRODUCTION	12.00 min/ea	
OVERALL PRODUCTION RATE		5 ea/hr

1057

TITLE:	Los Angeles River Ecosystem Restoration		
SUBJECT:	Output Rates for Utility Tower Work		
MADE BY:	SKV	JOB NO.:	T26313
CHECKED BY:		DATE:	3/24/2014

Sheet No. 1 of 1

CSI TASK:

TRANSMISSION TOWER DEMOLITION

CREW: Steel Lattice Tower Crew — 12 crew members

- 6 Laborers
- 5 Electricians
- 1 Foreman
- 2 Crane

PRODUCTION 40.00 hr/ea

OVERALL PRODUCTION RATE 0.025 ea/hr

1058

US Army Corps
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Los Angeles District

Los Angeles River Ecosystem Restoration Feasibility Study

Cost Appendix

Attachment 12
Cost and Schedule Risk Analysis (CSRA)

April 2015

NATIONAL ECOSYSTEM RESTORATION PLAN – ALTERNATIVE 13v

COST AND SCHEDULE RISK ANALYSIS

US Army Corps
of Engineers®

Los Angeles District

Los Angeles River Ecosystem Restoration

Feasibility Study

DRAFT
Cost and Schedule Risk Analysis Report
National Ecosystem Restoration Plan
Alternative 13v

March 2015

TETRA TECH

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ATTACHMENTS

Attachment A Project Delivery Team Risk Register
Attachment B Market Research

EXECUTIVE SUMMARY

This report presents a recommendation for the total project cost and schedule contingency for the Los Angeles River Ecosystem Restoration Project. A formal risk analysis study was conducted to develop a reliable and defensible contingency factor for the total project cost associated with the MCACES construction cost estimate. The cost and schedule risk analysis involved the development of project contingencies by identifying and evaluating the impacts of project uncertainties on the construction cost and schedule and a subsequent calculation of the estimated total project cost.

The Project Delivery Team (PDT) conducted one brainstorming session on November 5, 2013, to identify the risks associated with the project. Additional coordination of the PDT for review and input occurred thereafter. Key project and risk assumptions reflected in the analysis were identified. The risk analysis was performed using Oracle Crystal Ball software to estimate a contingency with the use of Monte Carlo simulations in correlation with the proposed risks and uncertainties.

The contingency is based on an 80 percent (P80) confidence level, per accepted U.S. Army Corps of Engineers Civil Works guidance. For the Los Angeles river Ecosystem Restoration project, the most likely baseline construction cost is estimated at approximately $129,610,919 (Table ES-1). The risk analysis resulted in a contingency value of $37,970,169 based on the cost risks and a contingency of $5,820,801 based on the schedule risks. This translates to a total project contingency value of $43,790,969 which equates to approximately 33.79 percent of construction costs.

CONTINGENCY SUMMARY

Contingency on Baseline Cost Estimate	80% Confidence Project Cost
Baseline Estimated Cost (Most Likely) ->	**$129,610,919**
Baseline Estimated Cost Contingency Amount ->	$37,970,169
Baseline Estimated Construction Cost (80% Confidence) ->	**$167,581,088**

Contingency on Schedule	80% Confidence Project Schedule
Project Schedule Duration (Most Likely) ->	129.0 Months
Schedule Contingency Duration ->	44.4 Months
Project Schedule Duration (80% Confidence) ->	173.4 Months
Project Schedule Contingency Amount (80% Confidence) ->	$5,820,801

Project Contingency	80% Confidence Project Cost
Project Contingency Amount (80% Confidence) ->	$43,790,969
Project Contingency Percentage (80% Confidence) ->	33.79%

Project Cost (80% Confidence) ->	**$173,401,889**

Please note that cost estimates fluctuate over time. During this period of study, minor cost fluctuations can and have occurred. For this reason, costs may vary a slight degree between this document and the primary cost estimating components of the MCACES construction cost estimate and the Total Project Cost Summary (TPCS). Therefore, values in this document may not exactly match those from the TPCS and MCACES, but should be very similar in scale.

KEY FINDINGS/OBSERVATIONS RECOMMENDATIONS

An analysis of the relative impact of the key cost drivers on the cost and schedule contingency indicates that following risks result in the most impact on the overall project contingency:

- Cost Risks:
  - PR-7: political factors change at local, state or federal level – Due to the projected costs of this project, and the number of different agencies involved, funding difficulties may arise which could impact the costs of construction.
  - TL-1: low design level – This project is currently at a preliminary design level. All quantities and costs are based on typical cross sections, but as the project progresses more design detail will be completed. Thus this risk should be mitigated during future design phases.
  - PR-4: market conditions and bidding competition – This risk falls outside the PDT's sphere of influence. It is difficult to project these conditions several years out, but given that this project is also anticipated to take over 10-years to construct, it is even more difficult to predict adequate conditions that far out. Thus costs for this must be accounted for at this time.
  - TL-2: investigations remain to be completed – As noted in risk item TL-1, this project is still at a low design level. As the project moves forward all outstanding investigations will be completed, and the impact of this risk will be lowered.
- Schedule Risks:
  - PR-6: flooding / earthquake – Los Angeles is renowned for earthquakes and is susceptible to flash floods. These risks are unavoidable, but would pose significant delays to construction if they occur, which is likely due to the proposed construction duration.
  - PR-7: political factors change at local, state or federal level – As noted under the costs risks above, the different entities involved in this project may not always see eye to eye. Construction could be delayed if all agencies are not on board with the selected plan.
  - CA-4: acquisition plan to accommodate funding stream – The current estimate assumes intermittent funding, but the assumption of four contracts may not be sufficient. The funding stream could change the number of contracts, which may push the construction schedule out.

The key recommendations from this study are the implementation of cost and schedule contingencies, further iterative study of risks throughout the project life cycle, potential mitigation throughout the planning, engineering and design phase, and proactive monitoring and control of the internal risks identified in this study.

1. PURPOSE

A cost and schedule risk analysis (CSRA) was conducted to develop a reliable and defensible contingency factor for the construction cost estimate developed for the Los Angeles River Ecosystem Restoration Feasibility Study Cost Appendix with the use of the Micro-Computer Aided Estimating System (MII). The appendix describes the design and cost assumptions that go into developing the MII estimate. The contingency factor was calculated at the 80 percent confidence level as recommended by U.S. Army Corps of Engineers (USACE) guidance (2009). The contingency was calculated in terms of dollars for the cost analysis and in terms of months for the schedule analysis.

The Project Delivery Team (PDT) studied a variety of risks that could affect the construction cost and/or schedule. The events were grouped into the following categories:

- Project and program management
- Contract acquisition
- Technical
- Lands and damages
- Construction
- Estimate and schedule
- Programmatic (external)

All of the risk categories except "programmatic" include risks that could be generated, caused, or controlled by the PDT. Programmatic, or external, risks are those outside the sphere of influence of the PDT.

2. BACKGROUND

The primary purpose of this project is to restore approximately 11 miles of the Los Angeles River. This stretch of channel starts at Griffith Park and extends to the Downtown Los Angeles area. The project is designed to reestablish riparian strands, freshwater marshes and aquatic habitat communities as well as reconnect the river to major tributaries, historic floodplains and regional habitat zones. This project is also designed to provide recreational opportunities that are consistent with the restored ecosystem.

The Los Angeles River has been degraded over time by a cycle of increasing urban development, flooding, and channelization. This cycle led to the Los Angeles County Drainage Area (LACDA) project that was completed in the mid-20th century. The LACDA was a Federal flood control project that straightened the channel and encased much of it with concrete banks and concrete beds. This greatly diminished the plant and wildlife diversity and quality and disconnected the channel from its floodplains and significant ecological zones.

Other sections of the Los Angeles River that are outside of this project's reach are too urbanized to be considered for potential habitat connectivity and expansion projects. Thus this 11 mile stretch, known as the "Area with Restoration Benefits and Opportunities for Revitalization (ARBOR)" reach, has the most potential for restoration benefits.

This project initially looked at various alternatives that comprised of numerous restoration sub-measures. Initial construction cost estimates were developed and a final array of four alternatives was selected for further analysis. From these four alternatives, the National Ecosystem Restoration (NER) Plan was identified as Alternative 13v. This alternative was estimated using MII software and is the basis for the risk analysis within this report.

The following design documents were available for use in this CSRA:

- Los Angeles River Ecosystem Restoration – Feasibility Study, Draft Integrated Report September 2013
- Los Angeles River Ecosystem Restoration – Feasibility Study, Conceptual Design Drawings, April 2013
- Los Angeles River Ecosystem Restoration – Feasibility Study, Design Appendix, April 2013
- Los Angeles River Ecosystem Restoration – Feasibility Study, Cost Appendix, March 2014

3. REPORT SCOPE

The scope of this CSRA report is the calculation and presentation of cost and schedule contingencies at the 80 percent confidence level using the risk analysis processes mandated by USACE Engineer Regulation (ER) 1110-2-1150, ER 1110-2-1302, and Engineer Technical Letter 1110-2-573 (USACE 1999, 2008a, 2008b). The report presents the contingency results for cost risks for all project features. The study excluded a consideration of operation and maintenance and life cycle costs.

3.1 Project Scope

3.1.1 Mandates and Appropriations

- The study was authorized by Senate Committee on Public Works Resolution, approved June 25, 1969.
- Section 4018 of the Water Resources Development Act of 2007 provided authorization for a "feasibility study for environmental ecosystem restoration, flood risk management, recreation and other aspects of Los Angeles River revitalization that is consistent with the goals of the Los Angeles River Revitalization Master Plan published by the city of Los Angeles..."

3.1.2 Product Development

The project technical scope, estimate, and schedule developed by Tetra Tech, Inc. served as the basis for the risk analysis for the construction cost estimate. The construction cost estimate scope consists of the following:

- Civil Works Work Breakdown Structure feature account: 06, Fish and Wildlife Facilities and 14, Recreation (USACE 2008b)

- Design level: includes conceptual design cross sections for the Los Angeles River Ecosystem Restoration Feasibility Study

3.2 USACE Risk Analysis Process

The risk analysis process used in this study follows the USACE Headquarters requirements as well as guidance from the Cost Engineering Directory of Expertise for Civil Works. It uses probabilistic CSRA methods within the framework of the Oracle Crystal Ball software. The results of a risk analysis are intended to serve several functions, one being the establishment of reasonable contingencies reflective of an 80 percent confidence level to successfully accomplish the project work within that established contingency amount. The scope of the report includes the identification of important steps, rationale, key assumptions, limitations, and decisions to help ensure that risk analysis results can be appropriately interpreted.

The risk analysis results discussed in this report are intended to provide project leadership with contingency information for scheduling, budgeting, and project control purposes, as well as tools to support decision making and risk management as the project progresses through planning and implementation. To fully recognize its benefits, CSRAs should be considered an ongoing process that is conducted concurrently and iteratively with other important project processes such as scope and execution plan development, resource planning, procurement planning, cost estimating, budgeting, and scheduling.

In addition to satisfying broadly defined risk analysis standards and recommended practices, this risk analysis was performed in accordance with the requirements and recommendations of the following documents and sources:

- Cost and Schedule Risk Analysis Guidance USACE (2009)
- Memorandum from Major General Don T. Riley, U.S. Army Director of Civil Works (USACE 2007a)
- Engineering and Construction Bulletin 2007-17 (USACE 2007b)
- Engineer Regulation 1110-2-1150 (USACE 1999)
- Engineer Regulation 1110-2-1302 (USACE 2008a)
- Engineer Technical Letter 1110-2-573 (USACE 2008b)

4. METHODOLOGY/PROCESS

The risk analysis team received cost support from the cost engineer as well as coordination support from project management and the assigned PDT. Several other disciplines, such as Construction, were invited, but not all disciplines attended the meeting. The members of the risk analysis team are indicated in Table 1.

Table 1 – PDT Member Positions and Organizations

Position	Name	Organization
Hydrology and Hydraulics	Kerry Casey	USACE, Los Angeles
Geotechnical	Chris Spitzer	USACE, Los Angeles
Plan Formulation Branch Chief	Ed Demesa	USACE, Los Angeles
Project Manager	Tawny Tran	USACE, Los Angeles
Cost Engineer	Arnecia Williams	USACE, Los Angeles
Biologist	Eric Jones	USACE, Los Angeles
Design	Frank Mallette	USACE, Los Angeles
Real Estate	Lisa Sandoval	USACE, Los Angeles
Economics	Mike Hallisy	USACE, Los Angeles
Project Manager	Scott Estergard	Tetra Tech
Cost Estimator	Scott Vose	Tetra Tech
Project Engineer	Ike Pace	Tetra Tech
Senior Water Resource Planner	Ira Artz	Tetra Tech
Local Sponsor Representative	Megan Whalen	City of Los Angeles
Local Sponsor Representative	Rene Curtis	City of Los Angeles
Local Sponsor Representative	Carol Armstrong	City of Los Angeles
Local Sponsor Representative	Michael Affeldt	City of Los Angeles

The risk analysis process for this study is intended to determine the probability of various cost outcomes and quantify the required contingency needed in the cost estimate to achieve the desired level of confidence related to project cost.

Contingency is defined as an amount added to an estimate to allow for items, conditions, or events for which the occurrence or impact is uncertain and that experience suggests will likely result in additional costs or additional time. The amount of contingency included in project control plans depends, at least in part, on the project leadership's willingness to accept the risk of project overruns. The less risk that project leadership is willing to accept, the more contingency should be applied in the project control plans. The risk of overrun is expressed, in a probabilistic context, using confidence levels.

The Cost Engineering District guidance for CSRA generally focuses on the 80 percent level of confidence (P80) for cost contingency calculation. The use of P80 as a decision criterion is a risk-averse approach (whereas the use of P50 is considered a risk-neutral approach, and the use of levels less than 50 percent is considered a risk-seeking approach). Thus, the use of a P80 confidence level results in a greater contingency relative to that resulting from a P50 confidence level. The selection of contingency at a particular confidence level is ultimately the decision and responsibility of the project's district and/or division management.

The risk analysis process uses Monte Carlo techniques to determine probabilities and contingency. The Monte Carlo techniques are facilitated computationally by a commercially available risk analysis software package (Oracle Crystal Ball), which is an add-in to Microsoft Excel. Cost estimates are packaged into an Excel format and used directly for cost risk analysis

purposes. The level of detail recreated in the Excel-format schedule is sufficient for risk analysis purposes that reflect the established risk register, but generally less than that of the native format.

In functional terms, the primary steps of the risk analysis process are described in the following subsections. The results of the risk analysis are provided in Section 6.

4.1 Identification and Assessment of Risk Factors

Identification of the risk factors by the PDT is considered a qualitative process that results in the establishment of a risk register, which is used to document the results of the quantitative study of risks. Risk factors are events and conditions that may influence or drive uncertainty associated with project performance. They may be inherent characteristics or conditions of the project or external influences, events, or conditions such as weather or economic conditions. Risk factors may have either favorable or unfavorable impacts on project cost and schedule.

Checklists or historical databases of common risk factors are sometimes used to facilitate the identification of risk factors. However, the key risk factors are often unique to a project and cannot be readily derived from historical information. Therefore, input is obtained from the entire PDT be means of creative processes such as brainstorming or other facilitated risk assessment meetings. In practice, a combination of professional judgment from the PDT and empirical data from similar projects is desirable.

Formal PDT meetings are held for the purposes of identifying and assessing risk factors. The meetings should include capable and qualified representatives from multiple project team disciplines and functions, for example:

- Project/program managers
- Contracting/acquisitions
- Real estate
- Relocations
- Environmental
- Civil and coastal design
- Cost and schedule engineers
- Construction
- Key sponsors

The initial formal meetings should focus primarily on risk factor identification using brainstorming techniques but also include some facilitated discussions based on risk factors common to projects of similar scope and geographic location. Subsequent meetings should focus primarily on risk factor assessment and quantification. Conference calls and informal meetings also occur throughout the risk analysis process on an as-needed basis to further facilitate risk factor identification, market analysis, and risk assessment. The risk register document developed for this project can be seen in Attachment A.

4.2 Quantification of Risk Factor Impacts

The quantitative impacts of risk factors on project plans are analyzed using a combination of professional judgment, empirical data, and analytical techniques. Risk factor impacts are quantified using probability distributions (density functions) because risk factors are entered into the Crystal Ball software in the form of probability density functions.

Similar to the identification and assessment process, risk factor quantification involves multiple project team disciplines and functions. However, the quantification process relies more extensively on collaboration between cost engineering and risk analysis team members with lesser input from the other functions and disciplines. The quantification process uses an iterative approach to estimate the following elements of each risk factor:

- Maximum possible value for the risk factor
- Minimum possible value for the risk factor
- Most likely value (the statistical mode), if applicable
- Nature of the probability density function used to approximate risk factor uncertainty
- Mathematical correlations between risk factors
- Affected cost estimate and schedule elements

The resulting product from the PDT discussions is captured within a risk register for both cost and schedule risk concerns. The risk register documents the PDT's risk concerns, discussions related to those concerns, and potential impacts on the current cost and schedule estimates. The concerns and discussions are meant to support the team's decisions related to event likelihood, impact, and the resulting risk levels for each risk event.

4.3 Analysis of Cost Estimate and Schedule Contingency

Contingency is analyzed using the Crystal Ball software, an add-in to the Microsoft Excel format of the cost estimate and schedule. Monte Carlo simulations are performed by applying the risk factors (quantified as probability density functions) to the appropriate estimated cost and schedule elements identified by the PDT and the market research. Contingencies are calculated by applying only the moderate- and high-level risks identified for each option (i.e., low-level risks are typically not considered but remain within the risk register to serve historical purposes as well as support follow-on risk studies as the project and risks evolve).

For the cost estimate in this study, the contingency was calculated as the difference between the P80 cost forecast and the base cost estimate. Each option-specific contingency was then allocated on a civil works feature level based on the dollar-weighted relative risk of each feature as quantified by Monte Carlo simulation. Standard deviation was used as the feature-specific measure of risk for contingency allocation purposes. This approach resulted in a relatively larger portion of all the project feature cost contingency being allocated to features with relatively higher estimated cost uncertainty.

For the schedule in this study, contingency was calculated as the difference between the duration forecast at various confidence level intervals and the base schedule duration. The duration contingency was then used to estimate hotel costs and calculate the additional time value of

money impact due to project delays that are included in the total cost contingency presented in Section 6. The resulting time value of money, or added escalation risk, and hotel costs were added into the cost contingency amount to reflect the USACE standard for presenting the estimated cost for the fully funded project amount.

Schedule contingency was analyzed only on the basis of each option and not allocated to specific tasks. Based on the guidance, only critical path and near critical path tasks are considered uncertain for the purposes of contingency analysis (USACE 2009).

5. KEY ASSUMPTIONS

The CSRA for the Los Angeles River Ecosystem Restoration project was based on the following key assumptions:

- The project is currently in the conceptual design stage. Various alternatives were analyzed previously based on conceptual cross-sections for each reach. These same cross-sections and designs are utilized for development of the MCACES cost estimate.
- Many of the requisite studies (geotechnical, H&H, etc.) have not been completed. The design is subject to change once the information from these reports can be incorporated.
- Project study costs to date are not included in the risk study.
- Neither life cycle nor operation and maintenance costs are included in the risk study. This study is based solely on the initial construction of the project.
- Major features of this project include concrete demolition; excavation and fill; riprap; grouted riprap; turf reinforcement mats; fencing; clearing and grubbing; reinforced cast-in-place concrete;; sub-drainage system; asphalt; multi-use trail; trail access points; pedestrian bridges and other recreation components.
- The feature cost accounts for this project include Lands and Damages; Relocations; Fish and Wildlife Facilities; Recreation; Planning, Engineering, and Design; and Construction Management.
    - Lands and Damages: The costs for this account have been estimated by the USACE. However, these costs have not been included in this CSRA analysis, because due to the overwhelming size of the costs for this account, the risk analysis would be completed swayed towards the risks associated with this account. Also, the real estate report develops their own contingencies to be utilized for this project, which have been deemed sufficient to account for any unforeseen changes that may occur to these costs.
    - Relocations: Costs for this account have been estimated by the USACE. Again, like the lands and damages, these costs have not been included in this analysis. A contingency has been provided for this account, which is utilized in the total project cost summary sheet.
    - Fish and Wildlife Facilities: Costs for this account include the majority of the construction costs for this project.

- Recreation: Costs for this account include the components that are not primarily aimed at ecosystem restoration. These include construction activities such as multi-use trails, trail access points, wildlife viewing areas, pedestrian bridges and other recreation trail components.
- Planning, Engineering, and Design: Costs for this account were estimated at 11 percent of the construction cost. This account covers the preparation of the plans, specifications, and estimate for construction.
- Construction Management: Costs for this account were estimated at 6.5 percent of the construction cost. This account covers construction management during the construction contract.
- Monitoring and Adaptive Management: Costs for this item were added to the costs estimated for construction management. These costs were estimated as 3% of the Fish and Wildlife Facilities costs only.

- The cost estimate is based on local labor, material, and fuel costs. The construction schedule is based on production rates of the construction elements in the cost estimate.
- The recommended contingency is based on an 80 percent confidence level, per accepted USACE Civil Works guidance.
- Only the high and moderate risk levels as determined by the PDT in the risk register are included in the risk analysis. The low risk levels are excluded based on the assumption that they would have a negligible impact in determining the contingency.

6. RISK ANALYSIS RESULTS

The CSRA results are provided in the following subsections. In addition to the contingency calculations, the results of sensitivity analyses are presented to provide decision makers with an understanding of variability and the key contributors to the variability.

6.1 Risk Register

A risk register is a tool commonly used in project planning and risk analysis. The risk register developed for this project is provided in Attachment A; a condensed version of the risk register is provided in Table 2. The complete risk register includes low-level risks, as well as additional information regarding the nature and impacts of each risk.

A risk register can be an effective tool for managing identified risks throughout the project life cycle. As such, it is generally recommended that risk registers be updated as the designs, cost estimates, and schedule are further refined, especially on large projects with extended schedules. Recommended uses of the risk register going forward include the following:

- Documenting risk mitigation strategies being pursued in response to the identified risks and their assessment in terms of probability and impact
- Providing project sponsors, stakeholders, and leadership/management with a documented framework from which risk status can be reported in the context of project controls
- Communicating risk management issues
- Providing a mechanism for eliciting feedback and project control input

- Identifying risk transfer, elimination, or mitigation actions required for implementation of risk management plans

Table 2 – Condensed Risk Register

Risk No.	Risk/Opportunity Event	Concerns	Project Cost			Project Schedule		
			Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*
Contract Risks (Internal Risk Items are those that are generated, caused, or controlled within the PDT's sphere of influence.)								
	PROJECT & PROGRAM MGMT							
PPM-1	Interactions between all agencies involved in project	Many different agencies will be involved in order to complete this project. Managing and assuring that all agencies complete requisite needs may prove difficult.	Very Likely	Marginal	MODERATE	Very Likely	Marginal	MODERATE
PPM-2	Dealings with multiple stakeholders	The various stakeholders in the project may cause difficulties in funding, changes to design, etc.	Very Likely	Marginal	MODERATE	Very Likely	Marginal	MODERATE
PPM-3	Project competing with other projects, funding and resources	Other projects may threaten funding streams and/or delays receive of funds needed to meet design/construction milestones.	Very Likely	Marginal	MODERATE	Very Likely	Marginal	MODERATE
PPM-4	Losing critical staff at crucial points of project	Loss of crucial staff prior to or during critical milestones could delay project.	Likely	Marginal	MODERATE	Likely	Marginal	MODERATE
PPM-5	Product development by several sources	This project requires members from various entities both governmental and private to complete.	Likely	Negligible	LOW	Likely	Negligible	LOW
PPM-6	Priorities change on existing program	If USACE priorities on ecosystem restoration change, then this project could be impacted.	Unlikely	Negligible	LOW	Likely	Marginal	MODERATE
	CONTRACT ACQUISITION RISKS							
CA-1	Contracting plan has not been developed	Contracting plan has not been fully developed at this stage. Changes to current assumptions could occur.	Likely	Marginal	MODERATE	Likely	Significant	HIGH
CA-2	Possibility for 8(a) or small business contractor(s)	Some portions of the project may be bid to 8(a) contractors, which could increase costs for construction.	Likely	Negligible	LOW	Likely	Negligible	LOW
CA-3	Number of separate contracts and prime contractors	Current estimate assumes 4 separate contracts with each one having a separate prime contractor. Further analysis into contracting plan may change this.	Likely	Negligible	LOW	Likely	Negligible	LOW
CA-4	Acquisition plan to accommodate funding stream	The funding stream will be a major driver of the contracts. If funding stream changes or is inadequate current assumptions will change.	Likely	Marginal	MODERATE	Likely	Significant	HIGH
	TECHNICAL RISKS							

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Risk No.	Risk/Opportunity Event	Concerns	Project Cost			Project Schedule		
			Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*
TL-1	Low design level	Project is at a low design level. All quantities and assumptions are subject to changes as project progresses.	Very Likely	Critical	HIGH	Very Likely	Marginal	MODERATE
TL-2	Investigations remain to be completed (H&H, Geotech, HTRW, etc.)	Many investigations still remain to be completed. Once finalized, these reports may cause design changes.	Very Likely	Significant	HIGH	Very Likely	Marginal	MODERATE
TL-3	Hazardous waste concerns	Encountering unanticipated HTRWs can cause significant increase in earthwork costs.	Very Likely	Significant	HIGH	Very Likely	Marginal	MODERATE
TL-4	Disposal locations and costs for excavated materials	Preliminary landfills have been assumed to be capable of accepting excavated materials. Further analysis could lead to cost savings (if cheap/no cost site is found) or increased costs based on tipping fees.	Likely	Marginal	MODERATE	Likely	Negligible	LOW
TL-5	All Disciplines	Many investigations remain to be completed, which once finished, could change current design	Very Likely	Significant	HIGH	Likely	Negligible	LOW
TL-6	Locations and costs for borrow materials	Changes in material prices and locations from borrow sites may change.	Unlikely	Significant	MODERATE	Unlikely	Negligible	LOW
	LANDS AND DAMAGES RISKS							
LD-1	Status of real estate / easement acquisition	Real estate and easements need to be purchased in a timely fashion such that the construction phases can begin as scheduled.	Likely	Negligible	LOW	Likely	Marginal	MODERATE
LD-2	Railroad involvement	Project may require railroad involvement for culverts and right-of-way acquisition	Likely	Negligible	LOW	Likely	Marginal	MODERATE
LD-3	Relocations identified	Detailed relocation designs/report has not been fully developed at time of estimate.	Likely	Marginal	MODERATE	Likely	Negligible	LOW
LD-4	Known and unknown utility impacts	Unknown utilities may be found during construction thus causing increased costs and delayed schedules.	Likely	Marginal	MODERATE	Likely	Marginal	MODERATE
LD-5	Vagrancy, loitering issues	Dealing with vagrant population may cause some minor delays.	Likely	Negligible	LOW	Likely	Negligible	LOW
LD-6	Accuracy of current values of lands and easements	Real estate costs are more than 3 times more costly than the current construction costs. Thus changes in costs to real estate effect total cost significantly.	Very Unlikely	Critical	LOW	Unlikely	Critical	MODERATE
LD-7	Railroad trestle	Railroad involvement, design of trestles, other easement acquisition, temporary operation facilities	Likely	Significant	HIGH	Likely	Significant	HIGH
	REGULATORY AND ENVIRONMENTAL RISKS							

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Risk No.	Risk/Opportunity Event	Concerns	Project Cost			Project Schedule		
			Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*
RE-1	Status of permits	Many permits will need to be obtained for construction. Prompt receive of permits will be needed to keep construction schedule on track.	Likely	Negligible	LOW	Likely	Marginal	MODERATE
RE-2	Potential for critical regulation changes	Regulation changes within the Corps could impact this project	Likely	Marginal	MODERATE	Likely	Marginal	MODERATE
RE-3	Negative community impacts	Construction vehicles, noise, pollution, etc., are all to be encountered during construction.	Likely	Negligible	LOW	Likely	Negligible	LOW
RE-4	Endangered species present	Further research may find endangered species present which could delay project.	Unlikely	Negligible	LOW	Unlikely	Negligible	LOW
RE-5	Preliminary HTRW complete	HTRW report is not finalized currently	Likely	Significant	HIGH	Likely	Negligible	LOW
RE-6	Agency actions/reviews are delayed or take longer than expected	Due to number of agencies involved, keeping all actions and reviews on time will be imperative to meeting the project milestones.	Likely	Negligible	LOW	Likely	Marginal	MODERATE
RE-7	Flood risk policy	Flood risk policies from FEMA, DWR, USACE, may change which would impact design	Likely	Negligible	LOW	Likely	Marginal	MODERATE
	CONSTRUCTION RISKS							
CON-1	Permits, licenses, submittal approvals	Delays in acquiring all permits, licenses, and receiving submittal approvals can delay the start of construction or alter sequencing.	Likely	Negligible	LOW	Likely	Marginal	MODERATE
CON-2	Permit and environmental work windows	Work windows based on environmental issues are accounted for, but could change.	Unlikely	Marginal	LOW	Unlikely	Marginal	LOW
CON-3	Site access restrictions	Due to the length of the reaches, site accessibility may be a problem.	Likely	Marginal	MODERATE	Likely	Negligible	LOW
CON-4	Adequate staging areas	No staging areas have been designed, and due to size of project significant staging would be required.	Likely	Marginal	MODERATE	Likely	Negligible	LOW
CON-5	Unknown utilities	Unknown utilities may be found during construction thus causing increased costs and delayed schedules.	Likely	Significant	HIGH	Likely	Negligible	LOW
CON-6	Traffic issues for all haul vehicles	Traffic is going to be an issue for any haul trucks bringing or taking away materials to and from the project site.	Likely	Marginal	MODERATE	Likely	Marginal	MODERATE
CON-7	Diversion and control of water	Diversion and control of water is going to be significant effort, and is based on general assumptions at this time.	Unlikely	Significant	MODERATE	Likely	Negligible	LOW
CON-8	Change orders and modification growths	There may be modification issues that have not been captured in the estimate or schedule.	Likely	Marginal	MODERATE	Likely	Marginal	MODERATE

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Risk No.	Risk/Opportunity Event	Concerns	Project Cost			Project Schedule		
			Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*
CON-9	Unidentified hazardous waste	Encountering unanticipated HTRWs during construction can cause significant increase in earthwork costs.	Unlikely	Significant	MODERATE	Unlikely	Significant	MODERATE
CON-10	Adaptive management	Managing the project through unexpected changes.	Likely	Marginal	MODERATE	Likely	Marginal	MODERATE
	ESTIMATE AND SCHEDULE RISKS							
EST-1	Estimate confidence in large and critical quantities	Design is at low level, and quantities are based on one typical section for each reach.	Likely	Marginal	MODERATE	Likely	Significant	HIGH
EST-2	Estimate reasonableness of crews and productivities	Production rates used in estimate may differ from those in the field.	Likely	Significant	HIGH	Likely	Significant	HIGH
EST-3	Accuracy of construction schedule durations, sequencing, phasing, etc.	Contractor may have different sequencing to construction activities within the contracts which could decrease or increase duration.	Unlikely	Marginal	LOW	Unlikely	Marginal	LOW
Programmatic Risks (External Risk items are those that are generated, caused, or controlled exclusively outside the PDT's sphere of influence.)								
PR-1	Adequacy of project funding	There is some concern in obtaining funds on a timely basis or in the necessary increments. Receiving less than required or in delayed increments is a concern.	Unlikely	Marginal	LOW	Unlikely	Significant	MODERATE
PR-2	Local communities have objections	Delays may occur due to local communities objecting to the work planning to be constructed.	Unlikely	Significant	MODERATE	Unlikely	Significant	MODERATE
PR-3	Stakeholders request late changes	Late changes by the various stakeholders can cause redesign, increased costs and delays.	Likely	Marginal	MODERATE	Likely	Negligible	LOW
PR-4	Market conditions and bidding competition	Real estate market could be significant risk with variability in this market.	Likely	Significant	HIGH	Unlikely	Marginal	LOW
PR-5	Unexpected escalation on key materials	There could be increases in the cost materials, primarily including the riprap and borrow materials.	Likely	Marginal	MODERATE	Likely	Marginal	MODERATE
PR-6	Flooding/Earthquake	Small chance of major floods and earthquakes occurring, but these could delay project and cause major re-work.	Likely	Marginal	MODERATE	Likely	Significant	HIGH
PR-7	Political factors change at local, state or federal level	Concern due to large cost and all government agencies agreeing on design and implementation.	Likely	Significant	HIGH	Likely	Significant	HIGH

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6.2 Discussion of Moderate and High Risks

The following sections discuss the risk items that have are the most impactful to the contingency development. All risk items that generate over 10 percent of the contingency, as shown in the sensitivity analysis, for both cost and schedule are here. Further information on all risk items and their corresponding PDT discussions can be found in Attachment A.

The discussion of each item includes general concerns and discussions developed by the PDT as well as a general discussion of the anticipated cost increases or opportunities that the risks could have. The full market research back-up can be found in Attachment B.

6.2.1 Cost Risks

(i) High Risks

- PR-7: political factors change at local, state or federal level – This risk is an external risk that falls outside of the PDT's sphere of influence. There is a concern that due to the large costs and all the government agencies that are involved, that agreement on the design and implementation may be difficult to achieve. There are already discussions surrounding the various alternatives and which should be the selected plan. Also, political opposition may arise to the current plan due to the overall total cost of the project. The CSRA assumes that political opposition could decrease the scope of the project, thus decreasing construction costs by 7.5%. The political pressures could significantly increase costs as well, and it is assumed that a possible 10% increase may occur.
- TL-1: low design level – This risk is one that should decrease as the project progresses. Currently, the design is at a conceptual level with all quantities and costs based on one typical section per reach. Obviously, as the project moves forward the impacts of this risk will be lowered as the design becomes more detailed and the quantities are fine tuned. But at the time being, the low design level could lead to significant changes in quantities. The CSRA assumed that due to the level of design the cost estimate could decrease upwards of 7.5% or increase by 10%.
- PR-4: market conditions and bidding competition – This risk is an external risk that falls outside of the PDT's sphere of influence. At time of bidding, the market conditions are an unknown and could significantly impact the values of the bids received. There could be a saturation of contractors willing to bid, which could lead to lower bids received, or the opposite is possible. The market research assumed a possible 5% decrease in the overall construction costs for the low cost and a 7.5% increase to construction costs for the possibility of higher bids.
- TL-2: investigations remain to be completed (H&H, Geotech, HTRW, etc.) – This project is currently at the conceptual design level and thus many investigations still remain to be completed. Upon completion of all the necessary studies, the PDT agrees that many aspects of the current design may change. These changes, plus the overall scale of the project, could result in significant impacts to the overall cost of the project. The cost impacts could be positive or negative, as further analysis may show that current designs are over designed to meet all engineering standards, or perhaps the project is significantly under-designed thus requiring larger structures.

The CSRA assumes a 5% decrease in total construction costs and a 10 % increase in are possible.

6.2.2 Schedule Risks

(i) High Risks

- PR-6: flooding / earthquake – There is a small chance that a major flood or earthquake could occur at some point during the construction time frame. If either of these occurred, then major delays could be expected and even some re-work may be required if structures are damaged. Therefore the CSRA analysis assumed construction continuing for twelve more months if a major flood or earthquake is experienced.
- PR-7: political factors change at local, state or federal level – This risk is an external risk that falls outside of the PDT's sphere of influence. There is a concern that due to the large costs and all the government agencies that are involved, that agreement on the design and implementation may be difficult to achieve. There are already discussions surrounding the various alternatives and which should be the selected plan. Also, political opposition to the current plan may arise due to the overall total cost of the project. Disagreement between all the governmental entities could delay the project from being completed. For this risk it was assumed that the project would be pushed back twelve months.
- CA-4: acquisition plan to accommodate funding stream – The funding stream is anticipated to be the major driver of the number and size of the contracts issued. If the funding stream is changed or inadequate, then the current assumption of four contracts would require changing. The PDT thinks there is a risk of this occurring and that it would primarily impact the schedule. Therefore the CSRA analysis assumes that the schedule would not decrease, but funding stream delays may increase by up to twelve months.

6.3 Cost Risk Analysis – Cost Contingency Results

The project cost contingencies calculated for each confidence level are provided in Table 3. The estimated project cost contingency for the P80 confidence level was quantified as approximately $38.0 million, which equates to approximately 29.3 percent of the total project cost. This contingency value was calculated solely from the costs of the project and is not for use as the overall project contingency.

Table 3 – Project Cost Contingency Summary

Confidence Level	Baseline Total Project Cost	Contingency	Total Project Cost with Contingency	Contingency
0%	$129,610,919	($2,967,405)	$126,643,515	-2.29%
5%	$129,610,919	$14,746,725	$144,357,645	11.38%
10%	$129,610,919	$17,882,817	$147,493,737	13.80%
15%	$129,610,919	$20,016,062	$149,626,982	15.44%
20%	$129,610,919	$21,804,988	$151,415,908	16.82%
25%	$129,610,919	$23,386,907	$152,997,827	18.04%
30%	$129,610,919	$24,833,895	$154,444,815	19.16%
35%	$129,610,919	$26,155,502	$155,766,422	20.18%
40%	$129,610,919	$27,312,425	$156,923,345	21.07%
45%	$129,610,919	$28,478,878	$158,089,797	21.97%
50%	$129,610,919	$29,690,887	$159,301,807	22.91%
55%	$129,610,919	$30,880,438	$160,491,358	23.83%
60%	$129,610,919	$32,168,393	$161,779,312	24.82%
65%	$129,610,919	$33,515,968	$163,126,887	25.86%
70%	$129,610,919	$34,868,416	$164,479,336	26.90%
75%	$129,610,919	$36,318,659	$165,929,578	28.02%
80%	$129,610,919	$37,970,169	$167,581,088	29.30%
85%	$129,610,919	$39,849,645	$169,460,565	30.75%
90%	$129,610,919	$42,211,239	$171,822,158	32.57%
95%	$129,610,919	$45,849,967	$175,460,887	35.38%
100%	$129,610,919	$66,975,278	$196,586,197	51.67%

A sensitivity analysis generally ranks the relative impact of each risk/opportunity as a percentage of total cost uncertainty. From this analysis, the key cost drivers can be identified and used to support the development of a risk management plan that will facilitate control of risk factors and their potential impacts throughout the project life cycle.

The cost sensitivity analysis for this project shows the rank of the risks from the highest impact on the cost contingency to the lowest (Figure 1). Approximately 59.5 percent of the resulting cost contingency comes from four of the analyzed risk items: PR-7 (political factors change at local, state or federal level), TL-1 (low design level), TL-2 (investigations remain to be completed) and PR-4 (market conditions and bidding competition).

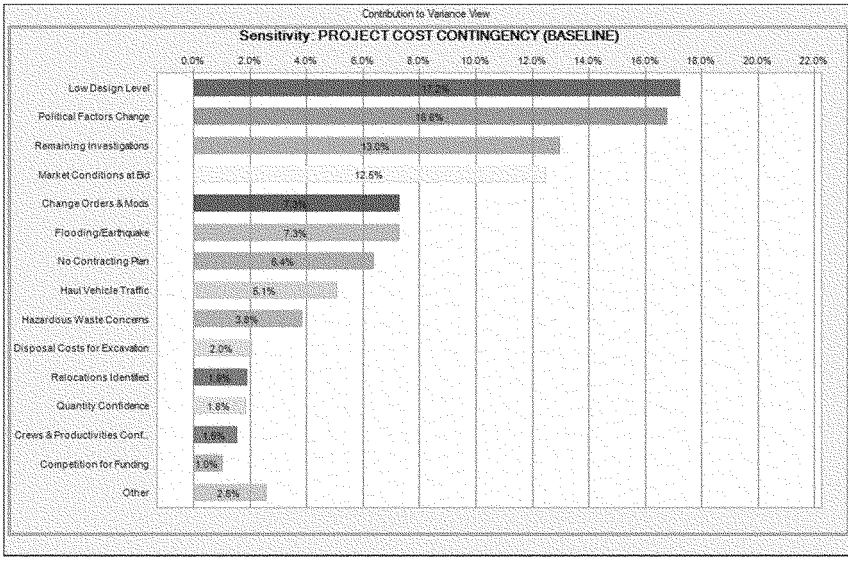


Figure 1 – Sensitivity Analysis (Cost)

6.4 Schedule Duration Risk Analysis – Schedule Contingency Results

The schedule duration contingencies calculated for each confidence level are provided in Table 4. The estimated schedule duration contingency for the P80 confidence level was quantified as approximately 44.4 months, which equates to approximately 34.4 percent of the total project schedule duration. This contingency duration was calculated solely from the schedule of the project and is not for use as the overall project contingency.

Table 4 – Project Schedule Duration Contingency Summary

Confidence Level	Baseline Schedule Duration	Contingency (Duration)	Baseline Schedule Duration with Contingency	Contingency
0%	129.0 Months	16.6 Months	145.6 Months	12.88%
5%	129.0 Months	27.2 Months	156.2 Months	21.12%
10%	129.0 Months	29.6 Months	158.6 Months	22.93%
15%	129.0 Months	31.1 Months	160.1 Months	24.13%
20%	129.0 Months	32.5 Months	161.5 Months	25.16%
25%	129.0 Months	33.6 Months	162.6 Months	26.04%
30%	129.0 Months	34.6 Months	163.6 Months	26.84%
35%	129.0 Months	35.7 Months	164.7 Months	27.66%
40%	129.0 Months	36.6 Months	165.6 Months	28.34%
45%	129.0 Months	37.5 Months	166.5 Months	29.05%
50%	129.0 Months	38.4 Months	167.4 Months	29.77%
55%	129.0 Months	39.3 Months	168.3 Months	30.43%
60%	129.0 Months	40.2 Months	169.2 Months	31.15%
65%	129.0 Months	41.1 Months	170.1 Months	31.90%
70%	129.0 Months	42.2 Months	171.2 Months	32.70%
75%	129.0 Months	43.3 Months	172.3 Months	33.59%
80%	129.0 Months	44.4 Months	173.4 Months	34.43%
85%	129.0 Months	45.8 Months	174.8 Months	35.51%
90%	129.0 Months	47.6 Months	176.6 Months	36.92%
95%	129.0 Months	50.2 Months	179.2 Months	38.88%
100%	129.0 Months	67.2 Months	196.2 Months	52.06%

The schedule duration sensitivity analysis for this project shows the rank of the risks from the highest impact on the schedule duration contingency to the lowest (Figure 2). Approximately 48.2 percent of the resulting schedule duration contingency comes from three of the analyzed risk items: CA-4 (acquisition plan to accommodate funding stream), PR-6 (flooding/earthquake), and PR-7 (political factors change at local, state or federal level).

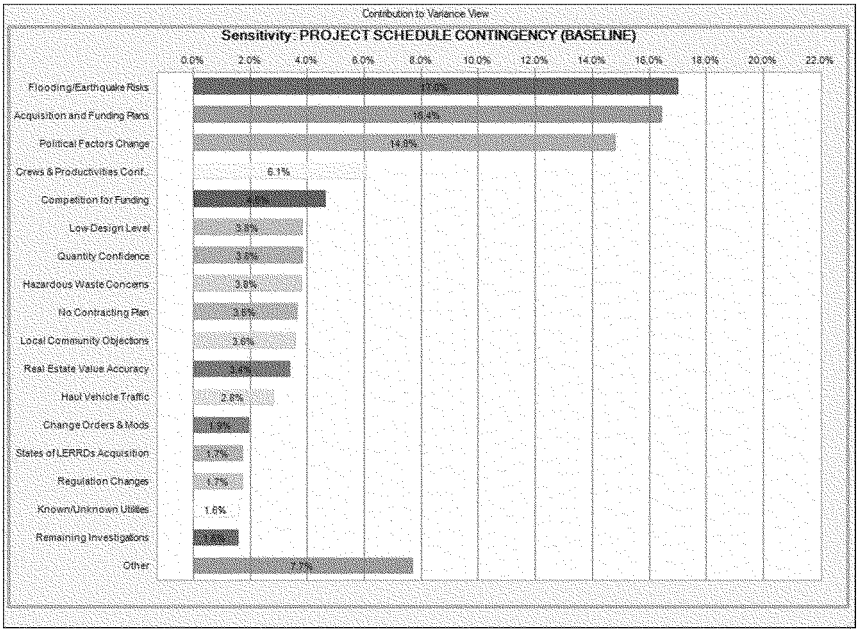


Figure 2 – Sensitivity Analysis (Schedule)

6.5 Schedule Contingency Value Results

The schedule contingency is presented as a monetary value such that it can be combined with the cost contingency to generate the total project contingency (Table 5). The schedule contingency is calculated from the estimated "hotel" costs, which are fixed costs that are inherently incurred as a result of schedule delays. These fixed costs may include rents, project management, supervision and administration, and elements of home office or field office overhead. In practice, sufficiently detailed cost estimates and resource-loaded schedules are often not available to support detailed hotel cost estimates for risk analysis, and only rough order of magnitude estimates can be developed.

For this analysis the combined job office overhead costs from both prime contractors was used to develop an assumed hotel rate of 8.46 percent. This percentage is applied to the overall project cost along with the current escalation rate from the Office of Management and Budget and local project escalation obtained from the USACE escalation factors. These rates generated an approximate schedule contingency of $5.8 million for the P80 confidence level.

Table 5 – Schedule Contingency Value Summary

Confidence Level	Date	Escalation Delta Amount	Hotel Amount	Total Schedule Contingency
0%	12-Mar-28	$1,730,222	$1,399,766	$3,129,988
5%	29-Jan-29	$1,856,548	$2,302,344	$4,158,892
10%	11-Apr-29	$1,884,326	$2,500,814	$4,385,140
15%	28-May-29	$1,902,697	$2,632,072	$4,534,769
20%	7-Jul-29	$1,918,545	$2,745,305	$4,663,850
25%	11-Aug-29	$1,932,035	$2,841,690	$4,773,725
30%	11-Sep-29	$1,944,242	$2,928,909	$4,873,151
35%	13-Oct-29	$1,956,778	$3,018,471	$4,975,248
40%	9-Nov-29	$1,967,232	$3,093,167	$5,060,399
45%	7-Dec-29	$1,978,130	$3,171,030	$5,149,160
50%	4-Jan-30	$1,989,133	$3,249,643	$5,238,775
55%	30-Jan-30	$1,999,282	$3,322,157	$5,321,439
60%	27-Feb-30	$2,010,284	$3,400,764	$5,411,047
65%	28-Mar-30	$2,021,758	$3,482,742	$5,504,500
70%	29-Apr-30	$2,034,106	$3,570,967	$5,605,073
75%	3-Jun-30	$2,047,614	$3,667,485	$5,715,099
80%	6-Jul-30	$2,060,592	$3,760,209	$5,820,801
85%	17-Aug-30	$2,077,130	$3,878,367	$5,955,497
90%	12-Oct-30	$2,098,739	$4,032,763	$6,131,502
95%	28-Dec-30	$2,128,852	$4,247,917	$6,376,769
100%	28-May-32	$2,330,818	$5,690,930	$8,021,748

6.6 Combined Cost and Schedule Contingency Results

The combined cost and schedule contingency results show a 33.79 percent contingency (or $43,790,969) at the P80 confidence level (Table 6). This table combines the cost and schedule contingencies in summation to generate the contingency amount to be used in developing the fully funded project amount.

Table 6 – Combined Cost and Schedule Contingency Values

Confidence Level	Baseline Total Project Cost	Cost Contingency	Schedule Contingency	Total Project Cost with Contingency	Contingency
0%	$129,610,919	($2,967,405)	$3,129,988	$129,773,502	0.13%
5%	$129,610,919	$14,746,725	$4,158,892	$148,516,536	14.59%
10%	$129,610,919	$17,882,817	$4,385,140	$151,878,876	17.18%
15%	$129,610,919	$20,016,062	$4,534,769	$154,161,751	18.94%
20%	$129,610,919	$21,804,988	$4,663,850	$156,079,758	20.42%
25%	$129,610,919	$23,386,907	$4,773,725	$157,771,552	21.73%
30%	$129,610,919	$24,833,895	$4,873,151	$159,317,966	22.92%
35%	$129,610,919	$26,155,502	$4,975,248	$160,741,670	24.02%
40%	$129,610,919	$27,312,425	$5,060,399	$161,983,744	24.98%
45%	$129,610,919	$28,478,878	$5,149,160	$163,238,957	25.95%
50%	$129,610,919	$29,690,887	$5,238,775	$164,540,582	26.95%
55%	$129,610,919	$30,880,438	$5,321,439	$165,812,797	27.93%
60%	$129,610,919	$32,168,393	$5,411,047	$167,190,359	28.99%
65%	$129,610,919	$33,515,968	$5,504,500	$168,631,387	30.11%
70%	$129,610,919	$34,868,416	$5,605,073	$170,084,409	31.23%
75%	$129,610,919	$36,318,659	$5,715,099	$171,644,677	32.43%
80%	$129,610,919	$37,970,169	$5,820,801	$173,401,889	33.79%
85%	$129,610,919	$39,849,645	$5,955,497	$175,416,061	35.34%
90%	$129,610,919	$42,211,239	$6,131,502	$177,953,660	37.30%
95%	$129,610,919	$45,849,967	$6,376,769	$181,837,655	40.30%
100%	$129,610,919	$66,975,278	$8,021,748	$204,607,945	57.86%

The overall cost with contingency for each of the confidence levels along with the overall confidence curve are shown in Figure 3.

Contingency Analysis

Most Likely Cost Estimate	$129,610,919	
Confidence Level	Value	Contingency
0%	$129,773,502	0.13%
5%	$148,516,536	14.59%
10%	$151,879,876	17.18%
15%	$154,161,751	18.94%
20%	$156,079,758	20.42%
25%	$157,771,552	21.73%
30%	$159,317,966	22.92%
35%	$160,741,670	24.02%
40%	$161,983,744	24.98%
45%	$163,238,957	25.95%
50%	$164,540,582	26.95%
55%	$165,812,797	27.93%
60%	$167,190,359	28.99%
65%	$168,631,387	30.11%
70%	$170,084,409	31.23%
75%	$171,644,677	32.43%
80%	$173,401,889	33.79%
85%	$175,416,061	35.34%
90%	$177,953,660	37.30%
95%	$181,837,655	40.30%
100%	$204,607,845	57.86%

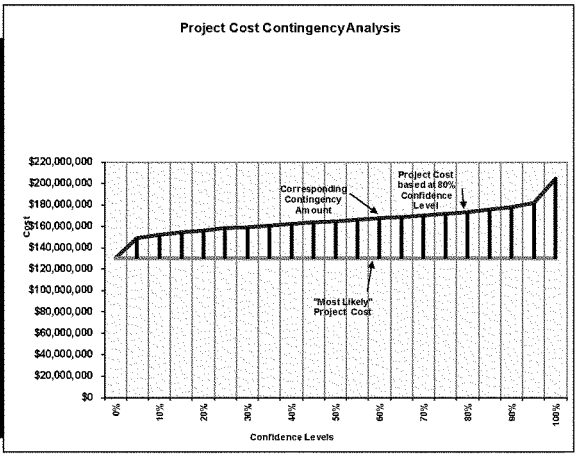


Figure 3 – Combined Cost and Schedule Contingency Value Curve

7. MAJOR FINDINGS/OBSERVATIONS

This section summarizes the significant results of the risk analysis:

1) Based on the results of this analysis a recommended contingency value of $43.8 million dollars or 33.79 percent of the total costs is to be used to generate the fully funded project cost. Of this $43.8 million, approximately $38.0 million (86.8 percent) was derived from the construction cost risks, and $5.8 million (13.2 percent) was derived from the schedule risks.

2) The schedule duration contingency is estimated to be 44.4 months, which equates to an approximate contingency of 34.4 percent of the total project duration.

3) The key cost risk drivers identified through the sensitivity analysis are:

   - PR-7: political factors change at local, state or federal level
   - TL-1: low design level
   - PR-4: market conditions and bidding competition
   - TL-2: investigations remain to be completed

4) The key schedule duration risk drivers identified through the sensitivity analysis are:

   - PR-6: flooding / earthquake
   - PR-7: political factors change at local, state or federal level
   - CA-4: acquisition plan to accommodate funding stream

5) PR-4, PR-6 and PR-7 are external risks, meaning that the PDT has no control over them. If the opinions of the political organizations change or if a major flood or earthquake occurs, then major delays and increased costs are to be incurred.

8. MITIGATION RECOMMENDATIONS

Risk management is an all-encompassing, iterative, life cycle process of project management. According to *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*, "project risk management includes the processes concerned with conducting risk management planning, identification, analysis, responses, and monitoring and control on a project" (PMI 2008). Risk identification and risk analysis are processes within the knowledge area of risk management. Their output pertinent to this effort includes the risk register, risk quantification (risk analysis model), the contingency report, and the sensitivity analysis.

The results of the CSRA sensitivity analysis indicate that the following risk factors have the most significant impact on the project contingency and thus mitigation recommendations are discussed for these items:

- TL-1: low design level (cost)
- TL-2: investigations remain to be completed (cost)
- PR-4: market conditions and bidding competition (cost)
- PR-7: political factors change at local, state or federal level (cost and schedule)
- CA-4: contracting plan has not been developed (schedule)
- PR-6: flooding / earthquake (schedule)

8.2 Cost Mitigation Recommendations

One of the significant risks to the cost contingency is that **investigations remain to be completed**. The current cost estimate is based on the information at hand, and thus may be subject to significant changes due to the findings of the various outstanding studies. The impact of this risk may be lowered as the project progresses provided that these investigations are completed in a timely and accurate fashion. Incorporation of the findings into the design and thus into the estimate will ensure that this risk is reduced in future iterations of this document.

Another significant risk to the cost is the risk of **market conditions and bidding competition.** This risk is not something the PDT can help to mitigate significantly over the course of the project. The primary method to limiting this risk is as the project nears construction the estimate must be updated continually to best estimate the current market conditions. The current USACE policies regarding construction cost estimating will help to ensure this, and should help limit the risk. However, given the current estimated timeframe, market conditions are still going to be a significant risk moving forward.

The risk of **political factors changing at local, state or federal level** is significant to both the cost and schedule. This risk is beyond the control of the PDT because various political entities must be involved to complete this project, and all must be onboard with the design and costs of the project. Thus, it would be beneficial of management personnel to try and keep all government agencies involved with the planning of this project, and to monitor any significant changes in preferences that these agencies may have in terms of design and implementation of the project. Again, this risk will be tough to mitigate against as the project progresses, but ensuring any changes are dealt with early on will limit the unanticipated delays and cost

increases that would be most detrimental if they arise as the project nears the onset of construction.

8.3 Schedule Mitigation Recommendations

Political factors changing at local, state or federal level also has a significant impact on the schedule contingency. As noted in the cost section, this risk can be mitigated by management personnel consistently monitoring all policy stakeholder opinions and keeping an open dialogue with these agencies in order to try and keep design in line with what is asked for.

The contracting plan has not been developed and thus the current assumptions used to develop the cost estimate and tentative project schedule are subject to change. As the project progresses more analysis should be taken to look into the appropriate contracting plan and this should be incorporated into the estimate and schedule respectively. As the project nears completion this risk should theoretically decrease in impact as the updated contracting plan will have a better guarantee of being correct.

The risk of **flooding, or earthquake** occurring is significant risk to the project. This risk is entirely beyond the control of the PDT because these are naturally occurring events. Due to the overall length of the construction period, encountering one of these events during construction is fairly likely. If a major event of either of these does occur, then significant delays could be incurred due to major repairs and re-construction of failed structures. The avoidance of flooding may be mitigated against by not constructing during flood seasons, but mitigating against a major earthquake is more difficult. Ensuring design of the elements that may be affected by these types of events takes these risks into account may also limit the overall risk to the project.

9. REFERENCES

PMI (Project Management Institute). 2008. *A Guide to the Project Management Body of Knowledge (PMBOK® Guide). 4th edition.*

USACE (U.S. Army Corps of Engineers) 1999. *Engineering and Design for Civil Works Projects.* Engineer Regulation 1110-2-1150. Department of the Army, Washington, D.C. August 31.

USACE. 2007a. Memorandum from Major General Don T. Riley, U.S. Army Director of Civil Works, July 3.

USACE. 2007b. *Application of Cost Risk Analysis Methods to Develop Contingencies for Civil Works Total Project Costs.* Engineering and Construction Bulletin 2007-17. September 10.

USACE. 2008a. *Civil Works Cost Engineering.* Engineer Regulation 1110-2-1302. Department of the Army, Washington, D.C. September 15.

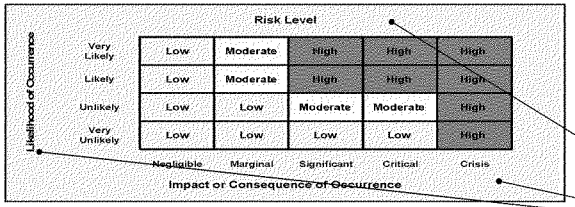
USACE. 2008b. *Construction Cost Estimating Guide for Civil Works.* Engineer Technical Letter 1110-2-573. Department of the Army, Washington, D.C. September 30.

USACE. 2009. *Cost and Schedule Risk Analysis Guidance.* Directory of Expertise for Civil Works, Cost Engineering, USACE, Department of the Army, Walla Walla, WA. May 17.

ATTACHMENT A

Project Delivery Team Risk Register

Los Angeles River Ecosystem Restoration Project - PDT Risk Register



Overall Project Scope
The Los Angeles River Ecosystem Restoration Feasibility Study is evaluating ecosystem restoration opportunities along an 11.5-mile long stretch of the Los Angeles River. This project is based on preliminary, planning-level conceptual designs, and common engineering practices. The project is split into eight (8) sub-reaches and the design features for each of these sub-reaches includes: demolition of existing concrete structures; riprap and grouted riprap placement; earthwork; turf reinforcement mats; chain link fences; clearing and grubbing; cast-in-place concrete walls, planters, slabs, and piers; detention basins; sub-drainage systems; and recreation features.

Cost Impacts
For the LA River Project, any cost impact of $1.0 Million or higher should be considered at least "Significant."
Anything over $0.5 Million should be considered at least "Marginal."

Schedule Impacts
For the LA River Project, any schedule impact of 12 months or greater should be considered at least "Significant."
Anything over 6 months shonld be considered at least "Marginal."

				Project Cost				Project Schedule							
Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)	Variance Distribution	Correlation to Other(s)	Responsibility/POC	Affected Project Component
Contract Risks (Internal Risk items are those that are generated, caused, or controlled within the PDT's sphere of influence.)															
	PROJECT & PROGRAM MGMT														
PPM-1	Interactions between all agencies involved in project	Many different agencies will be involved in order to complete this project. Managing and assuring that all agencies complete requeste needs may prove difficult.	PDT agrees that this risk is already occuring on the project and that significant cost and schedule impacts could occur in the future	Very Likely	Marginal	MODERATE		Very Likely	Marginal	MODERATE					
PPM-2	Dealings with multiple stakeholders	The various stakeholders in the project may cause difficulties in funding, changes to design, etc.	There are so many stakeholders on the project that this risk is likely to occur; issues are already arising from stakeholders. PDT agrees marginal impact is appropriate	Very Likely	Marginal	MODERATE		Very Likely	Marginal	MODERATE					
PPM-3	Project competing with other projects, funding and resources	Other projects may threaten funding streams and/or delay receival of funds needed to meet design/construction milestones.	This is a typically risk at this stage as other projects may take away funding and resources leading up to the construction. Also construction funds might not be available if other large projects are approved prior to this one. PDT feels this is high risk to project schedule primarily	Very Likely	Marginal	MODERATE		Very Likely	Marginal	MODERATE					
PPM-4	Losing critical staff at crucial points of project	Loss of crucial staff prior to or during critical milestones could delay project	Impact: overall life of project would cause marginal impacts; project staff would probably be lost but project would move forward.	Likely	Marginal	MODERATE		Likely	Marginal	MODERATE					
PPM-5	Product development by several sources	This project requires members from various entities both governmental and private to complete.	This project does involve many entities, but USACE is used to and able to manage and complete projects with various entities completing work	Likely	Negligible	LOW		Likely	Negligible	LOW					
PPM-6	Priorities change on existing program	If USACE priorities on ecosystem restoration change, then this project could be impacted.	This project is a major priority to the City and not likely to change; USACE priority on ecosystem restoration may change, but this project is already a priority; Assumes unlikely to impact costs, but schedule could marginally change;	Unlikely	Negligible	LOW		Likely	Marginal	MODERATE					
	CONTRACT ACQUISITION RISKS														
CA-1	Contracting plan has not been developed	Contracting plan has not been fully developed at this stage. Changes to current assumptions could occur.	Current assumption of 4 separate contracts is very likely to change but is a conservative assumption; methods will be looked at to minimize costs of multiple contracts; certain sections (Piggyback Yard/Taylor Yard) may be broken out in separate contracts; PDT agrees for both cost and schedule this would likely occur but impacts would be marginal	Likely	Marginal	MODERATE		Likely	Significant	HIGH					
CA-2	Possibility for 8(a) or small business contractor(s)	Some portions of the project may be bid to 8(a) contractors, which could increase costs for construction.	There may be some small business contractors for some of the smaller portions of the project. But PDT feels low risk that these contractors would impact cost/schedule significantly as work would be low risk.	Likely	Negligible	LOW		Likely	Negligible	LOW					
CA-3	Number of separate contracts and prime contractors	Current estimate assumes 4 separate contracts with each one having a separate prime contractor. Further analyses into contracting plan may change this.	Estimate currently matches current contracting plan. Plan seems more than reasonable and not anticipated to change significantly. PDT thinks this would be low risk for both cost and schedule as an intermittent funding stream is a "less risky" assumption, and is not anticipated to have significant impacts to cost or schedule.	Likely	Negligible	LOW		Likely	Negligible	LOW					
CA-4	Acquisition plan to accommodate funding stream	The funding stream will be a major driver of the contracts. If funding stream changes or is inadequate current assumptions will change.	Project could have agreement in place to have funding available; PDT agrees this would be likely to occur but that the impacts would be marginal to the costs, but significant to the schdeule as project would be delayed.	Likely	Marginal	MODERATE		Likely	Significant	HIGH					

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Project Cost				Project Schedule				Variance Distribution	Correlation to Other(s)	Responsibility/POC	Affected Project Component
				Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)				
	TECHNICAL RISKS														
TL-1	Low design level	Project is at a low design level. All quantities and assumptions are subject to changes as project progresses.	PDT agrees that changes are very likely to occur; There are items missing from the current design and estimate; This item impacts the costs greater than the schedule;	Very Likely	Critical	HIGH		Very Likely	Marginal	MODERATE					
TL-2	Investigations remain to be completed (H&H, Geotech, HTRW, etc.)	Many investigations still remain to be completed. Once finalized, these reports may cause design changes.	These studies need to be completed, and PDT agrees that risk is very likely and significant; Further analysis not currently anticipated may cause significant increases in PED;	Very Likely	Significant	HIGH		Very Likely	Marginal	MODERATE					
TL-3	Hazardous waste concerns	Encountering unanticipated HTRWs can cause significant increase in earthwork costs.	It is known that hazardous wastes are to be encountered, thus it is a very likely risk; HTRWs is not considered a project cost but will need to be accounted for in the schedule; City is to take care of known HTRWs, and unknown HTRWs will need to be removed during construction, but will not be project cost to USACE;	Very Likely	Significant	HIGH		Very Likely	Marginal	MODERATE					
TL-4	Disposal locations and costs for excavated materials	Preliminary landfills have been assumed to be capable of accepting excavated materials. Further analysis could lead to cost savings (if cheaper/no cost site is found) or increased costs based on tipping fees.	PDT agrees there is a high chance of a change in disposal costs; Current estimate assumes materials would be hauled off-site and include tipping fees; There are benefits due to HTRW removal will lower earthwork quantities at some sites (need to estimate quantity of HTRW);	Likely	Marginal	MODERATE		Likely	Negligible	LOW					
TL-5	All Disciplines	Many investigations remain to be completed, which once finished, could change current design	Investigations have yet to be completed to verify current design; Once all investigations are completed changes to design are likely to occur; If changes to certain design items occurred impacts to costs would be significant; Schedule is not anticipated to be impacted as plenty of design time is currently in schedule.	Very Likely	Significant	HIGH		Likely	Negligible	LOW					
TL-6	Locations and costs for borrow materials	Changes in material prices and locations from borrow sites may change.	PDT agrees there is a good chance of assumed borrow sites are not going to be same at time of construction; Changes in location or cost of borrow material would be significant to costs.	Unlikely	Significant	MODERATE		Unlikely	Negligible	LOW					
	LANDS AND DAMAGES RISKS														
LD-1	Status of real estate / easement acquisition	Real estate and easements need to be purchased in a timely fashion such that the construction phases can begin as scheduled.	Current plan only requires two areas two be purchased; Schedule is estimated to limit the risk generated from this item; Therefore PDT concludes that this risk is likely to occur but negligible to costs as the cost is being paid regardless; for schedule assumes it is likely to occur and marginal	Likely	Negligible	LOW		Likely	Marginal	MODERATE					
LD-2	Railroad involvement	Project may require railroad involvement for culverts and right-of-way acquisition	Railroad involvement would be required in Piggyback Yard and Taylor Yard; PDT agrees that this is more impactful to schedule than cost; PDT thinks cost risks are low, but for schedule it is likely and significant; any track closures have been estimated to cost $1,000,000/hr	Likely	Negligible	LOW		Likely	Marginal	MODERATE					
LD-3	Relocations identified	Detailed relocation design/report has not been fully developed at time of estimate.	Current relocation costs are based on building relocations, and it is assumed to be very likely that these would be encountered; Costs for relocating items would be significant, but would negligable to schedule;	Likely	Marginal	MODERATE		Likely	Negligible	LOW					
LD-4	Known and unknown utility impacts	Unknown utilities may be found during construction thus causing increased costs and delayed schedules.	Utilities have been constructed along the banks and right-of-way of the channel. Therefore these items are very likely to occur, but the quantity is unknown; PDT agrees both for schedule and costs are high risk;	Likely	Marginal	MODERATE		Likely	Marginal	MODERATE					
LD-5	Vagrancy, loitering issues	Dealing with vagrant population may cause some minor delays.	PDT agrees this is likely to occur but negligible to both costs and schedule;	Likely	Negligible	LOW		Likely	Negligible	LOW					
LD-6	Accuracy of current values of lands and easements	Real estate costs are more than 3 times more costly than the current construction costs. Thus changes in costs to real estate effect total cost significantly.	Detailed appraisals have been completed; PDT agrees costs are anticipated to change, and any increases would be critical; could be significant impact to schedule if land values increase; Changes to the boundaries could add cost and delay construction as well; PDT feels that contingency developed by RE should be more than sufficient, as the current boundaries are very well defined and not likely to change for the current plan.	Very Unlikely	Critical	LOW		Unlikely	Critical	MODERATE					
LD-7	Railroad trestle	Railroad involement, design of trestles, other easement acquisition, temporary operation facilities	If TSP changes to an alternative that requires the railroad trestles, then significant changes to costs and schedule could be incurred. A lot of coordination would be required between agencies and railroads, and additional costs may be needed than currently assumed. PDT thinks this is high risk for both cost and schedule.	Likely	Significant	HIGH		Likely	Significant	HIGH					
	REGULATORY AND ENVIRONMENTAL RISKS														

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Project Cost				Project Schedule				Variance Distribution	Correlation to Other(s)	Responsibility/POC	Affected Project Component
				Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)				
RE-1	Status of permits	Many permits will need to be obtained for construction. Prompt receival of permits will be needed to keep construction schedule on track.	Not anticipated to be a risk to costs, but is assumed to be a schedule risk; It is assumed to be likely to occur, but would be marginal impact to schedule;	Likely	Negligible	LOW		Likely	Marginal	MODERATE					
RE-2	Potential for critical regulation changes	Regulation changes within the Corps could impact this project	Regulations are anticipated to change; PDT agrees that the impact would be marginal;	Likely	Marginal	MODERATE		Likely	Marginal	MODERATE					
RE-3	Negative community impacts	Construction vehicities, noise, pollution, etc. are all to be encountered during construction.	These negative impacts are all likely to occur, but would be negligible to cost; There may be some specific BMP that was not assumed; However, very low risks to the both cost and schedule;	Likely	Negligible	LOW		Likely	Negligible	LOW					
RE-4	Endangered species present	Further research may find endangered species present which could delay project.	This is unlikely to occur throughout this reach; It is not anticipated to impact cost significantly, and project is generally designed to be constructed around at risk species;	Unlikely	Negligible	LOW		Unlikely	Negligible	LOW					
RE-5	Preliminary HTRW complete	HTRW report is not finalized currently	Correlated to TL-2	Likely	Significant	HIGH		Likely	Negligible	LOW					
RE-6	Agency actions/reviews are delayed or take longer than expected	Due to number of agencies involved, keeping all actions and reviews on time will be imperative to meeting the project milestones.	This is similar to RE-1; It is likely to occur but only marginal impact to schedule and negligible to costs.	Likely	Negligible	LOW		Likely	Marginal	MODERATE					
RE-7	Flood risk policy	Flood risk policies from FEMA, DWR, USACE, may change which would impact design	Flood risk policy is likely to change, and this could put some delays in this project. However, PDT does not think this would impact costs much as design is currently capable of handling some policy changes without need for too much new items.	Likely	Negligible	LOW		Likely	Marginal	MODERATE					
	CONSTRUCTION RISKS														
CON-1	Permits, licenses, submittal approvals	Delays in acquiring all permits, licenses, and receiving submittal approvals can delay the start of construction or alter sequencing.	There are many permits and licenses that contractors will have to obtain. This will probably be negligible to costs, and marginal to the schedule;	Likely	Negligible	LOW		Likely	Marginal	MODERATE					
CON-2	Permit and environmental work windows	Work windows based on environmental issues are accounted for, but could change.	PDT agrees that this is unlikely to occur for both costs and schedule; The schedule includes windows for working around nesting season and flood season; Assumes impacts would be marginal to both cost and schedule	Unlikely	Marginal	LOW		Unlikely	Marginal	LOW					
CON-3	Site access restrictions	Due to the length of the reaches, site accessibility may be a problem.	This is likley to occur as there are railroads, and bridges; Contractor should be able to work around these issues and plan accordingly. Some reaches may have more restrictions, and secondary access may be required; PDT agrees the costs impacts would be likely and marginal, and likely and negligible for the schedule	Likely	Marginal	MODERATE		Likely	Negligible	LOW					
CON-4	Adequate staging areas	No staging areas have been designed, and due to size of project significant staging would be required.	Staging areas would be designed as the project progresses. Current costs for staging may not be adequate once more detailed analysis is completed. PDT thinks this is likely to occur but only be marginal impact to costs and negligible to schedule.	Likely	Marginal	MODERATE		Likely	Negligible	LOW					
CON-5	Unknown utilities	Unknown utilities may be found during construction thus causing increased costs and delayed schedules.	Similar to LD-4 this would be a high risk to cost but a low risk to schedule.	Likely	Significant	HIGH		Likely	Negligible	LOW					
CON-6	Traffic issues for all haul vehicles	Traffic is going to be an issue for any haul trucks bringing or taking away materials to and from the project site.	There is no traffic control plan at this point; Construction is in an urbanized location, and traffic is likely to occur; If roads need to be repaired then there would be significant cost increases.	Likely	Marginal	MODERATE		Likely	Marginal	MODERATE					
CON-7	Diversion and control of water	Diversion and control of water is going to be significant effort, and is based on general assumptions at this time.	70% of the flow is from Tillman, and if flows are incresed for any reason, then assumptions for water control would change; PDT assumes that this would be likely and significant impact to costs;	Unlikely	Significant	MODERATE		Likely	Negligible	LOW					
CON-8	Change orders and modification growths	There may be modification issues that have not been captured in the estimate or schedule.	Redesign to sponsor changes, discovering unidentified utilities, etc.; A project of this scale is likely to incur some changes during construction; These changes are assumed to be significantly impacted to both cost and schedule;	Likely	Marginal	MODERATE		Likely	Marginal	MODERATE					
CON-9	Unidentified hazardous waste	Encountering unanticipated HTRWs during construction can cause significant increase in earthwork costs.	After the investigations are complete, construction activities still may encounter hazardous materials; PDT agrees that impact for both cost and schedule would be unlikely and significant;	Unlikely	Significant	MODERATE		Unlikely	Significant	MODERATE					

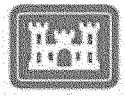
Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Project Cost				Project Schedule				Variance Distribution	Correlation to Other(s)	Responsibility/POC	Affected Project Component
				Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)				
CON-10	Adaptive management	Managing the project through unexpected changes	Not anticipated to be a significant risk to either cost or schedule, but is likely to have some issues brought up.	Likely	Marginal	MODERATE		Likely	Marginal	MODERATE					
	ESTIMATE AND SCHEDULE RISKS														
EST-1	Estimate confidence in large and critical quantities	Design is at low level, end quantities are based on one typical section for each reach.	As progress progresses it is very likely that quantities will change since design is currently at a very low level. This would impact both cost and construction schedule. This could also be a benefit to the project if quantities are currently over estimated compared to future designs.	Likely	Marginal	MODERATE		Likely	Significant	HIGH					
EST-2	Estimate reasonableness of crews and productivities	Production rates used in estimate may differ from those in the field.	Production rates for primary construction items have been estimated based on various sources as well as estimator experience and expected site conditions. However, actual rates may still vary based on contractors capabilities. The are likely to be different but would only marginally effect costs and construction schedule. Could be a benefit too.	Likely	Significant	HIGH		Likely	Significant	HIGH					
EST-3	Accuracy of construction schedule durations, sequencing, phasing, etc.	Contractor may have different sequencing to construction activities within the contracts which could decrease or increase duration.	Construction schedule may be different than currently assumed. The current assumptions are based on proposed contracting plan, which has been considered a low risk to change. Therfore this item is unlikely to be a high risk either.	Unlikely	Marginal	LOW		Unlikely	Marginal	LOW					
	Programmatic Risks (External Risk Items are those that are generated, caused, or controlled exclusively outside the PDT's sphere of influence.)														
PR-1	Adequacy of project funding	There is some concern in obtaining funds on a timely basis or in the necessary increments. Receiving less than required or in delayed increments is a concern.	This would be a significant risk to the schedule as the project would be delayed if funding is not available.	Unlikely	Marginal	LOW		Unlikely	Significant	MODERATE					
PR-2	Local communities have objections	Delays may occur due to local communities objecting to the work planning to be constructed.	There are already objections to the current plan; Most of these objecting views are asking for alternatives that are greater in scope than the proposed one. Therfore costs and schedules could be impacted significantly if this changes.	Unlikely	Significant	MODERATE		Unlikely	Significant	MODERATE					
PR-3	Stakeholders request late changes	Late changes by the various stakeholders can cause redesign, increased costs and delays.	Similar to PR-2, in that requests for changes to the plan are already being made, and more changes are expected to be requested in the future. These changes would most likely only raise costs, but not anticipated to impact schedule as stakeholders want this work done sooner as opposed to later.	Likely	Marginal	MODERATE		Likely	Negligible	LOW					
PR-4	Market conditions and bidding competition	Real estate market could be significant risk with variability in this market.	This could be an opportunity or negative risk based on the bidding climate; With real estate property and construction this could be a significant impact to costs: There may be others bidding on real estate; Not anticipated to impact the schedule significantly.	Likely	Significant	HIGH		Unlikely	Marginal	LOW					
PR-5	Unexpected escalation on key materials	There could be increases in the cost materials, primarily including the riprap and borrow materials.	Costs for materials could increase or decrease based on market conditions; It is anticipated that materials would more likely increase than decrease; Some materials may become more scarce; These are likely to impact both cost and schedule significantly.	Likely	Marginal	MODERATE		Likely	Marginal	MODERATE					
PR-6	Flooding/Earthquake	Small chance of major floods and earthquakes occuring, but these could delay project and cause major re-work.	PDT believes likelihood of having a major flood or earthquake during construction is high due to the overall length of construction. If one of these events occurred there would probably be significant delays and large cost impacts due to repairs and re-construction due to failed structures.	Likely	Marginal	MODERATE		Likely	Significant	HIGH					
PR-7	Political factors change at local, state or federal level	Concern due to large cost and all government agencies agreeing on design and implementation.	There is already some discussions between various agencies over the selected plan. Also due the projected costs to the project many political issues could arise that deter funding. Due to number of agencies involved this risk is believed to be likely to occur and could significantly affect both the cost and schedule.	Likely	Significant	HIGH		Likely	Significant	HIGH					

*Likelihood, Impact, and Risk Level to be verified through market research and analysis (conducted by cost engineer).

1. Risk/Opportunity identified with reference to the Risk Identification Checklist and through deliberation and study of the PDT.
2. Discussions and Concerns elaborates on Risk/Opportunity Events and includes any assumptions or findings (should contain information pertinent to eventual study and analysis of event's impact to project).
3. Likelihood is a measure of the probability of the event occurring -- **Very Unlikely**, **Unlikely**, **Moderately Likely**, **Likely**, **Very Likely.** The likelihood of the event will be the same for both Cost and Schedule, regardless of impact.
4. Impact is a measure of the event's effect on project objectives with relation to scope, cost, and/or schedule -- **Negligible**, **Marginal**, **Significant**, **Critical**, or **Crisis.** Impacts on Project Cost may vary in severity from impacts on Project Schedule.
5. Risk Level is the resultant of Likelihood and Impact **Low**, **Moderate**, or **High**. Refer to the matrix located at top of page.
6. Variance Distribution refers to the behavior of the individual risk item with respect to its potential effects on Project Cost and Schedule. For example, an item with clearly defined parameters and a solid most likely scenario would probably follow a triangular or normal distribution. A risk item for which the PDT has little data or probability of modeling with respect to effects on cost or schedule (i.e. "anyone's guess") would probably follow a uniform or discrete uniform distribution.
7. The responsibility or POC is the entity responsible as the Subject Matter Expert (SME) for action, monitoring, or information on the PDT for the identified risk or opportunity.
8. Correlation recognizes those risk events that may be related to one another. Care should be given to ensure the risks are handled correctly without a "double counting."
9. Affected Project Component identifies the specific item of the project to which the risk directly or strongly correlates.
10. Project Implications identifies whether or not the risk item affects project cost, project schedule, or both. The PDT is responsible for conducting studies for both Project Cost and for Project Schedule.
11. Results of the risk identification process are studied and further developed by the Cost Engineer, then analyzed through the Monte Carlo Analysis Method for Cost (Contingency) and Schedule (Escalation) Growth.

ATTACHMENT B

Market Research



US Army Corps
of Engineers®

Los Angeles District

Los Angeles River Ecosystem Restoration

Feasibility Study

DRAFT
Cost and Schedule Risk Analysis Report
Locally Preferred Plan
Alternative 20

March 2015

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Attachment A Project Delivery Team Risk Register
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EXECUTIVE SUMMARY

This report presents a recommendation for the total project cost and schedule contingency for the Los Angeles River Ecosystem Restoration Project's Locally Preferred Plan. A formal risk analysis study was conducted to develop a reliable and defensible contingency factor for the total project cost associated with the MCACES construction cost estimate. The cost and schedule risk analysis involved the development of project contingencies by identifying and evaluating the impacts of project uncertainties on the construction cost and schedule and a subsequent calculation of the estimated total project cost.

The Project Delivery Team (PDT) conducted one brainstorming session on November 5, 2013, to identify the risks associated with the project. Additional coordination of the PDT for review and input occurred thereafter. Key project and risk assumptions reflected in the analysis were identified. The risk analysis was performed using Oracle Crystal Ball software to estimate a contingency with the use of Monte Carlo simulations in correlation with the proposed risks and uncertainties.

The contingency is based on an 80 percent (P80) confidence level, per accepted U.S. Army Corps of Engineers Civil Works guidance. For the Los Angeles river Ecosystem Restoration project, the most likely baseline construction cost is estimated at approximately $464,924,107 (Table ES-1). The risk analysis resulted in a contingency value of $152,771,267 based on the cost risks and a contingency of $18,342,738 based on the schedule risks. This translates to a total project contingency value of $171,114,005 which equates to approximately 36.80 percent of construction costs.

CONTINGENCY SUMMARY

Contingency on Baseline Cost Estimate	80% Confidence Project Cost
Baseline Estimated Cost (Most Likely) ->	**$464,924,107**
Baseline Estimated Cost Contingency Amount ->	$152,771,267
Baseline Estimated Construction Cost (80% Confidence) ->	**$617,695,374**

Contingency on Schedule	80% Confidence Project Schedule
Project Schedule Duration (Most Likely) ->	192.0 Months
Schedule Contingency Duration ->	53.9 Months
Project Schedule Duration (80% Confidence) ->	245.9 Months
Project Schedule Contingency Amount (80% Confidence) ->	$18,342,738

Project Contingency	80% Confidence Project Cost
Project Contingency Amount (80% Confidence) ->	$171,114,005
Project Contingency Percentage (80% Confidence) ->	36.80%

Project Cost (80% Confidence) ->	**$636,038,112**

Please note that cost estimates fluctuate over time. During this period of study, minor cost fluctuations can and have occurred. For this reason, costs may vary a slight degree between this document and the primary cost estimating components of the MCACES construction cost estimate and the Total Project Cost Summary (TPCS). Therefore, values in this document may not exactly match those from the TPCS and MCACES, but should be very similar in scale.

KEY FINDINGS/OBSERVATIONS RECOMMENDATIONS

An analysis of the relative impact of the key cost drivers on the cost and schedule contingency indicates that following risks result in the most impact on the overall project contingency:

- Cost Risks:
  - PR-7: political factors change at local, state or federal level – Due to the projected costs of this project, and the number of different agencies involved, funding difficulties may arise which could impact the costs of construction.
  - TL-1: low design level – This project is currently at a preliminary design level. All quantities and costs are based on typical cross sections, but as the project progresses more design detail will be completed. Thus this risk should be mitigated during future design phases.
  - PR-4: market conditions and bidding competition – This risk falls outside the PDT's sphere of influence. It is difficult to project these conditions several years out, but given that this project is also anticipated to take over 10-years to construct, it is even more difficult to predict adequate conditions that far out. Thus costs for this must be accounted for at this time.
  - TL-2: investigations remain to be completed – As noted in risk item TL-1, this project is still at a low design level. As the project moves forward all outstanding investigations will be completed, and the impact of this risk will be lowered.
- Schedule Risks:
  - PR-6: flooding / earthquake – Los Angeles is renowned for earthquakes and is susceptible to flash floods. These risks are unavoidable, but would pose significant delays to construction if they occur, which is likely due to the proposed construction duration.
  - PR-7: political factors change at local, state or federal level – As noted under the costs risks above, the different entities involved in this project may not always see eye to eye. Construction could be delayed if all agencies are not on board with the selected plan.
  - CA-4: acquisition plan to accommodate funding stream – The current estimate assumes intermittent funding, but the assumption of four contracts may not be sufficient. The funding stream could change the number of contracts, which may push the construction schedule out.

The key recommendations from this study are the implementation of cost and schedule contingencies, further iterative study of risks throughout the project life cycle, potential mitigation throughout the planning, engineering and design phase, and proactive monitoring and control of the internal risks identified in this study.

1. PURPOSE

A cost and schedule risk analysis (CSRA) was conducted to develop a reliable and defensible contingency factor for the construction cost estimate developed for the Los Angeles River Ecosystem Restoration Feasibility Study Cost Appendix with the use of the Micro-Computer Aided Estimating System (MII). The appendix describes the design and cost assumptions that go into developing the MII estimate. The contingency factor was calculated at the 80 percent confidence level as recommended by U.S. Army Corps of Engineers (USACE) guidance (2009). The contingency was calculated in terms of dollars for the cost analysis and in terms of months for the schedule analysis.

The Project Delivery Team (PDT) studied a variety of risks that could affect the construction cost and/or schedule. The events were grouped into the following categories:

- Project and program management
- Contract acquisition
- Technical
- Lands and damages
- Construction
- Estimate and schedule
- Programmatic (external)

All of the risk categories except "programmatic" include risks that could be generated, caused, or controlled by the PDT. Programmatic, or external, risks are those outside the sphere of influence of the PDT.

2. BACKGROUND

The primary purpose of this project is to restore approximately 11 miles of the Los Angeles River. This stretch of channel starts at Griffith Park and extends to the Downtown Los Angeles area. The project is designed to reestablish riparian strands, freshwater marshes and aquatic habitat communities as well as reconnect the river to major tributaries, historic floodplains and regional habitat zones. This project is also designed to provide recreational opportunities that are consistent with the restored ecosystem.

The Los Angeles River has been degraded over time by a cycle of increasing urban development, flooding, and channelization. This cycle led to the Los Angeles County Drainage Area (LACDA) project that was completed in the mid-20th century. The LACDA was a Federal flood control project that straightened the channel and encased much of it with concrete banks and concrete beds. This greatly diminished the plant and wildlife diversity and quality and disconnected the channel from its floodplains and significant ecological zones.

Other sections of the Los Angeles River that are outside of this project's reach are more urbanized and were not considered for potential habitat connectivity and expansion projects. Thus this 11 mile stretch, known as the "Area with Restoration Benefits and Opportunities for Revitalization (ARBOR)" reach, has the most potential for restoration benefits.

This project initially looked at various alternatives that comprised numerous restoration sub-measures. Initial construction cost estimates were developed and a final array of four alternatives was selected for further analysis. From these four alternatives, the locally preferred plan (LPP) was chosen. The LPP turned out to be Alternative 20, entitled ARBOR Riparian Integration via Varied Ecological Reintroduction (RIVER). This alternative was estimated using MII software and is the basis for the risk analysis within this report.

The following design documents were available for use in this CSRA:

- Los Angeles River Ecosystem Restoration – Feasibility Study, Draft Integrated Report September 2013
- Los Angeles River Ecosystem Restoration – Feasibility Study, Conceptual Design Drawings, April 2013
- Los Angeles River Ecosystem Restoration – Feasibility Study, Design Appendix, August 2014
- Los Angeles River Ecosystem Restoration – Feasibility Study, Cost Appendix, August 2014

3. REPORT SCOPE

The scope of this CSRA report is the calculation and presentation of cost and schedule contingencies at the 80 percent confidence level using the risk analysis processes mandated by USACE Engineer Regulation (ER) 1110-2-1150, ER 1110-2-1302, and Engineer Technical Letter 1110-2-573 (USACE 1999, 2008a, 2008b). The report presents the contingency results for cost risks for all project features. The study excluded a consideration of operation and maintenance and life cycle costs.

3.1 Project Scope

3.1.1 Mandates and Appropriations

- The study was authorized by Senate Committee on Public Works Resolution, approved June 25, 1969.
- Section 4018 of the Water Resources Development Act of 2007 provided authorization for a "feasibility study for environmental ecosystem restoration, flood risk management, recreation and other aspects of Los Angeles River revitalization that is consistent with the goals of the Los Angeles River Revitalization Master Plan published by the city of Los Angeles..."

3.1.2 Product Development

The project technical scope, estimate, and schedule developed by Tetra Tech, Inc. served as the basis for the risk analysis for the construction cost estimate. The construction cost estimate scope consists of the following:

- Civil Works Work Breakdown Structure feature account: 02, Relocations, 06, Fish and Wildlife Facilities and 14, Recreation (USACE 2008b)

- Design level: includes conceptual design cross sections for the Los Angeles River Ecosystem Restoration Feasibility Study

3.2 USACE Risk Analysis Process

The risk analysis process used in this study follows the USACE Headquarters requirements as well as guidance from the Cost Engineering Directory of Expertise for Civil Works. It uses probabilistic CSRA methods within the framework of the Oracle Crystal Ball software. The results of a risk analysis are intended to serve several functions, one being the establishment of reasonable contingencies reflective of an 80 percent confidence level to successfully accomplish the project work within that established contingency amount. The scope of the report includes the identification of important steps, rationale, key assumptions, limitations, and decisions to help ensure that risk analysis results can be appropriately interpreted.

The risk analysis results discussed in this report are intended to provide project leadership with contingency information for scheduling, budgeting, and project control purposes, as well as tools to support decision making and risk management as the project progresses through planning and implementation. To fully recognize its benefits, a CSRA should be considered an ongoing process that is conducted concurrently and iteratively with other important project processes such as scope and execution plan development, resource planning, procurement planning, cost estimating, budgeting, and scheduling.

In addition to satisfying broadly defined risk analysis standards and recommended practices, this risk analysis was performed in accordance with the requirements and recommendations of the following documents and sources:

- Cost and Schedule Risk Analysis Guidance USACE (2009)
- Memorandum from Major General Don T. Riley, U.S. Army Director of Civil Works (USACE 2007a)
- Engineering and Construction Bulletin 2007-17 (USACE 2007b)
- Engineer Regulation 1110-2-1150 (USACE 1999)
- Engineer Regulation 1110-2-1302 (USACE 2008a)
- Engineer Technical Letter 1110-2-573 (USACE 2008b)

4. METHODOLOGY/PROCESS

The risk analysis team received cost support from the cost engineer as well as coordination support from project management and the assigned PDT. Several other disciplines, such as Construction, were invited, but not all disciplines attended the meeting. The members of the risk analysis team are indicated in Table 1.

Table 1 – PDT Member Positions and Organizations

Position	Name	Organization
Hydrology and Hydraulics	Kerry Casey	USACE, Los Angeles
Geotechnical	Chris Spitzer	USACE, Los Angeles
Plan Formulation Branch Chief	Ed Demesa	USACE, Los Angeles
Project Manager	Tawny Tran	USACE, Los Angeles
Cost Engineer	Arnecia Williams	USACE, Los Angeles
Biologist	Eric Jones	USACE, Los Angeles
Design	Frank Mallette	USACE, Los Angeles
Real Estate	Lisa Sandoval	USACE, Los Angeles
Economics	Mike Hallisy	USACE, Los Angeles
Project Manager	Scott Estergard	Tetra Tech
Cost Estimator	Scott Vose	Tetra Tech
Project Engineer	Ike Pace	Tetra Tech
Senior Water Resource Planner	Ira Artz	Tetra Tech
Local Sponsor Representative	Megan Whalen	City of Los Angeles
Local Sponsor Representative	Rene Curtis	City of Los Angeles
Local Sponsor Representative	Carol Armstrong	City of Los Angeles
Local Sponsor Representative	Michael Affeldt	City of Los Angeles

The risk analysis process for this study is intended to determine the probability of various cost outcomes and quantify the required contingency needed in the cost estimate to achieve the desired level of confidence related to project cost.

Contingency is defined as an amount added to an estimate to allow for items, conditions, or events for which the occurrence or impact is uncertain and that experience suggests will likely result in additional costs or additional time. The amount of contingency included in project control plans depends, at least in part, on the project leadership's willingness to accept the risk of project overruns. The less risk that project leadership is willing to accept, the more contingency should be applied in the project control plans. The risk of overrun is expressed, in a probabilistic context, using confidence levels.

The Cost Engineering District guidance for CSRA generally focuses on the 80 percent level of confidence (P80) for cost contingency calculation. The use of P80 as a decision criterion is a risk-averse approach (whereas the use of P50 is considered a risk-neutral approach, and the use of levels less than 50 percent is considered a risk-seeking approach). Thus, the use of a P80 confidence level results in a greater contingency relative to that resulting from a P50 confidence level. The selection of contingency at a particular confidence level is ultimately the decision and responsibility of the project's district and/or division management.

The risk analysis process uses Monte Carlo techniques to determine probabilities and contingency. The Monte Carlo techniques are facilitated computationally by a commercially available risk analysis software package (Oracle Crystal Ball), which is an add-in to Microsoft Excel. Cost estimates are packaged into an Excel format and used directly for cost risk analysis

purposes. The level of detail recreated in the Excel-format schedule is sufficient for risk analysis purposes that reflect the established risk register, but generally less than that of the native format.

In functional terms, the primary steps of the risk analysis process are described in the following subsections. The results of the risk analysis are provided in Section 6.

4.1 Identification and Assessment of Risk Factors

Identification of the risk factors by the PDT is considered a qualitative process that results in the establishment of a risk register, which is used to document the results of the quantitative study of risks. Risk factors are events and conditions that may influence or drive uncertainty associated with project performance. They may be inherent characteristics or conditions of the project or external influences, events, or conditions such as weather or economic conditions. Risk factors may have either favorable or unfavorable impacts on project cost and schedule.

Checklists or historical databases of common risk factors are sometimes used to facilitate the identification of risk factors. However, the key risk factors are often unique to a project and cannot be readily derived from historical information. Therefore, input is obtained from the entire PDT be means of creative processes such as brainstorming or other facilitated risk assessment meetings. In practice, a combination of professional judgment from the PDT and empirical data from similar projects is desirable.

Formal PDT meetings are held for the purposes of identifying and assessing risk factors. The meetings should include capable and qualified representatives from multiple project team disciplines and functions, for example:

- Project/program managers
- Contracting/acquisitions
- Real estate
- Relocations
- Environmental
- Civil and coastal design
- Cost and schedule engineers
- Construction
- Key sponsors

The initial formal meetings should focus primarily on risk factor identification using brainstorming techniques but also include some facilitated discussions based on risk factors common to projects of similar scope and geographic location. Subsequent meetings should focus primarily on risk factor assessment and quantification. Conference calls and informal meetings also occur throughout the risk analysis process on an as-needed basis to further facilitate risk factor identification, market analysis, and risk assessment. The risk register document developed for this project can be seen in Attachment A.

4.2 Quantification of Risk Factor Impacts

The quantitative impacts of risk factors on project plans are analyzed using a combination of professional judgment, empirical data, and analytical techniques. Risk factor impacts are quantified using probability distributions (density functions) because risk factors are entered into the Crystal Ball software in the form of probability density functions.

Similar to the identification and assessment process, risk factor quantification involves multiple project team disciplines and functions. However, the quantification process relies more extensively on collaboration between cost engineering and risk analysis team members with lesser input from the other functions and disciplines. The quantification process uses an iterative approach to estimate the following elements of each risk factor:

- Maximum possible value for the risk factor
- Minimum possible value for the risk factor
- Most likely value (the statistical mode), if applicable
- Nature of the probability density function used to approximate risk factor uncertainty
- Mathematical correlations between risk factors
- Affected cost estimate and schedule elements

The resulting product from the PDT discussions is captured within a risk register for both cost and schedule risk concerns. The risk register documents the PDT's risk concerns, discussions related to those concerns, and potential impacts on the current cost and schedule estimates. The concerns and discussions are meant to support the team's decisions related to event likelihood, impact, and the resulting risk levels for each risk event.

4.3 Analysis of Cost Estimate and Schedule Contingency

Contingency is analyzed using the Crystal Ball software, an add-in to the Microsoft Excel format of the cost estimate and schedule. Monte Carlo simulations are performed by applying the risk factors (quantified as probability density functions) to the appropriate estimated cost and schedule elements identified by the PDT and the market research. Contingencies are calculated by applying only the moderate- and high-level risks identified for each option (i.e., low-level risks are typically not considered but remain within the risk register to serve historical purposes as well as support follow-on risk studies as the project and risks evolve).

For the cost estimate in this study, the contingency was calculated as the difference between the P80 cost forecast and the base cost estimate. Each option-specific contingency was then allocated on a civil works feature level based on the dollar-weighted relative risk of each feature as quantified by Monte Carlo simulation. Standard deviation was used as the feature-specific measure of risk for contingency allocation purposes. This approach resulted in a relatively larger portion of all the project feature cost contingency being allocated to features with relatively higher estimated cost uncertainty.

For the schedule in this study, contingency was calculated as the difference between the duration forecast at various confidence level intervals and the base schedule duration. The duration contingency was then used to estimate hotel costs and calculate the additional time value of

money impact due to project delays that are included in the total cost contingency presented in Section 6. The resulting time value of money, or added escalation risk, and hotel costs were added into the cost contingency amount to reflect the USACE standard for presenting the estimated cost for the fully funded project amount.

Schedule contingency was analyzed only on the basis of each option and not allocated to specific tasks. Based on the guidance, only critical path and near critical path tasks are considered uncertain for the purposes of contingency analysis (USACE 2009).

5. KEY ASSUMPTIONS

The CSRA for the Los Angeles River Ecosystem Restoration project was based on the following key assumptions:

- The project is currently in the conceptual design stage. Various alternatives were analyzed previously based on conceptual cross-sections for each reach. These same cross-sections and designs are utilized for development of the MCACES cost estimate.
- Many of the requisite studies (geotechnical, H&H, etc.) have not been completed. The design is subject to change once the information from these reports can be incorporated.
- Project study costs to date are not included in the risk study.
- Neither life cycle nor operation and maintenance costs are included in the risk study. This study is based solely on the initial construction of the project.
- Major features of this project include concrete demolition; excavation and fill; riprap; grouted riprap; turf reinforcement mats; fencing; clearing and grubbing; reinforced cast-in-place concrete; sub-drainage system; asphalt; multi-use trail; trail access points; pedestrian bridges and other recreation components.
- The feature cost accounts for this project include Lands and Damages; Relocations; Fish and Wildlife Facilities; Recreation; Planning, Engineering, and Design; and Construction Management.
    - Lands and Damages: The costs for this account have been estimated by the USACE. However, these costs have not been included in this CSRA analysis, because due to the overwhelming size of the costs for this account, the risk analysis would be completed swayed towards the risks associated with this account. Also, the real estate report develops their own contingencies to be utilized for this project, which have been deemed sufficient to account for any unforeseen changes that may occur to these costs.
    - Relocations: Costs for this account include utility relocations, estimated in MII, and business relocation costs that have been provided by the USACE. The utility relocations include electrical tower relocations and several pipe relocations. The utility relocations are included in this risk analysis.
    - Fish and Wildlife Facilities: Costs for this account include the majority of the construction costs for this project.

- Recreation: Costs for this account include the components that are not primarily aimed at ecosystem restoration. These include construction activities such as multi-use trails, trail access points, wildlife viewing areas, pedestrian bridges and other recreation trail components.
- Planning, Engineering, and Design: Costs for this account were estimated at 14 percent of the construction cost. This account covers the preparation of the plans, specifications, and estimate for construction, as well as adaptive management and monitoring post construction.
- Construction Management: Costs for this account were estimated at 6.5 percent of the construction cost. This account covers construction management during the construction contract.
- Monitoring and Adaptive Management: Costs for this item were added to the costs estimated for construction management. These costs were estimated as 3% of the Fish and Wildlife Facilities costs only.

- The cost estimate is based on local labor, material, and fuel costs. The construction schedule is based on production rates of the construction elements in the cost estimate.
- The recommended contingency is based on an 80 percent confidence level, per accepted USACE Civil Works guidance.
- Only the high and moderate risk levels as determined by the PDT in the risk register are included in the risk analysis. The low risk levels are excluded based on the assumption that they would have a negligible impact in determining the contingency.

6. RISK ANALYSIS RESULTS

The CSRA results are provided in the following subsections. In addition to the contingency calculations, the results of sensitivity analyses are presented to provide decision makers with an understanding of variability and the key contributors to the variability.

6.1 Risk Register

A risk register is a tool commonly used in project planning and risk analysis. The risk register developed for this project is provided in Attachment A; a condensed version of the risk register is provided in Table 2. The complete risk register includes low-level risks, as well as additional information regarding the nature and impacts of each risk.

A risk register can be an effective tool for managing identified risks throughout the project life cycle. As such, it is generally recommended that risk registers be updated as the designs, cost estimates, and schedule are further refined, especially on large projects with extended schedules. Recommended uses of the risk register going forward include the following:

- Documenting risk mitigation strategies being pursued in response to the identified risks and their assessment in terms of probability and impact
- Providing project sponsors, stakeholders, and leadership/management with a documented framework from which risk status can be reported in the context of project controls
- Communicating risk management issues

- Providing a mechanism for eliciting feedback and project control input
- Identifying risk transfer, elimination, or mitigation actions required for implementation of risk management plans

Table 2 – Condensed Risk Register

Risk No.	Risk/Opportunity Event	Concerns	Project Cost			Project Schedule		
			Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*
Contract Risks (Internal Risk Items are those that are generated, caused, or controlled within the PDT's sphere of influence.)								
	PROJECT & PROGRAM MGMT							
PPM-1	Interactions between all agencies involved in project	Many different agencies will be involved in order to complete this project. Managing and assuring that all agencies complete requisite needs may prove difficult.	Very Likely	Marginal	MODERATE	Very Likely	Marginal	MODERATE
PPM-2	Dealings with multiple stakeholders	The various stakeholders in the project may cause difficulties in funding, changes to design, etc.	Very Likely	Marginal	MODERATE	Very Likely	Marginal	MODERATE
PPM-3	Project competing with other projects, funding and resources	Other projects may threaten funding streams and/or delays receive of funds needed to meet design/construction milestones.	Very Likely	Marginal	MODERATE	Very Likely	Marginal	MODERATE
PPM-4	Losing critical staff at crucial points of project	Loss of crucial staff prior to or during critical milestones could delay project.	Likely	Marginal	MODERATE	Likely	Marginal	MODERATE
PPM-5	Product development by several sources	This project requires members from various entities both governmental and private to complete.	Likely	Negligible	LOW	Likely	Negligible	LOW
PPM-6	Priorities change on existing program	If USACE priorities on ecosystem restoration change, then this project could be impacted.	Unlikely	Negligible	LOW	Likely	Marginal	MODERATE
	CONTRACT ACQUISITION RISKS							
CA-1	Contracting plan has not been developed	Contracting plan has not been fully developed at this stage. Changes to current assumptions could occur.	Likely	Marginal	MODERATE	Likely	Significant	HIGH
CA-2	Possibility for 8(a) or small business contractor(s)	Some portions of the project may be bid to 8(a) contractors, which could increase costs for construction.	Likely	Negligible	LOW	Likely	Negligible	LOW
CA-3	Number of separate contracts and prime contractors	Current estimate assumes 4 separate contracts with each one having a separate prime contractor. Further analysis into contracting plan may change this.	Likely	Negligible	LOW	Likely	Negligible	LOW
CA-4	Acquisition plan to accommodate funding stream	The funding stream will be a major driver of the contracts. If funding stream changes or is inadequate current assumptions will change.	Likely	Marginal	MODERATE	Likely	Significant	HIGH
	TECHNICAL RISKS							

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Risk No.	Risk/Opportunity Event	Concerns	Project Cost			Project Schedule		
			Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*
TL-1	Low design level	Project is at a low design level. All quantities and assumptions are subject to changes as project progresses.	Very Likely	Critical	HIGH	Very Likely	Marginal	MODERATE
TL-2	Investigations remain to be completed (H&H, Geotech, HTRW, etc.)	Many investigations still remain to be completed. Once finalized, these reports may cause design changes.	Very Likely	Significant	HIGH	Very Likely	Marginal	MODERATE
TL-3	Hazardous waste concerns	Encountering unanticipated HTRWs can cause significant increase in earthwork costs.	Very Likely	Significant	HIGH	Very Likely	Marginal	MODERATE
TL-4	Disposal locations and costs for excavated materials	Preliminary landfills have been assumed to be capable of accepting excavated materials. Further analysis could lead to cost savings (if cheap/no cost site is found) or increased costs based on tipping fees.	Likely	Marginal	MODERATE	Likely	Negligible	LOW
TL-5	All Disciplines	Many investigations remain to be completed, which once finished, could change current design	Very Likely	Significant	HIGH	Likely	Negligible	LOW
TL-6	Locations and costs for borrow materials	Changes in material prices and locations from borrow sites may change.	Unlikely	Significant	MODERATE	Unlikely	Negligible	LOW
	LANDS AND DAMAGES RISKS							
LD-1	Status of real estate / easement acquisition	Real estate and easements need to be purchased in a timely fashion such that the construction phases can begin as scheduled.	Likely	Negligible	LOW	Likely	Marginal	MODERATE
LD-2	Railroad involvement	Project may require railroad involvement for culverts and right-of-way acquisition	Likely	Negligible	LOW	Likely	Marginal	MODERATE
LD-3	Relocations identified	Detailed relocation designs/report has not been fully developed at time of estimate.	Likely	Marginal	MODERATE	Likely	Negligible	LOW
LD-4	Known and unknown utility impacts	Unknown utilities may be found during construction thus causing increased costs and delayed schedules.	Likely	Marginal	MODERATE	Likely	Marginal	MODERATE
LD-5	Vagrancy, loitering issues	Dealing with vagrant population may cause some minor delays.	Likely	Negligible	LOW	Likely	Negligible	LOW
LD-6	Accuracy of current values of lands and easements	Real estate costs are more than 3 times more costly than the current construction costs. Thus changes in costs to real estate effect total cost significantly.	Very Unlikely	Critical	LOW	Unlikely	Critical	MODERATE
LD-7	Railroad trestle	Railroad involvement, design of trestles, other easement acquisition, temporary operation facilities	Likely	Significant	HIGH	Likely	Significant	HIGH
	REGULATORY AND ENVIRONMENTAL RISKS							

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Risk No.	Risk/Opportunity Event	Concerns	Project Cost			Project Schedule		
			Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*
RE-1	Status of permits	Many permits will need to be obtained for construction. Prompt receive of permits will be needed to keep construction schedule on track.	Likely	Negligible	LOW	Likely	Marginal	MODERATE
RE-2	Potential for critical regulation changes	Regulation changes within the Corps could impact this project	Likely	Marginal	MODERATE	Likely	Marginal	MODERATE
RE-3	Negative community impacts	Construction vehicles, noise, pollution, etc., are all to be encountered during construction.	Likely	Negligible	LOW	Likely	Negligible	LOW
RE-4	Endangered species present	Further research may find endangered species present which could delay project.	Unlikely	Negligible	LOW	Unlikely	Negligible	LOW
RE-5	Preliminary HTRW complete	HTRW report is not finalized currently	Likely	Significant	HIGH	Likely	Negligible	LOW
RE-6	Agency actions/reviews are delayed or take longer than expected	Due to number of agencies involved, keeping all actions and reviews on time will be imperative to meeting the project milestones.	Likely	Negligible	LOW	Likely	Marginal	MODERATE
RE-7	Flood risk policy	Flood risk policies from FEMA, DWR, USACE, may change which would impact design	Likely	Negligible	LOW	Likely	Marginal	MODERATE
	CONSTRUCTION RISKS							
CON-1	Permits, licenses, submittal approvals	Delays in acquiring all permits, licenses, and receiving submittal approvals can delay the start of construction or alter sequencing.	Likely	Negligible	LOW	Likely	Marginal	MODERATE
CON-2	Permit and environmental work windows	Work windows based on environmental issues are accounted for, but could change.	Unlikely	Marginal	LOW	Unlikely	Marginal	LOW
CON-3	Site access restrictions	Due to the length of the reaches, site accessibility may be a problem.	Likely	Marginal	MODERATE	Likely	Negligible	LOW
CON-4	Adequate staging areas	No staging areas have been designed, and due to size of project significant staging would be required.	Likely	Marginal	MODERATE	Likely	Negligible	LOW
CON-5	Unknown utilities	Unknown utilities may be found during construction thus causing increased costs and delayed schedules.	Likely	Significant	HIGH	Likely	Negligible	LOW
CON-6	Traffic issues for all haul vehicles	Traffic is going to be an issue for any haul trucks bringing or taking away materials to and from the project site.	Likely	Marginal	MODERATE	Likely	Marginal	MODERATE
CON-7	Diversion and control of water	Diversion and control of water is going to be significant effort, and is based on general assumptions at this time.	Unlikely	Significant	MODERATE	Likely	Negligible	LOW
CON-8	Change orders and modification growths	There may be modification issues that have not been captured in the estimate or schedule.	Likely	Marginal	MODERATE	Likely	Marginal	MODERATE

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Risk No.	Risk/Opportunity Event	Concerns	Project Cost			Project Schedule		
			Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*
CON-9	Unidentified hazardous waste	Encountering unanticipated HTRWs during construction can cause significant increase in earthwork costs.	Unlikely	Significant	MODERATE	Unlikely	Significant	MODERATE
CON-10	Adaptive management	Managing the project through unexpected changes.	Likely	Marginal	MODERATE	Likely	Marginal	MODERATE
	ESTIMATE AND SCHEDULE RISKS							
EST-1	Estimate confidence in large and critical quantities	Design is at low level, and quantities are based on one typical section for each reach.	Likely	Marginal	MODERATE	Likely	Significant	HIGH
EST-2	Estimate reasonableness of crews and productivities	Production rates used in estimate may differ from those in the field.	Likely	Significant	HIGH	Likely	Significant	HIGH
EST-3	Accuracy of construction schedule durations, sequencing, phasing, etc.	Contractor may have different sequencing to construction activities within the contracts which could decrease or increase duration.	Unlikely	Marginal	LOW	Unlikely	Marginal	LOW
Programmatic Risks (External Risk Items are those that are generated, caused, or controlled exclusively outside the PDT's sphere of influence.)								
PR-1	Adequacy of project funding	There is some concern in obtaining funds on a timely basis or in the necessary increments. Receiving less than required or in delayed increments is a concern.	Unlikely	Marginal	LOW	Unlikely	Significant	MODERATE
PR-2	Local communities have objections	Delays may occur due to local communities objecting to the work planning to be constructed.	Unlikely	Significant	MODERATE	Unlikely	Significant	MODERATE
PR-3	Stakeholders request late changes	Late changes by the various stakeholders can cause redesign, increased costs and delays.	Likely	Marginal	MODERATE	Likely	Negligible	LOW
PR-4	Market conditions and bidding competition	Real estate market could be significant risk with variability in this market.	Likely	Significant	HIGH	Unlikely	Marginal	LOW
PR-5	Unexpected escalation on key materials	There could be increases in the cost materials, primarily including the riprap and borrow materials.	Likely	Marginal	MODERATE	Likely	Marginal	MODERATE
PR-6	Flooding/Earthquake	Small chance of major floods and earthquakes occurring, but these could delay project and cause major re-work.	Likely	Marginal	MODERATE	Likely	Significant	HIGH
PR-7	Political factors change at local, state or federal level	Concern due to large cost and all government agencies agreeing on design and implementation.	Likely	Significant	HIGH	Likely	Significant	HIGH

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6.2 Discussion of Moderate and High Risks

The following sections discuss the risk items that have are the most impactful to the contingency development. All risk items that generate over 7 percent of the contingency, as shown in the sensitivity analysis, for both cost and schedule are here. Further information on all risk items and their corresponding PDT discussions can be found in Attachment A.

The discussion of each item includes general concerns and discussions developed by the PDT as well as a general discussion of the anticipated cost increases or opportunities that the risks could have. The full market research back-up can be found in Attachment B.

6.2.1 Cost Risks

(i) High Risks

- PR-4: market conditions and bidding competition – This risk is an external risk that falls outside of the PDT's sphere of influence. At time of bidding, the market conditions are an unknown and could significantly impact the values of the bids received. There could be a saturation of contractors willing to bid, which could lead to lower bids received, or the opposite is possible. The market research assumed a possible 5% decrease in the overall construction costs for the low cost and a 15% increase to construction costs for the possibility of higher bids.
- PR-7: political factors change at local, state or federal level – This risk is an external risk that falls outside of the PDT's sphere of influence. There is a concern that due to the large costs and all the government agencies that are involved, that agreement on the design and implementation may be difficult to achieve. There are already discussions surrounding the various alternatives and which should be the selected plan. Also, political opposition may arise to the current plan due to the overall total cost of the project. The CSRA assumes that political opposition could decrease the scope of the project, thus decreasing construction costs by 7.5%. The political pressures could significantly increase costs as well, and it is assumed that a possible 10% increase may occur.
- TL-1: low design level – This risk is one that should decrease as the project progresses. Currently, the design is at a conceptual level with all quantities and costs based on one typical section per reach. Obviously, as the project moves forward the impacts of this risk will be lowered as the design becomes more detailed and the quantities are fine tuned. But at the time being, the low design level could lead to significant changes in quantities. The CSRA assumed that due to the level of design the cost estimate could decrease upwards of 7.5% or increase by 10%.
- TL-2: investigations remain to be completed (H&H, Geotech, HTRW, etc.) – This project is currently at the conceptual design level and thus many investigations still remain to be completed. Upon completion of all the necessary studies, the PDT agrees that many aspects of the current design may change. These changes, plus the overall scale of the project, could result in significant impacts to the overall cost of the project. The cost impacts could be positive or negative, as further analysis may show that current designs are over designed to meet all engineering standards, or perhaps the project is significantly under-designed thus requiring larger structures.

The CSRA assumes a 5% decrease in total construction costs and a 10% increase in are possible.

6.2.2 Schedule Risks

(i) High Risks

- CA-4: acquisition plan to accommodate funding stream – The funding stream is anticipated to be the major driver of the number and size of the contracts issued. If the funding stream is changed or inadequate, then the current assumption of seven contracts would require changing. The PDT thinks there is a risk of this occurring and that it would primarily impact the schedule. Therefore the CSRA analysis assumes that the schedule may decrease by six months if funding stream requires, or may increase by up to twelve months.
- PR-6: flooding / earthquake – There is a small chance that a major flood or earthquake could occur at some point during the construction time frame. If either of these occurred, then major delays could be expected and even some re-work may be required if structures are damaged. Therefore the CSRA analysis assumed construction continuing for twelve more months if a major flood or earthquake is experienced.
- PR-7: political factors change at local, state or federal level – This risk is an external risk that falls outside of the PDT's sphere of influence. There is a concern that due to the large costs and all the government agencies that are involved, that agreement on the design and implementation may be difficult to achieve. There are already discussions surrounding the various alternatives and which should be the selected plan. Also, political opposition to the current plan may arise due to the overall total cost of the project. Disagreement between all the governmental entities could delay the project from being completed. For this risk it was assumed that the project would be pushed back twelve months.

6.3 Cost Risk Analysis – Cost Contingency Results

The project cost contingencies calculated for each confidence level are provided in Table 3. The estimated project cost contingency for the P80 confidence level was quantified as approximately $152.8 million, which equates to approximately 32.9 percent of the total project cost. This contingency value was calculated solely from the costs of the project and is not for use as the overall project contingency.

Table 3 – Project Cost Contingency Summary

Confidence Level	Baseline Total Project Cost	Contingency	Total Project Cost with Contingency	Contingency
0%	$464,924,107	$2,563,494	$467,487,601	0.55%
5%	$464,924,107	$63,597,773	$528,521,880	13.68%
10%	$464,924,107	$75,586,811	$540,510,918	16.26%
15%	$464,924,107	$83,720,942	$548,645,049	18.01%
20%	$464,924,107	$90,830,029	$555,754,136	19.54%
25%	$464,924,107	$96,959,129	$561,883,236	20.85%
30%	$464,924,107	$102,561,180	$567,485,287	22.06%
35%	$464,924,107	$107,552,486	$572,476,593	23.13%
40%	$464,924,107	$112,355,379	$577,279,486	24.17%
45%	$464,924,107	$117,150,356	$582,074,463	25.20%
50%	$464,924,107	$121,519,808	$586,443,915	26.14%
55%	$464,924,107	$126,307,043	$591,231,150	27.17%
60%	$464,924,107	$130,843,157	$595,767,264	28.14%
65%	$464,924,107	$135,603,537	$600,527,644	29.17%
70%	$464,924,107	$140,942,464	$605,866,571	30.32%
75%	$464,924,107	$146,551,074	$611,475,181	31.52%
80%	$464,924,107	$152,771,267	$617,695,374	32.86%
85%	$464,924,107	$160,352,838	$625,276,945	34.49%
90%	$464,924,107	$169,184,041	$634,108,148	36.39%
95%	$464,924,107	$183,870,021	$648,794,129	39.55%
100%	$464,924,107	$261,655,158	$726,579,265	56.28%

A sensitivity analysis generally ranks the relative impact of each risk/opportunity as a percentage of total cost uncertainty. From this analysis, the key cost drivers can be identified and used to support the development of a risk management plan that will facilitate control of risk factors and their potential impacts throughout the project life cycle.

The cost sensitivity analysis for this project shows the rank of the risks from the highest impact on the cost contingency to the lowest (Figure 1). Approximately 60.4 percent of the resulting cost contingency comes from four of the analyzed risk items: PR-7 (political factors change at local, state or federal level), TL-1 (low design level), TL-2 (investigations remain to be completed) and PR-4 (market conditions and bidding competition).

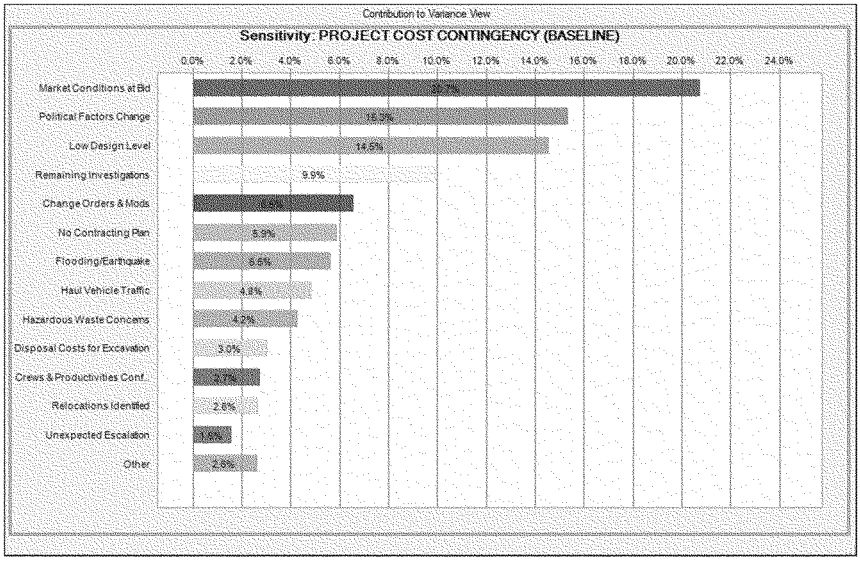


Figure 1 – Sensitivity Analysis (Cost)

6.4 Schedule Duration Risk Analysis – Schedule Contingency Results

The schedule duration contingencies calculated for each confidence level are provided in Table 4. The estimated schedule duration contingency for the P80 confidence level was quantified as approximately 53.9 months, which equates to approximately 28.1 percent of the total project schedule duration. This contingency duration was calculated solely from the schedule of the project and is not for use as the overall project contingency.

Table 4 – Project Schedule Duration Contingency Summary

Confidence Level	Baseline Schedule Duration	Contingency (Duration)	Baseline Schedule Duration with Contingency	Contingency
0%	192.0 Months	19.1 Months	211.1 Months	9.92%
5%	192.0 Months	34.5 Months	226.5 Months	17.98%
10%	192.0 Months	37.0 Months	229.0 Months	19.27%
15%	192.0 Months	38.8 Months	230.8 Months	20.21%
20%	192.0 Months	40.3 Months	232.3 Months	20.99%
25%	192.0 Months	41.6 Months	233.6 Months	21.66%
30%	192.0 Months	42.8 Months	234.8 Months	22.28%
35%	192.0 Months	43.9 Months	235.9 Months	22.87%
40%	192.0 Months	45.0 Months	237.0 Months	23.46%
45%	192.0 Months	46.0 Months	238.0 Months	23.96%
50%	192.0 Months	47.1 Months	239.1 Months	24.53%
55%	192.0 Months	48.1 Months	240.1 Months	25.07%
60%	192.0 Months	49.2 Months	241.2 Months	25.60%
65%	192.0 Months	50.2 Months	242.2 Months	26.13%
70%	192.0 Months	51.3 Months	243.3 Months	26.74%
75%	192.0 Months	52.6 Months	244.6 Months	27.38%
80%	192.0 Months	53.9 Months	245.9 Months	28.09%
85%	192.0 Months	55.6 Months	247.6 Months	28.95%
90%	192.0 Months	57.7 Months	249.7 Months	30.03%
95%	192.0 Months	60.6 Months	252.6 Months	31.57%
100%	192.0 Months	79.2 Months	271.2 Months	41.24%

The schedule duration sensitivity analysis for this project shows the rank of the risks from the highest impact on the schedule duration contingency to the lowest (Figure 2). Approximately 37.8 percent of the resulting schedule duration contingency comes from three of the analyzed risk items: CA-4 (acquisition plan to accommodate funding stream), PR-6 (flooding/earthquake), and PR-7 (political factors change at local, state or federal level).

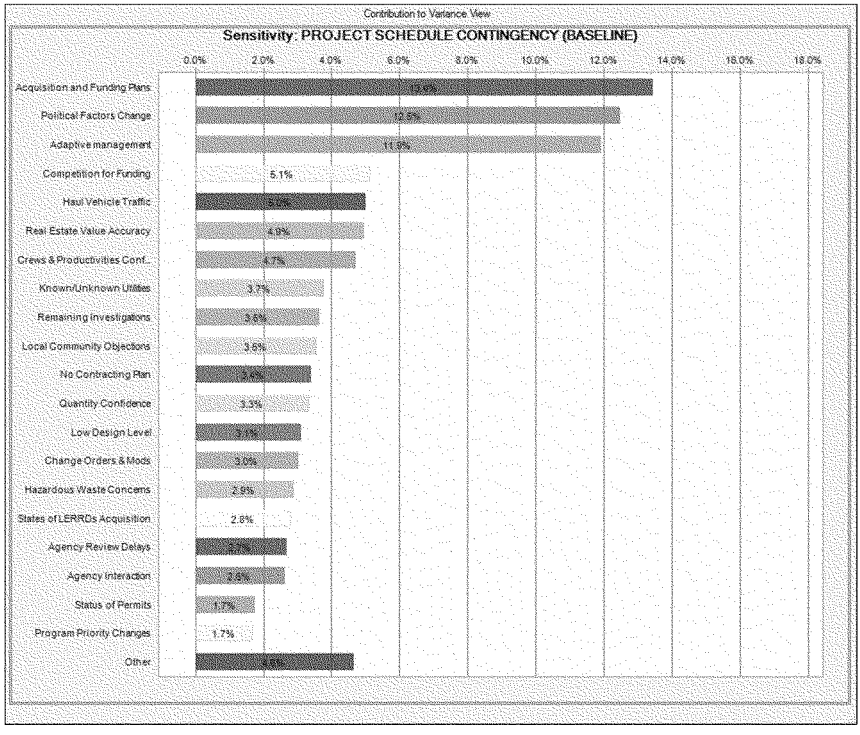


Figure 2 – Sensitivity Analysis (Schedule)

6.5 Schedule Contingency Value Results

The schedule contingency is presented as a monetary value such that it can be combined with the cost contingency to generate the total project contingency (Table 5). The schedule contingency is calculated from the estimated "hotel" costs, which are fixed costs that are inherently incurred as a result of schedule delays. These fixed costs may include rents, project management, supervision and administration, and elements of home office or field office overhead. In practice, sufficiently detailed cost estimates and resource-loaded schedules are often not available to support detailed hotel cost estimates for risk analysis, and only rough order of magnitude estimates can be developed.

For this analysis the combined job office overhead costs from the prime contractors was used to develop an assumed hotel rate of 6.04 percent. This percentage is applied to the overall project cost along with the current escalation rate from the Office of Management and Budget and local project escalation obtained from the USACE escalation factors. These rates generated an approximate schedule contingency of $18.3 million for the P80 confidence level.

Table 5 – Schedule Contingency Value Summary

Confidence Level	Date	Escalation Delta Amount	Hotel Amount	Total Schedule Contingency
0%	5-Sep-34	$8,995,594	$2,759,431	$11,755,025
5%	19-Dec-35	$9,654,885	$5,020,729	$14,675,615
10%	4-Mar-36	$9,760,593	$5,383,294	$15,143,887
15%	27-Apr-36	$9,837,108	$5,645,735	$15,482,844
20%	12-Jun-36	$9,901,474	$5,866,501	$15,767,975
25%	21-Jul-36	$9,956,074	$6,053,773	$16,009,847
30%	26-Aug-36	$10,006,496	$6,226,716	$16,233,211
35%	30-Sep-36	$10,054,877	$6,392,659	$16,447,536
40%	3-Nov-36	$10,103,291	$6,558,714	$16,662,005
45%	3-Dec-36	$10,144,439	$6,699,848	$16,844,287
50%	5-Jan-37	$10,190,766	$6,858,745	$17,049,512
55%	5-Feb-37	$10,234,914	$7,010,167	$17,245,081
60%	8-Mar-37	$10,278,691	$7,160,317	$17,439,007
65%	8-Apr-37	$10,321,956	$7,308,712	$17,630,668
70%	14-May-37	$10,371,834	$7,479,787	$17,851,620
75%	21-Jun-37	$10,424,498	$7,660,420	$18,084,918
80%	1-Aug-37	$10,482,698	$7,860,040	$18,342,738
85%	20-Sep-37	$10,552,561	$8,099,662	$18,652,223
90%	22-Nov-37	$10,641,119	$8,403,409	$19,044,528
95%	20-Feb-38	$10,767,031	$8,835,274	$19,602,305
100%	8-Sep-39	$11,558,314	$11,549,289	$23,107,602

6.6 Combined Cost and Schedule Contingency Results

The combined cost and schedule contingency results show a 36.80 percent contingency (or $171,114,005) at the P80 confidence level (Table 6). This table combines the cost and schedule contingencies in summation to generate the contingency amount to be used in developing the fully funded project amount.

Table 6 – Combined Cost and Schedule Contingency Values

Confidence Level	Baseline Total Project Cost	Cost Contingency	Schedule Contingency	Total Project Cost with Contingency	Contingency
0%	$464,924,107	$2,563,494	$11,755,025	$479,242,626	3.08%
5%	$464,924,107	$63,597,773	$14,675,615	$543,197,495	16.84%
10%	$464,924,107	$75,586,811	$15,143,887	$555,654,805	19.52%
15%	$464,924,107	$83,720,942	$15,482,844	$564,127,893	21.34%
20%	$464,924,107	$90,830,029	$15,767,975	$571,522,111	22.93%
25%	$464,924,107	$96,959,129	$16,009,847	$577,893,083	24.30%
30%	$464,924,107	$102,561,180	$16,233,211	$583,718,498	25.55%
35%	$464,924,107	$107,552,486	$16,447,536	$588,924,129	26.67%
40%	$464,924,107	$112,355,379	$16,662,005	$593,941,491	27.75%
45%	$464,924,107	$117,150,356	$16,844,287	$598,918,749	28.82%
50%	$464,924,107	$121,519,808	$17,049,512	$603,493,427	29.80%
55%	$464,924,107	$126,307,043	$17,245,081	$608,476,231	30.88%
60%	$464,924,107	$130,843,157	$17,439,007	$613,206,271	31.89%
65%	$464,924,107	$135,603,537	$17,630,668	$618,158,312	32.96%
70%	$464,924,107	$140,942,464	$17,851,620	$623,718,192	34.15%
75%	$464,924,107	$146,551,074	$18,084,918	$629,560,099	35.41%
80%	$464,924,107	$152,771,267	$18,342,738	$636,038,112	36.80%
85%	$464,924,107	$160,352,838	$18,652,223	$643,929,168	38.50%
90%	$464,924,107	$169,184,041	$19,044,528	$653,152,676	40.49%
95%	$464,924,107	$183,870,021	$19,602,305	$668,396,434	43.76%
100%	$464,924,107	$261,655,158	$23,107,602	$749,686,867	61.25%

The overall cost with contingency for each of the confidence levels along with the overall confidence curve are shown in Figure 3.

Contingency Analysis

Most Likely Cost Estimate	$464,924,107	
Confidence Level	Value	Contingency
0%	$479,242,626	3.08%
5%	$543,197,495	16.84%
10%	$555,654,805	19.52%
15%	$564,127,893	21.34%
20%	$571,522,111	22.93%
25%	$577,893,083	24.30%
30%	$583,718,498	25.55%
35%	$588,924,129	26.67%
40%	$593,941,491	27.75%
45%	$598,918,749	28.82%
50%	$603,493,427	29.80%
55%	$608,476,231	30.88%
60%	$613,206,271	31.89%
65%	$618,158,312	32.96%
70%	$623,718,192	34.15%
75%	$629,560,099	35.41%
80%	$636,038,112	36.80%
85%	$643,929,168	38.50%
90%	$653,152,676	40.49%
95%	$668,396,434	43.76%
100%	$749,686,867	61.25%

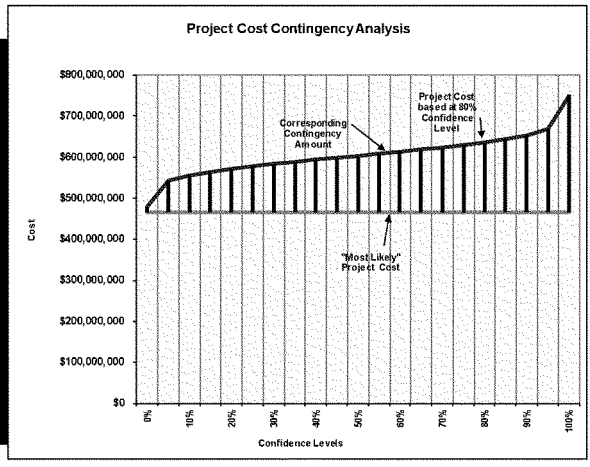


Figure 3 – Combined Cost and Schedule Contingency Value Curve

7. MAJOR FINDINGS/OBSERVATIONS

This section summarizes the significant results of the risk analysis:

1) Based on the results of this analysis a recommended contingency value of $171.1 million dollars or 36.80 percent of the total costs is to be used to generate the fully funded project cost. Of this $171.1 million, approximately $152.8 million (89.3 percent) was derived from the construction cost risks, and $18.3 million (10.7 percent) was derived from the schedule risks.

2) The schedule duration contingency is estimated to be 53.9 months, which equates to an approximate contingency of 28.1 percent of the total project duration.

3) The key cost risk drivers identified through the sensitivity analysis are:

   - PR-7: political factors change at local, state or federal level
   - TL-1: low design level
   - PR-4: market conditions and bidding competition
   - TL-2: investigations remain to be completed

4) The key schedule duration risk drivers identified through the sensitivity analysis are:

   - PR-6: flooding / earthquake
   - PR-7: political factors change at local, state or federal level
   - CA-4: acquisition plan to accommodate funding stream

5) PR-4, PR-6 and PR-7 are external risks, meaning that the PDT has no control over them. If the opinions of the political organizations change or if a major flood or earthquake occurs, then major delays and increased costs would be incurred.

8. MITIGATION RECOMMENDATIONS

Risk management is an all-encompassing, iterative, life cycle process of project management. According to *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*, "project risk management includes the processes concerned with conducting risk management planning, identification, analysis, responses, and monitoring and control on a project" (PMI 2008). Risk identification and risk analysis are processes within the knowledge area of risk management. Their output pertinent to this effort includes the risk register, risk quantification (risk analysis model), the contingency report, and the sensitivity analysis.

The results of the CSRA sensitivity analysis indicate that the following risk factors have the most significant impact on the project contingency and thus mitigation recommendations are discussed for these items:

- TL-1: low design level (cost)
- TL-2: investigations remain to be completed (cost)
- PR-4: market conditions and bidding competition (cost)
- PR-7: political factors change at local, state or federal level (cost and schedule)
- CA-4: contracting plan has not been developed (schedule)
- PR-6: flooding / earthquake (schedule)

8.2 Cost Mitigation Recommendations

One of the significant risks to the cost contingency is that **investigations remain to be completed**. The current cost estimate is based on the information at hand, and thus may be subject to significant changes due to the findings of the various outstanding studies. The impact of this risk may be lowered as the project progresses provided that these investigations are completed in a timely and accurate fashion. Incorporation of the findings into the design and thus into the estimate will ensure that this risk is reduced in future iterations of this document.

Another significant risk to the cost is the risk of **market conditions and bidding competition.** This risk is not something the PDT can help to mitigate significantly over the course of the project. The primary method to limiting this risk is as the project nears construction the estimate must be updated continually to best estimate the current market conditions. The current USACE policies regarding construction cost estimating will help to ensure this, and should help limit the risk. However, given the current estimated timeframe, market conditions are still going to be a significant risk moving forward.

The risk of **political factors changing at local, state or federal level** is significant to both the cost and schedule. This risk is beyond the control of the PDT because various political entities must be involved to complete this project, and all must be onboard with the design and costs of the project. Thus, it would be beneficial of management personnel to try and keep all government agencies involved with the planning of this project, and to monitor any significant changes in preferences that these agencies may have in terms of design and implementation of the project. Again, this risk will be tough to mitigate against as the project progresses, but ensuring any changes are dealt with early on will limit the unanticipated delays and cost

increases that would be most detrimental if they arise as the project nears the onset of construction.

8.3 Schedule Mitigation Recommendations

Political factors changing at local, state or federal level also has a significant impact on the schedule contingency. As noted in the cost section, this risk can be mitigated by management personnel consistently monitoring all policy stakeholder opinions and keeping an open dialogue with these agencies in order to try and keep design in line with what is asked for.

The contracting plan has not been developed and thus the current assumptions used to develop the cost estimate and tentative project schedule are subject to change. As the project progresses more analysis should be taken to look into the appropriate contracting plan and this should be incorporated into the estimate and schedule respectively. As the project nears completion this risk should theoretically decrease in impact as the updated contracting plan will be more certain.

The risk of **flooding, or earthquake** occurring is a significant risk to the project. This risk is entirely beyond the control of the PDT because these are naturally occurring events. Due to the overall length of the construction period, encountering one of these events during construction is fairly likely. If a major event of either of these does occur, then significant delays could be incurred due to major repairs and re-construction of failed structures. The avoidance of flooding may be mitigated against by not constructing during flood seasons, but mitigating against a major earthquake is more difficult. Ensuring design of the elements that may be affected by these types of events takes these risks into account may also limit the overall risk to the project.

9. REFERENCES

PMI (Project Management Institute). 2008. *A Guide to the Project Management Body of Knowledge (PMBOK® Guide). 4th edition.*

USACE (U.S. Army Corps of Engineers) 1999. *Engineering and Design for Civil Works Projects.* Engineer Regulation 1110-2-1150. Department of the Army, Washington, D.C. August 31.

USACE. 2007a. Memorandum from Major General Don T. Riley, U.S. Army Director of Civil Works, July 3.

USACE. 2007b. *Application of Cost Risk Analysis Methods to Develop Contingencies for Civil Works Total Project Costs.* Engineering and Construction Bulletin 2007-17. September 10.

USACE. 2008a. *Civil Works Cost Engineering.* Engineer Regulation 1110-2-1302. Department of the Army, Washington, D.C. September 15.

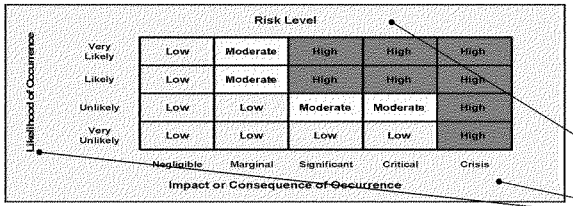
USACE. 2008b. *Construction Cost Estimating Guide for Civil Works.* Engineer Technical Letter 1110-2-573. Department of the Army, Washington, D.C. September 30.

USACE. 2009. *Cost and Schedule Risk Analysis Guidance.* Directory of Expertise for Civil Works, Cost Engineering, USACE, Department of the Army, Walla Walla, WA. May 17.

ATTACHMENT A

Project Delivery Team Risk Register

Los Angeles River Ecosystem Restoration Project - PDT Risk Register



Overall Project Scope
The Los Angeles River Ecosystem Restoration Feasibility Study is evaluating ecosystem restoration opportunities along an 11.5-mile long stretch of the Los Angeles River. This project is based on preliminary, planning-level conceptual designs, and common engineering practices. The project is split into eight (8) sub-reaches and the design features for each of these sub-reaches includes: demolition of existing concrete structures; riprap and grouted riprap placement; earthwork; turf reinforcement mats; chain link fences; clearing and grubbing; cast-in-place concrete walls, planters, slabs, and piers; detention basins; sub-drainage systems; and recreation features.

Cost Impacts
For the LA River Project, any cost impact of $1.0 Million or higher should be considered at least "Significant."
Anything over $0.5 Million should be considered at least "Marginal."

Schedule Impacts
For the LA River Project, any schedule impact of 12 months or greater should be considered at least "Significant."
Anything over 6 months should be considered at least "Marginal."

				Project Cost				Project Schedule							
Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Likelihood[1]	Impact[2]	Risk Level[3]	Rough Order Impact ($)	Likelihood[1]	Impact[2]	Risk Level[3]	Rough Order Impact (mo)	Variance Distribution	Correlation to Other(s)	Responsibility/POC	Affected Project Component
Contract Risks (Internal Risk items are those that are generated, caused, or controlled within the PDT's sphere of influence.)															
	PROJECT & PROGRAM MGMT														
PPM-1	Interactions between all agencies involved in project	Many different agencies will be involved in order to complete this project. Managing and assuring that all agencies complete requisite needs may prove difficult.	PDT agrees that this risk is already occuring on the project and that significant cost and schedule impacts could occur in the future	Very Likely	Marginal	MODERATE		Very Likely	Marginal	MODERATE					
PPM-2	Dealings with multiple stakeholders	The various stakeholders in the project may cause difficulties in funding, changes to design, etc.	There are so many stakeholders on the project that this risk is likely to occur. Issues are already arising from stakeholders. PDT agrees marginal impact is appropriate	Very Likely	Marginal	MODERATE		Very Likely	Marginal	MODERATE					
PPM-3	Project competing with other projects, funding and resources	Other projects may threaten funding streams and/or delay receival of funds needed to meet design/construction milestones.	This is a typically risk at this stage as other projects may take away funding and resources leading up to the construction; Also construction funds might not be available if other large projects are approved prior to this one. PDT feels this is high risk to project schedule primarily.	Very Likely	Marginal	MODERATE		Very Likely	Marginal	MODERATE					
PPM-4	Losing critical staff at crucial points of project	Loss of crucial staff prior to or during critical milestones could delay project.	Impact overall life of project would cause marginal impacts; project staff would probably be lost but project would move forward.	Likely	Marginal	MODERATE		Likely	Marginal	MODERATE					
PPM-5	Product development by several sources	This project requires members from various entities both governmental and private to complete.	This project does involve many entities, but USACE is used to and able to manage and complete projects with various entities completing work.	Likely	Negligible	LOW		Likely	Negligible	LOW					
PPM-6	Priorities change on existing program	If USACE priorities on ecosystem restoration change, then this project could be impacted.	This project is a major priority to the City and not likely to change; USACE priority on ecosystem restoration may change, but this project is already a priority; Assumes unlikely to impact costs, but schedule could marginally change.	Unlikely	Negligible	LOW		Likely	Marginal	MODERATE					
	CONTRACT ACQUISITION RISKS														
CA-1	Contracting plan has not been developed	Contracting plan has not been fully developed at this stage. Changes to current assumptions could occur.	Current assumption of 4 separate contracts is very likely to change but is a conservative assumption; methods will be looked at to minimize costs of multiple contracts; certain sections (Piggyback Yard/Taylor Yard) may be broken out in separate contracts; PDT agrees for both cost and schedule this would likely occur but impacts would be marginal	Likely	Marginal	MODERATE		Likely	Significant	HIGH					
CA-2	Possibility for 8(a) or small business contractor(s)	Some portions of the project may be bid to 8(a) contractors, which could increase costs for construction.	There may be some small business contractors for some of the smaller portions of the project. But PDT feels low risk that these contractors would impact cost/schedule significantly as work would be low risk.	Likely	Negligible	LOW		Likely	Negligible	LOW					
CA-3	Number of separate contracts and prime contractors	Current estimate assumes 4 separate contracts with each one having a separate prime contractor. Further analysis into contracting plan may change this.	Estimate currently insidches current contracting plan. Plan seems more than reasonable and not anticipated to change significantly. PDT thinks this would be low risk for both cost and schedule as an itermittent funding stream is a "less risky" assumption, and is not anticipated to have significant impacts to cost or schedule.	Likely	Negligible	LOW		Likely	Negligible	LOW					
CA-4	Acquisition plan to accommodate funding stream	The funding stream will be a major driver of the contracts. If funding stream changes or is inadequate current assumptions will change.	Project could have agreement in place to have funding available; PDT agrees this would be likely to occur but that the impacts would be marginal to the costs, but significant to the schedule as project would be delayed.	Likely	Marginal	MODERATE		Likely	Significant	HIGH					

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Project Cost				Project Schedule				Variance Distribution	Correlation to Other(s)	Responsibility/POC	Affected Project Component
				Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)				
	TECHNICAL RISKS														
TL-1	Low design level	Project is at a low design level. All quantities and assumptions are subject to changes as project progresses.	PDT agrees that changes are very likely to occur; There are items missing from the current design and estimate; This item impacts the costs greater than the schedule;	Very Likely	Critical	HIGH		Very Likely	Marginal	MODERATE					
TL-2	Investigations remain to be completed (H&H, Geotech, HTRW, etc.)	Many investigations still remain to be completed. Once finalized, these reports may cause design changes.	These studies need to be completed, and PDT agrees that risk is very likely and significant; Further analysis not currently anticipated may cause significant increases in PED;	Very Likely	Significant	HIGH		Very Likely	Marginal	MODERATE					
TL-3	Hazardous waste concerns	Encountering unanticipated HTRWs can cause significant increase in earthwork costs.	It is known that hazardous wastes are to be encountered, thus it is a very likely risk; HTRWs is not considered a project cost but will need to be accounted for in the schedule; City is to take care of known HTRWs, and unknown HTRWs will need to be removed during construction, but will not be project cost to USACE.	Very Likely	Significant	HIGH		Very Likely	Marginal	MODERATE					
TL-4	Disposal locations and costs for excavated materials	Preliminary landfills have been assumed to be capable of accepting excavated materials. Further analysis could lead to cost savings (if cheap/no cost site is found) or increased costs based on tipping fees.	PDT agrees there is a high chance of a change in disposal costs; Current estimate assumes materials would be hauled off-site and include tipping fees; There are benefits due to HTRW removal will lower earthwork quantities at some sites (need to estimate quantity of HTRW);	Likely	Marginal	MODERATE		Likely	Negligible	LOW					
TL-5	All Disciplines	Many investigations remain to be completed, which once finished, could change current design	Investigations have yet to be completed to verify current design; Once all investigations are completed changes to design are likely to occur. If changes to certain design items occurred impacts to costs would be significant; Schedule is not anticipated to be impacted as plenty of design time is currently in schedule.	Very Likely	Significant	HIGH		Likely	Negligible	LOW					
TL-6	Locations and costs for borrow materials	Changes in material prices and locations from borrow sites may change.	PDT agrees there is a good chance of assumed borrow sites are not going to be same at time of construction; Changes in location or cost of borrow material would be significant to costs.	Unlikely	Significant	MODERATE		Unlikely	Negligible	LOW					
	LANDS AND DAMAGES RISKS														
LD-1	Status of real estate / easement acquisition	Real estate and easements need to be purchased in a timely fashion such that the construction phases can begin as scheduled.	Current plan only requires two areas two be purchased; Schedule is estimated to limit the risk generated from this item; Therefore PDT concludes that this risk is likely to occur but negligible to costs as the cost is being paid regardless; for schedule assumes it is likely to occur and marginal	Likely	Negligible	LOW		Likely	Marginal	MODERATE					
LD-2	Railroad involvement	Project may require railroad involvement for culverts and right-of-way acquisition	Railroad involvement would be required in FloydBack Yard and Taylor Yard; PDT agrees that this is more impactful to schedule than cost; PDT thinks cost risks are low, but for schedule it is likely and significant; any track closures have been estimated to cost $1,000,000/hr	Likely	Negligible	LOW		Likely	Marginal	MODERATE					
LD-3	Relocations identified	Detailed relocation designs/report has not been fully developed at time of estimate.	Current relocation costs are based on building relocations, and it is assumed to be very likely that these would be encountered; Costs for relocating items would be significant, but would negligable to schedule;	Likely	Marginal	MODERATE		Likely	Negligible	LOW					
LD-4	Known and unknown utility impacts	Unknown utilities may be found during construction thus causing increased costs and delayed schedules.	Utilities have been constructed along the banks and right-of-way of the channel. Therefore these items are very likely to occur, but the quantity is unknown; PDT agrees both for schedule and costs are high risk;	Likely	Marginal	MODERATE		Likely	Marginal	MODERATE					
LD-5	Vagrancy, loitering issues	Dealing with vagrant population may cause some minor delays.	PDT agrees this is likely to occur but negligible to both costs and schedule;	Likely	Negligible	LOW		Likely	Negligible	LOW					
LD-6	Accuracy of current values of lands and easements	Real estate costs are more than 3 times more costly than the current construction costs. Thus changes in costs to real estate effect total cost significantly.	Detailed appraisals have been completed; PDT agrees costs are anticipated to change, and any increases would be critical; could be significant impact to schedule if land values increase; Changes to the boundaries could add cost and delay construction as well; PDT feels that contingency developed by RE should be more than sufficient, as the current boundaries are very well defined and not likely to change for the current plan.	Very Unlikely	Critical	LOW		Unlikely	Critical	MODERATE					
LD-7	Railroad trestle	Railroad involement, design of trestles, other easement acquisition, temporary operation facilities	If TSP changes to an alternative that requires the railroad trestles, then significant changes to costs and schedule could be incurred. A lot of coordination would be required between agencies and railroads, and additional costs may be needed than currently assumed; PDT thinks this is high risk for both cost and schedule.	Likely	Significant	HIGH		Likely	Significant	HIGH					
	REGULATORY AND ENVIRONMENTAL RISKS														

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Project Cost				Project Schedule				Variance Distribution	Correlation to Other(s)	Responsibility/POC	Affected Project Component
				Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)				
RE-1	Status of permits	Many permits will need to be obtained for construction. Prompt receival of permits will be needed to keep construction schedule on track.	Not anticipated to be a risk to costs, but is assumed to be a schedule risk; it is assumed to be likely to occur, but would be marginal impact to schedule;	Likely	Negligible	LOW		Likely	Marginal	MODERATE					
RE-2	Potential for critical regulation changes	Regulation changes within the Corps could impact this project.	Regulations are anticipated to change; PDT agrees that the impact would be marginal;	Likely	Marginal	MODERATE		Likely	Marginal	MODERATE					
RE-3	Negative community impacts	Construction vehicles, noise, pollution, etc. are all to be encountered during construction.	These negative impacts are all likely to occur, but would be negligible to cost; There may be some specific BMP that was not assumed; However, very low risks to the both cost and schedule;	Likely	Negligible	LOW		Likely	Negligible	LOW					
RE-4	Endangered species present	Further research may find endangered species present which could delay project.	This is unlikely to occur throughout this reach; It is not anticipated to impact cost significantly, and project is generally designed to be constructed around at risk species;	Unlikely	Negligible	LOW		Unlikely	Negligible	LOW					
RE-5	Preliminary HTRW complete	HTRW report is not finalized currently	Correlated to TL-2	Likely	Significant	HIGH		Likely	Negligible	LOW					
RE-6	Agency actions/reviews are delayed or take longer than expected	Due to number of agencies involved, keeping all actions and reviews on time will be imperative to meeting the project milestones.	This is similar to RE-1; it is likely to occur but only marginal impact to schedule and negligible to costs.	Likely	Negligible	LOW		Likely	Marginal	MODERATE					
RE-7	Flood risk policy	Flood risk policies from FEMA, IWR, USACE, may change which would impact design	Flood risk policy is likely to change, and this could put some delays in this project. However, PDT does not think this would impact costs much as design is currently capable of handling some policy changes without need for too much new items.	Likely	Negligible	LOW		Likely	Marginal	MODERATE					
	CONSTRUCTION RISKS														
CON-1	Permits, licenses, submittal approvals	Delays in acquiring all permits, licenses, and receiving submittal approvals can delay the start of construction or alter sequencing.	There are many permits and licenses that contractors will have to obtain; This will probably be negligible to costs, and marginal to the schedule;	Likely	Negligible	LOW		Likely	Marginal	MODERATE					
CON-2	Permit and environmental work windows	Work windows based on environmental issues are accounted for, but could change.	PDT agrees that this is unlikely to occur for both costs and schedule; The schedule includes windows for working around nesting season and flood season; Assumes impacts would be marginal to both cost and schedule	Unlikely	Marginal	LOW		Unlikely	Marginal	LOW					
CON-3	Site access restrictions	Due to the length of the reaches, site accessibility may be a problem.	This is likley to occur as there are railroads, and bridges; Contractor should be able to work around these issues and plan accordingly. Some reaches may have more restrictions, and secondary access may be required; PDT agrees the costs impacts would be likely and marginal, and likely and negligible for the schedule	Likely	Marginal	MODERATE		Likely	Negligible	LOW					
CON-4	Adequate staging areas	No staging areas have been designed, and due to size of project significant staging would be required.	Staging areas would be designed as the project progresses. Current costs for staging may not be adequate once more detailed analysis is completed. PDT thinks this is likely to occur but only be marginal impact to costs and negligible to schedule.	Likely	Marginal	MODERATE		Likely	Negligible	LOW					
CON-5	Unknown utilities	Unknown utilities may be found during construction thus causing increased costs and delayed schedules.	Similar to LO-4 this would be a high risk to cost but a low risk to schedule.	Likely	Significant	HIGH		Likely	Negligible	LOW					
CON-6	Traffic issues for all haul vehicles	Traffic is going to be an issue for any haul trucks bringing or taking away materials to and from the project site.	There is no traffic control plan at this point; Construction is in an urbanized location, and traffic is likely to occur; If roads need to be repaired then there would be significant cost increases;	Likely	Marginal	MODERATE		Likely	Marginal	MODERATE					
CON-7	Diversion and control of water	Diversion and control of water is going to be significant effort, and is based on general assumptions at this time.	75% of the flow is from Tillman, and if flows are increased for any reason, then assumptions for water control would change; PDT assumes that this would be likely and significant impact to costs;	Unlikely	Significant	MODERATE		Likely	Negligible	LOW					
CON-8	Change orders and modification growths	There may be modification issues that have not been captured in the estimate or schedule.	Redesign to sponsor changes, discovering unidentified utilities, etc.; A project of this scale is likely to incur some changes during construction; These changes are assumed to be significantly impacted to both cost and schedule;	Likely	Marginal	MODERATE		Likely	Marginal	MODERATE					
CON-9	Unidentified hazardous waste	Encountering unanticipated HTRWs during construction can cause significant increase in earthwork costs.	After the investigations are complete, construction activities still may encounter hazardous materials; PDT agrees that impact for both cost and schedule would be unlikely and significant;	Unlikely	Significant	MODERATE		Unlikely	Significant	MODERATE					

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Project Cost				Project Schedule				Variance Distribution	Correlation to Other(s)	Responsibility/POC	Affected Project Component
				Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)				
CON-10	Adaptive management	Managing the project through unexpected changes.	Not anticipated to be a significant risk to either cost or schedule, but is likely to have some issues brought up.	Likely	Marginal	MODERATE		Likely	Marginal	MODERATE					
	ESTIMATE AND SCHEDULE RISKS														
EST-1	Estimate confidence in large and critical quantities	Design is at low level, and quantities are based on one typical section for each reach.	As progress progresses it is very likely that quantities will change since design is currently at a very low level. This would impact both cost and construction schedule. This could also be a benefit to the project if quantities are currently over estimated compared to future designs.	Likely	Marginal	MODERATE		Likely	Significant	HIGH					
EST-2	Estimate reasonableness of crews and productivities	Production rates used in estimate may differ from those in the field.	Production rates for primary construction items have been estimated based on various sources as well as estimator experience and expected site conditions. However, actual rates may still vary based on contractors capabilities. The are likely to be different but would only marginally affect costs and construction schedule. Could be a benefit too.	Likely	Significant	HIGH		Likely	Significant	HIGH					
EST-3	Accuracy of construction schedule durations, sequencing, phasing, etc.	Contractor may have different sequencing to construction activities within the contracts which could decrease or increase duration.	Construction schedule may be different than currently assumed. The current assumptions are based on proposed contracting plan, which has been considered a low risk to change. Therfore this item is unlikely to be a high risk either.	Unlikely	Marginal	LOW		Unlikely	Marginal	LOW					
	Programmatic Risks (External Risk items are those that are generated, caused, or controlled exclusively outside the PDT's sphere of influence.)														
PR-1	Adequacy of project funding	There is some concern in obtaining funds on a timely basis or in the necessary increments. Receiving less than required or in delayed increments is a concern.	This would be a significant risk to the schedule as the project would be delayed if funding is not available.	Unlikely	Marginal	LOW		Unlikely	Significant	MODERATE					
PR-2	Local communities have objections	Delays may occur due to local communities objecting to the work planning to be constructed.	There are already objections to the current plan; Most of these objecting views are asking for alternatives that are greater in scope than the proposed one. Therfore costs and schedules could be impacted significantly if this changes.	Unlikely	Significant	MODERATE		Unlikely	Significant	MODERATE					
PR-3	Stakeholders request late changes	Late changes by the various stakeholders can cause redesign, increased costs and delays.	Similar to PR-2, in that requests for changes to the plan are already being made, and more changes are expected to be requested in the future. These changes would most likely only raise costs, but not anticipated to impact schedule as stakeholders want this work done sooner as opposed to later.	Likely	Marginal	MODERATE		Likely	Negligible	LOW					
PR-4	Market conditions and bidding competition	Real estate market could be significant risk with variability in this market.	This could be an opportunity or negative risk based on the bidding climate; With real estate property and construction this could be a significant impact to costs; There may be others bidding on real estate; Not anticipated to impact the schedule significantly	Likely	Significant	HIGH		Unlikely	Marginal	LOW					
PR-5	Unexpected escalation on key materials	There could be increases in the cost materials, primarily including the riprap and borrow materials.	Costs for materials could increase or decrease based on market conditions; It is anticipated that materials would more likely increase than decrease. Some materials may become more scarce. These are likely to impact both cost and schedule significantly	Likely	Marginal	MODERATE		Likely	Marginal	MODERATE					
PR-6	Flooding/Earthquake	Small chance of major floods and earthquakes occuring, but these could delay project and cause major re-work	PDT believes likelihood of having a major flood or earthquake during construction is high due to the overall length of construction. If one of these events occurred there would probably be significant delays and large cost impacts due to repairs and re-construction due to failed structures.	Likely	Marginal	MODERATE		Likely	Significant	HIGH					
PR-7	Political factors change at local, state or federal level	Concern due to large cost and all government agencies agreeing on design and implementation	There is already some discussions between various agencies over the selected plan. Also due the projected costs to the project many political issues could arise that deter funding; Due to number of agencies involved this risk is believed to be likely to occur and could significantly affect both the cost and schedule.	Likely	Significant	HIGH		Likely	Significant	HIGH					

*Likelihood, Impact, and Risk Level to be verified through market research and analysis (conducted by cost engineer).

1. Risk/Opportunity identified with reference to the Risk Identification Checklist and through deliberation and study of the PDT.
2. Discussions and Concerns elaborates on Risk/Opportunity Events and includes any assumptions or findings (should contain information pertinent to eventual study and analysis of event's impact to project).
3. Likelihood is a measure of the probability of the event occurring -- **Very Unlikely**, **Unlikely**, **Moderately Likely**, **Likely**, **Very Likely.** The likelihood of the event will be the same for both Cost and Schedule, regardless of impact.
4. Impact is a measure of the event's effect on project objectives with relation to scope, cost, and/or schedule -- **Negligible**, **Marginal**, **Significant**, **Critical**, or **Crisis.** Impacts on Project Cost may vary in severity from impacts on Project Schedule.
5. Risk Level is the resultant of Likelihood and Impact **Low**, **Moderate**, or **High**. Refer to the matrix located at top of page.
6. Variance Distribution refers to the behavior of the individual risk item with respect to its potential effects on Project Cost and Schedule. For example, an item with clearly defined parameters and a solid most likely scenario would probably follow a triangular or normal distribution. A risk item for which the PDT has little data or probability of modeling with respect to effects on cost or schedule (i.e. "anyone's guess") would probably follow a uniform or discrete uniform distribution.
7. The responsibility or POC is the entity responsible as the Subject Matter Expert (SME) for action, monitoring, or information on the PDT for the identified risk or opportunity.
8. Correlation recognizes those risk events that may be related to one another. Care should be given to ensure the risks are handled correctly without a "double counting."
9. Affected Project Component identifies the specific item of the project to which the risk directly or strongly correlates.
10. Project Implications identifies whether or not the risk item affects project cost, project schedule, or both. The PDT is responsible for conducting studies for both Project Cost and for Project Schedule.
11. Results of the risk identification process are studied and further developed by the Cost Engineer, then analyzed through the Monte Carlo Analysis Method for Cost (Contingency) and Schedule (Escalation) Growth.

ATTACHMENT B

Market Research

US Army Corps
of Engineers®
Los Angeles District

Los Angeles River Ecosystem Restoration Feasibility Study

Cost Appendix

Attachment 13
MCACES Construction Cost Estimate Summary

April 2015

NATIONAL ECOSYSTEM RESTORATION PLAN – ALTERNATIVE 13v

MCACES COST ESTIMATE SUMMARY

The Los Angeles River Ecosystem Restoration Feasibility Study is evaluating ecosystem restoration opportunities on an 11.5-mile long reach of the Los Angeles River (River) located in southern California. This reach, named the Los Angeles River ARBOR (Area with Restoration Benefits and Opportunities for Revitalization) extends from the Headworks area downstream to First Street in downtown Los Angeles. The ARBOR reach includes the Glendale Narrows—one of the few sections of the study area that does not have a hardened river bed—and contains several distinctive sites and connections including the Headworks, Pollywog Park, Bette Davis Park, the Burbank-Western Channel and Glendale River Walk, Griffith Park, Ferraro Fields, Verdugo Wash, Atwater Village, Taylor Yard and the Rio de Los Angeles State Park, the "Cornfields" (Los Angeles State Historic Park), Arroyo Seco, Elysian Park, "Piggyback Yard" (also known as the "Los Angeles Transportation Center" as well as "Mission Yard"), and downtown Los Angeles.

The National Ecosystem Restoration (NER) Plan is Alternative 13SPL. This alternative incorporates various construction items from each of the eight sub-reaches of the project. The design features for the sub-reaches are designed at a conceptual level. Features for the NER Plan include concrete demolition; excavation and fill; riprap; grouted riprap; turf reinforcement mats; fencing; clearing and grubbing; reinforced cast-in-place concrete;; sub-drainage system; asphalt; multi-use trail; trail access points; pedestrian bridges and other recreation components.

The current designs are based on preliminary, planning-level conceptual designs, and common engineering practices. The design level used to complete the MCACES construction cost estimate has not progressed beyond the level used at the alternatives analysis stage. More detailed assumptions have been developed for key construction items that were not included in the alternatives analysis, which primarily includes diversion and control of water elements.

Estimated by Tetra Tech, Inc.
Designed by Tetra Tech, Inc.
Prepared by Tetra Tech, Inc
Preparation Date 3/5/2015
Effective Date of Pricing 3/5/2015
Estimated Construction Time 2,807 Days

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Description	Quantity	UOM	ContractCost	ProjectCost	C/O
Project Cost Summary Report			229,932,569	229,932,569	
Los Angeles River - ARBOR Corridor Extension (ACE)	1.00	LS	229,932,569	229,932,569	
Contract 1 [Reach 6]	1.00	LS	33,454,901	33,454,901	
R6 Reach 6 - Glendale Freeway to I-5	1.00	LS	30,951,845	30,951,845	
R6 02 Relocations	1.00	LS	2,330,372	2,330,372	
R6 06 06 - Fish and Wildlife Facilities	1.00	LS	27,630,226	27,630,226	
R6 14 14 - Recreation	1.00	LS	991,247	991,247	
MAM Monitoring and Adaptive Management - Contract 1	1.00	LS	2,503,056	2,503,056	
MAM 01 Monitoring and Adaptive Management - Contract 1	1.00	LS	2,503,056	2,503,056	
Contract 2 [Reach 3, 4 & 5]	1.00	LS	35,787,032	35,787,032	
R5 Reach 5 - Los Feliz Blvd to Glendale Freeway	1.00	LS	1,709,583	1,709,583	
R5 06 06 - Fish and Wildlife Facilities	1.00	LS	263,583	263,583	
R5 14 14 - Recreation	1.00	LS	1,446,000	1,446,000	
R4 Reach 4 - Brazil St. to Los Feliz Blvd	1.00	LS	17,560,643	17,560,643	
R4 06 06 - Fish and Wildlife Facilities	1.00	LS	16,640,334	16,640,334	
R4 14 14 - Recreation	1.00	LS	920,309	920,309	
R3 Reach 3 - Ferraro Fields to Brazil St.	1.00	LS	13,821,591	13,821,591	
R3 06 06 - Fish and Wildlife Facilities	1.00	LS	12,847,469	12,847,469	
R3 14 14 - Recrcation	1.00	LS	974,122	974,122	
MAM Monitoring and Adaptive Management - Contract 2	1.00	LS	2,695,215	2,695,215	
MAM 01 Monitoring and Adaptive Management - Contract 2	1.00	LS	2,695,215	2,695,215	
Contract 3 [Reach 1 & 2]	1.00	LS	2,800,650	2,800,650	
R2 Reach 2 - Midpoint of Betty Davis Park to Upstream End of Ferraro Fields	1.00	LS	341,679	341,679	
R2 06 06 - Fish and Wildlife Facilities	1.00	LS	157,481	157,481	
R2 14 14 - Recreation	1.00	LS	184,198	184,198	
R1 Reach 1 - Pollywog Park / Headworks to Midpoint of Betty Davis Park	1.00	LS	2,266,243	2,266,243	
R1 06 06 - Fish and Wildlife Facilities	1.00	LS	1,969,960	1,969,960	
R1 14 14 - Recreation	1.00	LS	296,283	296,283	
MAM Monitoring and Adaptive Management - Contract 3	1.00	LS	192,728	192,728	
MAM 01 Monitoring and Adaptive Management - Contract 3	1.00	LS	192,728	192,728	
Contract 4 [Reach 7 & 8]	1.00	LS	35,518,336	35,518,336	
R8 Reach 8 - Main St. to 1st St.	1.00	LS	15,095,175	15,095,175	

Description	Quantity	UOM	ContractCost	ProjectCost	C/O
R8 06 06 - Fish and Wildlife Facilities	**1.00**	**LS**	**13,776,400**	**13,776,400**	
R8 14 14 - Recreation	**1.00**	**LS**	**1,318,775**	**1,318,775**	
R7 Reach 7 - I-5 to Main St.	**1.00**	**LS**	**18,194,310**	**18,194,310**	
R7 02 02 - Relocations	**1.00**	**LS**	**7,219,964**	**7,219,964**	
R7 06 06 - Fish and Wildlife Facilities	**1.00**	**LS**	**10,826,987**	**10,826,987**	
R7 14 14 - Recreation	**1.00**	**LS**	**147,359**	**147,359**	
MAM Monitoring and Adaptive Management - Contract 4	**1.00**	**LS**	**2,228,851**	**2,228,851**	
MAM 01 Monitoring and Adaptive Management - Contract 4	**1.00**	**LS**	**2,228,851**	**2,228,851**	
Contract 5 [LATC]	**1.00**	**LS**	**122,371,650**	**122,371,650**	
LATC LATC Intermodal Facility Relocation	**1.00**	**LS**	**122,371,650**	**122,371,650**	
LATC 02 02 - Relocations	**1.00**	**LS**	**122,371,650**	**122,371,650**	

LOCALLY PREFERRED PLAN – ALTERNATIVE 20

MCACES COST ESTIMATE SUMMARY

The Los Angeles River Ecosystem Restoration Feasibility Study is evaluating ecosystem restoration opportunities on an 11.5-mile long reach of the Los Angeles River (River) located in southern California. This reach, named the Los Angeles River ARBOR (Area with Restoration Benefits and Opportunities for Revitalization) extends from the Headworks area downstream to First Street in downtown Los Angeles. The ARBOR reach includes the Glendale Narrows—one of the few sections of the study area that does not have a hardened river bed—and contains several distinctive sites and connections including the Headworks, Pollywog Park, Bette Davis Park, the Burbank-Western Channel and Glendale River Walk, Griffith Park, Ferraro Fields, Verdugo Wash, Atwater Village, Taylor Yard and the Rio de Los Angeles State Park, the "Cornfields" (Los Angeles State Historic Park), Arroyo Seco, Elysian Park, "Piggyback Yard" (also known as the "Los Angeles Transportation Center" as well as "Mission Yard"), and downtown Los Angeles.

The LPP is Alternative 20, ARBOR Riparian Integration via Varied Ecological Reintroduction (RIVER). This alternative incorporates various construction items from each of the eight sub-reaches of the project. The design features for the sub-reaches are designed at a conceptual level. Features for the LPP include concrete demolition; excavation and fill; riprap; grouted riprap; turf reinforcement mats; fencing; clearing and grubbing; reinforced cast-in-place concrete; sub-drainage system; asphalt; multi-use trail; trail access points; railroad trestles; pedestrian bridges and other recreation components.

The current designs are based on preliminary, planning-level conceptual designs, and common engineering practices. The design level used to complete the MCACES construction cost estimate has not progressed beyond the level used at the alternatives analysis stage. More detailed assumptions have been developed for key construction items that were not included in the alternatives analysis, which primarily includes diversion and control of water elements.

Estimated by Tetra Tech, Inc.
Designed by Tetra Tech, Inc.
Prepared by Tetra Tech, Inc
Preparation Date 3/5/2015
Effective Date of Pricing 3/5/2015
Estimated Construction Time 4,177 Days

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Description	Quantity	UOM	ContractCost	ProjectCost	C/O
Project Cost Summary Report			**508,200,756**	**508,200,756**	
Los Angeles River - ARBOR Riparian Integration via Varied Ecological Reintroduction (RIVER)	**1.00**	**LS**	**508,200,756**	**508,200,756**	
			32,822,960.56	*32,822,960.56*	
Contract 1 [Reach 6]	**1.00**	**EA**	**32,822,961**	**32,822,961**	
R6 Reach 6 - Glendale Freeway to I-5	**1.00**	**LS**	**32,045,089**	**32,045,089**	
R6 02 Relocations	**1.00**	**LS**	**2,430,078**	**2,430,078**	
R6 06 06 - Fish and Wildlife Facilities	**1.00**	**LS**	**28,589,134**	**28,589,134**	
R6 14 14 - Recreation	**1.00**	**LS**	**1,025,877**	**1,025,877**	
MAM Monitoring and Adaptive Management - Contract 1	**1.00**	**LS**	**777,872**	**777,872**	
MAM 01 Monitoring and Adaptive Management - Contract 1	**1.00**	**LS**	**777,872**	**777,872**	
Contract 2 [Reach 5]	**1.00**	**LS**	**93,930,602**	**93,930,602**	
R5 Reach 5 - Los Feliz Blvd to Glendale Freeway	**1.00**	**LS**	**91,480,824**	**91,480,824**	
R5 06 06 - Fish and Wildlife Facilities	**1.00**	**LS**	**90,036,767**	**90,036,767**	
R5 14 14 - Recreation	**1.00**	**LS**	**1,444,057**	**1,444,057**	
MAM Monitoring and Adaptive Management - Contract 2	**1.00**	**LS**	**2,449,778**	**2,449,778**	
MAM 01 Monitoring and Adaptive Management - Contract 2	**1.00**	**LS**	**2,449,778**	**2,449,778**	
Contract 3 [Reach 4]	**1.00**	**LS**	**18,263,614**	**18,263,614**	
R4 Reach 4 - Brazil St. to Los Feliz Blvd	**1.00**	**LS**	**17,804,241**	**17,804,241**	
R4 06 06 - Fish and Wildlife Facilities	**1.00**	**LS**	**16,883,366**	**16,883,366**	
R4 14 14 - Recreation	**1.00**	**LS**	**920,874**	**920,874**	
MAM Monitoring and Adaptive Management - Contract 3	**1.00**	**LS**	**459,373**	**459,373**	
MAM 01 Monitoring and Adaptive Management - Contract 3	**1.00**	**LS**	**459,373**	**459,373**	
Contract 4 [Reach 7]	**1.00**	**LS**	**19,879,663**	**19,879,663**	
R7 Reach 7 - I-5 to Main St.	**1.00**	**LS**	**19,590,936**	**19,590,936**	
R7 02 02 - Relocations	**1.00**	**LS**	**7,122,644**	**7,122,644**	
R7 06 06 - Fish and Wildlife Facilities	**1.00**	**LS**	**10,611,601**	**10,611,601**	
R7 14 14 - Recreation	**1.00**	**LS**	**1,856,691**	**1,856,691**	
MAM Monitoring and Adaptive Management - Contract 4	**1.00**	**LS**	**288,727**	**288,727**	
MAM 01 Monitoring and Adaptive Management - Contract 4	**1.00**	**LS**	**288,727**	**288,727**	
Contract 5 [Reach 3]	**1.00**	**LS**	**64,125,133**	**64,125,133**	
R3 Reach 3 - Ferraro Fields to Brazil St.	**1.00**	**LS**	**62,454,445**	**62,454,445**	
R3 06 06 - Fish and Wildlife Facilities	**1.00**	**LS**	**61,402,853**	**61,402,853**	

Description	Quantity	UOM	ContractCost	ProjectCost	C/O
R3 14 14 - Recreation	1.00	LS	1,051,593	1,051,593	
MAM Monitoring and Adaptive Management - Contract 5	1.00	LS	1,670,688	1,670,688	
MAM 01 Monitoring and Adaptive Management - Contract 5	1.00	LS	1,670,688	1,670,688	
Contract 6 [Reach 1 & 2]	1.00	LS	20,967,329	20,967,329	
R2 Reach 2 - Midpoint of Betty Davis Park to Upstream End of Ferraro Fields	1.00	LS	18,298,564	18,298,564	
R2 06 06 - Fish and Wildlife Facilities	1.00	LS	18,104,648	18,104,648	
R2 14 14 - Recreation	1.00	LS	193,915	193,915	
R1 Reach 1 - Pollywog Park / Headworks to Midpoint of Betty Davis Park	1.00	LS	2,125,950	2,125,950	
R1 06 06 - Fish and Wildlife Facilities	1.00	LS	1,845,443	1,845,443	
R1 14 14 - Recreation	1.00	LS	280,507	280,507	
MAM Monitoring and Adaptive Management - Contract 6	1.00	LS	542,815	542,815	
MAM 01 Monitoring and Adaptive Management - Contract 6	1.00	LS	542,815	542,815	
Contract 7 [Reach 8]	1.00	LS	135,839,804	135,839,804	
R8 Reach 8 - Main St. to 1st St.	1.00	LS	133,238,538	133,238,538	
R8 02 02 - Relocations	1.00	LS	33,699,479	33,699,479	
R8 06 06 - Fish and Wildlife Facilities	1.00	LS	95,604,405	95,604,405	
R8 14 14 - Recreation	1.00	LS	3,934,655	3,934,655	
MAM Monitoring and Adaptive Management - Contract 7	1.00	LS	2,601,266	2,601,266	
MAM 01 Monitoring and Adaptive Management - Contract 7	1.00	LS	2,601,266	2,601,266	
Contract 8 [LATC]	1.00	LS	122,371,650	122,371,650	
LATC LATC Intermodal Facility Relocation	1.00	LS	122,371,650	122,371,650	
LATC 02 02 - Relocations	1.00	LS	122,371,650	122,371,650	

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Los Angeles River Ecosystem Restoration Feasibility Study

Cost Appendix

Attachment 14
Total Project Cost Summary (TPCS)

April 2015

NATIONAL ECOSYSTEM RESTORATION PLAN – ALTERNATIVE 13v

TPCS SPREADSHEET

****** TOTAL PROJECT COST SUMMARY ******

PROJECT: Los Angeles River Feasibility Project, NER Plan
PROJECT No: 104791
LOCATION: Los Angeles, CA

DISTRICT: Los Angeles District
POC: Mike Newnam, Chief, Cost Engineering

PREPARED: February 27, 2015

This Estimate reflects the scope and schedule in feasibility report; Los Angeles River Ecosystem Restoration Feasibility Report

WBS STRUCTURE		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
						Program Year (Budget EC): 2016								
						Effective Price Level Date: 1 Oct 2015								
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Spent Thru: 1 Oct 2015 ($K)	Obligations up to: 1 Oct 2015 ($K)	COST ($K)	CNTG ($K)	FULL ($K)
02	RELOCATIONS	131,922	46,057	34.9%	177,979	1.9%	134,387	46,918	181,305			158,239	55,245	213,484
06	FISH & WILDLIFE FACILITIES	84,112	28,421	33.8%	112,533	1.9%	85,685	28,952	114,637			97,670	33,069	130,939
06	FISH & WILDLIFE FACILITIES (Monitoring & Adaptive Management)	7,620	2,575	33.8%	10,195	1.9%	7,763	2,623	10,386			9,171	3,098	12,269
14	RECREATION FACILITIES	6,278	2,121	33.8%	8,399	1.9%	6,396	2,160	8,556			7,341	2,479	9,820
	CONSTRUCTION ESTIMATE TOTALS:	229,933	79,174		309,107		234,231	80,653	314,884			272,621	93,891	366,512
01	LANDS AND DAMAGES	296,303	44,445	15.0%	340,748	2.3%	303,144	45,471	348,615			341,842	51,275	393,117
30	PLANNING, ENGINEERING & DESIGN	19,862	6,764	34.0%	26,646	3.4%	20,564	6,992	27,556			25,258	8,596	33,854
31	CONSTRUCTION MANAGEMENT	9,688	3,299	34.1%	12,987	3.4%	10,000	3,412	13,412			13,375	4,564	17,939
	PROJECT COST TOTALS:	555,785	133,682	24.1%	689,468		567,939	136,528	**704,467**			653,096	158,326	**811,422**

CHIEF, COST ENGINEERING AND SPECIFICATIONS, Michael D. Newnam, P.E.

PROJECT MANAGEMENT, Tawny Tran

CHIEF, REAL ESTATE, Theresa Kaplan

CHIEF, ENGINEERING, Richard J. Leifield, P.E.

ESTIMATED FEDERAL COST:	24.5%	**198,880**
ESTIMATED NON-FEDERAL COST:	75.5%	**612,542**
ESTIMATED TOTAL PROJECT COST:		**811,422**
PREVIOUS TPCS:		
Dated:		
THIS TPCS REFLECTS A PROJECT COST INCREASE OF:		**811,422**
THE 902 COST LIMIT IS:		
Dated:		
O&M OUTSIDE OF TOTAL PROJECT COST:		**N/A**

Filename: LA River Restoration_TPCS_ALT 13_20150305 JGN
TPCS

CONTRACT 1 - REACH 6

**** CONTRACT COST SUMMARY ****

PROJECT: Los Angeles River Feasibility Project, NER Plan
LOCATION: Los Angeles, CA
This Estimate reflects the scope and schedule in feasibility report;

DISTRICT: Los Angeles District
POC: Mike Newnam, Chief, Cost Engineering

PREPARED: February 27, 2015

Los Angeles River Ecosystem Restoration Feasibility Report

WBS STRUCTURE		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Mii Estimate Prepared: 2014(Oct - Dec)				Program Year (Budget EC): 2016 Effective Price Level Date: 1 Oct 2015								
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
	CONTRACT 1 - REACH 6													
02	RELOCATIONS	2,330	787	33.8%	3,117	1.9%	2,374	802	3,176	2020Q2	8.7%	2,582	872	3,454
06	FISH & WILDLIFE FACILITIES	27,630	9,336	33.8%	36,966	1.9%	28,147	9,511	37,658	2020Q2	8.7%	30,609	10,343	40,952
06	FISH & WILDLIFE FACILITIES (Monitoring & Adaptive Management)	2,503	846	33.8%	3,349	1.9%	2,550	862	3,412	2022Q4	14.3%	2,914	985	3,899
14	RECREATION FACILITIES	991	335	33.8%	1,326	1.9%	1,010	341	1,351	2020Q2	8.7%	1,098	371	1,469
	CONSTRUCTION ESTIMATE TOTALS:	33,455	11,304	33.8%	44,759		34,081	11,516	45,597			37,203	12,571	49,774
01	LANDS AND DAMAGES	$63,227	9,484	15.0%	72,711	2.3%	64,687	9,703	74,390	2017Q1	2.3%	66,147	9,922	76,069
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	335	113	33.8%	448	3.4%	347	117	464	2017Q1	3.9%	360	122	482
1.0%	Planning & Environmental Compliance	335	113	33.8%	448	3.4%	347	117	464	2017Q1	3.9%	360	122	482
10.0%	Engineering & Design	3,345	1,130	33.8%	4,475	3.4%	3,460	1,169	4,629	2017Q1	3.9%	3,594	1,214	4,808
1.0%	Reviews, ATRs, IEPRs, VE	335	113	33.8%	448	3.4%	347	117	464	2017Q1	3.9%	360	122	482
0.5%	Life Cycle Updates (cost, schedule, risks)	167	56	33.8%	223	3.4%	173	58	231	2017Q1	3.9%	180	60	240
0.5%	Contracting & ReprographicsContracting	167	56	33.8%	223	3.4%	173	58	231	2017Q1	3.9%	180	60	240
0.5%	Engineering During Construction	167	56	33.8%	223	3.4%	173	58	231	2020Q2	17.7%	204	68	272
	Planning During Construction			33.8%										
	Project Operation			33.8%										
			PED Subtotal:		6,488		PED Subtotal:		6,714			PED Subtotal:		7,006
31	CONSTRUCTION MANAGEMENT													
6.5%	Construction Management	2,175	735	33.8%	2,910	3.4%	2,250	760	3,010	2020Q2	17.7%	2,649	895	3,544
	Project Operation:			33.8%										
	Project Management			33.8%										
	CONTRACT COST TOTALS:	103,708	23,160		126,868		106,035	23,673	129,711			111,237	25,156	**136,393**

COST SPLIT

Filename: LA River Restoration_TPCS_ALT 13_20150305 JGN
TPCS

****** TOTAL PROJECT COST SUMMARY ******

CONTRACT 2 - REACHES 3, 4 & 5

****** CONTRACT COST SUMMARY ******

PROJECT: Los Angeles River Feasibility Project, NER Plan
LOCATION: Los Angeles, CA
This Estimate reflects the scope and schedule in feasibility report; Los Angeles River Ecosystem Restoration Feasibility Report

DISTRICT: Los Angeles District
POC: Mike Newnam, Chief, Cost Engineering

PREPARED: February 27, 2015

WBS STRUCTURE		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Mii Estimate Prepared: 2014(Oct - Dec)				Program Year (Budget EC): 2016 Effective Price Level Date: 1 Oct 2015								
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
	CONTRACT 2 - REACHES 3, 4 & 5													
02	RELOCATIONS			33.8%										
06	FISH & WILDLIFE FACILITIES	29,751	10,053	33.8%	39,804	1.9%	30,308	10,241	40,549	2022Q2	13.1%	34,291	11,587	45,878
06	FISH & WILDLIFE FACILITIES (Monitoring & Adaptive Management)	2,695	911	33.8%	3,606	1.9%	2,746	928	3,674	2024Q4	18.9%	3,265	1,103	4,368
14	RECREATION FACILITIES	3,340	1,129	33.8%	4,469	1.9%	3,403	1,150	4,553	2022Q2	13.1%	3,850	1,301	5,151
	CONSTRUCTION ESTIMATE TOTALS:	35,787	12,093	33.8%	47,880		36,457	12,319	48,776			41,406	13,991	55,397
01	LANDS AND DAMAGES	$10,258	1,539	15.0%	11,797	2.3%	10,495	1,574	12,069	2019Q2	6.8%	11,206	1,681	12,887
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	358	121	33.8%	479	3.4%	370	125	495	2019Q2	13.3%	419	142	561
1.0%	Planning & Environmental Compliance	358	121	33.8%	479	3.4%	370	125	495	2019Q2	13.3%	419	142	561
10.0%	Engineering & Design	3,579	1,209	33.8%	4,788	3.4%	3,702	1,251	4,953	2019Q2	13.3%	4,193	1,417	5,610
1.0%	Reviews, ATRs, IEPRs, VE	358	121	33.8%	479	3.4%	370	125	495	2019Q2	13.3%	419	142	561
0.5%	Life Cycle Updates (cost, schedule, risks)	179	60	33.8%	239	3.4%	185	62	247	2019Q2	13.3%	210	70	280
0.5%	Contracting & ReprographicsContracting	179	60	33.8%	239	3.4%	185	62	247	2019Q2	13.3%	210	70	280
0.5%	Engineering During Construction	179	60	33.8%	239	3.4%	185	62	247	2022Q2	27.3%	236	79	315
	Planning During Construction			33.8%										
	Project Operation			33.8%										
			PED Subtotal:		6,942			PED Subtotal:	7,179				PED Subtotal:	8,168
31	CONSTRUCTION MANAGEMENT													
6.5%	Construction Management	2,326	786	33.8%	3,112	3.4%	2,406	813	3,219	2022Q2	27.3%	3,064	1,035	4,099
	Project Operation:			33.8%										
	Project Management			33.8%										
	CONTRACT COST TOTALS:	53,562	18,170		69,731		54,725	16,518	71,243			61,782	18,769	**80,551**

COST SPLIT

Filename: LA River Restoration_TPCS_ALT 13_20150305 JGN
TPCS

CONTRACT 3 - REACHES 1 & 2

**** CONTRACT COST SUMMARY ****

PROJECT: Los Angeles River Feasibility Project; NER Plan
LOCATION: Los Angeles, CA
This Estimate reflects the scope and schedule in feasibility report;

DISTRICT: Los Angeles District
POC: Mike Newnam, Chief, Cost Engineering

PREPARED: February 27, 2015

Los Angeles River Ecosystem Restoration Feasibility Report

WBS STRUCTURE		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Mii Estimate Prepared:		2014(Oct - Dec)		Program Year (Budget EC): 2016 Effective Price Level Date: 1 Oct 2015								
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
	CONTRACT 3 - REACHES 1 & 2													
02	RELOCATIONS			33.8%										
06	FISH & WILDLIFE FACILITIES	2,127	719	33.8%	2,846	1.9%	2,167	732	2,899	2024Q4	18.9%	2,576	870	3,446
06	FISH & WILDLIFE FACILITIES (Monitoring & Adaptive Management)	193	65	33.8%	258	1.9%	196	66	262	2027Q2	21.3%	238	80	318
14	RECREATION FACILITIES	480	162	33.8%	642	1.9%	489	165	654	2024Q4	18.9%	581	196	777
	CONSTRUCTION ESTIMATE TOTALS:	2,801	946	33.8%	3,747		2,852	963	3,815			3,395	1,146	4,541
01	LANDS AND DAMAGES	59,841	1,476	15.0%	11,317	2.3%	10,068	1,510	11,578	2022Q2	13.5%	11,431	1,714	13,145
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	28	9	33.8%	37	3.4%	29	9	38	2022Q2	27.3%	37	11	48
1.0%	Planning & Environmental Compliance	28	9	33.8%	37	3.4%	29	9	38	2022Q2	27.3%	37	11	48
10.0%	Engineering & Design	280	95	33.8%	375	3.4%	290	98	388	2022Q2	27.3%	369	125	494
1.0%	Reviews, ATRs, IEPRs, VE	28	9	33.8%	37	3.4%	29	9	38	2022Q2	27.3%	37	11	48
0.5%	Life Cycle Updates (cost, schedule, risks)	14	5	33.8%	19	3.4%	14	5	19	2022Q2	27.3%	18	6	24
0.5%	Contracting & ReprographicsContracting	14	5	33.8%	19	3.4%	14	5	19	2022Q2	27.3%	18	6	24
0.5%	Engineering During Construction	14	5	33.8%	19	3.4%	14	5	19	2024Q4	40.8%	20	7	27
	Planning During Construction			33.8%										
	Project Operation			33.8%										
			PED Subtotal:		543		PED Subtotal:		559			PED Subtotal:		713
31	CONSTRUCTION MANAGEMENT													
6.5%	Construction Management	182	61	33.8%	243	3.4%	188	63	251	2024Q4	40.8%	265	89	354
	Project Operation:			33.8%										
	Project Management			33.8%										
	CONTRACT COST TOTALS:	13,229	2,620		15,849		13,527	2,676	16,203			15,627	3,126	**18,753**

COST SPLIT

CONTRACT 4 - REACHES 5 & 7

**** CONTRACT COST SUMMARY ****

PROJECT: Los Angeles River Feasibility Project, NER Plan
LOCATION: Los Angeles, CA
This Estimate reflects the scope and schedule in feasibility report; Los Angeles River Ecosystem Restoration Feasibility Report

DISTRICT: Los Angeles District
POC: Mike Newnam, Chief, Cost Engineering

PREPARED: February 27, 2015

WBS STRUCTURE		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Mii Estimate Prepared: 2014(Oct - Dec)				Program Year (Budget EC): 2016 Effective Price Level Date: 1 Oct 2015								
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
	CONTRACT 4 - REACHES 5 & 7													
02	RELOCATIONS	7,220	2,440	33.8%	9,660	1.9%	7,355	2,486	9,841	2026Q2	21.3%	8,919	3,015	11,934
06	FISH & WILDLIFE FACILITIES	24,603	8,313	33.8%	32,916	1.9%	25,063	8,468	33,531	2026Q2	21.3%	30,394	10,269	40,663
06	FISH & WILDLIFE FACILITIES (Monitoring & Adaptive Management)	2,229	753	33.8%	2,982	1.9%	2,271	767	3,038	2028Q4	21.3%	2,754	930	3,684
14	RECREATION FACILITIES	1,466	495	33.8%	1,961	1.9%	1,494	504	1,998	2026Q2	21.3%	1,812	611	2,423
	CONSTRUCTION ESTIMATE TOTALS:	35,518	12,001	33.8%	47,519		36,183	12,225	48,408			43,879	14,825	58,704
01	LANDS AND DAMAGES	$32,141	4,821	15.0%	36,962	2.3%	32,983	4,932	37,815	2024Q2	18.1%	38,820	5,822	44,642
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	355	120	33.8%	475	3.4%	367	124	491	2024Q2	37.9%	506	171	677
1.0%	Planning & Environmental Compliance	355	120	33.8%	475	3.4%	367	124	491	2024Q2	37.9%	506	171	677
10.0%	Engineering & Design	3,552	1,200	33.8%	4,752	3.4%	3,674	1,241	4,915	2024Q2	37.9%	5,067	1,712	6,779
1.0%	Reviews, ATRs, IEPRs, VE	355	120	33.8%	475	3.4%	367	124	491	2024Q2	37.9%	506	171	677
0.5%	Life Cycle Updates (cost, schedule, risks)	178	60	33.8%	238	3.4%	184	62	246	2024Q2	37.9%	254	86	340
0.5%	Contracting & ReprographicsContracting	178	60	33.8%	238	3.4%	184	62	246	2024Q2	37.9%	254	86	340
0.5%	Engineering During Construction	178	60	33.8%	238	3.4%	184	62	246	2026Q2	49.9%	276	93	369
	Planning During Construction			33.8%										
	Project Operation			33.8%										
			PED Subtotal:		6,891		PED Subtotal:		7,126			PED Subtotal:		9,859
31	CONSTRUCTION MANAGEMENT													
6.5%	Construction Management	2,309	780	33.8%	3,089	3.4%	2,388	807	3,195	2026Q2	49.9%	3,579	1,209	4,788
	Project Operation:			33.8%										
	Project Management			33.8%										
	CONTRACT COST TOTALS:	75,119	19,342		94,461		78,781	19,763	98,544			93,647	24,346	**117,993**

COST SPLIT

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Filename: LA River Restoration_TPCS_ALT 13_20150305 JGN
TPCS

CONTRACT 5 - LATC RELOCATION

**** CONTRACT COST SUMMARY ****

PROJECT: Los Angeles River Feasibility Project, NER Plan
LOCATION: Los Angeles, CA
This Estimate reflects the scope and schedule in feasibility report;

DISTRICT: Los Angeles District
POC: Mike Newnam, Chief, Cost Engineering

PREPARED: February 27, 2015

Los Angeles River Ecosystem Restoration Feasibility Report

WBS STRUCTURE		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Mii Estimate Prepared:		2014(Oct - Dec)		Program Year (Budget EC): 2016 Effective Price Level Date: 1 Oct 2015								
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
	CONTRACT 5 - LATC RELOCATION													
02	RELOCATIONS	122,372	42,830	35.0%	165,202	1.9%	124,658	43,630	168,288	2024Q2	17.7%	146,738	51,358	198,096
06	FISH & WILDLIFE FACILITIES													
06	FISH & WILDLIFE FACILITIES (Monitoring & Adaptive Management)													
14	RECREATION FACILITIES													
	CONSTRUCTION ESTIMATE TOTALS:	122,372	42,830	35.0%	165,202		124,658	43,630	168,288			146,738	51,358	198,096
01	LANDS AND DAMAGES	$180,836	27,125	15.0%	207,961	2.3%	185,011	27,752	212,763	2023Q4	15.8%	214,238	32,136	246,374
30	PLANNING, ENGINEERING & DESIGN													
0.5%	Project Management	612	214	35.0%	826	3.4%	633	221	854	2023Q4	35.2%	856	299	1,155
0.5%	Planning & Environmental Compliance	612	214	35.0%	826	3.4%	633	221	854	2023Q4	35.2%	856	299	1,155
0.5%	Engineering & Design	612	214	35.0%	826	3.4%	633	221	854	2023Q4	35.2%	856	299	1,155
0.5%	Reviews, ATRs, IEPRs, VE	612	214	35.0%	826	3.4%	633	221	854	2023Q4	35.2%	856	299	1,155
0.5%	Life Cycle Updates (cost, schedule, risks)	612	214	35.0%	826	3.4%	633	221	854	2023Q4	35.2%	856	299	1,155
0.5%	Contracting & ReprographicsContracting	612	214	35.0%	826	3.4%	633	221	854	2023Q4	35.2%	856	299	1,155
0.5%	Engineering During Construction	612	214	35.0%	826	3.4%	633	221	854	2024Q2	37.9%	873	305	1,178
	Planning During Construction			35.0%										
	Project Operation			35.0%										
			PED Subtotal:		5,782		PED Subtotal:		5,978			PED Subtotal:		8,108
31	CONSTRUCTION MANAGEMENT													
2.2%	Construction Management	2,676	937	35.0%	3,613	3.4%	2,768	969	3,737	2024Q2	37.9%	3,818	1,336	5,154
	Project Operation:			35.0%										
	Project Management			35.0%										
	CONTRACT COST TOTALS:	310,168	72,390.39		382,558		316,868	73,898	390,766			370,803	86,929	**457,732**

COST SPLIT

Filename: LA River Restoration_TPCS_ALT 13_20150305 JGN
TPCS

LOCALLY PREFERRED PLAN – ALTERNATIVE 20

TPCS SPREADSHEET

****** TOTAL PROJECT COST SUMMARY ******

PROJECT: Los Angeles River Feasibility Project, LPP Plan
PROJECT No: 104791
LOCATION: Los Angeles, CA

DISTRICT: Los Angeles District
POC: Mike Newnam, Chief, Cost Engineering

PREPARED: February 27, 2015

This Estimate reflects the scope and schedule in feasibility report; Los Angeles River Ecosystem Restoration Feasibility Report

WBS STRUCTURE		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
						Program Year (Budget EC):			2016					
						Effective Price Level Date:			1 Oct 2015					
										Spent Thru:	Obligations up to:			
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	1 Oct 2014 ($K)	1 Oct 2015 ($K)	COST ($K)	CNTG ($K)	FULL ($K)
02	RELOCATIONS	165,624	58,746	35.5%	224,370	1.9%	168,718	59,844	228,562			203,859	72,298	276,157
06	FISH & WILDLIFE FACILITIES	323,078	118,893	36.8%	441,971	1.9%	329,118	121,115	450,233			389,515	143,342	532,857
06	FISH & WILDLIFE FACILITIES (Monitoring & Adaptive Management)	8,791	3,235	36.8%	12,026	1.9%	8,955	3,295	12,250			10,810	3,976	14,786
14	RECREATION FACILITIES	10,708	3,941	36.8%	14,649	1.9%	10,907	4,014	14,921			12,923	4,756	17,679
	CONSTRUCTION ESTIMATE TOTALS:	508,201	184,815		693,016		517,698	188,268	705,966			617,107	224,372	841,479
01	LANDS AND DAMAGES	446,789	67,620	15.1%	514,409	2.3%	457,104	69,181	526,285			536,142	81,137	617,279
30	PLANNING, ENGINEERING & DESIGN	80,228	22,085	36.7%	82,313	3.4%	82,294	22,841	85,135			88,662	32,487	121,149
31	CONSTRUCTION MANAGEMENT	27,754	10,186	36.6%	37,920	3.4%	28,707	10,515	39,222			45,819	16,770	62,589
	PROJECT COST TOTALS:	1,042,971	284,686	27.3%	1,327,657		1,085,803	290,805	**1,356,608**			1,287,730	354,766	**1,642,496**

CHIEF, COST ENGINEERING AND SPECIFICATIONS, Michael D. Newnam, P.E.

PROJECT MANAGEMENT, Tawny Tran

CHIEF, REAL ESTATE, Theresa Kaplan

CHIEF, ENGINEERING, Richard J. Leifield, P.E.

ESTIMATED TOTAL PROJECT COST: **1,642,496**

OPTION 1

ESTIMATED FEDERAL COST:	11.6%	**191,121**
ESTIMATED NON-FEDERAL COST:	88.4%	**1,451,375**

OPTION 2

ESTIMATED FEDERAL COST:	30.0%	**492,034**
ESTIMATED NON-FEDERAL COST:	70.0%	**1,150,462**

Filename: LA River Restoration_TPCS_ALT 20_20150306 JGN
TPCS

CONTRACT 1 - REACH 6

**** CONTRACT COST SUMMARY ****

PROJECT: Los Angeles River Feasibility Project, LPP Plan
LOCATION: Los Angeles, CA
This Estimate reflects the scope and schedule in feasibility report; Los Angeles River Ecosystem Restoration Feasibility Report

DISTRICT: Los Angeles District
POC: Mike Newnam, Chief, Cost Engineering

PREPARED: February 27, 2015

WBS STRUCTURE		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Mii Estimate Prepared: 2014(Oct - Dec)				Program Year (Budget EC): 2016 Effective Price Level Date: 1 Oct 2015								
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
	CONTRACT 1 - REACH 6													
02	RELOCATIONS	2,430	894	36.8%	3,324	1.9%	2,475	911	3,386	2019Q2	6.6%	2,639	971	3,610
05	FISH & WILDLIFE FACILITIES	28,589	10,521	36.8%	39,110	1.9%	29,124	10,718	39,842	2020Q3	9.3%	31,830	11,714	43,544
06	FISH & WILDLIFE FACILITIES (Monitoring & Adaptive Management)	778	286	36.8%	1,064	1.9%	792	291	1,083	2023Q1	14.8%	909	334	1,243
14	RECREATION FACILITIES	1,026	378	36.8%	1,404	1.9%	1,045	385	1,430	2020Q3	9.3%	1,142	421	1,563
	CONSTRUCTION ESTIMATE TOTALS:	32,823	12,079	36.8%	44,902		33,436	12,305	45,741			36,520	13,440	49,960
01	LANDS AND DAMAGES	$63,227	9,484	15.0%	72,711	2.3%	64,687	9,703	74,390	2017Q4	2.3%	66,147	9,922	76,069
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	328	121	36.8%	449	3.4%	339	125	464	2017Q4	6.9%	362	134	496
1.0%	Planning & Environmental Compliance	328	121	36.8%	449	3.4%	339	125	464	2017Q4	6.9%	362	134	496
10.0%	Engineering & Design	3,282	1,208	36.8%	4,490	3.4%	3,395	1,249	4,644	2017Q4	6.9%	3,630	1,335	4,965
1.0%	Reviews, ATRs, IEPRs, VE	328	121	36.8%	449	3.4%	339	125	464	2017Q4	6.9%	362	134	496
0.5%	Life Cycle Updates (cost, schedule, risks)	164	60	36.8%	224	3.4%	170	62	232	2017Q4	6.9%	182	66	248
0.5%	Contracting & ReprographicsContracting	164	60	36.8%	224	3.4%	170	62	232	2017Q4	6.9%	182	66	248
0.5%	Engineering During Construction	164	60	36.8%	224	3.4%	170	62	232	2020Q3	18.9%	202	74	276
	Planning During Construction			36.8%										
	Project Operation			36.8%										
			PED Subtotal:		6,509		PED Subtotal:		6,732			PED Subtotal:		7,225
31	CONSTRUCTION MANAGEMENT													
6.5%	Construction Management	2,133	785	36.8%	2,918	3.4%	2,206	812	3,018	2020Q3	18.9%	2,623	966	3,589
	Project Operation:			36.8%										
	Project Management			36.8%										
	CONTRACT COST TOTALS:	102,941	24,099		127,040		105,251	24,630	129,881			110,572	26,271	**136,843**

COST SPLIT

Filename: LA River Restoration_TPCS_ALT 20_20150306 JGN
TPCS

****** TOTAL PROJECT COST SUMMARY ******

CONTRACT 2 - REACH 5

****** CONTRACT COST SUMMARY ******

PROJECT: Los Angeles River Feasibility Project, LPP Plan
LOCATION: Los Angeles, CA
This Estimate reflects the scope and schedule in feasibility report; Los Angeles River Ecosystem Restoration Feasibility Report

DISTRICT: Los Angeles District PREPARED: February 27, 2015
POC: Mike Newnam, Chief, Cost Engineering

WBS STRUCTURE		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Mii Estimate Prepared: 2014(Oct - Dec)				Program Year (Budget EC): 2016 Effective Price Level Date: 1 Oct 2015								
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
	CONTRACT 2 - REACH 5													
02	RELOCATIONS			36.8%										
06	FISH & WILDLIFE FACILITIES	90,037	33,134	36.8%	123,171	1.9%	91,720	33,753	125,473	2023Q3	16.0%	106,379	39,147	145,526
06	FISH & WILDLIFE FACILITIES (Monitoring & Adaptive Management)	2,450	902	36.8%	3,352	1.9%	2,496	919	3,415	2026Q1	21.3%	3,027	1,114	4,141
14	RECREATION FACILITIES	1,444	531	36.8%	1,975	1.9%	1,471	541	2,012	2023Q3	16.0%	1,706	627	2,333
	CONSTRUCTION ESTIMATE TOTALS:	93,931	34,567	36.8%	128,498		95,687	35,213	130,900			111,112	40,888	152,000
01	LANDS AND DAMAGES	$449	78	17.3%	526	2.31%	459	79	538	2020Q2	9.0%	500	86	586
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	939	346	36.8%	1,285	3.4%	971	358	1,329	2020Q2	17.7%	1,143	422	1,565
1.0%	Planning & Environmental Compliance	939	346	36.8%	1,285	3.4%	971	358	1,329	2020Q2	17.7%	1,143	422	1,565
10.0%	Engineering & Design	9,393	3,457	36.8%	12,850	3.4%	9,716	3,576	13,292	2020Q2	17.7%	11,440	4,210	15,650
1.0%	Reviews, ATRs, IEPRs, VE	939	346	36.8%	1,285	3.4%	971	358	1,329	2020Q2	17.7%	1,143	422	1,565
0.5%	Life Cycle Updates (cost, schedule, risks)	470	173	36.8%	643	3.4%	486	179	665	2020Q2	17.7%	572	211	783
0.5%	Contracting & ReprographicsContracting	470	173	36.8%	643	3.4%	486	179	665	2020Q2	17.7%	572	211	783
0.5%	Engineering During Construction	470	173	36.8%	643	3.4%	486	179	665	2023Q3	33.8%	650	240	890
	Planning During Construction			36.8%										
	Project Operation			36.8%										
			PED Subtotal:		18,634		PED Subtotal:		19,274			PED Subtotal:		22,801
31	CONSTRUCTION MANAGEMENT													
5.5%	Construction Management	6,105	2,247	36.8%	8,352	3.4%	6,315	2,324	8,639	2023Q3	33.8%	8,452	3,111	11,563
	Project Operation:			36.8%										
	Project Management			36.8%										
	CONTRACT COST TOTALS:	114,104	41,906		156,010		116,548	42,803	159,351			136,727	50,223	**186,950**

COST SPLIT

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Filename: LA River Restoration_TPCS_ALT 20_20150306 JGN
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CONTRACT 3 - REACH 4

**** CONTRACT COST SUMMARY ****

PROJECT: Los Angeles River Feasibility Project, LPP Plan
LOCATION: Los Angeles, CA
This Estimate reflects the scope and schedule in feasibility report; Los Angeles River Ecosystem Restoration Feasibility Report

DISTRICT: Los Angeles District
POC: Mike Newnam, Chief, Cost Engineering

PREPARED: February 27, 2015

WBS STRUCTURE		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Mii Estimate Prepared: 2014(Oct - Dec)				Program Year (Budget EC): 2016 Effective Price Level Date: 1 Oct 2015								
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
	CONTRACT 3 - REACH 4													
02	RELOCATIONS			36.8%										
06	FISH & WILDLIFE FACILITIES	16,883	6,213	36.8%	23,096	1.9%	17,199	6,329	23,528	2023Q2	15.4%	19,848	7,304	27,152
06	FISH & WILDLIFE FACILITIES (Monitoring & Adaptive Management)	459	169	36.8%	628	1.9%	468	172	640	2025Q4	21.3%	568	209	777
14	RECREATION FACILITIES	921	339	36.8%	1,260	1.9%	938	345	1,283	2023Q2	15.4%	1,082	398	1,480
	CONSTRUCTION ESTIMATE TOTALS:	18,264	6,721	36.8%	24,985		18,605	6,846	25,451			21,498	7,911	29,409
01	LANDS AND DAMAGES	$5,314	956	18.0%	6,269	2.3%	5,436	978	6,414	2021Q2	11.3%	6,049	1,088	7,137
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	183	67	36.8%	250	3.4%	189	69	258	2021Q2	22.4%	231	84	315
1.0%	Planning & Environmental Compliance	183	67	36.8%	250	3.4%	189	69	258	2021Q2	22.4%	231	84	315
10.0%	Engineering & Design	1,826	672	36.8%	2,498	3.4%	1,889	695	2,584	2021Q2	22.4%	2,313	851	3,164
1.0%	Reviews, ATRs, IEPRs, VE	183	67	36.8%	250	3.4%	189	69	258	2021Q2	22.4%	231	84	315
0.5%	Life Cycle Updates (cost, schedule, risks)	91	33	36.8%	124	3.4%	94	34	128	2021Q2	22.4%	115	42	157
0.5%	Contracting & ReprographicsContracting	91	33	36.8%	124	3.4%	94	34	128	2021Q2	22.4%	115	42	157
0.5%	Engineering During Construction	91	33	36.8%	124	3.4%	94	34	128	2023Q2	32.5%	125	45	170
	Planning During Construction			36.8%										
	Project Operation			36.8%										
			PED Subtotal:		3,620		PED Subtotal:		3,742			PED Subtotal:		4,593
31	CONSTRUCTION MANAGEMENT													
6.5%	Construction Management	1,187	437	36.8%	1,624	3.4%	1,228	452	1,680	2023Q2	32.5%	1,627	599	2,226
	Project Operation:			36.8%										
	Project Management			36.8%										
	CONTRACT COST TOTALS:	27,412	9,086		36,498		28,007	9,280	37,287			32,535	10,830	**43,365**

COST SPLIT

Filename: LA River Restoration_TPCS_ALT 20_20150306 JGN
TPCS

CONTRACT 4 - REACH 7

**** CONTRACT COST SUMMARY ****

PROJECT: Los Angeles River Feasibility Project, LPP Plan
LOCATION: Los Angeles, CA
This Estimate reflects the scope and schedule in feasibility report; Los Angeles River Ecosystem Restoration Feasibility Report

DISTRICT: Los Angeles District
POC: Mike Newnam, Chief, Cost Engineering

PREPARED: February 27, 2015

WBS STRUCTURE		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Mii Estimate Prepared: 2014(Oct - Dec)				Program Year (Budget EC): 2016 Effective Price Level Date: 1 Oct 2015								
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
	CONTRACT 4 - REACH 7													
02	RELOCATIONS	7,123	2,621	36.8%	9,744	1.9%	7,256	2,670	9,926	2023Q3	16.0%	8,416	3,097	11,513
06	FISH & WILDLIFE FACILITIES	10,612	3,905	36.8%	14,517	1.9%	10,810	3,978	14,788	2024Q4	18.9%	12,852	4,730	17,582
06	FISH & WILDLIFE FACILITIES (Monitoring & Adaptive Management)	289	106	36.8%	395	1.9%	294	108	402	2027Q2	21.3%	357	131	488
14	RECREATION FACILITIES	1,857	683	36.8%	2,540	1.9%	1,891	696	2,587	2024Q4	18.9%	2,248	827	3,075
	CONSTRUCTION ESTIMATE TOTALS:	19,880	7,315	36.8%	27,195		20,251	7,452	27,703			23,873	8,785	32,658
01	LANDS AND DAMAGES	$24,896	3,834	15.4%	28,730	2.3%	25,470	3,922	29,392	2023Q3	15.8%	29,494	4,542	34,036
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	199	73	36.8%	272	3.4%	206	76	282	2023Q3	33.8%	276	102	378
1.0%	Planning & Environmental Compliance	199	73	36.8%	272	3.4%	206	76	282	2023Q3	33.8%	276	102	378
10.0%	Engineering & Design	1,988	732	36.8%	2,720	3.4%	2,056	757	2,813	2023Q3	33.8%	2,752	1,013	3,765
1.0%	Reviews, ATRs, IEPRs, VE	199	73	36.8%	272	3.4%	206	76	282	2023Q3	33.8%	276	102	378
0.5%	Life Cycle Updates (cost, schedule, risks)	99	36	36.8%	135	3.4%	102	37	139	2023Q3	33.8%	137	50	187
0.5%	Contracting & ReprographicsContracting	99	36	36.8%	135	3.4%	102	37	139	2023Q3	33.8%	137	50	187
0.5%	Engineering During Construction	99	36	36.8%	135	3.4%	102	37	139	2024Q4	40.8%	144	52	196
	Planning During Construction			36.8%										
	Project Operation			36.8%										
			PED Subtotal:		3,941		PED Subtotal:		4,076			PED Subtotal:		5,469
31	CONSTRUCTION MANAGEMENT													
6.5%	Construction Management	1,292	475	36.8%	1,767	3.4%	1,336	491	1,827	2024Q4	40.8%	1,881	691	2,572
	Project Operation:			36.8%										
	Project Management			36.8%										
	CONTRACT COST TOTALS:	48,949	12,683		61,632		50,037	12,961	62,998			59,246	15,489	**74,735**

COST SPLIT

Filename: LA River Restoration_TPCS_ALT 20_20150306 JGN
TPCS

CONTRACT 5 - REACH 3

**** CONTRACT COST SUMMARY ****

PROJECT: Los Angeles River Feasibility Project, LPP Plan
LOCATION: Los Angeles, CA
This Estimate reflects the scope and schedule in feasibility report; Los Angeles River Ecosystem Restoration Feasibility Report

DISTRICT: Los Angeles District
POC: Mike Newnam, Chief, Cost Engineering

PREPARED: February 27, 2015

WBS STRUCTURE		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Mid Estimate Prepared: 2014(Oct - Dec)				Program Year (Budget EC): 2016 Effective Price Level Date: 1 Oct 2015								
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
	CONTRACT 5 - REACH 3													
02	RELOCATIONS			36.8%										
06	FISH & WILDLIFE FACILITIES	61,403	22,596	36.8%	83,999	1.9%	62,551	23,018	85,569	2026Q4	21.3%	75,855	27,914	103,769
06	FISH & WILDLIFE FACILITIES (Monitoring & Adaptive Management)	1,671	615	36.8%	2,286	1.9%	1,702	626	2,328	2029Q2	21.3%	2,064	759	2,823
14	RECREATION FACILITIES	1,052	387	36.8%	1,439	1.9%	1,071	394	1,465	2026Q4	21.3%	1,299	478	1,777
	CONSTRUCTION ESTIMATE TOTALS:	64,125	23,598	36.8%	87,723		65,324	24,038	89,362			79,218	29,151	108,369
01	LANDS AND DAMAGES	$131,279	19,996	15.2%	151,275	2.3%	134,310	20,458	154,768	2024Q2	18.1%	158,559	24,152	182,711
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	641	236	36.8%	877	3.4%	663	244	907	2024Q2	37.9%	914	337	1,251
1.0%	Planning & Environmental Compliance	641	236	36.8%	877	3.4%	663	244	907	2024Q2	37.9%	914	337	1,251
10.0%	Engineering & Design	6,413	2,360	36.8%	8,773	3.4%	6,633	2,441	9,074	2024Q2	37.9%	9,148	3,367	12,515
1.0%	Reviews, ATRs, IEPRs, VE	641	236	36.8%	877	3.4%	663	244	907	2024Q2	37.9%	914	337	1,251
0.5%	Life Cycle Updates (cost, schedule, risks)	321	118	36.8%	439	3.4%	332	122	454	2024Q2	37.9%	458	168	626
0.5%	Contracting & ReprographicsContracting	321	118	36.8%	439	3.4%	332	122	454	2024Q2	37.9%	458	168	626
0.5%	Engineering During Construction	321	118	36.8%	439	3.4%	332	122	454	2026Q4	53.1%	508	187	695
	Planning During Construction			36.8%										
	Project Operation			36.8%										
			PED Subtotal:		12,721		PED Subtotal:		13,157			PED Subtotal:		18,215
31	CONSTRUCTION MANAGEMENT													
6.5%	Construction Management	4,168	1,534	36.8%	5,702	3.4%	4,311	1,587	5,898	2026Q4	53.1%	6,602	2,430	9,032
	Project Operation:			36.8%										
	Project Management			36.8%										
	CONTRACT COST TOTALS:	208,871	48,550		257,421		213,563	49,622	263,185			257,693	60,634	**318,327**

COST SPLIT

Filename: LA River Restoration_TPCS_ALT 20_20150306 JGN
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****** TOTAL PROJECT COST SUMMARY ******

CONTRACT 6 - REACHES 1 & 2

***** CONTRACT COST SUMMARY *****

PROJECT: Los Angeles River Feasibility Project, LPP Plan
LOCATION: Los Angeles, CA
This Estimate reflects the scope and schedule in feasibility report; Los Angeles River Ecosystem Restoration Feasibility Report

DISTRICT: Los Angeles District PREPARED: February 27, 2015
POC: Mike Newnam, Chief, Cost Engineering

WBS STRUCTURE		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Mii Estimate Prepared: 2014(Oct - Dec)				Program Year (Budget EC): 2016 Effective Price Level Date: 1 Oct 2015								
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
	CONTRACT 6 - REACHES 1 & 2													
02	RELOCATIONS			36.8%										
06	FISH & WILDLIFE FACILITIES	19,950	7,342	36.8%	27,292	1.9%	20,323	7,479	27,802	2029Q1	21.3%	24,646	9,070	33,716
06	FISH & WILDLIFE FACILITIES (Monitoring & Adaptive Management)	543	200	36.8%	743	1.9%	553	204	757	2031Q3	21.3%	671	247	918
14	RECREATION FACILITIES	474	175	36.8%	649	1.9%	483	178	661	2029Q1	21.3%	586	216	802
	CONSTRUCTION ESTIMATE TOTALS:	20,967	7,717	36.8%	28,684		21,359	7,861	29,220			25,903	9,533	35,436
01	LANDS AND DAMAGES	$9,913	1,494	15.1%	11,407	2.3%	10,142	1,529	11,671	2027Q2	24.8%	12,880	1,909	14,569
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	210	77	36.8%	287	3.4%	217	80	297	2027Q2	56.4%	339	125	464
1.0%	Planning & Environmental Compliance	210	77	36.8%	287	3.4%	217	80	297	2027Q2	56.4%	339	125	464
10.0%	Engineering & Design	2,097	772	36.8%	2,869	3.4%	2,169	799	2,968	2027Q2	56.4%	3,393	1,250	4,643
1.0%	Reviews, ATRs, IEPRs, VE	210	77	36.8%	287	3.4%	217	80	297	2027Q2	56.4%	339	125	464
0.5%	Life Cycle Updates (cost, schedule, risks)	105	39	36.8%	144	3.4%	109	40	149	2027Q2	56.4%	170	63	233
0.5%	Contracting & ReprographicsContracting	105	39	36.8%	144	3.4%	109	40	149	2027Q2	56.4%	170	63	233
0.5%	Engineering During Construction	105	39	36.8%	144	3.4%	109	40	149	2029Q1	68.9%	184	68	252
	Planning During Construction			36.8%										
	Project Operation			36.8%										
			PED Subtotal:		4,162			PED Subtotal:	4,306				PED Subtotal:	6,753
31	CONSTRUCTION MANAGEMENT													
6.5%	Construction Management	1,368	502	36.8%	1,865	3.4%	1,410	519	1,929	2029Q1	68.9%	2,381	876	3,257
	Project Operation:			36.8%										
	Project Management			36.8%										
	CONTRACT COST TOTALS:	35,285	10,833		46,118		36,058	11,068	47,126			45,878	14,137	**60,015**

COST SPLIT

Filename: LA River Restoration_TPCS_ALT 20_20150306 JGN
TPCS

CONTRACT 7 - REACH 8

**** CONTRACT COST SUMMARY ****

PROJECT: Los Angeles River Feasibility Project, LPP Plan
LOCATION: Los Angeles, CA
This Estimate reflects the scope and schedule in feasibility report; Los Angeles River Ecosystem Restoration Feasibility Report

DISTRICT: Los Angeles District
POC: Mike Newnam, Chief, Cost Engineering

PREPARED: February 27, 2015

WBS STRUCTURE		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Mii Estimate Prepared: 2014(Oct - Dec)				Program Year (Budget EC): 2016 Effective Price Level Date: 1 Oct 2015								
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
	CONTRACT 7 - REACH 8													
02	RELOCATIONS	33,699	12,401	36.8%	46,100	1.9%	34,329	12,633	46,962	2028Q2	21.3%	41,631	15,320	56,951
06	FISH & WILDLIFE FACILITIES	95,604	35,182	36.8%	130,786	1.9%	97,391	35,840	133,231	2031Q2	21.3%	118,105	43,463	161,568
06	FISH & WILDLIFE FACILITIES (Monitoring & Adaptive Management)	2,601	957	36.8%	3,558	1.9%	2,650	975	3,625	2033Q4	21.3%	3,214	1,182	4,396
14	RECREATION FACILITIES	3,935	1,448	36.8%	5,383	1.9%	4,008	1,475	5,483	2031Q2	21.3%	4,860	1,789	6,649
	CONSTRUCTION ESTIMATE TOTALS:	135,840	49,988	36.8%	185,828		138,378	50,923	189,301			167,810	61,754	229,564
01	LANDS AND DAMAGES	$30,876	4,653	15.1%	35,529	2.3%	31,589	4,760	36,349	2028Q2	27.1%	40,144	6,049	46,193
30	PLANNING, ENGINEERING & DESIGN													
1.0%	Project Management	1,358	500	36.8%	1,858	3.4%	1,405	517	1,922	2028Q2	63.3%	2,295	844	3,139
1.0%	Planning & Environmental Compliance	1,358	500	36.8%	1,858	3.4%	1,405	517	1,922	2028Q2	63.3%	2,295	844	3,139
10.0%	Engineering & Design	13,584	4,999	36.8%	18,583	3.4%	14,050	5,171	19,221	2028Q2	63.3%	22,948	8,446	31,394
1.0%	Reviews, ATRs, IEPRs, VE	1,358	500	36.8%	1,858	3.4%	1,405	517	1,922	2028Q2	63.3%	2,295	844	3,139
0.5%	Life Cycle Updates (cost, schedule, risks)	679	250	36.8%	929	3.4%	702	259	961	2028Q2	63.3%	1,147	423	1,570
0.5%	Contracting & ReprographicsContracting	679	250	36.8%	929	3.4%	702	259	961	2028Q2	63.3%	1,147	423	1,570
0.5%	Engineering During Construction	679	250	36.8%	929	3.4%	702	259	961	2031Q2	87.0%	1,313	484	1,797
	Planning During Construction			36.8%										
	Project Operation			36.8%										
			PED Subtotal:		26,944		PED Subtotal:		27,870			PED Subtotal:		45,748
31	CONSTRUCTION MANAGEMENT													
6.5%	Construction Management	8,830	3,249	36.8%	12,079	3.4%	9,133	3,361	12,494	2031Q2	87.0%	17,077	6,285	23,362
	Project Operation:			36.8%										
	Project Management			36.8%										
	CONTRACT COST TOTALS:	195,241	66,139		260,380		199,471	66,543	266,014			258,471	86,396	**344,867**

COST SPLIT

Filename: LA River Restoration_TPCS_ALT 20_20150306 JGN
TPCS

****** TOTAL PROJECT COST SUMMARY ******

LATC RELOCATION - CONSTRUCTION CONTRACT

****** CONTRACT COST SUMMARY ******

PROJECT: Los Angeles River Feasibility Project, LPP Plan
LOCATION: Los Angeles, CA
This Estimate reflects the scope and schedule in feasibility report; Los Angeles River Ecosystem Restoration Feasibility Report

DISTRICT: Los Angeles District PREPARED: February 27, 2015
POC: Mike Newnam, Chief, Cost Engineering

WBS STRUCTURE		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Mii Estimate Prepared: 2014(Oct - Dec)				Program Year (Budget EC): 2016 Effective Price Level Date: 1 Oct 2015								
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
	LATC RELOCATION - CONSTRUCTION CONTRACT													
02	RELOCATIONS	122,372	42,830	35.0%	165,202	1.9%	124,658	43,630	168,288	2029Q2	21.3%	151,173	52,910	204,083
06	FISH & WILDLIFE FACILITIES													
14	RECREATION FACILITIES													
	CONSTRUCTION ESTIMATE TOTALS:	122,372	42,830	35.0%	165,202		124,658	43,630	168,288			151,173	52,910	204,083
01	LANDS AND DAMAGES	$180,836	27,125	15.0%	207,961	2.3%	185,011	27,752	212,763	2025Q3	20.3%	222,589	33,389	255,978
30	PLANNING, ENGINEERING & DESIGN													
0.5%	Project Management	612	214	35.0%	826	3.4%	633	221	854	2029Q2	70.7%	1,081	377	1,458
0.5%	Planning & Environmental Compliance	612	214	35.0%	826	3.4%	633	221	854	2029Q2	70.7%	1,081	377	1,458
0.5%	Engineering & Design	612	214	35.0%	826	3.4%	633	221	854	2029Q2	70.7%	1,081	377	1,458
0.5%	Reviews, ATRs, IEPRs, VE	612	214	35.0%	826	3.4%	633	221	854	2029Q2	70.7%	1,081	377	1,458
0.5%	Life Cycle Updates (cost, schedule, risks)	612	214	35.0%	826	3.4%	633	221	854	2029Q2	70.7%	1,081	377	1,458
0.5%	Contracting & ReprographicsContracting	612	214	35.0%	826	3.4%	633	221	854	2029Q2	70.7%	1,081	377	1,458
0.5%	Engineering During Construction	612	214	35.0%	826	3.4%	633	221	854	2031Q2	87.0%	1,184	413	1,597
	Planning During Construction			35.0%										
	Project Operation			35.0%										
			PED Subtotal:		5,782		PED Subtotal:		5,978			PED Subtotal:		10,345
31	CONSTRUCTION MANAGEMENT													
2.2%	Construction Management	2,676	937	35.0%	3,613	3.4%	2,768	969	3,737	2031Q2	87.0%	5,176	1,812	6,988
	Project Operation:			35.0%										
	Project Management			35.0%										
	CONTRACT COST TOTALS:	310,168	72,390		382,558		316,868	73,898	390,766			386,608	90,786	**477,394**

COST SPLIT

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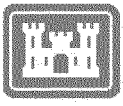
TPCS



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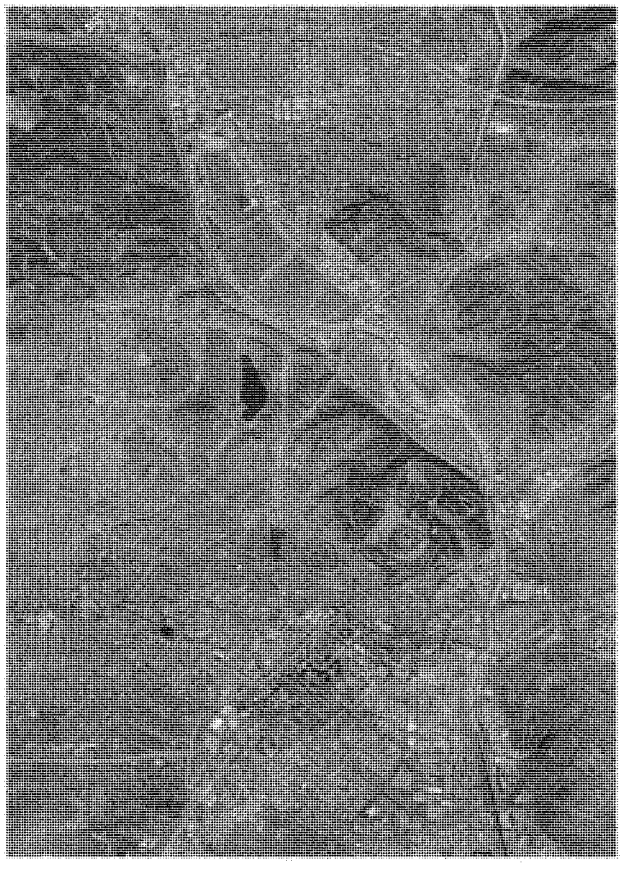
Geotechnical Feasibility Report
Los Angeles River Ecosystem Restoration Study Project Area, Los Angeles County, CA



2015

Geotechnical Feasibility Report
Los Angeles River Ecosystem Restoration Study Project Area

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ATTACHMENT 1 Levee Condition Inspection and Issue Discussion

1.0 INTRODUCTION

1.1 Context

This Geotechnical Feasibility Report has been prepared in support of the Los Angeles River Ecosystem Restoration Study (referred hereafter as the Study) and provides conditions and considerations from a geologic, geotechnical and environmental engineering perspective to aid in decision-making and alternative selection processes for the Ecosystem Restoration. The Geotechnical Feasibility Report is designed to address geologic, geotechnical and environmental conditions and constraints that are associated with the LA River Ecosystem Restoration Study (the Study) and should not be utilized for other purposes. Some sections and content within this report may also be repeated in other sections or appendices of the Study report.

1.2 Los Angeles River Description and General History

A brief description of the Los Angeles River (LA River), as it pertains to the Study, is presented in this section as background for the geologic, geotechnical and environmental concepts as presented in the report. A more detailed depiction of the LA River as a whole is presented in the Study report and associated appendices.

The LA River begins at the confluence of the Arroyo Calabasas and Bell Creek, flows through the San Fernando Valley, passes through the Glendale Narrows, onto the coastal plain, and eventually drains into the Pacific Ocean. From the confluence of Arroyo Calabasas and Bell Creek, the LA River flows through the western San Fernando Valley and through Sepulveda Reservoir where the flow is joined from the north by the Tujunga Wash. Tujunga Wash includes flow from both Hansen Dam and Pacoima Wash. Downstream of the Sepulveda Reservoir, the Burbank-Western channel, and smaller tributary drainages that emanate from the western San Gabriel Mountains join the River as it flows easterly through the San Fernando Valley. As the river approaches the Study area, it bends around the Hollywood Hills and is joined from the east by the Verdugo Wash, and then flows south through the Glendale Narrows and onto the broad coastal plain. The LA River is joined within the coastal plain by a number of tributaries including the Arroyo Seco and the Rio Hondo Diversion Channel from the Rio Hondo Diversion Channel confluence. The LA River then continues south for 12 miles and finally discharges into the Pacific Ocean at the San Pedro/Long Beach Harbor. Figure 1 presents a graphical depiction of the LA River and the Study area.

The LA River is an ephemeral stream that naturally meanders and periodically floods during the rainy winter season. Development in the LA River's natural floodplain has occurred and continues into the present. As such, the seasonal flows that would have been dispersed over the floodplain have been directed into the main channel. As the population has increased and

development has expanded within the LA River's natural floodplain, flood threats from the storm season flows have also increased. In the late 19th and early 20th centuries, massive storm flows in the LA River caused flooding that resulted in the loss of lives and significant property damage. As a result of these storm events, City of Los Angeles (City) and County of Los Angeles (County) leaders decided to have the LA River channelized. The U.S. Army Corps of Engineers (USACE) completed the task by channelizing the river with concrete bottoms, concrete side slopes, grouted stone slopes, stabilized soft bottoms, channel walls, floodwalls, and levees. The levees within the ARBOR reach total approximately 11.3 miles in length (located along both banks of the 11 mile ARBOR reach), vary in height from several to approximately 30 feet, are typically 2:1 (H:V) or shallower side slopes, and are constructed of material that was borrowed from the channel or the adjacent river banks. Further discussion on the historical impact of the LA River and the construction of the LA River channel can be found in the additional appendices which accompany the main Integrated Feasibility Report (IFR).

1.3 Scope of Work

The geotechnical support for the feasibility study included review and reference of existing geotechnical information, identification of project constraints, preliminary and ongoing evaluation of project alternatives, and preparation of this report. The scope of work included the following:

a. Review of published and unpublished data pertaining to the geotechnical conditions in the general vicinity of the project study;

b. Attendance of project meetings and review sessions;

c. Evaluation of geotechnical, geologic, and groundwater data collected during the review process;

d. Evaluation of the potential impact and the anticipated geologic conditions on proposed alternatives and measures;

e. Development of a list of constraints and considerations potentially impacting the proposed alternatives and measures for ecosystem restoration;

f. Preparation of comments and recommendations for geotechnical considerations on other documents for the study; and

g. Preparation of this report documenting the work performed, information gathered during the review of available data, and geotechnical considerations and constraints.

2.0 STUDY AREA

The Study area is known as the "ARBOR" Reach (Area with Restoration Benefits and Opportunities for Revitalization), an eleven mile portion of the LA River, which extends from the Headworks site downstream to First Street. The ARBOR Reach was chosen for study partly because of the soft-bottom within the "Glendale Narrows." The Study area also contains numerous restoration opportunity locations where restoration may be achieved as the locations are local Sponsor property or property that may be acquired by the local Sponsor. These areas include the following: Headworks, Pollywog Park, Bette Davis Park, Griffith Park, Ferraro Fields, the Burbank Western Channel and Glendale River Walk, Verdugo Wash, the Bowtie and Taylor Yard, Cornfields (LA State Historic Park), Arroyo Seco, Elysian Park, Atwater Park, Los Angeles Trailer and Container Intermodal Facility (LATC) (also known as Piggyback Yard or Mission Yard), and Downtown Los Angeles. Please refer to the main IFR for detailed descriptions and locations of these areas and the importance of these locations to the Study.

The ARBOR Reach has been subdivided into eight sub-reaches (Sub-Reach 1 through Sub-Reach 8). These sub-reaches are defined based on physical characteristics that define channel functions, existing habitat, and surrounding land uses. The selected criteria include: (1) channel bed type (e.g., soft-bottom with groundwater-surface water exchange or concrete); (2) side slope condition (e.g., vertical or trapezoidal); and (3) adjacent land uses (e.g. development or open space). The general extent of these sub-reaches are presented in Figure 1. A summary of the current conditions is presented in the attached Table 1 and a further detailed description of these sub-reaches is provided in the main IFR.

2.1 Proposed Improvements and Alternatives

Extensive plan formulation and community involvement was undertaken to develop the goals, objectives, and alternatives for this Study. Details are presented in the main report and other appendices. Due to the dynamic conditions of the planning processes and study timeframes, a detailed and complete description of plans, alternatives, measures and sub-measures, are not included in this portion of the Study. However, a summary of potential sub-measures and the sub-reaches where those sub-measures may be applied as well as the associated plan are included in the attached Table 2. The four plans considered in of the Draft IFR for the Study are plan numbers 10, 13, 16, and 20. Additional detailed cost analysis identified a variation on plan 13 that is identical to 13 except that it includes the Reach 7 plan from Alternative 20. This variation is called 13v for "variation" and is within the spectrum of plans considered in the Draft IFR. This numbering is discussed in the main IFR.

2.2 Considered Improvements

A comprehensive list of considered improvements can be found in the main IFR. The considered improvements included tunnels, underground basins, underground channels, ponds and pump stations, and other options. Many of the improvements were not carried forward due to exorbitant cost or hydraulic infeasibility. Details regarding these improvements can be found in other appendices and in the main IFR.

2.3 Locally Preferred Plan

The locally preferred plan (LPP) is currently Alternative 20. For consistency, the potential constraints and options associated with the other alternatives are included in this report.

3.0 SITE CONDITIONS

3.1 General Overview and Topography

The Los Angeles River Ecosystem Restoration Study area is located in Los Angeles County within portions of both the Los Angeles and the San Fernando topographic basins of southern California. These basins are connected by the LA River through a narrow gap between the Santa Monica Mountains and the Elysian Hills, to the west, and the Repetto Hills and the Verdugo Mountains, to the east, which is locally known as the Glendale Narrows. The LA River captures all of the drainage area of the San Fernando topographic basin and flows out onto the upper portion of the Los Angeles topographic basin. These basins and the Study portion of the LA River are depicted on Figure 2. Upstream of the Glendale Narrows, the LA River drains a watershed that is greater than 800 square miles.

Elevations in the Los Angeles River Watershed range from approximately 10,000 feet in the San Gabriel Mountains to sea level at the mouth of the Los Angeles River. Elevations of the river within the Study area itself range from approximately 490 feet at the upstream end of the Study area to approximately 240 feet at the downstream end. The average slope of the LA River is approximately 4 to 14 feet per mile.

The project area includes adjacent neighborhoods in the Cities of Glendale and Burbank in addition to those in the City of Los Angeles. Property uses include private residential, industrial and commercial properties as well as parks, public service yards, utilities, and other community service facilities. Transportation and infrastructure crossing the river includes local streets, an adjacent interstate highway, several state highways, rail yards, and two rail lines. Over 1,000,000 people live within a short distance of this reach.

3.2 Geology

3.2.1 Regional Geology

The Study area is located within a geologically complex region of southern California near the intersection of the Peninsular Ranges Geomorphic Province and the Transverse Ranges Geomorphic province. The roughly east-west trending Santa Monica-Raymond Hill Fault marks the boundary between the Transverse Ranges and the Peninsular Ranges geomorphic provinces.

The Transverse Ranges are characterized by east-west trending folds and faults (Wright, 1991). Regional geologic structure in the Transverse Ranges is characterized by right-lateral high angle to vertical strike-slip faults, folds and associated thrust or reverse faults. The Santa Monica Mountains, along with the offshore Channel Islands to the west and the San Bernardino Mountains to the east, are situated within the Transverse Ranges Geomorphic Province. The east-west structure of the Transverse Ranges is oblique to the normal northwest structural trend of the Coast Ranges to the north and the Peninsular Ranges to the south.

The Peninsular Ranges province is characterized by a series of northwest to southeast-oriented valleys, hills and mountains separated by faults associated with, and sub-parallel to, the San Andreas Fault system. The Peninsular Ranges Geomorphic Province extends southward to the tip of Baja California and is for the most part underlain by older metamorphic rocks that have been intruded by granitic rock. Along the coast, the granitic and metamorphic basement rocks are covered by a wedge of marine and non-marine sediments that thicken seaward.

3.2.2 Local Geology

The Study area lies between the eastern end of the Santa Monica Mountains and the Verdugo Mountains with the San Gabriel Mountains further to the east. The valley or gap between the Santa Monica Mountains and the Verdugo Mountains is also locally known as the Glendale Narrows. Within the Glendale Narrows, bedrock is relatively shallow and is covered with relatively thin deposits of alluvium, which increase in thickness to the north and south into the San Fernando and Los Angeles basins, respectively. As a corollary, groundwater is relatively shallow through the Glendale Narrows as well. This condition can be visualized as a small sediment filled bowl (i.e. the San Fernando Basin) with a spout (i.e. the Glendale Narrows) pouring water into a larger sediment filled bowl (i.e. the Los Angeles Basin). This interface between the bedrock, soils and groundwater define the surficial expression and subsurface conditions of the LA River in the Study area. Details of the bedrock, soils, and groundwater are presented in this section.

The local subsurface geology of the project Study area is shown in the LA River Geologic Profile Map, Figure 36. This profile runs approximately southwest to northeast across the

project site and is projected in a northwest direction. It averages approximately 6,000 to 7,000 feet thick and expresses the general structure and character of the bedrock and alluvium sediment. The structure of the geology is a series of thick folded sediments (formations of soft and hard bedrock) overlain by very thin (approximately 50 to 300 feet) layers of alluvium (unconsolidated sediment). The LA River and the approximate project Study area are marked on the profile in red lettering. The Study area is dominated by the Elysian Park Anticline structure and a thin layer of Recent and Older alluvium. The alluvium makes up the LA River floodplain and edges of the surrounding San Fernando basin. The local geology is depicted on Figures 28 through 35.

3.2.2.1 Bedrock

There are very few if any exposures of bedrock within the immediate vicinity of the LA River Study area, except for the eastern foothill section of the Santa Monica Mountains. The foothills are composed of Tertiary age sedimentary rocks. These rocks are located on the west side of the river between sub-reaches 1 and 6 (see Figure 1 for sub-reach locations), and are typically less than 1/2 mile from the LA River.

Exposures of shallow bedrock were uncovered in the 1930s and 1940s during original construction of the USACE built channel-levee, along southern portions of Sub-Reaches 7 to 8. This exposure is shown on the Top of Bedrock Contour Maps Figures 3 through 5. The bedrock here has been mapped and described as soft, sedimentary rock related to the Puente Formation. There is sparse evidence of additional exposures of bedrock within the immediate vicinity of the LA River. This is based on the general local geology as mapped by the California Department of Mines and Geology (CDMG), United States Geologic Survey (USGS), and as indicated on USACE as built records/drawings of the LA River channel-levee system. Additional shallow bedrock has not been described or encountered during subsurface samples taken amongst previous investigations; however, more recent geotechnical related soil-alluvium investigations have been done by others such as: the USACE, City, and various HTRW Potential Responsible Parties (PRPs).

Existing bedrock is buried beneath the LA River floodplain and is well below (potentially greater than 50 feet) the channel bottom in all sub-reaches, except at Sub-Reaches 7 to 8. Within these sub-reaches it is shallow and was encountered above the channel bottom and along the banks of the LA River. It is highly probable that bedrock will not be encountered in most of the excavations required for the structures (i.e. removal and redesign of existing Corps LA River channel, construction of bridges, stairways, trails, bathrooms, buildings, etc.) needed in support of the project. It is also not expected to be encountered in soils removed to support the general planting-cultivation requirements for the habitat plans. The exception will be areas alongside Sub-Reaches 7 to 8 and the LATC property. Bedrock is anticipated to be encountered in the near

surface in these areas sporadically. If encountered, the bedrock will likely be composed of soft sedimentary bedrock, which can be excavated with moderate to easy difficulty by using conventional heavy construction equipment, such as backhoes, excavators, etc. There are specialized attachments to this equipment such as rock saws and hoe rams, which can penetrate harder sedimentary rock, if encountered. These attachments can slice or break up the rock to where it can be removed easily.

3.3 Alluvium and Soils

In general, deposits of sediment along the LA River and on the alluvial fans and floodplains in the watershed drainages are among the youngest surface soils in the Study area. Deposits of soil within the Study area are generally considered alluvium. Alluvium is defined as soils that have been deposited and transported in their current position as a result of moving water by streams, rivers, sheet wash, etc. Recent alluvial deposits are those stream and river derived deposits that are less than 10,000 years old (Holocene age). The San Fernando Valley and Los Angeles basin alluvium can be generally characterized as recent alluvium and is comprised of moderately dense combinations of silt, sand, and gravel, with lesser amounts of clay.

3.3.1 Historical Soil Uses and Fill

The natural surface soils of the Study area have been highly modified as a result of farming, construction grading, and cut and fill practices during the past century. Artificial fill was generally imported and deposited along the major streams and river channels to fill in low lying areas and to channelize the LA River. Fill was also used in both private and public property in the Study area to raise the grade for the construction of roads, bridges, and railroads. In general, fill soils are brownish and consist of silty sands with gravel. However, fill material in the area ranges from clayey silt and silty clay, to angular gravel with sand (City of Los Angeles 2005).

Fill has also been known to contain a mixture of fill soil with solid waste. The solid waste portion of this mixture is known to commonly contain a combination of household trash, vegetation and construction debris. Fill of this character was commonly added to various properties within the Study area and property abutting the banks of the Los Angeles River during the mid 20th century (1920's to 1950's). In some cases the solid waste portion was burned to reduce its density before being mixed in with soil and buried as fill. This practice has been described as "landfilling", which is inappropriate terminology for use in today's solid waste environmental compliance regulatory arena. This is because legal disposal of solid waste and soil fill mixtures on both private and public property currently requires a solid waste permit. Using the loose terminology of "landfilling" assumes a specific set of rules, practices and procedures that must be followed, which are closely regulated according to Federal and California solid waste environmental regulations. There were no landfill permits in effect during

the time that this type of fill was used. The more appropriate and general description for this practice is "buried fill containing solid waste and soil". This terminology will be used throughout this report from herein in order to avoid the current regulatory complications inherently related to solid waste environmental regulations in use and enforced.

Buried fill containing solid waste and soil placed in the historical past has been found contaminated with various man made pollutants of metals, petroleum hydrocarbons, etc. The result is that there are various known properties within the Study area and along the upper banks of the LA River that contain this type of contaminated fill. There are also potential unknown amounts of this fill that may still exist in the Study area and particularly along the banks of the LA River because of the past practice of buried fill containing solid waste and soil. Any known contaminated buried solid waste and fill is currently being addressed and regulated by either the California Department of Toxic Substance and Control (DTSC) or the Los Angeles Regional Water Quality Control Board (LARWQCB). This type of fill is regulated not as a landfilled solid waste or landfill derived waste but as a hazardous substance per both the Federal laws of the Comprehensive Environmental Recovery Compensation Liability Act (CERCLA) and the Resource Conservation and Recovery Act (RCRA). Further details regarding disposition and use of such fill are described in the Hazardous Toxic and/or Radioactive Waste, HTRW Survey Report appendix.

The banks of many river courses that extended through communities developed during the early part of the last century were used as disposal sites for common trash. Residential and commercial trash was dumped on stream banks and sometimes burned. The resulting debris was typically carried away by intermittent high stream flow conditions and the dumping process was repeated. Because of the localized nature of this debris, typical geotechnical investigation methods are not always successful in identifying and characterizing these conditions. As a result, construction excavations that encounter this type of debris will need to be evaluated during grading.

3.3.2 Engineering Description of Soils (USCS)

The engineering classification (Unified Soil Classification System, USCS) for the surface and deeper soils (a.ka. alluvium) for the project Study area ranges from poorly graded sand (SP) to silty sand (SM) to well graded gravel (GW), with some minor amounts of clay. Samples of the soils were collected in the past by both the City of Los Angeles and the Los Angeles District, USACE. The samples were collected using typical geotechnical trenching and borehole methods. The sampling depths ranged from ground surface to approximately 100 feet below ground surface. The locations of the samples are shown on the Borehole Sample Locations Maps, Figures 21 through 27. The locations shown are approximately within 500 feet of the LA River. Additional samples were collected outside those shown and are not depicted on the Maps. The actual sample descriptions and/or logs of the soils are not provided within this appendix, but

are available in the Geotechnical Branch archive working files. To access the files, a Freedom of Information Act request must be generated; the phone number is provided on the inside cover of this report.

3.3.3 Anticipated Soil Usage and Disposal

The project will disturb the existing soils within the project area. Disturbance will involve excavation/removal and replacement of soils during the construction of the project habitat. The existing soils will be recycled/re-used as much as possible during construction. Reused soils will be needed for both engineering and landscaping applications. Uses for such soil will likely consist of engineered fill, filter and backfill and plant bedding/amendment mixtures and plant drainage materials.

Some amounts of soil will not have a use and may have to be hauled away from the project for re-use or disposal. Non-useable soils may consist of soils not meeting requirements for engineering or landscaping applications and HTRW contaminated soils. HTRW contaminated soils may be encountered at unknown locations within the project Study area. These soils may be encountered at or near the HTRW contaminated properties within the project footprint as described in the HTRW Survey Report. These soils are highly likely to be encountered at the Taylor Yard property, since it still contains known amounts of HTRW contaminated soil that have not yet been removed or remediated. According to the USACE Regulation ER 1165-2-132, HTRW Guidance for Civil Works Projects, HTRW contaminated soils must be remediated by the project Sponsor in accordance with Federal CERCLA and/or California State or local HTRW environmental laws prior to providing lands for construction. This means that all known HTRW contaminated soils at Taylor Yard will have to be remediated to meet both the human and ecological health risk standards specific to its land use for the study project. For this project, Taylor Yard's intended land use is for habitat restoration and recreation. As discussed below, HTRW contamination is suspected, although not confirmed, at the LATC site in Reach 8. This site would be subject to further investigation by the Sponsor with all necessary remediation of soils to be completed prior to the Sponsor providing the site to the Project for construction. Further details regarding disposition of HTRW contaminated soil are discussed within the separate HTRW Survey Report and the HTRW Section (6.0) within this report.

4.0 GEOTECHNICAL HAZARDS

Numerous geotechnical hazards exist within the Study area and will impact or could impact the Study area and the project. These hazards include faulting, seismicity and ground shaking, liquefaction and lateral spreading, and landslides.

4.1 Faulting

The intersection of the northwest trending San Andreas Fault System and east-west trending Transverse Ranges Fault system dominates the seismicity of southern California. The project Study area has the potential to experience strong ground shaking from local and regional faults. Three active faults near the Study area include the Verdugo Fault, the San Andreas Fault, and Northridge Blind Thrust Fault. These three faults and several other faults can be the cause of future seismic induced damage to the Study area. Such damages are impossible to predict, but the impacts would be wide reaching and variable depending on the distance and size of the fault that would cause the seismic disturbance of an earthquake. Such damages could affect not only the Study area, but also adjacent property, city wide damage, regional damage, and the loss of human life.

The Alquist-Priolo Earthquake Fault Zoning Act was passed in 1972 to mitigate the hazard of surface faulting to structures with human occupancy (California Geologic Survey 2006). The Act prohibits the siting or zoning for most types of structures built post-1972 across the traces of active faults that may pose a potential hazard to occupants and structures (California Department of Conservation 2012). The California Alquist-Priolo Earthquake Fault Zoning Act defines an active fault as one that has ruptured in the last 11,000 years.

The State of California Building Standards Commission provides a minimum standard for building design through the Building Standards Code. The Building Standards Code is used by the Cities of Los Angeles (LADBS 2012), Glendale (2012), and Burbank (2012) as minimum design criteria for construction of buildings and structures to protect against anticipated seismic events.

4.1.1 San Andreas Fault

The San Andreas Fault, located 30 miles to the northwest of the Study area, forms the boundary between the North America and Pacific Tectonic Plates, and is the most significant fault in the area. The fault extends for about 800 miles from the northern tip of the Gulf of California to the Mendocino triple junction west of San Francisco (Harden 1998). The fault runs along the base of the San Bernardino and San Gabriel Mountains.

In addition to the San Andreas Fault, the Study area lies near numerous other active faults. The Elysian Park Fault in Study Sub-Reaches 4-6 is a blind reverse fault that extends approximately 12 miles through the Elysian Park-Repetto Hills from Silverlake on the west to the Whittier Narrows on the east. Blind reverse faults are those that do not and never have extended upward to the surface of the earth. The Elysian Park anticline forms a segment of the southern boundary of the Transverse Ranges and has an estimated time-average rate of slip of 0.8 to 2.2 millimeters

per year (mm/year) (Oskin et al. 2000). The Elysian park anticline is formed by the Elysian Park blind reverse fault.

4.1.2 Verdugo Fault

The Verdugo Fault is located less than 2 miles to the northwest from the Study area Sub-Reach 3, and runs 14 miles from the San Fernando Valley in the northwest to the Los Angeles Basin in the southeast, from the City of Pacoima to the City of Glendale. The Verdugo Fault is an active north-dipping reverse fault, with a minimum uplift rate of 1.1 mm/yr, starting 2.3 million years ago (Arkle and Armstrong 2009).

4.1.3 Raymond Fault

The Raymond Fault is about 16 miles long, with a slip rate of between 0.10 and 0.22 mm/yr. Nearby communities include San Marino, Arcadia, and South Pasadena (Southern California Earthquake Data Center 2006). The Raymond Fault forms the eastern portion of the Santa Monica Mountains Frontal Fault System and extends from western Hollywood east to Pasadena. The fault runs east-west through the Study area in Sub-Reaches 4-6 upstream of Glendale Blvd, across the Los Angeles Narrows (City of Los Angeles 2005).

4.1.4 Hollywood Fault

The Hollywood Fault is about 9.3 miles long and has a slip rate of between 0.33 mm/yr and 0.75 mm/yr. Nearby communities include Hollywood, Beverly Hills, and Glendale. The eastern part of the Hollywood Fault zone extends along the base of the Santa Monica Mountains, near Los Feliz Blvd. From there, the fault trends eastward across the alluvial deposits of the Los Angeles River in the Atwater area. It can be considered a westward extension of the Raymond Fault and runs through the Sub-Reaches 4-6, parallel to the Santa Monica Fault (Southern California Earthquake Data Center 2006).

4.1.5 San Fernando Fault

The San Fernando Fault is about 10.5 miles long and runs from the area of Big Tujunga Canyon north to the San Fernando Valley. The slip rate is not well known, but is believed to be about 5 mm/yr. The last major rupture was February 9, 1971, and is known as the Sylmar or San Fernando Earthquake, which had a magnitude of 6.6. The rupture was roughly 12 miles long, with a maximum slip of six feet (Southern California Earthquake Data Center 2006).

4.1.6 Northridge Blind Thrust Fault

The Northridge Blind Thrust Fault (NBTF) (a.k.a. Pico Thrust Fault) is a south dipping blind thrust fault. It is part of the Oak Ridge Fault (ORF), an extensive fault system, which is

approximately 55 miles long and dips to the south at less than a 45 degree angle. It is proposed that the ORF curves from an east to west strike to an east to southeast strike that mimics changes in strike along the pre-Saugus Frew and Torrey Faults. The long term slip rate on the ORF is about 3.5 to 6 mm per year (Southern California Earthquake Data Center 2006). The NBTF is interpreted as the eastern blind continuation of the ORF, and the south slip movement along this portion was responsible for damage caused by the Moment Magnitude 6.7 Northridge Earthquake of 1994. This earthquake measured 6.7 on the moment magnitude scale and was one of the most destructive earthquakes in U.S. history.

4.2 Seismicity and Ground Shaking

The Study area is located within the seismically active area of southern California. Approximately 30 earthquakes happen each day, most of which register a Richter magnitude below 2.0. The last appreciable earthquake in the Los Angeles area was in January 1994 when the Northridge Earthquake hit the San Fernando Valley with a Richter magnitude of 6.7 (USGS 2012). The attached Table 3 is a summary of significant historical or larger magnitude earthquakes in the vicinity of the ARBOR Reach.

Ground shaking is the primary cause of earthquake damage in southern California. Structures on poorly consolidated and thick soils typically incur more damage than buildings on consolidated soils and bedrock. As discussed above, the majority of the Study area is on such soils. Damages to the surrounding areas as well as to the structures and features built as part of the project are to be expected following a major earthquake.

The intensity of the ground shaking is related to the magnitude of the earthquake, type of fault, depth of the earthquake, and distance of the site from the epicenter. Areas near major active faults generally experience stronger seismic shaking more frequently. The Study area can be assumed to experience strong seismic shaking, since it is in an area of high seismic activity and near several active faults. The Los Angeles District has utilized the USGS models to estimate the intensity of the ground motions that should be expected to be imparted on the ARBOR Reach and its foundation. These models are found online and available to the public. The USGS 2008 National Seismic Hazards Mapping Program (NSHMP) Probabilistic Seismic Hazard Assessment (PSHA) Interactive De-aggregations web site is located at https://geohazards.usgs.gov/deaggint/2008/. The following summary of site peak ground accelerations (PGAs) can be expected at the upstream end, the downstream end, and the approximate midpoint of the ARBOR Reach:

Estimated Ground Motions along the ARBOR Reach				
Return Period	Probability of Exceedance (PE)	Estimated PGA[1] (g)		
		Upstream	Downstream	Approximate

(years)		End (34.153°N, 118.326°W)	End (34.048°N, 118.230°W)	Midpoint (34.111°N, 118.262°W)
144	50% in 100 years (OBE)	0.28	0.25	0.29
475	10% in 50 years (MDE)	0.52	0.47	0.59
950	10% in 100 years	0.69	0.64	0.81
2475	2% in 50 years (MCE)	0.97	0.92	1.14

[1] Utilizes 0.0 seconds spectral acceleration, at the recommendation of the model developers, so as to most closely equate the results to PGA. Assumed Vs30=760 m/s

4.3 Liquefaction and Lateral Spreading

The greatest seismic induced damage risk (as opposed to the direct damage caused by ground shaking) to the Study area and the project is due to earthquake induced liquefaction of soils. Liquefaction is caused when the ground shakes wet granular soil and changes it to an unstable liquid state. Areas with high groundwater, saturated loose sands, and silty sands within 50 feet of the ground surface, and are in close proximity to active faulting are most susceptible to liquefaction. Lateral spreading is similar to liquefaction in that it is the deformation of shallow sloping ground towards an open face during a seismic event.

Regions in the Study area with high liquefaction and lateral spread potential include the majority of lowland areas along the LA River and tributaries. In addition, there is high liquefaction potential along the foothills of the Santa Monica Mountains in Sub-Reaches 1-3, along the base of the Elysian and Repetto Hills in Sub-Reaches 4-6, and along the base of the Elysian Hills in Sub-Reaches 7 and 8. These high liquefaction potential areas are all shown on the Liquefaction Potential Maps, Figures 12 through 20 and have been published by the California Department of Conservation Mines and Geology (CDCMG). Impacts of liquefaction and lateral spread will need to be addressed for all potential modifications.

4.4 Landslides

Landslides are a natural hazard throughout southern California, especially within steep terrain underlain by relatively weak soil materials. Factors that affect slope failure are angle, substrate, climate (e.g. precipitation), and seismic shaking. Hillside areas of Los Angeles have geologic and topographic conditions that are conducive to the development of landslides. Landslides can also be triggered by seismic events, causing the soils to lose their stability and possibly to liquefy. Debris flows due to prolonged and heavy precipitation are more localized in small gullies (large ditches or small valleys caused by an advanced stage of channel erosion). These are typically shallow landslides, where the surface material becomes saturated and begins to flow

downhill, taking vegetation and buildings with it. Debris flows are known to start on slopes as low as 15 degrees, but are more likely to develop on steeper slopes.

Within the Study area, landslide potential occurs along the eastern Santa Monica Mountains (Sub-Reaches 1-6), Elysian Hills (Sub-Reaches 4-8), and Repetto Hills (Sub-Reaches 4-6). It is anticipated that the alternatives will not affect or disturb any known or potential landslide hazard areas. However, considerations will need to be made for evaluation of landslides during design.

5.0 GROUNDWATER

The groundwater in the Study area is encountered in the shallow subsurface at depths from 15 to 30 feet along the upper banks of the LA River and at depths of river bottom (ground surface within the channel). The direction of the groundwater flow is from northwest to southeast in the general downstream direction of the LA River. The groundwater occurs within a shallow unconfined aquifer that is regionally extensive and is found throughout San Fernando and the Los Angeles Basins. This aquifer is fed from the surrounding runoff of both Basins, as well as man-made recharge areas in the San Fernando Basin. The water table surface of this shallow aquifer is shown as contours on the Water Table Contour Maps, Figures 6 through 11. This surface was estimated based on water level data accumulated from shallow piezometers and observation wells installed in support of geotechnical investigations by the USACE, City of LA and HTRW PRPs during the last 60 years.

5.1 Dewatering

The groundwater in the Study area will be affected more so during construction of the actual project than the time after it is built. This will occur in the case in which any groundwater is encountered and it interferes with future habitat construction activities of excavation, planting, etc. During the most likely case of excavation, this will require that groundwater be removed (dewatered) from the excavation(s) by bailing or by pumping out via temporary, dewatering wells. Because dewatering is temporary, it should not affect the long-term character nor deplete the quantity of the shallow groundwater. Therefore dewatering activities for the project should not impact or interrupt its overall use as a shallow water supply aquifer.

The dewatering activity will more likely affect the temporary movement of groundwater during its removal. This is usually not a cause for concern for construction projects in which the shallow aquifer is known to be uncontaminated with HTRW pollutants. However, there are approximately 22 known HTRW sites and one suspected HTRW site that are in or adjacent to the project Study area with potential to have introduced HTRW contaminants into the groundwater that could be encountered during dewatering. Of these properties, the San

Fernando Valley Superfund (SFVSS) site/property has the greatest impact to project dewatering activities because it is has already caused a regionally extensive amount of HTRW contamination to the shallow aquifer.

As previously mentioned, impacts to construction from routine dewatering of non-HTRW contaminated groundwater is straightforward and mainly involves removal and movement of dewatered groundwater back into (recharge) the surrounding aquifer or placement back into the nearest surface waters (LA River). This usually requires application only for a simple dewatering permit with California State and local regulatory agencies. The simple permit outlines basic coordination planning and monitoring for such non-HTRW dewatering activities. For the aforementioned reasons, existing HTRW contaminated groundwater is more likely to be encountered during future construction activities for this project. As such, the impacts are more complicated and will likely require a complex dewatering permit that requires more extensive monitoring than the simple permit. In addition, it may also require close coordination/consultation and approval from the Los Angeles Regional Water Quality Control Board (LARWQCB) and may also require a waste discharge permit (WDR) tailored specifically to the planned discharge of the project dewatered groundwater.

The additional permitting requirements may require instead that any dewatered groundwater be stored and treated prior to final discharge back into the surrounding shallow groundwater aquifer or LA River. According to USACE Regulation, ER 1165-2-132, "Hazardous, Toxic and Radioactive Waste (HTRW) Guidance for Civil Works Projects", these activities are considered as HTRW response activities. The non-Federal sponsor is responsible at 100 percent non-project cost for addressing any contaminated groundwater encountered during construction dewatering activities, including its treatment and disposal.

5.2 Pumps and Wells

Pump and treat well technology is the current response method being employed to remediate the HTRW contaminants from the shallow aquifer. Numerous wells are deployed across the SFVSS and the nearest pump and treatment facility to the project is the Pollock Well Field. This facility is a series of wells located about less than 1 mile northwest from the Taylor Yard property, near the center of the project. This well field has been in operation for about 10 years and recovers a large portion of the HTRW contamination from SFVSS and is operated by the City of Los Angeles Public Works. The Los Angeles Department of Water and Power (with oversight from the U.S. Environmental Protection Agency (U.S. EPA)), is managing and operations of SFVSS and the Pollock Well Field facility as well as other fields to ensure that they continue to properly remediate the HTRW contamination within the shallow aquifer. The migration pattern of HTRW contamination within the existing shallow groundwater aquifer caused by the SFVSS and

the recovery of such contamination by the Pollock well field may also be impacted by the project after it is built. Several of the more likely impacts are as described in the following sections.

5.2.1 Application of Irrigation Water for Establishment of Restoration Features and During Operation and Maintenance

Future irrigation water plans and budget for the habitat project may need to consider means for preventing potential interference with the ongoing pump and treat response for the SFVSS contaminated shallow aquifer. This is more likely to occur for any residual HTRW soil contamination left at the Taylor Yard property, because the vertical distance from this contamination to the shallow water aquifer is small. If irrigation water is allowed to infiltrate freely through the soil at this property, it is has the potential to leach out residual HTRW soil contaminants and directly transport them into the surrounding aquifer. However, the likelihood of this occurring will be low because of the following:

a. Residual soil contamination will be removed from this property by the Sponsor, to regulator-required levels as part of the Sponsor's required response activities to facilitate this project;

b. Environmental engineering technologies (e.g., impermeable barriers/covers, soil vapor extraction, localized pump and treat) have been used to remediate similar projects in the past. These technologies may be deployed as part of the overall response but is at the direction and discretion of the Sponsor and per approval of regulatory authorities and must be consistent with needs for the restoration project; and

c. The shallow aquifer beneath Taylor Yard is already contaminated by HTRW and some of this has been attributed to leaching of residual HTRW contaminants from its soil. Much of this attributed contamination is co-mingled with contamination emanating from SFVSS and is currently successfully being remediated by the U.S. EPA pump and treat well system at the nearby Pollock well field.

Nevertheless, as part of operation and maintenance requirements, irrigation water should be applied such that it does not infiltrate in amounts that will affect or alter the current mechanical transport (migration) of the SFVSS contaminated groundwater into the pump wells. The plans and budget also need to include prevention of the introduction or addition of any HTRW soil type contaminants into this aquifer. All of these plans would be reviewed by primary regulatory agencies such as the LARWQCB.

5.2.2 **Unique Habitat Project Designed Features Such as Wetlands**

The construction of unique project features such as wetlands may need to incorporate or consider additional means to avoid interference with ongoing groundwater remediation efforts. This will occur for Taylor Yard, since it directly overlies SFVSS and does include a unique wetland footprint plan for the alternatives selected as part of this project. The likelihood of altering and interfering with the SFVSS plume is low because of the following:

a. As mentioned earlier, much of the SFVSS contaminated groundwater plume is currently successfully being remediated by the LADPW pump and treat well system at the nearby Pollock Well Field. It is unlikely that built features such as wetlands will interfere with the success of this pump and treat system for Taylor Yard since this property is very close to the recovery forces (well radius of influence) of the Pollock Well Field. This will likely continue as long as the wells remain operating. According to EPA, the pump and treat response for Pollock and SFVSS will continue for approximately 10 to 20 years into the future, which will be ongoing beyond the date of final construction of the LA River project. Also, much of the higher concentrations of HTRW within the SFVSS plume are already successfully being captured directly near the Pollock and other pump and treatment well locations. As indicated on the 2010 SFVSS HTRW groundwater plume map (shown in the HTRW Survey Report, part of the HTRW Appendix), there are still portions of this plume that extend beyond the higher concentration areas of capture. These outlier areas contain lower HTRW concentrations from this plume. Because of this, it is likely that any migration of this plume through or around the project that is associated with unique features will be of lower concentrations; and

b. The construction of unique habitat features for this project should not interfere with or alter the existing pathways of migration of contaminated groundwater at SFVSS. This is because there are open bottom areas, plus an extensive system of weep holes/drains that already exist and that have been built into the LA River channel and levee. These devices were built around the 1940s for the purpose of relieving and draining the structure of any surrounding groundwater. They have continued to operate in this manner to this day. The presence of yet to be constructed unique habitat features such as wetlands should not interfere or alter the exiting migration of the SFVSS contaminated plume. This is because portions of the SFVSS HTRW contaminant plume have most likely already migrated through and beneath the LA River channel/levee, since this structure effectively already allows for groundwater seepage into the river.

The shallow groundwater and aquifer will remain unaffected without construction of the project. The SFVSS and HTRW contaminated portions of the shallow aquifer will remain unaffected

with construction of the project and with construction of unique features of the project such as wetlands.

6.0 HTRW

There are known HTRW impacts to various properties within the Study area. Taylor Yard G1, Taylor Yard G2 and SFVSS are the three known properties that have the highest HTRW impacts. This is because contamination in soil (at Taylor Yard) and groundwater (SFVSS) is widespread at these properties and most or all of the various habitat feature footprints selected from the final array of project alternatives directly overlie these particular properties.

Nineteen (19) known properties have low potential HTRW impacts to the project. This is because contamination in soil and groundwater is not heavy, is fairly well contained and not widespread at these properties, and all of the habitat footprints are adjacent to but do not directly overlie these properties. However, groundwater adjacent to these sites may impact the project during construction.

One additional property also has an unknown HTRW impact on the project. This property, the LATC, is planned to be a major feature of the project. LATC has potentially high levels of contamination based on its historical uses, although there are no public records available for that site, and as such, the impact to the project is unknown at the time of the study.

According to USACE regulation ER 1165-2-132, remediation of HTRW sites/properties should occur before project implementation or actual construction. This remediation is the responsibility of the project Sponsor and is not paid for by the project, i.e. it is at 100% of non-project cost, and in-kind project credit by the USACE cannot be given to the Sponsor. The ER definition for required remediation includes CERCLA HTRW, i.e. any CERCLA hazardous substance. Hazardous substances include all RCRA type hazardous waste; Clean Air Act hazardous substances and hazardous air pollutants; Clean Water Act toxic pollutants; and Toxic Substance Control Act hazardous chemical substances or mixtures. On the whole, it includes Federal EPA and California State HTRW of all types that have been released into the soil, surface water, groundwater or air at the project site and that are currently regulated under environmental law. The exceptions are petroleum and natural gas products released into the environment at the project site, as these products are not CERCLA hazardous substances. These non-CERCLA hazardous substances may be removed/remediated and paid for by the project, as long as they are required to be removed/remediated according to any validly promulgated Federal, California State, or local regulation.

A large known amount of HTRW contaminated soil exists at the two Taylor Yard properties of G1 and G2. A large amount of known HTRW contaminated groundwater also resides beneath

most of the Study project area and is part of the San Fernando Valley Superfund site/property. These are 3 of the 23 known and suspected HTRW contaminated properties described from the HTRW Survey Report in the study area and the 3 that lie within the project footprint. An unknown amount of residual soil and groundwater contamination may also exist at the LATC property and at or near the remaining 19 known properties that are near but outside the project footprint. It is possible, but less likely that unknown amount of soil and groundwater contamination will be encountered during construction of the project near the 19 properties. This is because most of the known HTRW contamination has already been actively removed/remediated from these sites, and any residual contamination is being monitored, and land use controls are in place, or it is being passively remediated, i.e. left to naturally attenuate. It is possible and more likely that unknown amounts of soil and groundwater contamination will be encountered at the habitat footprint at LATC, because much of this property was once used as a railroad maintenance yard. LATC is likely to contain HTRW contamination based on its historical similarity to Taylor Yard, which is heavily contaminated with HTRW and is also a high HTRW impact property to the project. However, there is no material evidence at this time to substantiate this. The sponsor will conduct all necessary investigations and remediate relevant soil contamination prior to project construction at that site.

Regardless of its state, any residual CERCLA derived HTRW contamination encountered before or during construction must be must be removed/remediated by the Sponsor at 100% their cost. The primary regulatory agencies for the approval of the remediation of HTRW will be the California Department of Toxic Substance and Control (DTSC) or the Los Angeles Regional Water Quality Control Board (LARWQCB). Please see the HTRW Survey Report and HTRW Issue Paper, for more information on the HTRW issues.

There will also be construction activities that involve routine transport, use, and disposal of common hazardous materials, such as fuels (gasoline and diesel), oils and lubricants, and cleaners (e.g., solvents, corrosives, soaps, detergents). Accidental spills of such materials can occur around such activities; however, minor spills are not likely to have significant effects. Best Management Practices (BMPs) would be implemented to minimize potential for the public to come into contact with or be exposed to hazardous materials during the routine transport, use, or disposal of hazardous materials or as a result of an accidental release. Prior to the start of construction, the USACE will develop engineering specifications and plans, which will include a written Environmental Protection Plan (EPP). The EPP will also include a written Pollution Prevention Plan that outlines the actions needed to respond and remediate any unknown/ unexpected HTRW contamination or potential release of construction derived hazardous materials.

Existing known and unknown amounts of HTRW will remain throughout the Study area without the project. On-going and progressive remediation, monitoring and regulation of the 23 known HTRW properties by the current PRPs will continue to occur.

7.0 POTENTIAL PLAN ALTERNATIVES AND DESIGN CONSTRAINTS

Existing conditions have been discussed above and are presented in Table 1. Modifications to the existing conditions will consist of specific sub-measures that will alter the existing condition to meet project objectives. The sub-measures proposed at this time are listed in Table 2. Various sub-measures are combined within sub-reaches to comprise various alternative plans. Five plans have been carried forward and are described in detail in other appendices. These five plans are presented in Table 2. A summary of the constraints discussed in sections below are summarized in table form in Table 4. Regardless of which sub-reach is being modified, the following geotechnical constraints and design considerations will need to be addressed:

a. Site-specific exploration and testing of the materials on site will need to be performed. The exploration and testing will be conducted to develop design parameters, which will be used in structural design of the elements required by the selected sub-measures. The parameters developed will be used in the analysis and considerations for hydrostatic pressures, potential seepage gradients, internal erosion potential, slope stability, settlement, and other geotechnical design considerations outlined in the current design standards;

b. Utilities, transportation corridors, infrastructure facilities, residential and commercial structures and other features are in close proximity of the LA River channel. A detailed delineation and inventory of these features will need to be conducted. Potential impacts of channel modifications on these features will need to be evaluated during design;

c. Levees are present throughout the ARBOR Reach. Modifications to existing levees will need to maintain existing flood protection, be designed and constructed according to current standards, and follow current vegetation guidance under ETL 1110-2-583. As part of this study, a memorandum for record has been prepared with "Levee Condition Inspection and Issue Discussion" as the subject. This memorandum is included as Attachment 1;

d. Grading plans will need to be developed and reviewed during design stages in accordance with codes, standards, and practices;

e. Seismic design parameters will need to be developed during design stages for structural design;

f. Scour estimates have not been made at this time, but would have a significant impact on the design and construction. Scour could potentially put the foundation of structures at risk from undermining or direct flow impacts that have not been considered as part of this Study. Scour estimates, when determined, will need to be incorporated into the development of the design parameters mentioned above. Deepened foundations to accommodate a deep scour condition will result in a more robust structural design to accommodate increased lateral loading. The resulting increases in project cost could be significant and are not presently accounted for in the costs. Currently, it is the assumption that scour issues would be able to be adequately addressed during design phases; and

g. The potential for unknown HTRW materials exist within the ARBOR Reach and may be encountered during design exploration as well as during construction.

7.1 Sub-Reach 1

Planned restoration actions and modifications within this sub-reach include habitat corridor construction and riparian planting on the right and left overbanks of the river as well as along the overbank of the Burbank Western Channel and at the Pollywog Park area of Griffith Park. No channel modifications are currently being considered at this time.

Other than those general issues mentioned above, the following constraints and design considerations impact this specific sub-reach:

a. Habitat Corridors will need to take into account potential impacts to the California State 134 Freeway (CA-134) from an easement and structural suitability standpoint;

b. Levees exist within this reach on both the right and left banks. It is currently the assumption that the levees will not be modified and that the planting will be done following policy guidance under ETL 1110-2-583 within this sub-reach; and

c. Soil impacted by known HTRW is not anticipated for this sub- reach. However, groundwater within the project area in this reach may be impacted by HTRW. These impacts may include existing Volatile Organic Compound (VOC/s) contamination associated with the Forest Lawn Cemetery. As the cemetery site is not within the project footprint, impacts from soil contamination are not anticipated. However, potential groundwater contamination may impact the project site as it is generally down gradient from contaminated areas and dewatering is likely during grading operations. This impact will need to be evaluated and if necessary addressed during design phases. As noted above, this remediation is the responsibility of the project Sponsor and is not paid for by

the project, i.e. it is at 100% of non-project cost, and in-kind project credit by the USACE cannot be given to the Sponsor.

7.2 Sub-Reach 2

Planned restoration actions within this sub-reach include habitat corridor construction and riparian planting on the overbanks of both sides of the river (all alternatives), a vertical wall from River Station (RS) RS-542+40 to 509+00 on the left bank (only in Alternative 20), planting of vines (only Alternative 20), and construction of a soft bottom (only Alternative 20).

Other than those general issues mentioned above, the following constraints and design considerations impact this specific sub-reach:

a. Habitat Corridors will need to take into account potential impacts to the CA-134 and Interstate 5 Freeway (I-5) from an easement and structural suitability standpoint. Currently, it is the assumption that these impacts will be evaluated during design phases;

b. Impacts to the bridge crossings of I-5 as a result of re-configuration of the channel associated with the vertical wall and scour will need to be considered. Currently, it is the assumption that the bridge impacts and scour will be evaluated during design phases;

c. The walls currently under consideration likely require counterfort or tieback designs. These designs will require extensive right of way, either temporary or permanent, and will need to be considered during design;

d. Levees exist within this reach on both the right and left banks. Modifications to existing levees will need to maintain existing flood protection, be designed and constructed according to current standards, and follow current vegetation guidance under ETL 1110-2-583; and

e. Soil impacted by known HTRW is not anticipated for this sub-reach. However, groundwater within the project area in this reach may be impacted by HTRW. These impacts may include existing VOC contamination associated with the Forest Lawn Cemetery. As the cemetery site is not within the project footprint, soil impacts from the contamination are not anticipated for the project. However, potential groundwater contamination may impact the project site as it is generally down gradient from the cemetery and dewatering operations are likely during site development. This impact will need to be evaluated and if necessary addressed during design phases. As noted above, this remediation is the responsibility of the project Sponsor and is not paid for by the

project, i.e. it is at 100% of non-project cost, and in-kind project credit by the USACE cannot be given to the Sponsor.

7.3 Sub-Reach 3

Planned restoration actions within this sub-reach include daylighting of two storm drains on the left bank (Alternatives 10, 13, 13v, and 16) and one on the right bank (all alternatives), expansion of the Verdugo Wash confluence (only in Alternative 20), planting of riparian habitat corridor along Verdugo Wash (Alternative 20 only) and the right bank of the LA River (all alternatives) and diversion of flows into a side channel at Ferraro Fields (all alternatives excluding 10). Daylighting of the storm drain connections would allow for habitat development at storm drain entrance to the river and eliminating closed pipes. The planned changes to Verdugo Wash include removal of the existing paved bottom and widening of the confluence with the LA River to create a soft bottom environment with vegetation.

Other than those general issues mentioned above, the following constraints and design considerations impact this specific sub-reach:

a. Modifications will need to take into account potential impacts to the CA-134 and I-5 interchange, as well as surface streets and railroad crossings from an easement and structural suitability standpoint. Currently, it is the assumption that these impacts will be evaluated during design phases and will be minimized;

b. Impacts to the bride crossings of CA-134 as a result of re-configuration of the channel and scour will need to be considered. Currently, it is the assumption that these impacts and scour will be evaluated during design phases and will be minimized;

c. The walls currently under consideration, in Alternative 20 for the Verdugo Wash confluence, will likely require counterfort or tieback designs. These designs will require extensive right of way, either temporary or permanent, and these issues will need to be evaluated during design;

d. Levees exist within this reach on both the right and left banks. Modifications to existing levees will need to maintain existing flood protection, be designed and constructed according to current standards for seepage, settlement and stability according to EM 1110-2-1913, and follow current vegetation guidance under ETL 1110-2-583; and

e. Soil impacted by known HTRW is not anticipated for this sub- reach. However, groundwater within the project may be impacted by HTRW. These impacts may include existing zinc and chromium contamination associated with the Former Hawkes Finishing site. As the finishing site is not within the footprint of the project site, impacts from soil

contamination are not anticipated for the project. However, groundwater that is contaminated by these conditions may impact the project site. Dewatering and grading operations could aggravate these conditions. This impact will need to be evaluated and if necessary addressed during design phases. As noted above, this remediation is the responsibility of the project Sponsor and is not paid for by the project, i.e. it is at 100% of non-project cost, and in-kind project credit by the USACE cannot be given to the Sponsor.

7.4 Sub-Reach 4

Planned restoration actions within this sub-reach include daylighting of storm drains (all alternatives on left bank), riparian planting (all alternatives on left bank), and diversion of flows into a side channel (all alternatives on right bank) and a lowered area to allow seasonal flooding (all alternatives, left bank). Daylighting of the storm drain connections would allow for habitat development at storm drain entrance to the river and eliminating closed pipes.

Other than those general issues mentioned above, the following constraints and design considerations impact this specific sub-reach:

a. Modifications will need to take into account potential impacts to the I-5, as well as surface street crossings from an easement and structural suitability standpoint. Currently, it is the assumption that these impacts will be evaluated during design phases;

b. Impacts to the bride crossings of the Colorado Street Freeway Extension and Los Feliz Boulevard as a result of re-configuration of the channel and scour will need to be considered. Currently, it is the assumption that these impacts and scour will be evaluated during design phases;

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c. Levees exist within this reach on both the right and left banks. Modifications to existing levees will need to maintain existing flood protection, be designed and constructed according to current standards, and follow current vegetation guidance under ETL 1110-2-583; and

d. No direct HTRW issues are within this sub-reach, but the sub-reach may be impacted by upstream or downstream sites if dewatering operations change the local groundwater gradient. Similarly, impact to the sub-reach may occur if grading changes surficial drainage or exposes soils. As noted above, this remediation is the responsibility of the project Sponsor and is not paid for by the project, i.e. it is at 100% of non-project cost, and in-kind project credit by the USACE cannot be given to the Sponsor.

7.5 Sub-Reach 5

Planned restoration actions within this sub-reach include a riparian corridor on the left bank, daylighting of one storm drain (left bank in all alternatives) and changes to the right and left banks in Alternatives 16 and 20. The right bank of the channel would change from trapezoidal to vertical configuration for the entire sub-reach in Alternatives 16 and 20. The left bank of the channel would change from trapezoidal to vegetated terraces from RS 356+22 to RS 286+05 in Alternatives 16 and 20 with widening at the downstream end on the left bank. The proposed terraces would be 12-feet wide by 4-feet deep and tie into the existing ground elevation at a 3:1 slope. The left bank would then transition from terraces to a vertical configuration from RS 286+05 to RS 271+89, and then transition back into the original design channel configuration starting at RS 274+78.29, before the channel passes under the Glendale Freeway in Alternatives 16 and 20. Daylighting of the storm drain connection would allow for habitat development at the storm drain entrance to the river and elimination of closed pipes.

Other than those general issues mentioned above, the following constraints and design considerations impact this specific sub-reach:

a. Channel modifications will need to take into account potential impacts to the I-5, as well as surface street crossings from an easement and structural suitability standpoint. This impact will not be a factor in Alternatives 10, 13, and 13v. Currently, it is the assumption that these impacts will be evaluated during design phases;

b. The walls currently under consideration in Alternatives 16 and 20 likely require counterfort or tieback designs, These designs will require extensive right of way, either temporary or permanent, and will need to be considered during design;

c. Proposed planting or daylighting of stormdrain structures may require deep foundations depending upon information derived from scour and other hydraulic analyses. Currently, it is the assumption that these requirements will be evaluated during design phases;

d. Impacts to the bride crossings of Hyperion Avenue, Fletcher Drive, and the Glendale Freeway in Alternatives 16 and 20 as a result of re-configuration of the channel and scour will need to be considered. Currently, it is the assumption that these impacts and scour will be evaluated and minimized during design phases;

e. Levees exist within this reach on both the right and left banks. Modifications to existing levees will need to maintain existing flood protection, be designed and constructed according to current standards, and follow current vegetation guidance under ETL 1110-2-583; and

f. Sites within this sub-reach that have known HTRW issues include the following:

- fuel contamination associated with the Former Triangle Gas Station
- fuel and solvent contamination of groundwater associated with the Chevron Gas Station.
- fuel-solvent & metals contamination directly downstream at the Taylor Yard G1 site

As the Taylor Yard G1 site is directly within the project habitat footprint, potential impacts from both soils and groundwater contamination, remediation of soil contamination will need to be addressed as part of the project. Although response at the Taylor Yard sites is currently being addressed, the Sponsor would be 100% responsible for any additional remediation to reach land use levels necessary for the project prior to construction at the site. As the other gas station sites are not within the project footprint, a direct impact from soil contamination is not anticipated. However, groundwater that may migrate from these sites could impact the project site and dewatering, if necessary, would need to account for this condition. These impacts will need to be addressed during design phases. As noted above, this remediation is the responsibility of the project Sponsor and is not paid for by the project, i.e. it is at 100% of non-project cost, and in-kind project credit by the USACE cannot be given to the Sponsor.

7.6 Sub-Reach 6

Planned restoration actions within this sub-reach include the following (note: items a and b are each representative of a different alternative):

a. A small terraced area is planned along the left bank with vegetation at the upstream end of the Bowtie parcel in Alternative 10 from RS 261+80 to RS 256+00; the channel is re-configured to take advantage of the lower Bowtie parcel at RS 243+17, where the channel invert starts to widen into the left bank to add width of more than 80 feet to the existing channel within Taylor Yard before it contracts back to the original channel size at RS 201+76 and the eastern edge of the widened invert is sloped back up at a 4:1 slope to the original ground elevation;

b. A backwater wetland at riverbed level is planned at the upstream end of the Bowtie parcel on the left bank with from RS 261+80 to RS 256+00; the channel is re-configured to take advantage of the lower Bowtie parcel at RS 243+17, where the channel invert starts to widen into the left bank to a width of more than 620 feet (300 feet of new channel width) within Taylor Yard before it contracts back to the original channel size at RS 201+76 and the eastern edge of the widened invert is sloped back at a 3:1 slope to the original ground elevation approximately 15 feet from the railroad tracks; and

c. Alternatives 13, 13v, 16 and 20 have implanted vegetation on the right bank through the entire reach.

Other than those general issues mentioned above, the following constraints and design considerations impact this specific sub-reach:

a. Modifications will need to take into account potential impacts to the I-5 crossing at the downstream end of the sub-reach, as well as surface streets and railroads adjacent to the channel from an easement and structural suitability standpoint. Currently, it is the assumption that these impacts will be evaluated during design phases;

b. Impacts to the bride crossings of I-5 as a result of re-configuration of the channel and scour will need to be considered. Currently, it is the assumption that these impacts and scour will be evaluated during design phases;

c. Proposed planting structures may require deep foundations depending upon information derived from scour and other hydraulic analyses. Currently, it is the assumption that impacts will be minimized and these requirements will be evaluated during design phases; and

d. Sites within this sub-reach that have known HTRW issues include the following:

- existing fuel-solvent & metals contamination of soils and groundwater associated with the Taylor Yard G1 and G2 parcels,
- fuel contamination of groundwater associated with the Shell Gas Station
- fuel contamination directly downstream, the San Fernando Consolidated Facility site

As the Taylor Yard G1 and G2 sites are directly within the project footprint, potential impacts of this contamination to dewatering and grading operations will need to be addressed and these properties will have to be remediated prior to construction by the Sponsor. Although these sites are currently being addressed by responsible parties, the Sponsor would be responsible for any additional remediation to reach land use levels necessary for the project. The Shell Gas Station site and the San Fernando Consolidated Facility site are not within the project footprint, soil impacts from the contamination are not anticipated for the project. However, these sites are generally up gradient from the project and groundwater flow from them could impact the project as shallow groundwater drains from construction excavations. These conditions would need to be accounted for and addressed during design phases. As noted above, this remediation is the responsibility of the project Sponsor and is not paid for by the project, i.e. it is at 100% of

non-project cost, and in-kind project credit by the USACE cannot be given to the Sponsor.

7.7 Sub-Reach 7

Planned restoration actions within this sub-reach include reconfiguration of Arroyo Seco (in four alternative plans, 13, 13v, 16, and 20) and terracing along the banks (of Arroyo Seco in Alternatives 13, 13v, 16, and 20 and of the LA River along the Cornfields site (in Alternatives 13v and 20) by construction of several modifications. Concrete bottom and side slopes would be removed from the Arroyo Seco Channel and riparian corridor vegetation would be planted on its banks for ½ mile upstream of the confluence with the LA River mainstem. Four 4-foot deep terraces on the right bank from RS 102+15 to 97+99 would be added adjacent to the Cornfields site (in Alternatives 13v and 20) and implanted with riparian corridor vegetation. At Cornfields, the western edge of the terrace would be sloped back up to the original ground elevation where the approximately 10 acres of freshwater marsh is restored. The elevation of the railroad would be maintained on trestles from RS 102+15 to 98+98. Modifications to the channel would also include daylighted storm drain connections in Alternatives 10, 13v, and 20 (two on the right bank and one on the left bank). Daylighting of the storm drain connections would allow for habitat development at storm drain entrances to the river and eliminate closed pipes.

Other than those general issues mentioned above, the following constraints and design considerations impact this specific sub-reach:

a. Modifications will need to take into account potential impacts to properties adjacent to the channel as well as surface street crossings from an easement and structural suitability standpoint. Currently, it is the assumption that these impacts will be evaluated during design phases;

b. Impacts to the bride crossings of North Figueroa Street, CA-110 Freeway, North Broadway Street, Spring Street, and North Main Street, and two rail lines as a result of re-configuration of the channel and scour will need to be considered. Currently, it is the assumption that these impacts and scour will be evaluated during design phases;

c. Under Alternatives 13v and 20 for this reach, existing railroad alignments would be kept at grade but placed onto a trestle in sub-reach 7 on the right bank adjacent to the Cornfields site, with excavation below the existing grade. This trestle will provide access to connect the Cornfields freshwater marsh with the mainstem of the LA River. Uninterrupted service to rail traffic is a primary design criterion and temporary shoofly trestles or bypass lines are not currently anticipated to be needed to allow for uninterrupted service. However, the existing track alignments, construction of new trestle alignments, the configuration of the proposed ecosystem restoration features and existing and anticipated train traffic will be further evaluated during the

design phase to verify that temporary shoofly trestles or bypass lines are not needed. If during the design phase, such temporary measures are identified as needed, supplemental analysis would be performed at that time;

d. Proposed planting structures may require deep foundations depending upon information derived from scour and other hydraulic analyses. Currently, it is the assumption that these requirements will be evaluated during design phases;

e. Levees exist within this reach on both the right and left banks. Modifications to existing levees will need to maintain existing flood protection, be designed and constructed according to current standards, and follow current vegetation guidance under ETL 1110-2-583; and

f. Sites within this sub-reach that have known HTRW issues include:

- fuel contamination associated with the San Fernando Consolidated facility,
- solvent and VOC contamination associated with the former Bortz Oil Company site (area a.k.a. Cornfields),
- fuel contamination associated with the former Albion Dairy.
- directly downstream, the former Manufacture Gas Plant site has PAH, metals, VOCs, and fuels contamination
- solvent contamination of the Valspar Corporation site.

As these sites are not within the project footprint, soil impacts from the contamination are not anticipated. However, if groundwater flow from the contaminated sites is toward the project some impact from these contamination sources should be anticipated. These conditions would need to be accounted for and addressed during design phases. As noted above, this remediation is the responsibility of the project Sponsor and is not paid for by the project, i.e. it is at 100% of non-project cost, and in-kind project credit by the USACE cannot be given to the Sponsor.

7.8 Sub-Reach 8

Planned restoration actions in this sub-reach include 3-foot-deep terraces along the right bank along the extent of the LADWP parking lot which would tie into the existing overbank ground elevation with a 3:1 slope (in Alternatives 16 and 20). The terraced area would begin with one 3-foot deep terrace at RS 83+61 and end with seven 3-foot deep terraces at RS 68+38. The Los Angeles River channel would be re-configured in Alternatives 16 and 20 to take advantage of the LATC parcel. At RS 69+93, the channel invert would start to widen into the left bank. The invert width would increase to more than 500 feet before it contracting back to the original channel size at RS 38+47. Within the LATC extent, a bench up to 1000-feet wide would extend from RS 64+92 to RS 50+15. The bench would be established at approximately the 2-year water surface

elevation and include marsh vegetation. The eastern edge of the bench would be sloped back up to the original ground elevation to a point about 1800 feet from the channel. The railroad would be trestled over the widened channel from RS 68+38 to RS 40+13. In Alternatives 10, 13, and 13v, the LATC parcel would also be used with restoration of the historic wash and development of a riparian area within its boundaries.

Other than those general issues mentioned above, the following constraints and design considerations impact this specific sub-reach:

a. Modifications will need to take into account potential impacts to properties adjacent to the channel as well as surface street crossings from an easement and structural suitability standpoint. Currently, it is the assumption that these impacts will be evaluated during design phases;

b. Impacts to the bridge crossings of two rail lines, East Cesar Chavez Avenue, US Highway 101, and First Street as a result of re-configuration of the channel and scour will need to be considered. Under the current alternatives for this reach, existing railroad alignments would be kept at grade but placed onto trestles in sub-reach 8 on the left bank south of Main Street to Cesar Chavez Avenue through LATC in Alternatives 16 and 20, with excavation below the existing grade. These trestles will provide access for additional channel capacity and space to implement other restoration measures. Uninterrupted service to rail traffic is a primary design criterion and temporary shoofly trestles or bypass lines are not currently anticipated to be needed to allow for uninterrupted service. However, the existing track alignments, construction of new trestle alignments, the configuration of the proposed ecosystem restoration features and existing and anticipated train traffic will be further evaluated during the design phase to verify that temporary shoofly trestles or bypass lines are not needed. If during the design phase, such temporary measures are identified as needed, supplemental analysis would be performed at that time;

c. Levees exist within this reach on both the right and left banks. Modifications to existing levees in two alternative plans will need to maintain existing flood protection, be designed and constructed according to current standards, and follow current vegetation guidance under ETL 1110-2-583; and

d. Sites within this sub-reach that have known HTRW issues include:
- fuel contamination associated with the former Albion Dairy,
- PAH, metals, VOCs, and fuels contamination of groundwater and soils associated the former Manufacture Gas Plant site,

- VOCs and metals contamination of soils and groundwater associated with the BNSF Tower Site,
- solvent contamination of groundwater associated with the Morton Intl Whittaker Corp. site,
- fuel contamination to soils and groundwater associated with the MTA site,
- fuel contamination of groundwater associated with the Chevron Gas Station site,
- fuel contamination of groundwater associated with the Gannett Outdoor Systems Inc. site,
- solvent contamination of soils and groundwater associated with the Infinity Outdoor Co. site,
- metals contamination to groundwater and soils associated with the Chromal Plating & Grinding Co. site,
- solvent contamination of groundwater associated with the Valspar Corporation site.

As these sites are not within the project footprint, soil impacts from the contamination are not anticipated. However, if groundwater flow from the contaminated sites is toward the project some impact from these contamination sources should be anticipated. These conditions would need to be accounted for and addressed during design phases. As noted above, this remediation is the responsibility of the project Sponsor and is not paid for by the project, i.e. it is at 100% of non-project cost, and in-kind project credit by the USACE cannot be given to the Sponsor.

8.0 LIMITATIONS AND ASSUMPTIONS

The alternatives and restoration actions discussed within this appendix were under development at the time of the compilation of this Geotechnical Study and may not be representative of the final selected alternative.

As is common with feasibility studies, certain engineering investigations and preliminary design aspects are routinely assigned to future stages of study. As a result, some risk is associated with this approach and has been documented in the risk analysis. These aspects include anticipated scour, construction easements and right-of-way considerations, and potential HTRW impacts. The impacts of assigning these Study items to future stages of Study include the unanticipated need for new mitigation measures, re-evaluation of alternatives, and could have impact on final construction costs. For example, scour could potentially put the foundation of structures at risk from undermining or direct flow impacts that have not been considered as part of this Study. Scour estimates will need to be incorporated into the development of the design parameters mentioned above. Deepened foundations to accommodate a deep scour condition will result in a more robust structural design to accommodate increased lateral loading. The resulting increases in project cost could be significant and are not currently accounted for in the costs. It is the current assumption that these aspects will be addressed in design phases.

All information contained within this Appendix is based on the information available to the project team; this information does not constitute all publically available data, and is presumed to be current to the date of the initial release of Geotechnical Study only.

As within any urbanized setting, the potential for undocumented fill, unknown utilities, and changing surface conditions exists. Future activities and studies will need to account for these conditions. Detailed studies could reveal subsurface conditions and issues not yet identified as part of this Study.

9.0 RECOMMENDATIONS FOR FUTURE STUDY AND PATH FORWARD

A thorough subsurface investigation will be required for any engineering design and should be in conformance with current investigation, analysis, and design standards. Efforts conducted during these studies may include subsurface exploration, well testing, data gathering, laboratory testing, and field mapping.

Significant coordination with multiple organizations and agencies as well as land and utility owners will be required for investigation and construction. A detailed breakdown of the selected alternative and the impacted properties should be made to focus investigation efforts. It should be noted that the investigations will likely require multiple phases and coordination efforts with the agencies and owners will need to be ongoing throughout the investigation and design phases.

10.0 REFERENCES

California Geologic Survey. 2006. Map of Alquist-Priolo Earthquake Fault Zones. Accessed August 2012 at http://www.consrv.ca.gov/cgs/rghm/ap/index.htm.

Southern California Earthquake Data Center. 2012. Significant Earthquakes and Faults. Accessed August 2012 at www.data.scec.org/index.html.

California Division of Mines and Geology. 1970. Geology of the Elysian Park-Repetto Hills Area, Los Angeles County, California.

U.S. Geologic Survey, 1991, Seismicity of Los Angeles, Wright.

Table 1
Sub-Reach Descriptions

Sub-Reach	Upstream End	Downstream End	Approximate Length (miles)	Existing Channel Configuration	Areas of Opportunity
Reach 1	Pollywog Park/Headworks	Midpoint of Bette Davis Park	1.5	Rectangular (vertical concrete wall) channel with concrete bottom	Headworks, Pollywog Park, Bette Davis Park
Reach 2	Midpoint of Bette Davis Park	Upstream end of Ferraro Fields	0.73	Trapezoidal channel with grouted stone or concrete side slopes with soft bottom	Bette Davis Park
Reach 3	Upstream end of Ferraro Fields	Brazil Street	1	Trapezoidal channel with concrete side slopes transition into rectangular channel transition into rectangular channel all with concrete bottom	Ferraro Fields, the Burbank Western Channel, Glendale River Walk, Verdugo Wash, Griffith Park,
Reach 4	Brazil Street	Los Feliz Boulevard	1.78	Trapezoidal channel with grouted stone side slopes and soft bottom	Griffith Park, Atwater Park
Reach 5	Los Feliz Boulevard	Glendale Freeway (CA 2)	1.68	Trapezoidal channel with grouted stone and concrete side slopes and soft bottom	Atwater Park, the Bowtie and Taylor Yard,
Reach 6	Glendale Freeway (CA 2)	Interstate 5 (I-5)	2.4	Trapezoidal channel with grouted stone and concrete side slopes and soft bottom	Elysian Park,
Reach 7	Interstate 5 (I-5)	Main Street	1.1	Rectangular and trapezoidal channel with concrete side slopes and concrete bottom	Cornfields (LA State Historic Park), Elysian Park, Arroyo Seco, Downtown Los Angeles
Reach 8	Main Street	First Street	1.44	Trapezoidal channel with concrete side slopes and concrete bottom	Piggyback Yard (also known as Mission Yard), Downtown Los Angeles

Table 2
Los Angeles River Ecosystem Restoration
Sub-Measure Application in Alternative Plans 10, 13, 13v, 16, 20

	Reach 1		Reach 2		Reach 3		Reach 4		Reach 5		Reach 6		Reach 7		Reach 8	
Sub-measure	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank	Left Bank	Right Bank
Riparian planting of habitat corridors	All	All	All	All	20	All	All		All		All	All	13, 13v, 16, 20	13v , 20		
Expose/daylight stormdrain outlets					10, 13, 13v, 16	All	All		All				10, 13v, 20	10, 13v, 20		
Channel widening			20		20				16, 20	16,20	All	All		13v, 20	16, 20	
Create/rebuild channel geomorphology*															16, 20	16, 20
Divert flows into side channels					13, 13v, 16, 20		All	All							16, 20	
Planting built into walls											13, 13v, 16, 20	13, 13v, 16, 20				
Channel Bed Deepening															16, 20	16, 20
Terrace banks			20						16, 20		13, 13v, 16, 20	13, 13v, 16, 20	13v, 20	13v, 20	All	All
Bioengineer Channel Walls (vines)			20							16, 20			13, 16	13, 16		
Trapezoidal to vertical walls				20						16, 20						
Widen Tributaries					20								13, 13v, 16, 20			
Elevate Railroad														13v, 20	16. 20	

* Within this appendix, references to restoration, creation, or improvement of "hydrology" and "geomorphology" are intended to refer to restoration, creation, or improvement of a more natural hydrologic regime and a more natural geomorphic character.

Table 3
Selected Historic Earthquakes of Southern California

Year	Date	Location	Time	Richter Magnitude	Mercalli Intensity	Casualties/Property Damage
1769	28-Jul	LA Area	--	6	VIII	No information.
1812	8-Dec	Los Angeles Area	3:00 PM	7	VII	40 deaths, Mission San Juan Capistrano severely to moderately damaged. Mission San Gabriel moderately damaged.
1827	24-Sep	Los Angeles Area	4:00 AM	5.5	--	No information.
1855	11-Jul	Los Angeles Area	4:15 AM	6	VIII	Bells of Mission San Gabriel were detached. 6 buildings damaged in LA.
1857	9-Jan	Fort Tejon	4:24 PM	7.9	IX	2 deaths; heavy property damage/loss.
1916	23-Oct	Tejon Pass Region	2:44 PM	5.3	--	No information.
1933	10-Mar	Long Beach	5:54 PM	6.4	IX	120 deaths; $50 million.
1941	21-Oct	Torrance-Gardena	10:57 PM	4.8	VII	No deaths; $100,000.
1941	14-Nov	Torrance-Gardena	12:42 AM	4.8	VIII	No deaths; $1 million.
1951	25-Dec	San Clemente Island	4:46 PM	5.9	--	No deaths; no appreciable damage.
1971	9-Feb	San Fernando	6:01 AM	6.6	--	65 deaths; $505 million.
1979	1-Jan	Malibu	3:15 PM	5.2	--	No deaths; minor damage.
1987	1-Oct	Whittier-Narrows	7:42 AM	5.9	--	8 deaths; $358 million.
1988	3-Dec	Pasadena	11:38 PM	5	--	No deaths; no appreciable damage.
1989	19-Jan	Malibu	10:38 PM	5	--	No deaths; slight damage.
1989	12-Jun	Montebello	9:57 AM	4.6	--	No deaths; no appreciable damage.
1991	28-Jun	Sierra Madre	7:44 AM	5.8	--	2 deaths; $40 million.
1994	17-Jan	Northridge	4:31 AM	6.7	--	61 deaths; est. $20 billion.
2001	9-Sep	SE of West Hollywood	4:59 PM	4.2	--	No deaths; moderate damage.
2005	16-Jun	Los Angeles Area	1:53 PM	4.4	--	No deaths; no appreciable damage
2007	9-Aug	Los Angeles Area	12:58 AM	4.4	--	No deaths; no appreciable damage
2008	29-Jul	Los Angeles Area	5:42 AM	5.5	--	No deaths; no appreciable damage
2009	9-Jan	Los Angeles Area	7:49 PM	4.5	--	No deaths; no appreciable damage
2009	18-May	Los Angeles Area	8:39 PM	4.7	--	No deaths; no appreciable damage

Source: USGS 2012

Table 4
Geotechnical Constaints and Considerations for Design

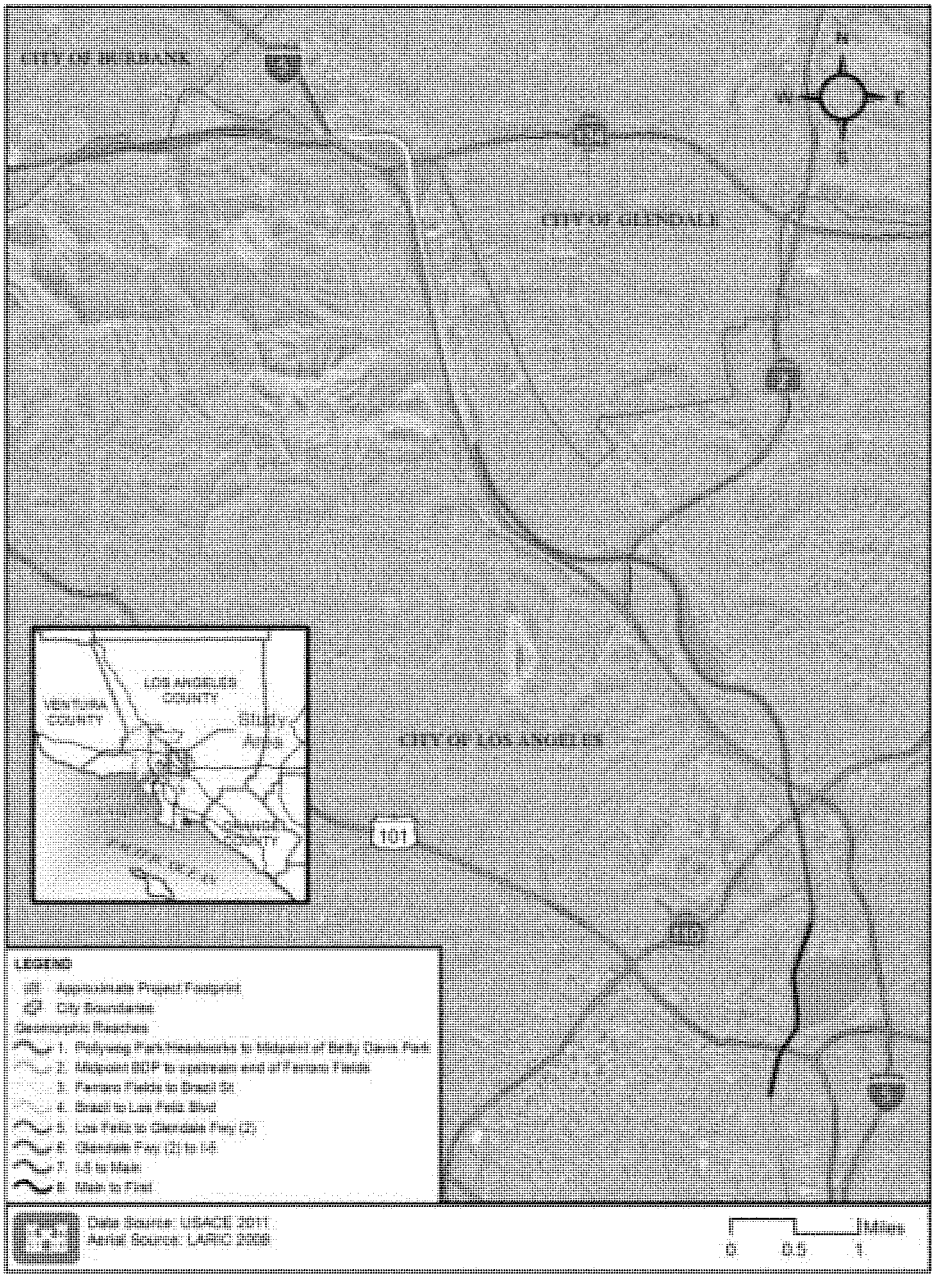
Sub-Reach	Geotechnical Discipline	Constraints and Considerations for Design
Sub-Reach1	Soils	For off bank grading, testing for soil compatibility, and grading operations will need to be conducted.
		Grading plans will need to be developed and reviewed. Habitat Corridors will need to take into account potential impacts to 134 Freeway.
		Habitat Corridors will need to take into account potential impacts to 134 Freeway.
	Levee Safety	Modifications to levees will need to maintain existing protection.
		Modifications are to be performed and designed according to current standards for levees, floodwalls, and channels.
		Vegetation must follow current vegetation guidance under ETL 1110-2-571.
	HTRW	Forest Lawn Cemetery (Open File CWQCB with VOC impact to groundwater) site may impact dewatering and grading operations and will need to be addressed.
Sub-Reach 2	Soils	Without scour estimate impact to design of wall can not be determined.
		Parameters for structural design will need to be determined.
		These walls will probably require counterfort or tieback designs which will require extensive right of way, either temporary or permanent, and will impact real-estate (estimate 45 feet permanent required behind the wall for anchors, probably less counterforts. An unknown amount for construction).
		Seismic design considerations will also need to be made during design as seismic deformation may require significant costs following an event for reconstruction.
		The I-5 crossing in this reach also has potential cost related issues. Scour could potentially put the bridge foundations at risk from undermining or direct flow impact that has not been considered.
		Foundation depths for both the walls and the potential underpinning of the I-5 Bridge could result in significant costs.
		For off bank grading, testing for soil compatibility, and grading operations will need to be conducted.
		Grading plans will need to be developed and reviewed.
		Habitat Corridors will need to take into account potential impacts to CA-134 and I-5 Freeways.
	Levee Safety	Modifications to levees will need to maintain existing protection.
		Modifications are to be performed and designed according to current standards for levees, floodwalls, and channels.
		Vegetation must follow current vegetation guidance under ETL 1110-2-571.
	HTRW	Forest Lawn Cemetery (Open File CWQCB with VOC impact to groundwater) site may impact dewatering and grading operations and will need to be addressed.
Sub-Reach 3	Soils	Without scour estimate impact to design of features can not be determined. In order to prevent potential undercutting, foundations for simple structures may be a required to be at significant depth and may be exorbitant cost for the proposed features.
		Parameters for structural design will need to be determined.
		Some of these features may require extensive right of way, either temporary or permanent, and will impact real-estate.
		Seismic design considerations will also need to be made during design as seismic deformation may require significant costs following an event for reconstruction.
		The CA-134 crossing in this reach also has potential cost related issues. Scour could potentially put the bridge foundations at risk from undermining or direct flow impact that has not been considered.
		Foundation depths for both features and the walls and the potential underpinning of the CA-134 Bridge could result in significant costs.
		Potential utility impacts (shoring, replacement, re-routing etc.) need to be evaluated and may pose significant cost.
	Levee Safety	Modifications to levees will need to maintain existing protection.
		Modifications are to be performed and designed according to current standards for levees, floodwalls, and channels.
		Vegetation must follow current vegetation guidance under ETL 1110-2-571.
	HTRW	Former Hawkes Finishing site (Open File CWQCB with Cr & Zn impact to soil) may impact dewatering and grading operations and will need to be addressed.

Table 4
Geotechnical Constaints and Considerations for Design

Sub-Reach	Geotechnical Discipline	Constraints and Considerations for Design
Sub-Reach 4	Soils	Without scour estimate impact to design of features can not be determined. In order to prevent potential undercutting, foundations for simple structures may be a required to be at significant depth and may be exorbitant cost for the proposed features.
		Parameters for structural design will need to be determined.
		Some of these features may require extensive right of way, either temporary or permanent, and will impact real-estate.
		Seismic design considerations will also need to be made during design as seismic deformation may require significant costs following an event for reconstruction.
	Levee Safety	Modifications to levees will need to maintain existing protection.
		Modifications are to be performed and designed according to current standards for levees, floodwalls, and channels.
		Vegetation must follow current vegetation guidance under ETL 1110-2-571.
	HTRW	None within reach but may be impacted by upstream or downstream sites if dewatering operations change the local groundwater gradient or grading changes surficial drainage or exposes soils.
Sub-Reach 5	Soils	Without scour estimate impact to design of wall can not be determined.
		These walls, directly adjacent to I-5 will probably require counterfort or tieback designs. That will require extensive right of way, either temporary or permanent, and will impact real-estate (estimate 45 feet permanent required behind the wall for anchors, probably less counterforts. An unknown amount for construction).
		Parameters for structural design will need to be determined.
		Seismic design considerations will also need to be made during design as seismic deformation may require significant costs following an event for reconstruction.
		The Glendale Freeway, Hyperion Avenue, and Los Feliz Blvd. crossings in this reach also have potential cost related issues. Scour could potentially put the bridge foundations at risk from undermining or direct flow impact that has not been considered.
		Foundation depths for both the walls and the potential underpinning of the bridges could result in significant costs.
	Levee Safety	Modifications to levees will need to maintain existing protection.
		Modifications are to be performed and designed according to current standards for levees, floodwalls, and channels.
		Vegetation must follow current vegetation guidance under ETL 1110-2-571.
	HTRW	Former Triangle Gas Station (Open File CWQCB with fuel impact to soil), Chevron Gas Station (Open File CWQCB with fuel-solvent impact to groundwater), and Taylor Yd G1 (Open case with DTSC with fuel-solvent & metals impact to soils and groundwater) directly downstream may impact dewatering and grading operations and will need to be addressed.
Sub-Reach 6	Soils	Without scour estimate impact to design of features can not be determined.
		In order to prevent potential undercutting, foundations for simple structures may be a required to be at significant depth and may be exorbitant cost for the proposed features.
		Parameters for structural design will need to be determined. Some of these features may require extensive right of way, either temporary or permanent, and will impact real-estate.
		Seismic design considerations will also need to be made during design as seismic deformation may require significant costs following an event for reconstruction.
		Potential slope stability issues will need to be evaluated on a case by case basis.
		Impacts to railroad tracks will need evaluation.
	Levee Safety	Modifications to levees will need to maintain existing protection.
		Modifications are to be performed and designed according to current standards for levees, floodwalls, and channels.
		Vegetation must follow current vegetation guidance under ETL 1110-2-571.
	HTRW	Taylor Yd G1 (Open case file with DTSC with fuel-solvent & metals impact to soils and groundwater), Taylor Yd G2 (Open case file with DTSC with fuel-solvent & metals impact to soils groundwater), Shell Gas Station (Open file with CWQCB with fuel impact to groundwater), Chevron Gas Station (Open file with CWQCB with fuel impact to groundwater), and San Fernando Consolidated Facility (Open file with CWQCB with fuel impact to groundwater downstream) may impact dewatering and grading operations and will need to be addressed.

Table 4
Geotechnical Constaints and Considerations for Design

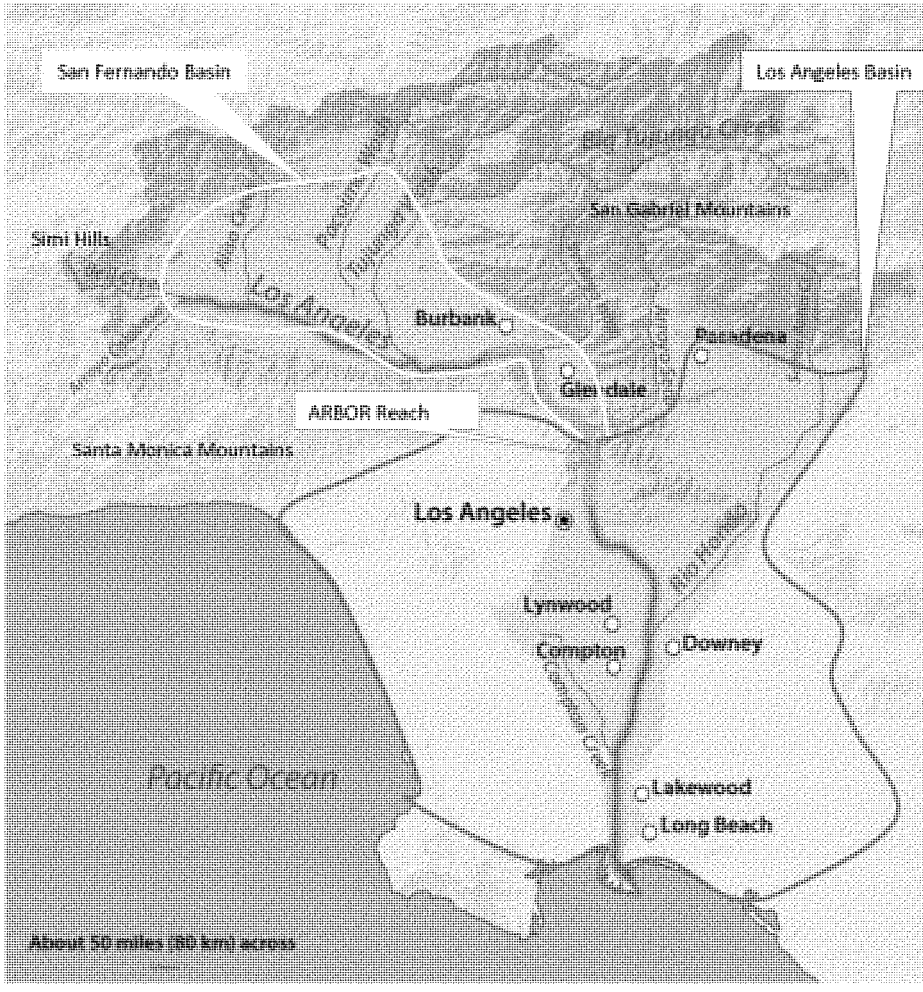
Sub-Reach	Geotechnical Discipline	Constraints and Considerations for Design
Sub-Reach 7	Soils	Without scour estimate impact to design of features can not be determined. In order to prevent potential undercutting, foundations for simple structures may be a required to be at significant depth and may be exorbitant cost for the proposed features.
		Parameters for structural design will need to be determined.
		Some of these features may require extensive right of way, either temporary or permanent, and will impact real-estate.
		Seismic design considerations will also need to be made during design as seismic deformation may require significant costs following an event for reconstruction.
		Potential slope stability issues will need to be evaluated on a case by case basis.
		Impacts to railroad tracks will need evaluation.
	Levee Safety	Modifications to levees will need to maintain existing protection.
		Modifications are to be performed and designed according to current standards for levees, floodwalls, and channels.
		Vegetation must follow current vegetation guidance under ETL 1110-2-571.
	HTRW	San Fernando Consolidated facility (Open file with CWQCB with fuel impact to groundwater), former Bortz Oil Company ((area a.k.a. Cornfields)Open case file with DTSC and CWQCB with solvent-VOC impact to groundwater & soils), former Albion Dairy (Open file with CWQCB with fuel impact to groundwater), former Manufacture Gas Plant (Open case file with DTSC with PAH, metals, VOCs, fuels impact to groundwater and soils is downstream), and Valspar Corporation (Open file with CWQCB with solvent impact to groundwater downstream) may impact dewatering and grading operations and will need to be addressed.
Sub-Reach 8	Soils	Without scour estimate impact to design of features can not be determined. In order to prevent potential undercutting, foundations for simple structures may be a required to be at significant depth and may be exorbitant cost for the proposed features.
		Parameters for structural design will need to be determined.
		Some of these features may require extensive right of way, either temporary or permanent, and will impact real-estate
		Seismic design considerations will also need to be made during design as seismic deformation may require significant costs following an event for reconstruction.
		Potential slope stability issues will need to be evaluated on a case by case basis.
		Impacts to railroad tracks will need evaluation.
	Levee Safety	Modifications to levees will need to maintain existing protection.
		Modifications are to be performed and designed according to current standards for levees, floodwalls, and channels.
		Vegetation must follow current vegetation guidance under ETL 1110-2-571.
	HTRW	Former Albion Dairy (Open file with CWQCB with fuel impact to groundwater), former Manufacture Gas Plant (Open file with DTSC with PAH, metals, VOCs, fuels impact to groundwater and soils), BNSF Tower (Open file with CWQCB with VOCs, metals impact to soils and groundwater), former Manufacture Gas Plant (Open Case file with DTSC with solvent, VOCs, metals impact to groundwater and soils), Morton Intl Whittaker Corp Open file with CWQCB with solvent impact to groundwater), MTA Open file with CWQCB with fuel impact to groundwater and soils), Chevron Gas Station (Open file with CWQCB with fuel impact to groundwater), Gannett Outdoor Systems Inc (Open file with CWQCB with fuel impact to groundwater), Infinity Outdoor Co (Open file with CWQCB with solvent impact to groundwater and soils), . Chromal Plating & Grinding Co (Open file with CWQCB with metals impact to groundwater and soils), and Valspar Corp (Open file with CWQCB with solvent impact to groundwater) may impact dewatering and grading operations and will need to be addressed.



Los Angeles River
Ecosystem Restoration Study
Geotechnical Feasibility Study

Figure 1
ARBOR Reach and Sub-reaches

US Army Corps of Engineers
Los Angeles District
Geotech Branch



Los Angeles River
Ecosystem Restoration Study
Geotechnical Feasibility Study

Figure 2
General Overview and Topography

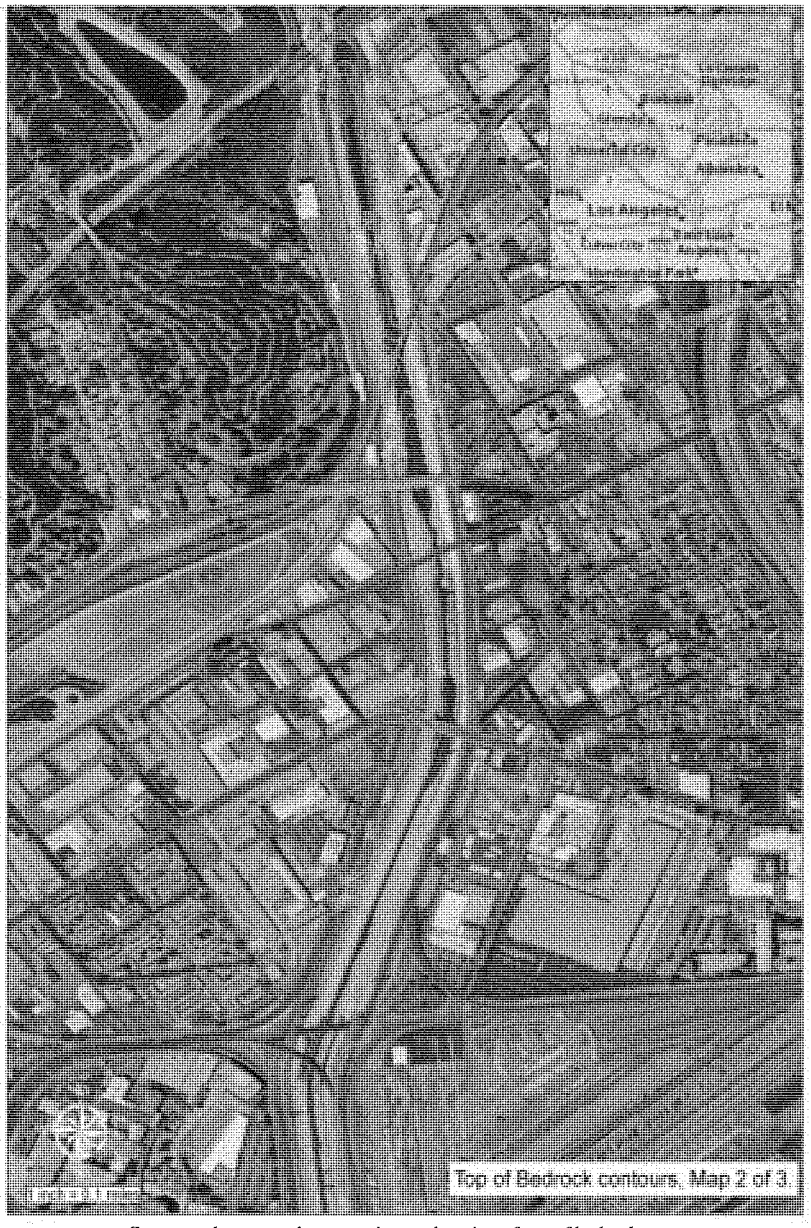
US Army Corps of Engineers
Los Angeles District
Geotech Branch

Contours shown are the approximate elevation of top of bedrock.

Los Angeles River
Ecosystem Restoration Study
Geotechnical Feasibility Study

Figure 3
Top of Bedrock Contour Map

US Army Corps of Engineers
Los Angeles District
Geotech Branch

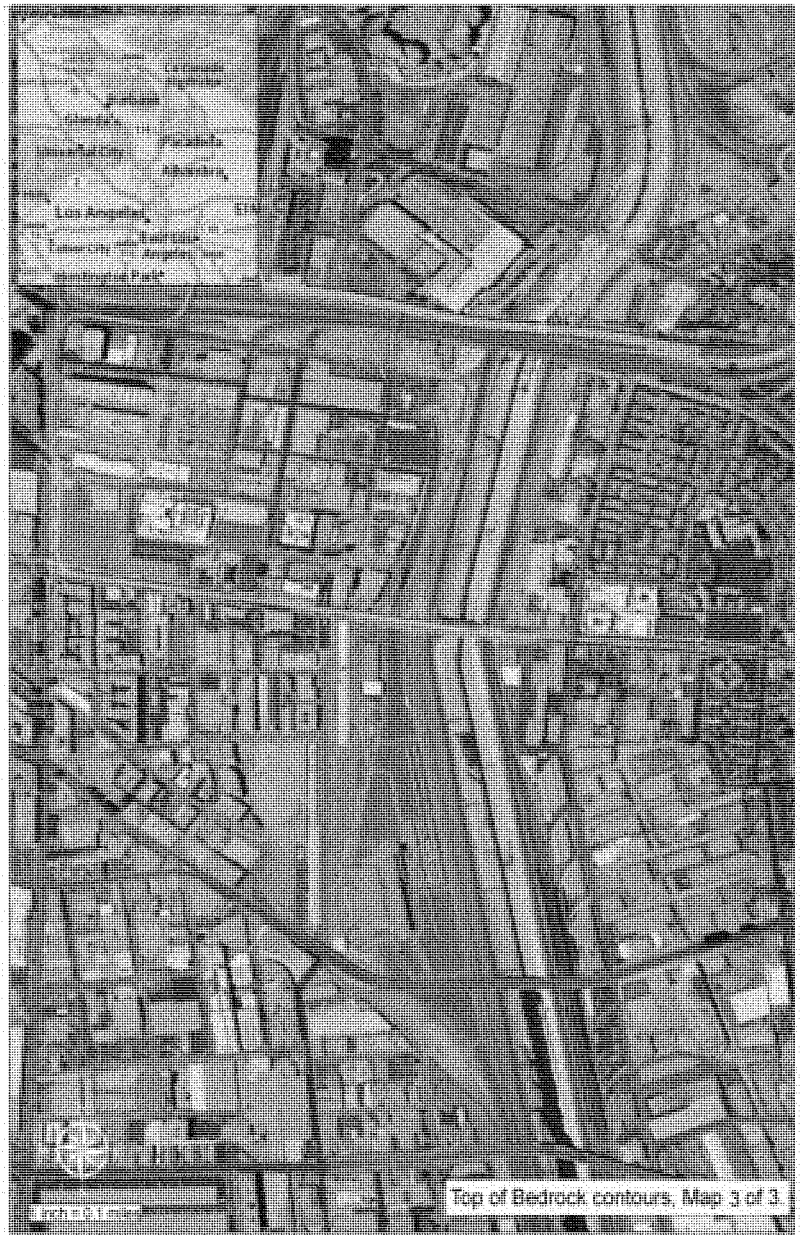


Contours shown are the approximate elevation of top of bedrock.

Los Angeles River
Ecosystem Restoration Study
Geotechnical Feasibility Study

Figure 4
Top of Bedrock Contour Map

US Army Corps of Engineers
Los Angeles District
Geotech Branch

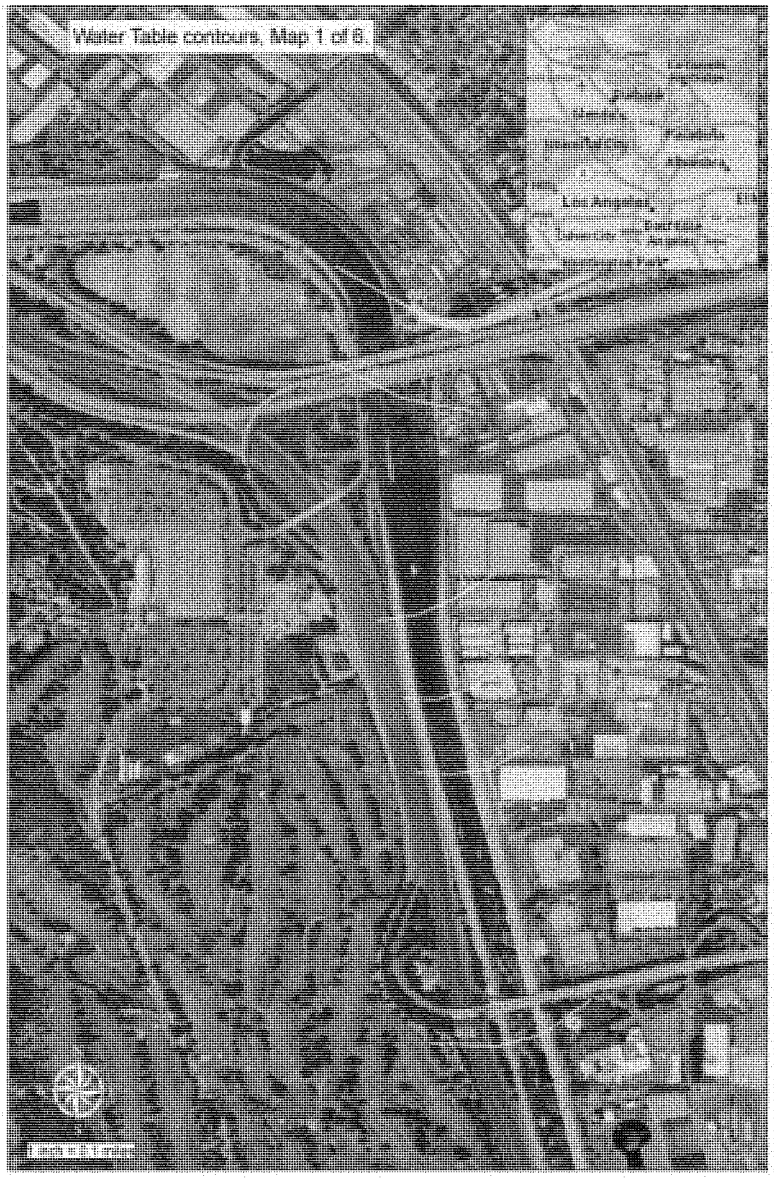


Contours shown are the approximate elevation of top of bedrock.

Los Angeles River
Ecosystem Restoration Study
Geotechnical Feasibility Study

Figure 5
Top of Bedrock Contour Map

US Army Corps of Engineers
Los Angeles District
Geotech Branch

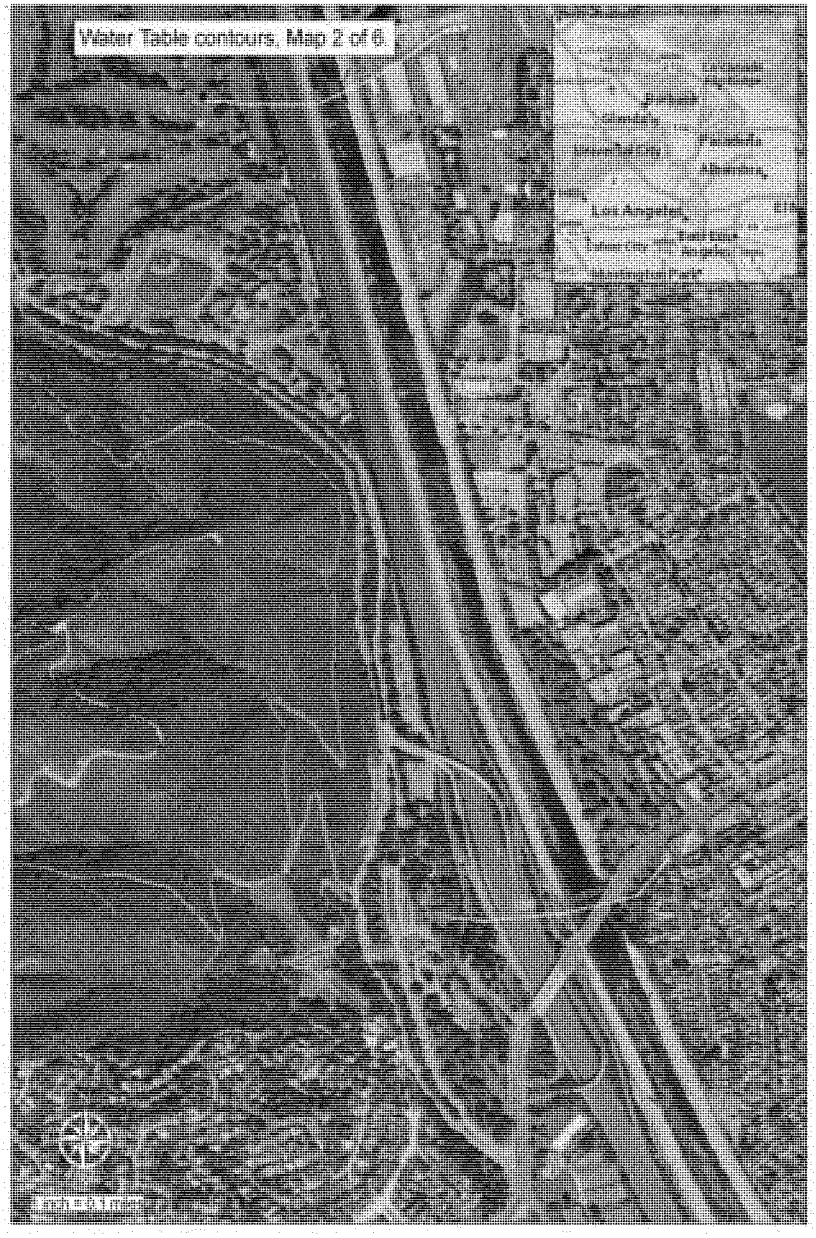


Contours shown are the approximate elevation of groundwater encountered.

Los Angeles River
Ecosystem Restoration Study
Geotechnical Feasibility Study

Figure 6
Water Table Contour Map

US Army Corps of Engineers
Los Angeles District
Geotech Branch

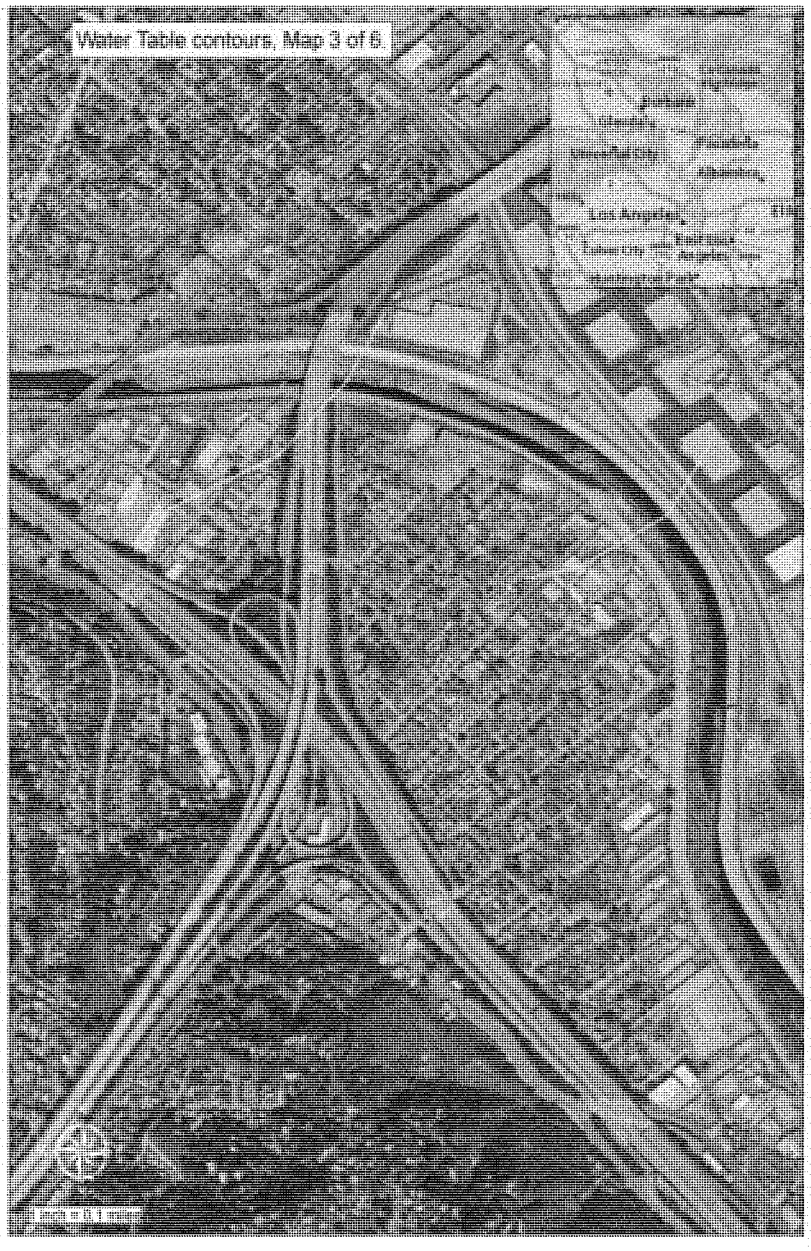


Contours shown are the approximate elevation of groundwater encountered.
The elevations presented hereon are based on the State of California Databases.
The data within those databases were provided by third parties.
As such, the data cannot be verified and the elevations are considered to be approximate.

Los Angeles River
Ecosystem Restoration Study
Geotechnical Feasibility Study

Figure 7
Water Table Contour Map

US Army Corps of Engineers
Los Angeles District
Geotech Branch



Contours shown are the approximate elevation of groundwater encountered.
The elevations presented hereon are based on the State of California Databases.
The data within those databases were provided by third parties.
As such, the data cannot be verified and the elevations are considered to be approximate.

Los Angeles River
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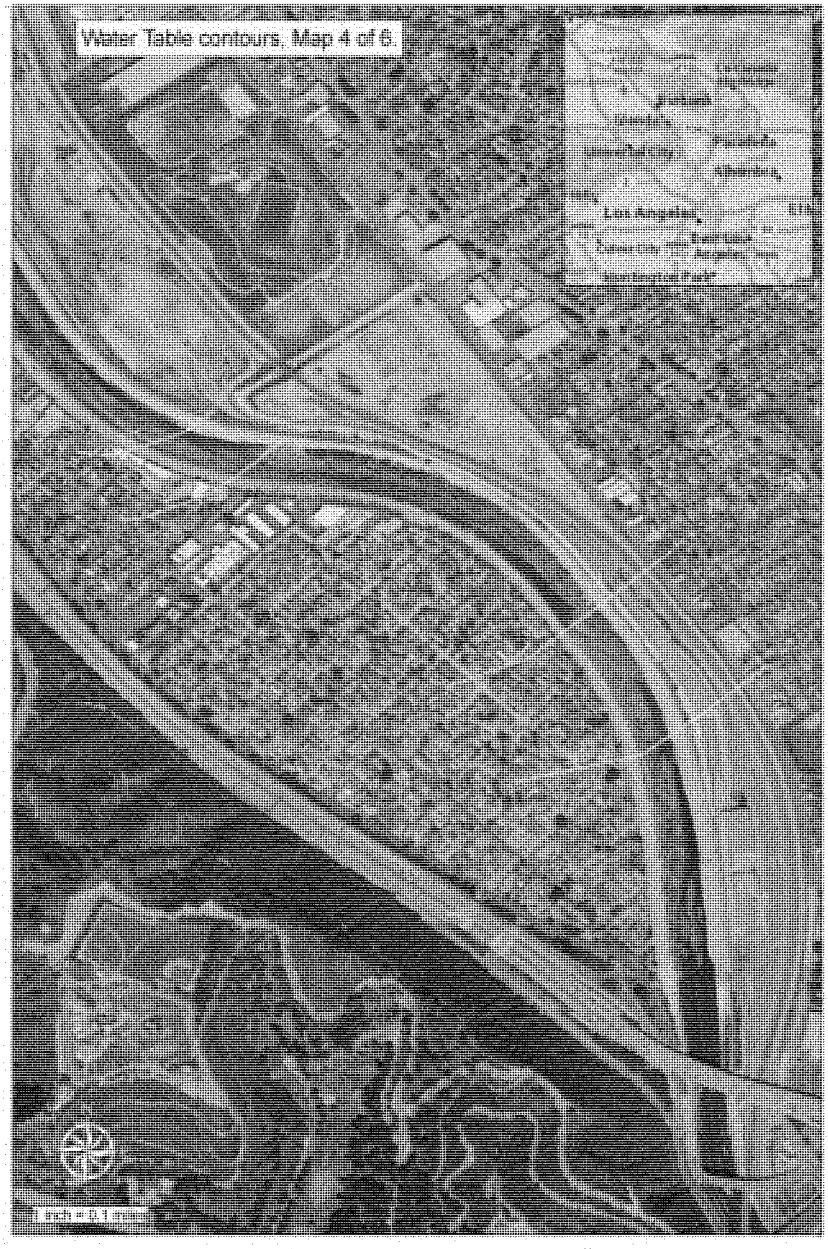
Geotechnical Feasibility Study

Figure 8
Water Table Contour Map

US Army Corps of Engineers
Los Angeles District
Geotech Branch



Contours shown are the approximate elevation of groundwater encountered.
The elevations presented hereon are based on the State of California Databases.
The data within those databases were provided by third parties.
As such, the data cannot be verified and the elevations are considered to be approximate.

Los Angeles River
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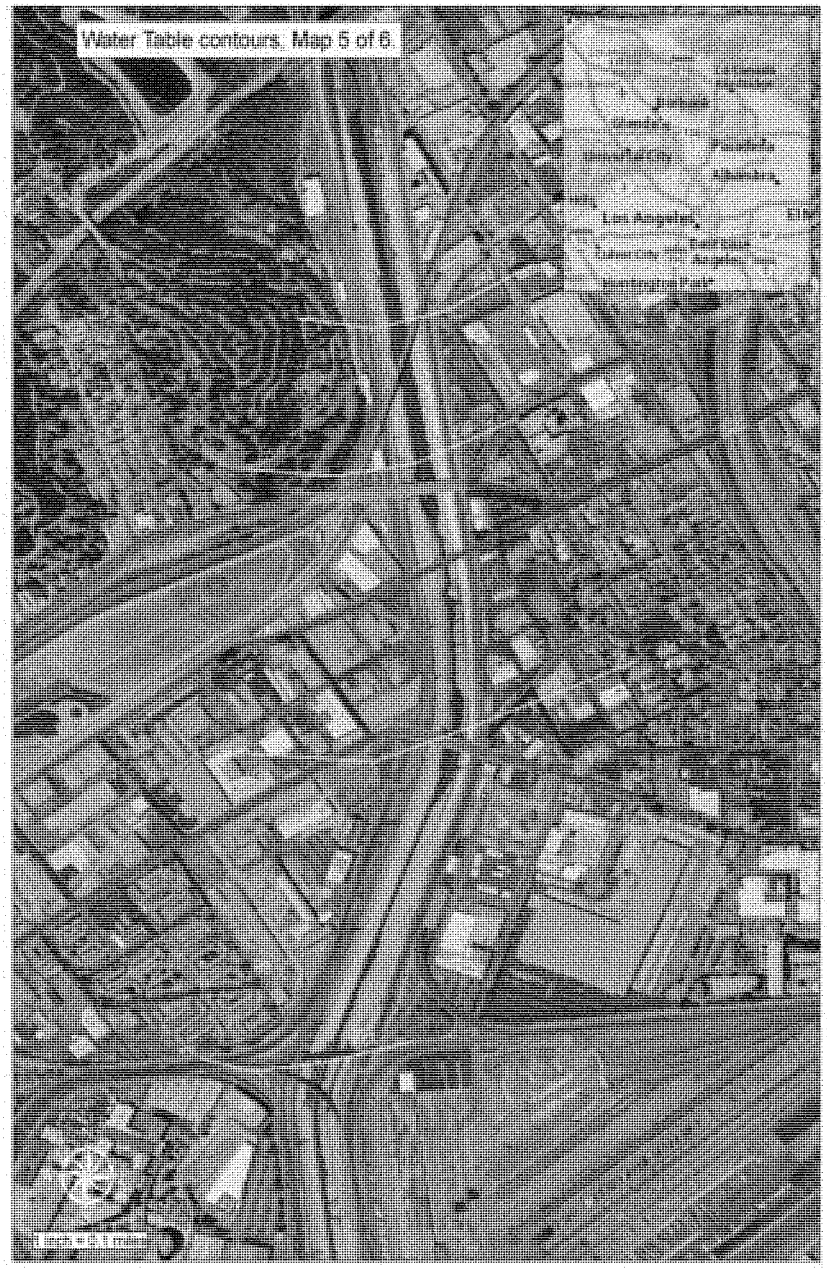
Geotechnical Feasibility Study

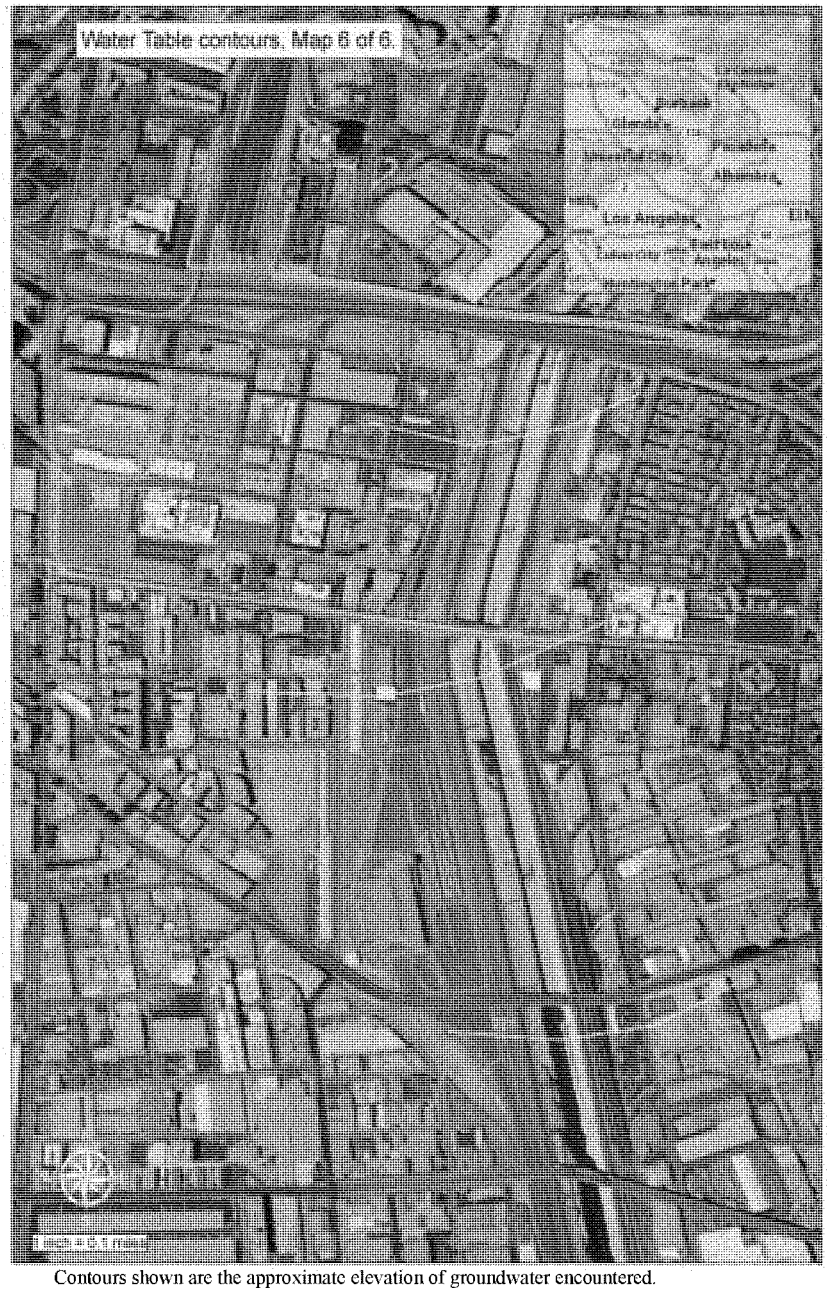
Figure 9
Water Table Contour Map

US Army Corps of Engineers
Los Angeles District
Geotech Branch



Contours shown are the approximate elevation of groundwater encountered.
The elevations presented hereon are based on the State of California Databases.
The data within those databases were provided by third parties.
As such, the data cannot be verified and the elevations are considered to be approximate.

Los Angeles River Ecosystem Restoration Study Geotechnical Feasibility Study	Figure 10 Water Table Contour Map	US Army Corps of Engineers Los Angeles District Geotech Branch

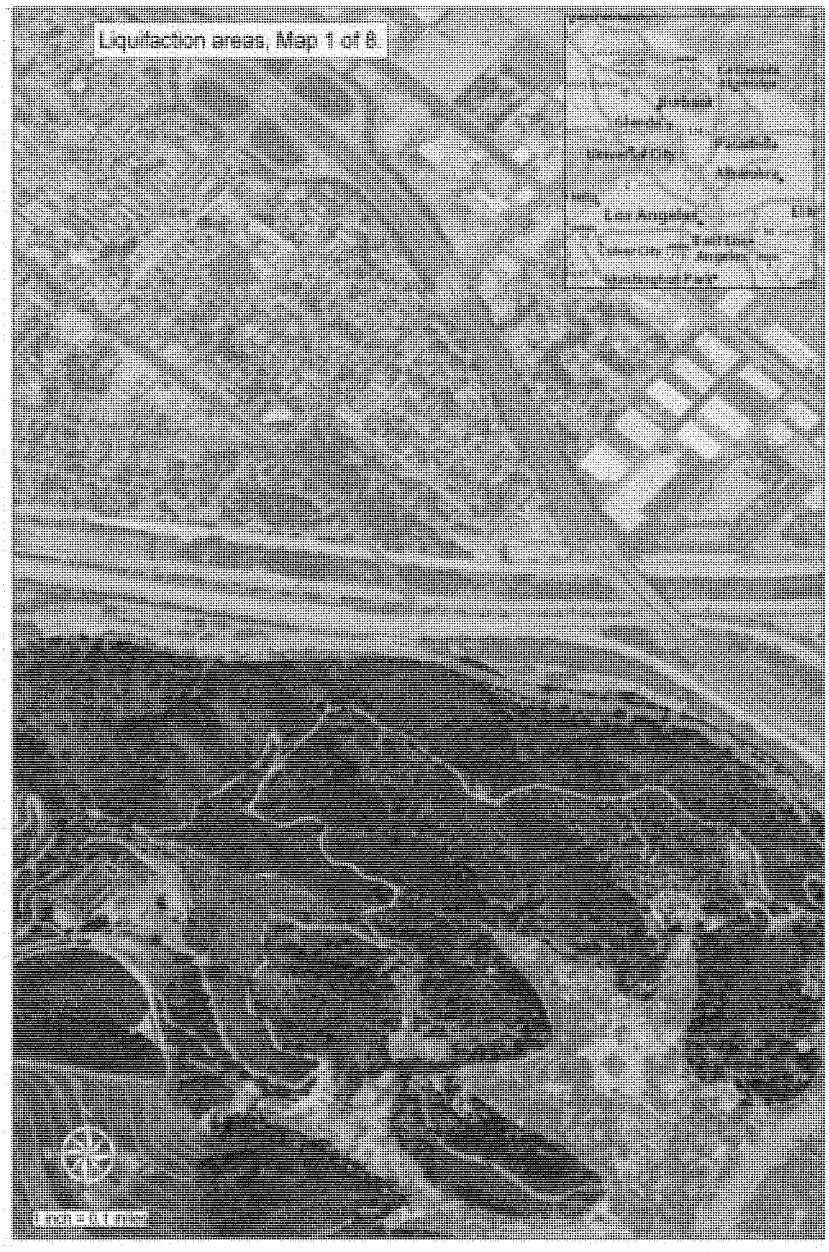


Contours shown are the approximate elevation of groundwater encountered.
The elevations presented hereon are based on the State of California Databases.
The data within those databases were provided by third parties.
As such, the data cannot be verified and the elevations are considered to be approximate.

Los Angeles River Ecosystem Restoration Study Geotechnical Feasibility Study

Figure 11 Water Table Contour Map

US Army Corps of Engineers Los Angeles District Geotech Branch

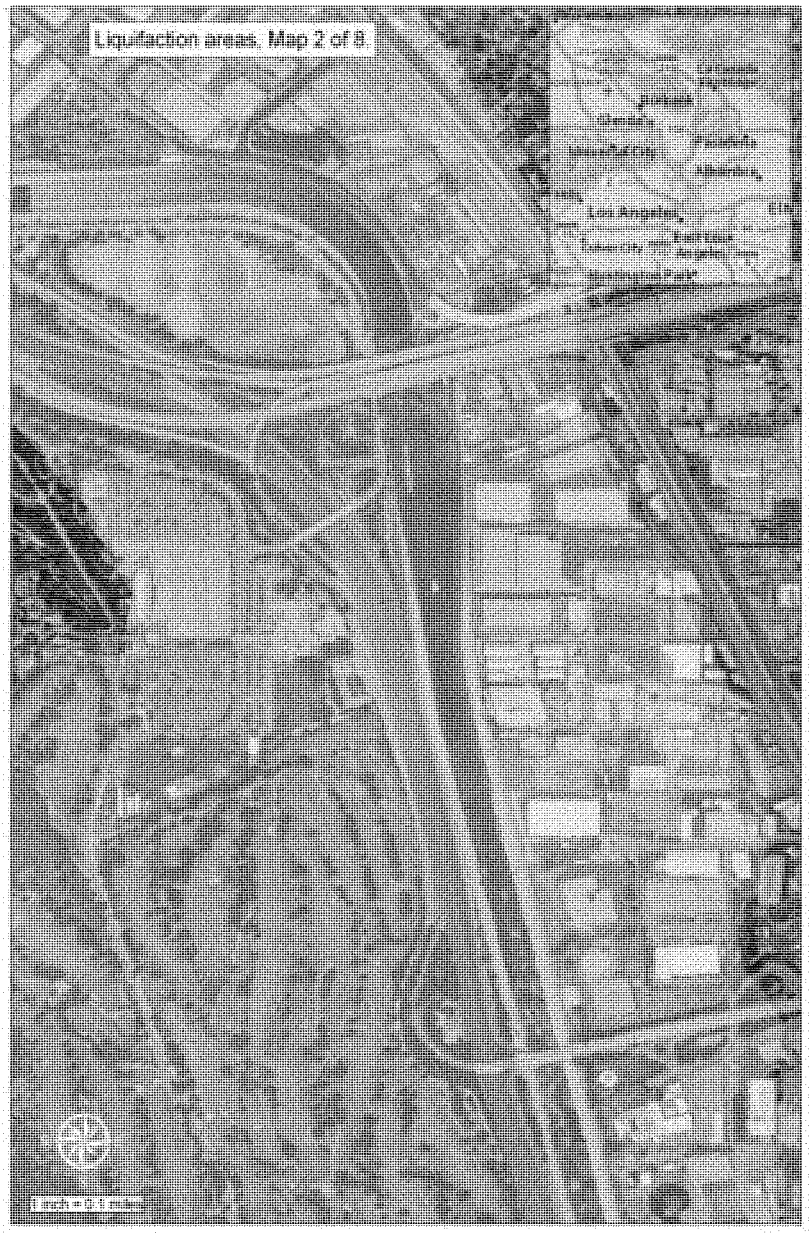


Green tinted area indicates potential liquefaction prone areas.

Los Angeles River
Ecosystem Restoration Study
Geotechnical Feasibility Study

Figure 12
Liquefaction Potential Map

US Army Corps of Engineers
Los Angeles District
Geotech Branch

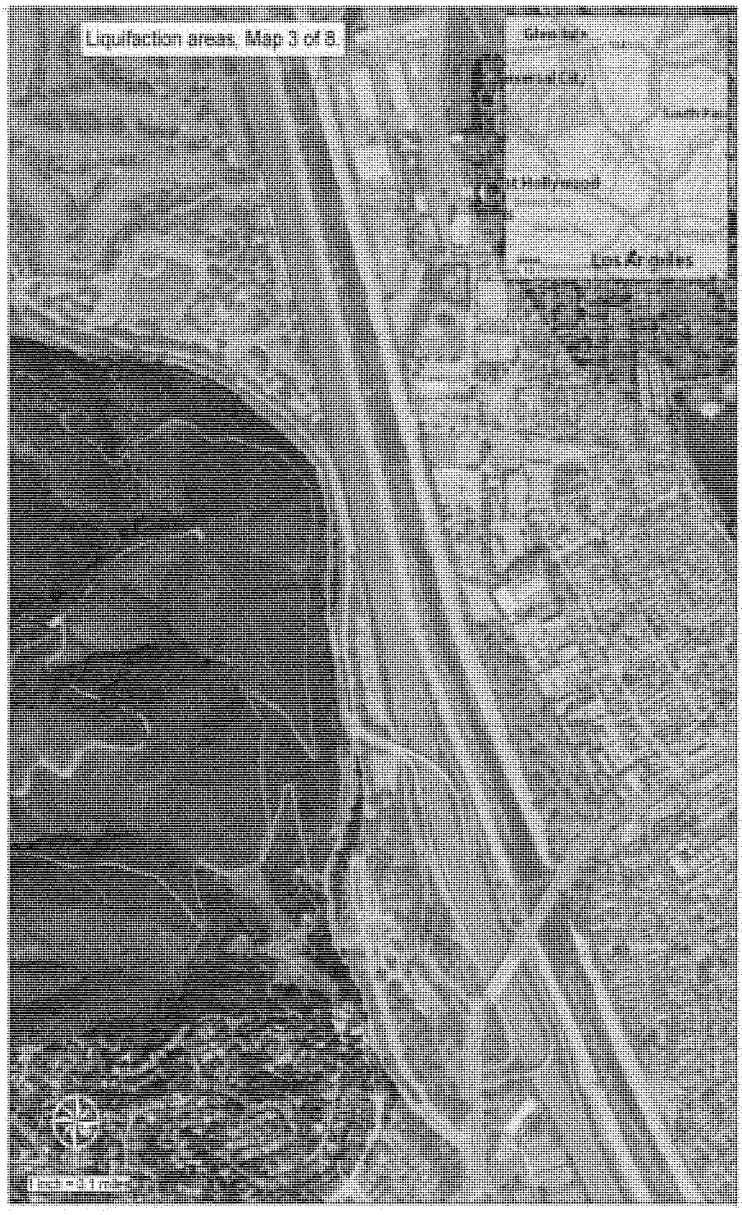


Green tinted area indicates potential liquefaction prone areas.

Los Angeles River
Ecosystem Restoration Study
Geotechnical Feasibility Study

Figure 13
Liquefaction Potential Map

US Army Corps of Engineers
Los Angeles District
Geotech Branch



Green tinted area indicates potential liquefaction prone areas.

Los Angeles River
Ecosystem Restoration Study
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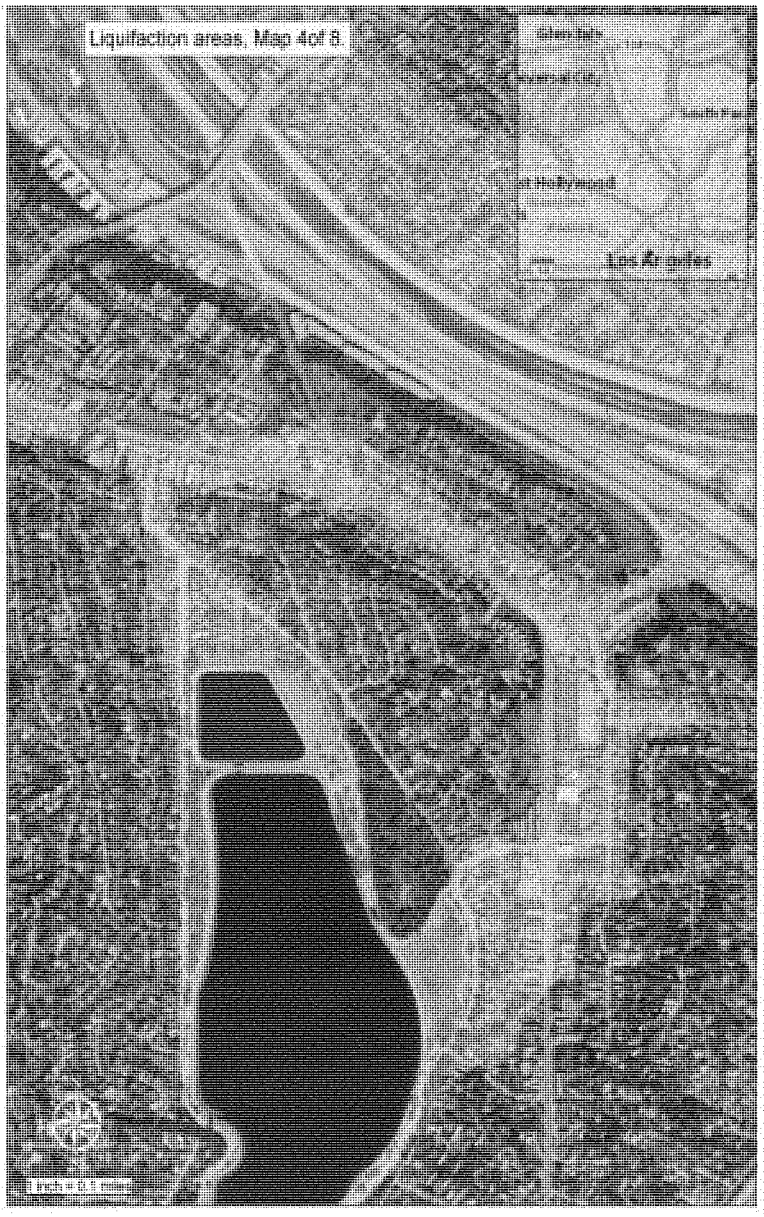
Figure 14
Liquefaction Potential Map

US Army Corps of Engineers
Los Angeles District
Geotech Branch

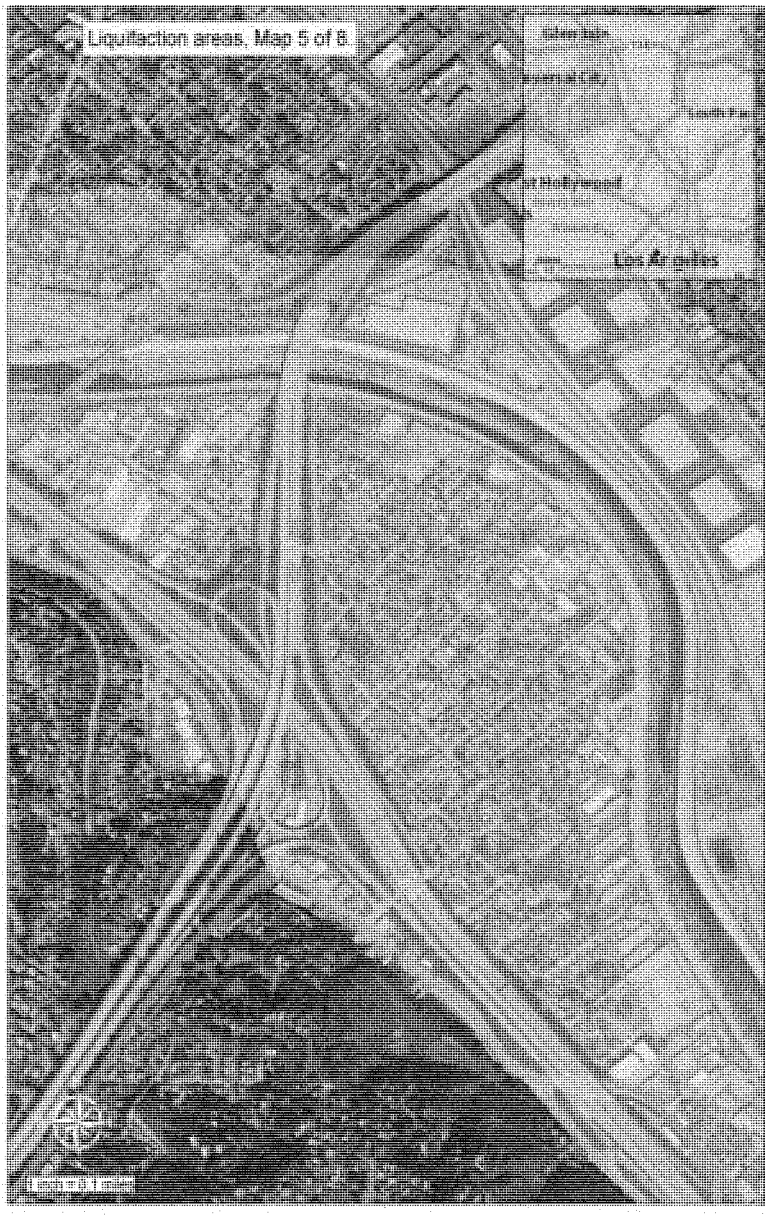


Green tinted area indicates potential liquefaction prone areas.

Los Angeles River
Ecosystem Restoration Study
Geotechnical Feasibility Study

Figure 15
Liquefaction Potential Map

US Army Corps of Engineers
Los Angeles District
Geotech Branch



Green tinted area indicates potential liquefaction prone areas.

Los Angeles River
Ecosystem Restoration Study
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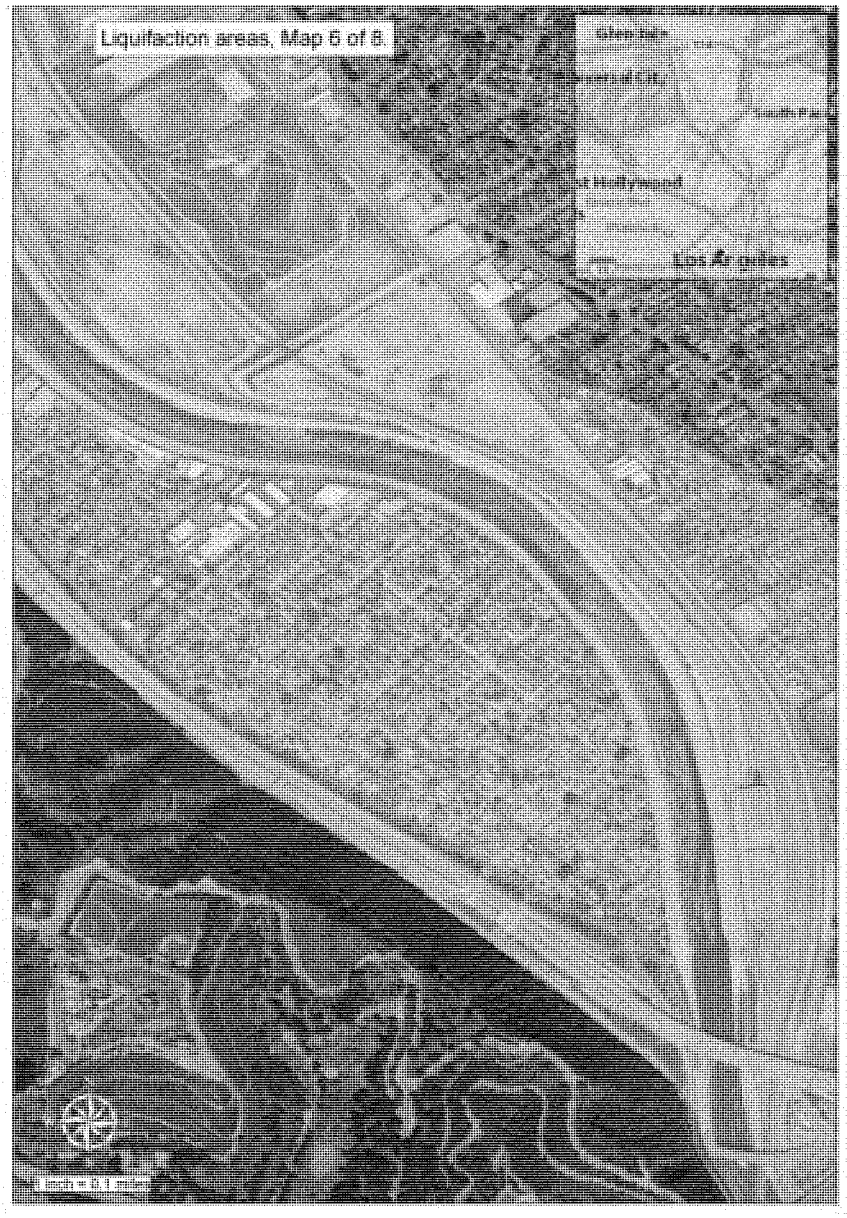
Figure 16
Liquefaction Potential Map

US Army Corps of Engineers
Los Angeles District
Geotech Branch



Green tinted area indicates potential liquefaction prone areas.

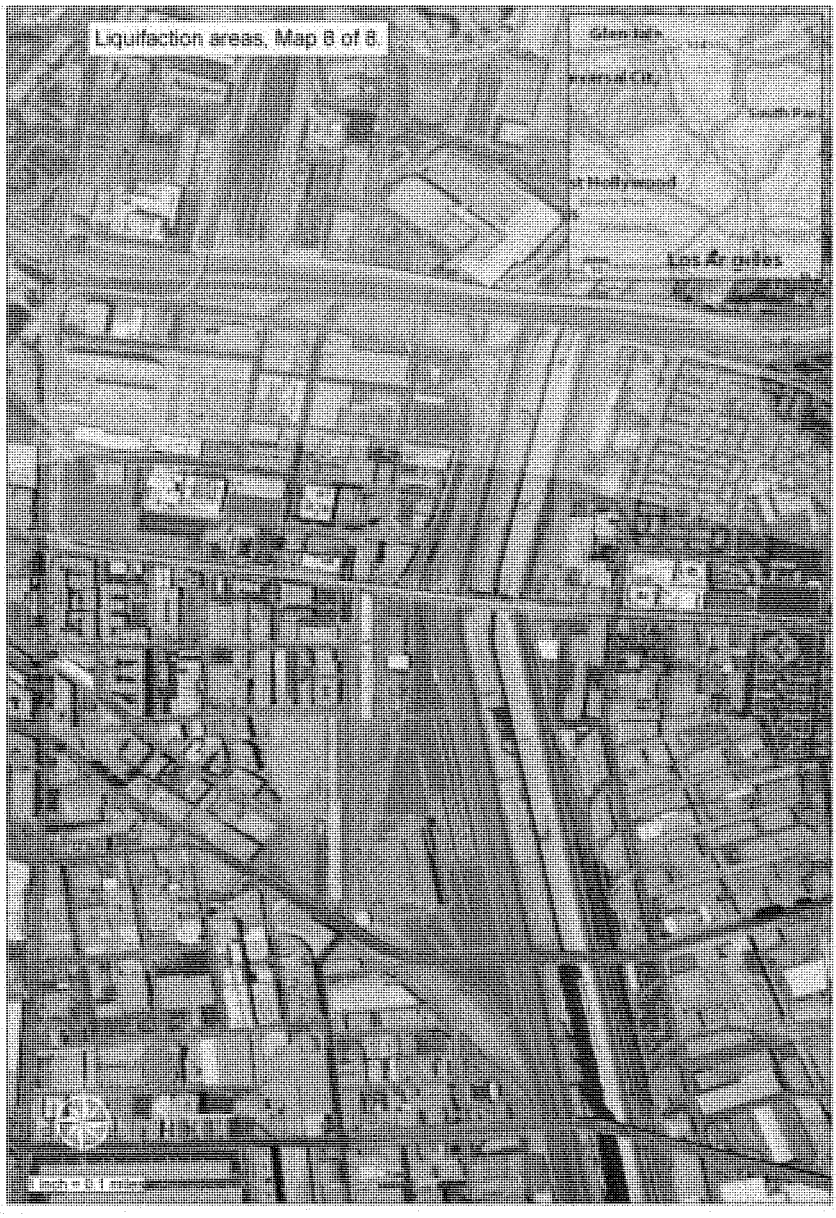
Los Angeles River
Ecosystem Restoration Study
Geotechnical Feasibility Study

Figure 17
Liquefaction Poteutial Map

US Army Corps of Engineers
Los Angeles District
Geotech Branch

Green tinted area indicates potential liquefaction prone areas.

Los Angeles River Ecosystem Restoration Study Geotechnical Feasibility Study	Figure 18 Liquefaction Potential Map	US Army Corps of Engineers Los Angeles District Geotech Branch

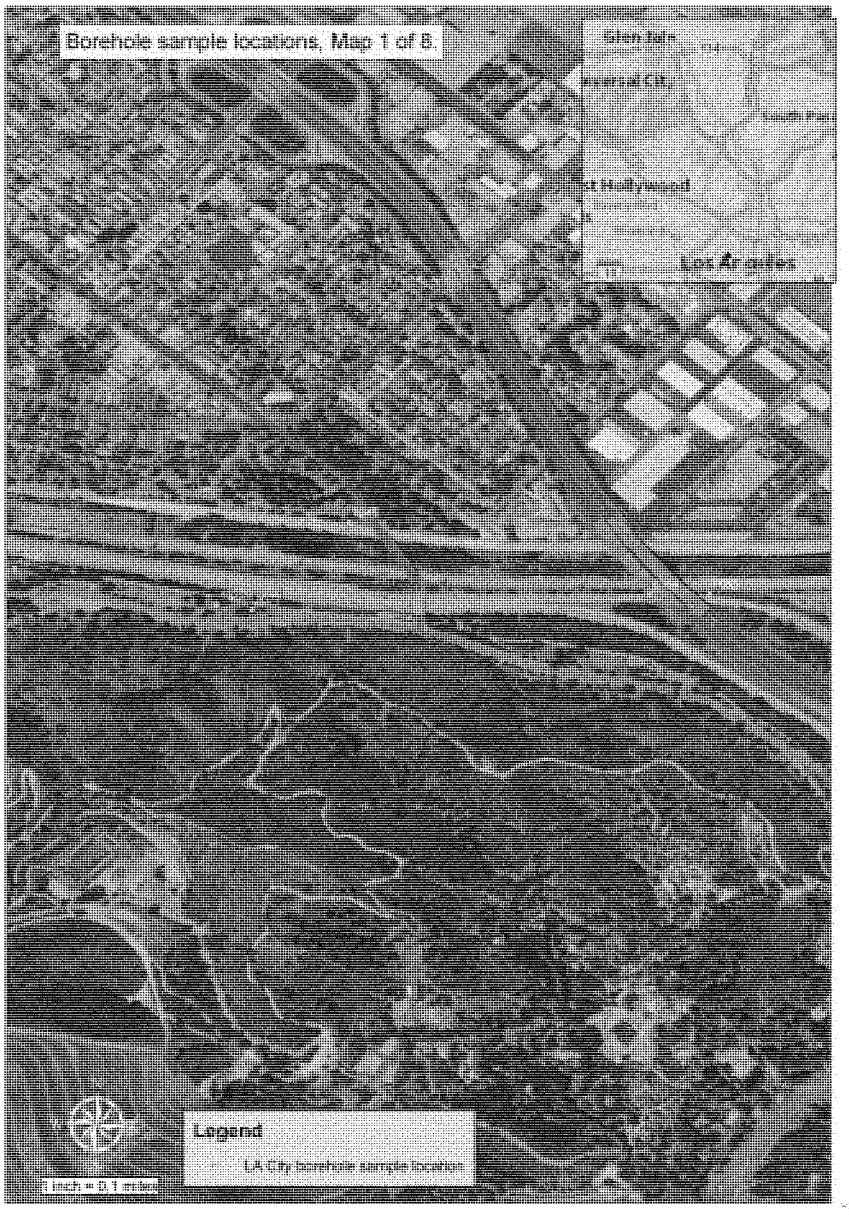


Green tinted area indicates potential liquefaction prone areas.

Los Angeles River
Ecosystem Restoration Study
Geotechnical Feasibility Study

Figure 19
Liquefaction Potential Map

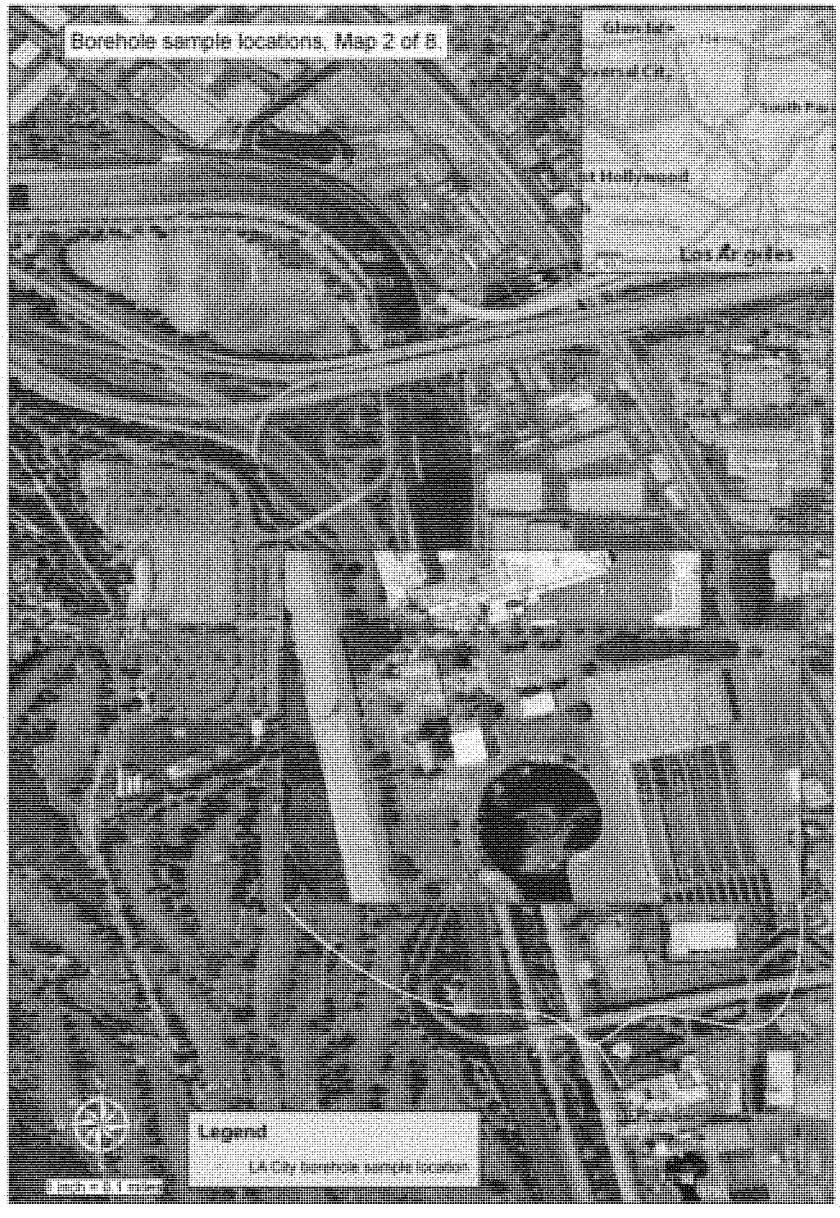
US Army Corps of Engineers
Los Angeles District
Geotech Branch



Los Angeles River
Ecosystem Restoration Study
Geotechnical Feasibility Study

Figure 20
Borehole Location Map

US Army Corps of Engineers
Los Angeles District
Geotech Branch



Los Angeles River
Ecosystem Restoration Study
Geotechnical Feasibility Study

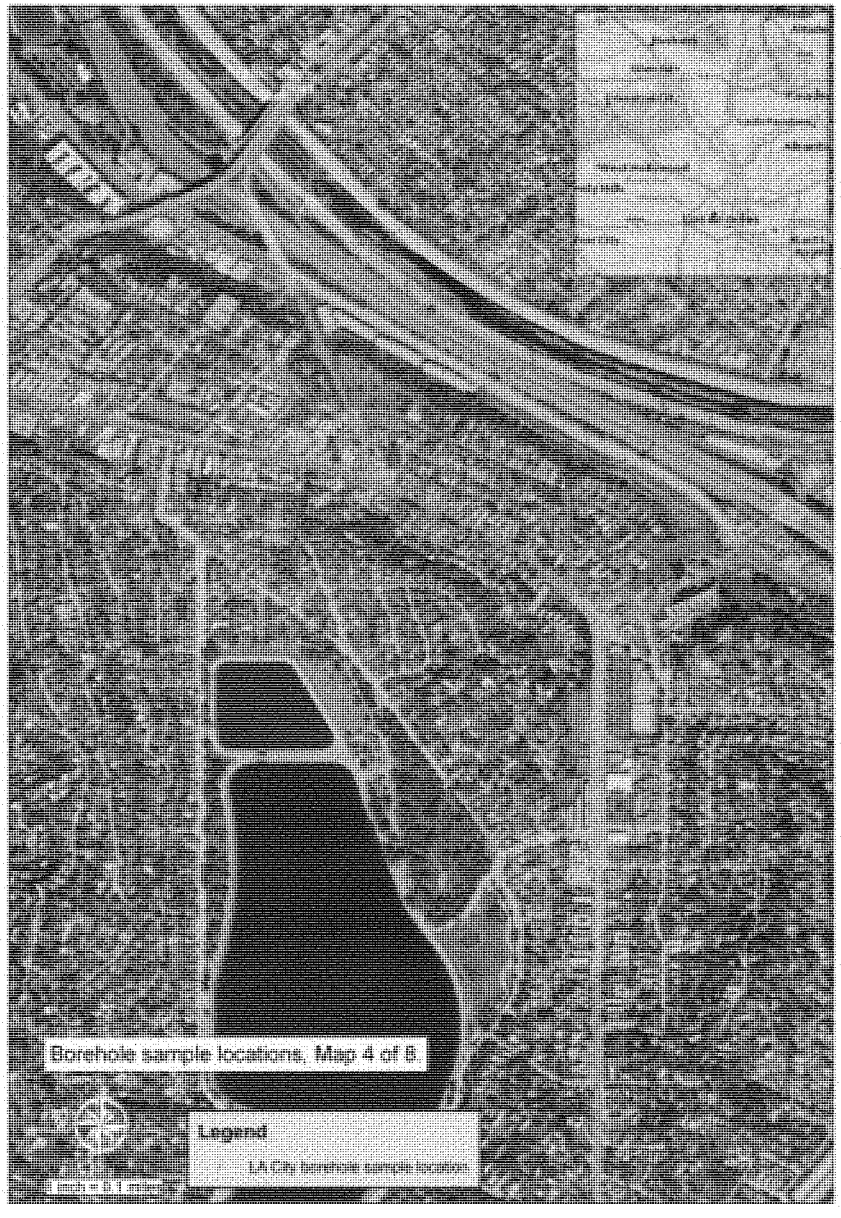
Figure 21
Borehole Location Map

US Army Corps of Engineers
Los Angeles District
Geotech Branch

Los Angeles River
Ecosystem Restoration Study
Geotechnical Feasibility Study

Figure 22
Borehole Location Map

US Army Corps of Engineers
Los Angeles District
Geotech Branch



Los Angeles River
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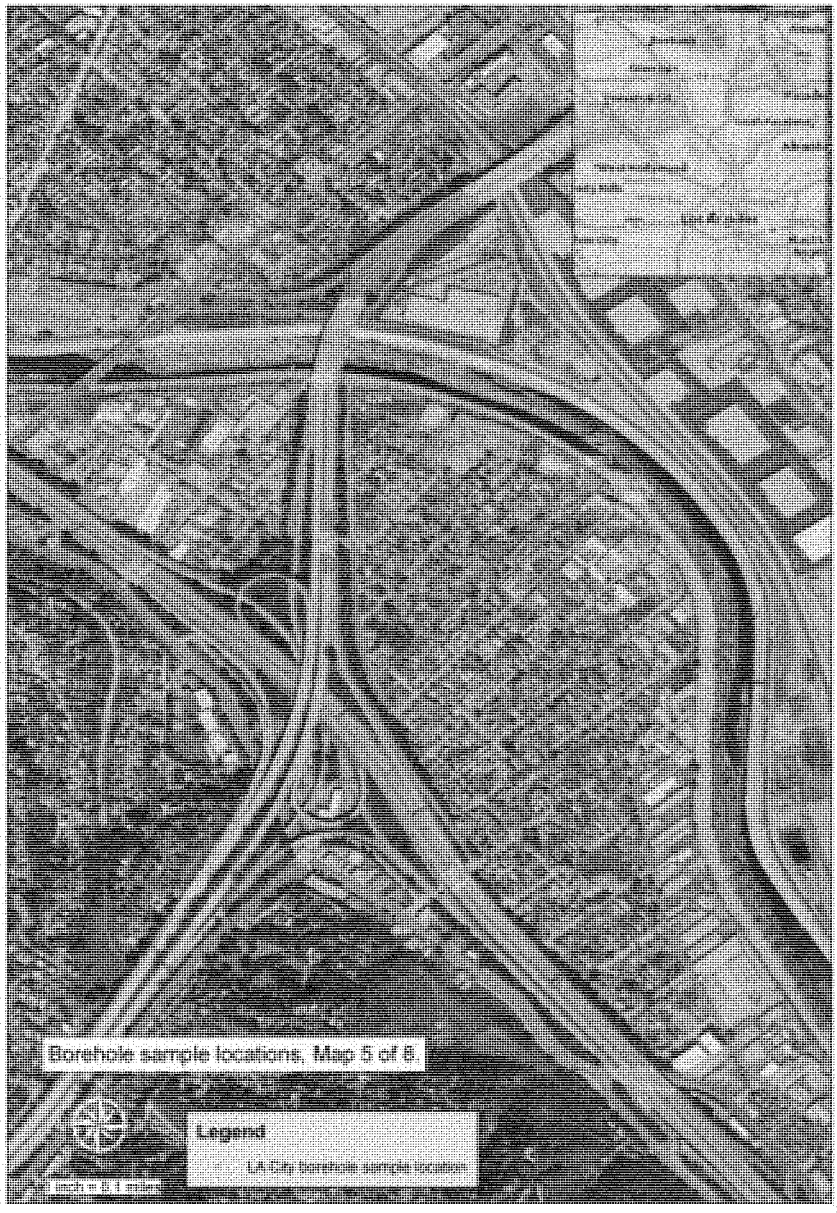
Geotechnical Feasibility Study

Figure 23
Borehole Location Map

US Army Corps of Engineers
Los Angeles District
Geotech Branch



Los Angeles River
Ecosystem Restoration Study
Geotechnical Feasibility Study

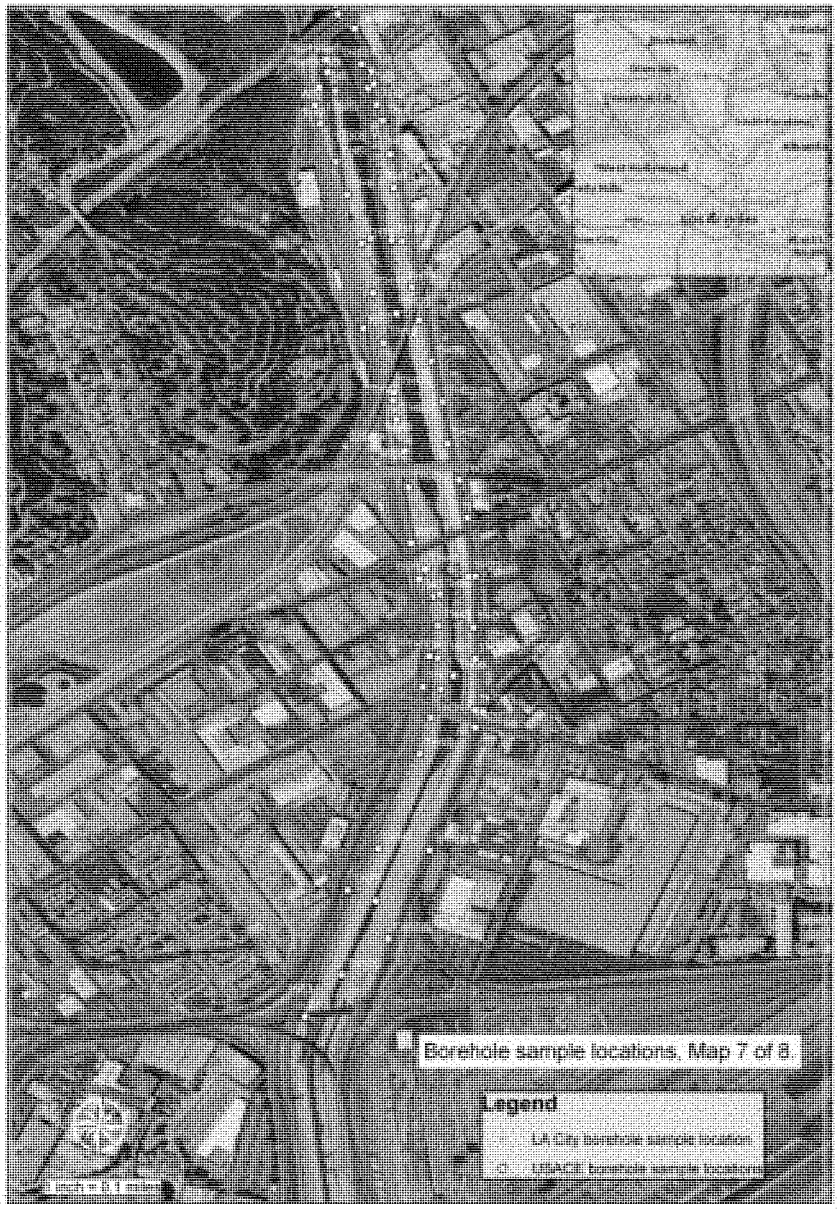
Figure 24
Borehole Location Map

US Army Corps of Engineers
Los Angeles District
Geotech Branch

Los Angeles River
Ecosystem Restoration Study
Geotechnical Feasibility Study

Figure 25
Borehole Location Map

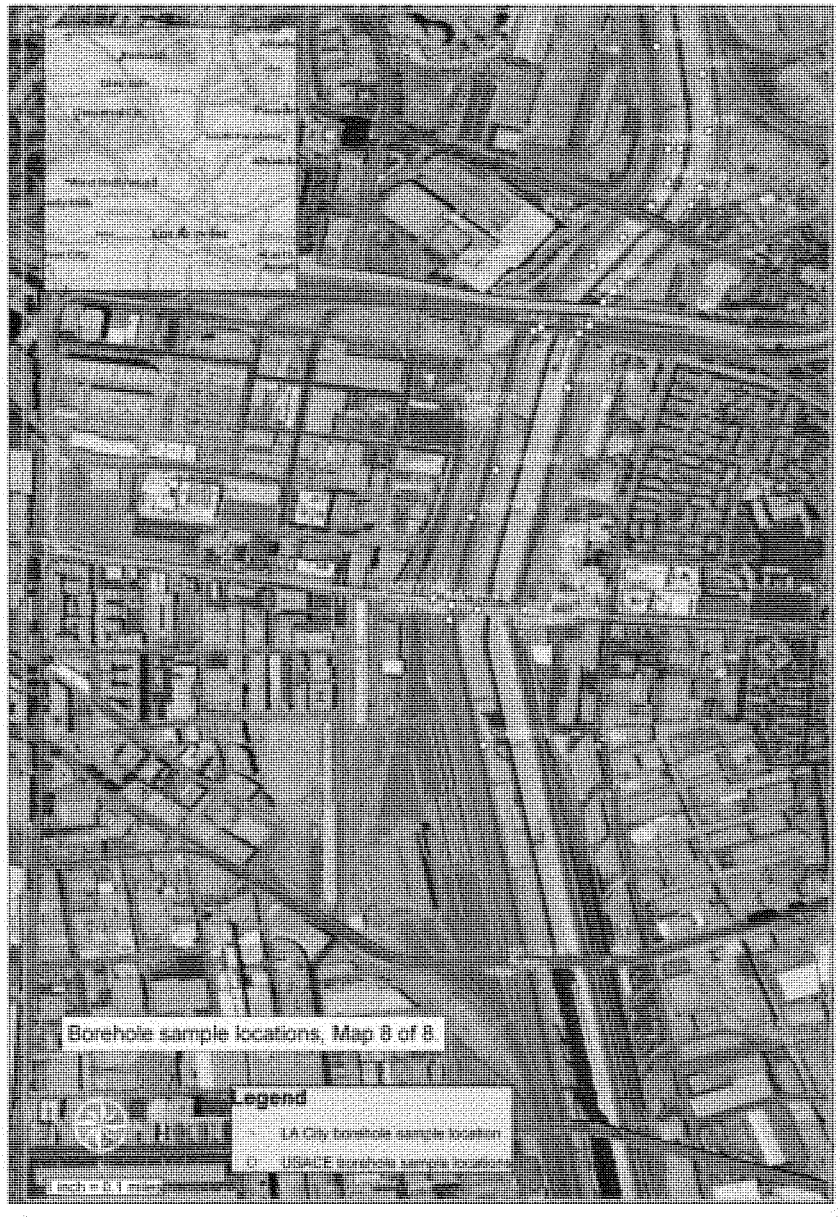
US Army Corps of Engineers
Los Angeles District
Geotech Branch



Los Angeles River
Ecosystem Restoration Study
Geotechnical Feasibility Study

Figure 26
Borehole Location Map

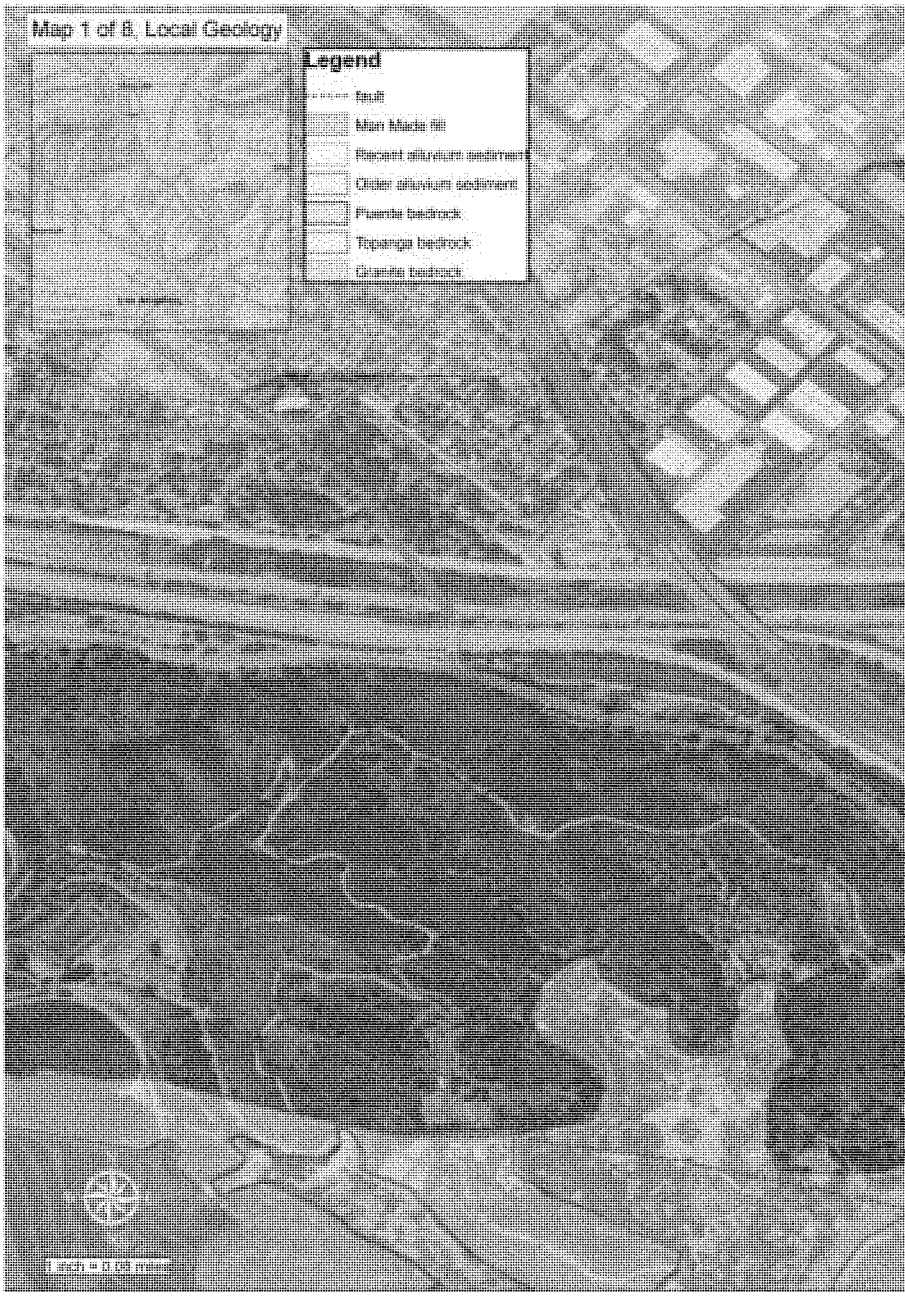
US Army Corps of Engineers
Los Angeles District
Geotech Branch



Los Angeles River
Ecosystem Restoration Study
Geotechnical Feasibility Study

Figure 27
Borehole Location Map

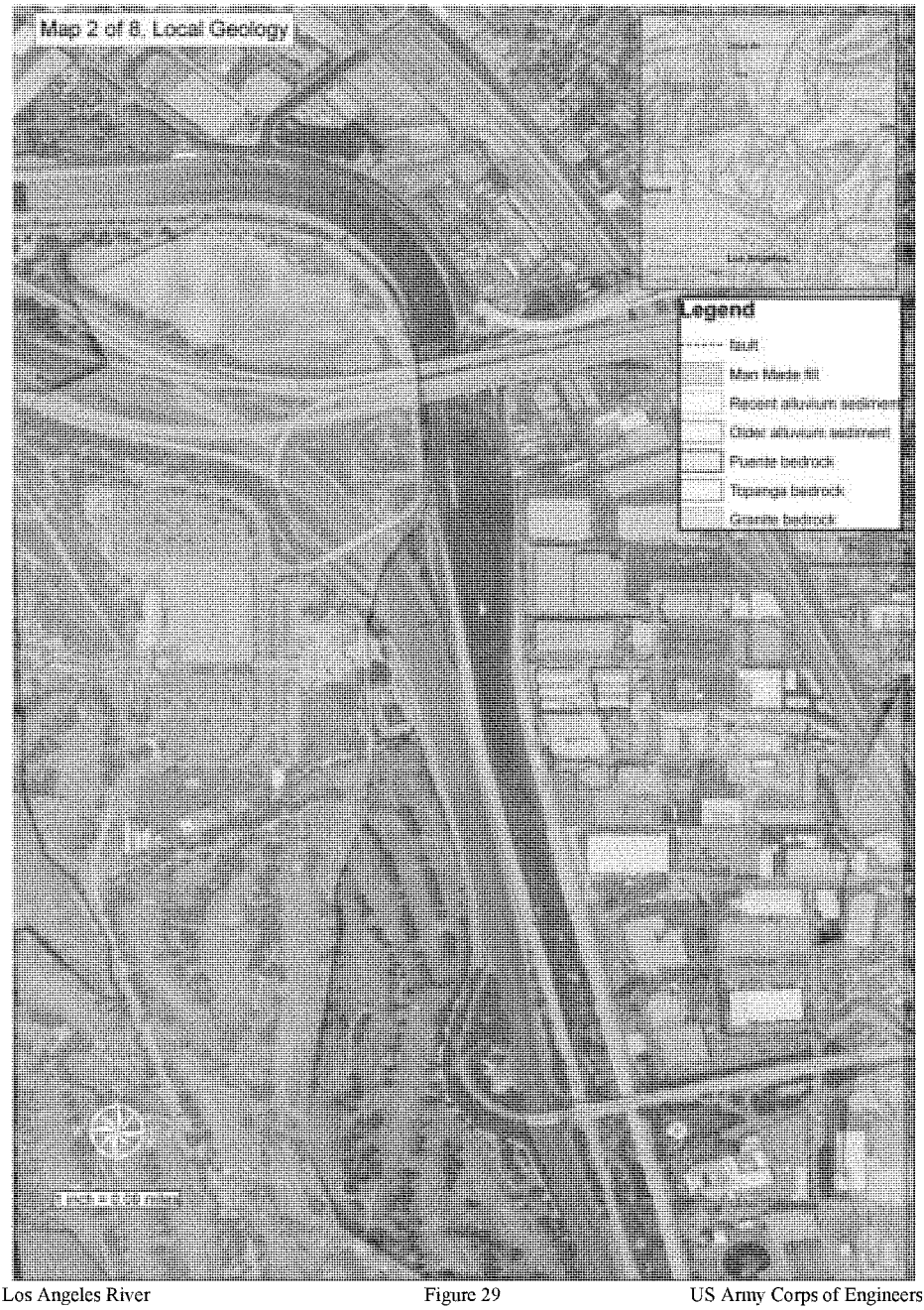
US Army Corps of Engineers
Los Angeles District
Geotech Branch



Los Angeles River
Ecosystem Restoration Study
Geotechnical Feasibility Study

Figure 28
Local Geology Map

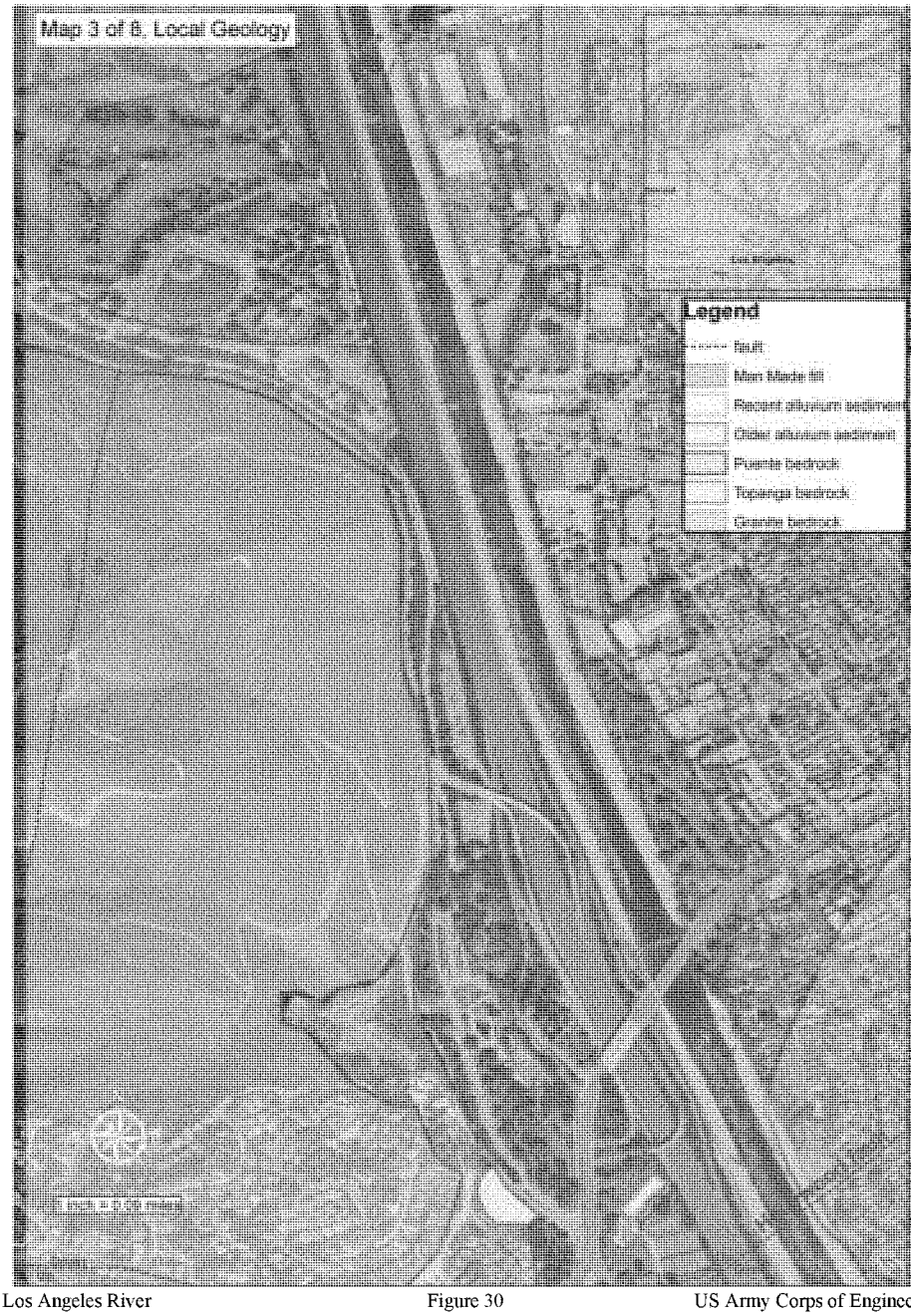
US Army Corps of Engineers
Los Angeles District
Geotech Branch



Los Angeles River
Ecosystem Restoration Study
Geotechnical Feasibility Study

Figure 29
Local Geology Map

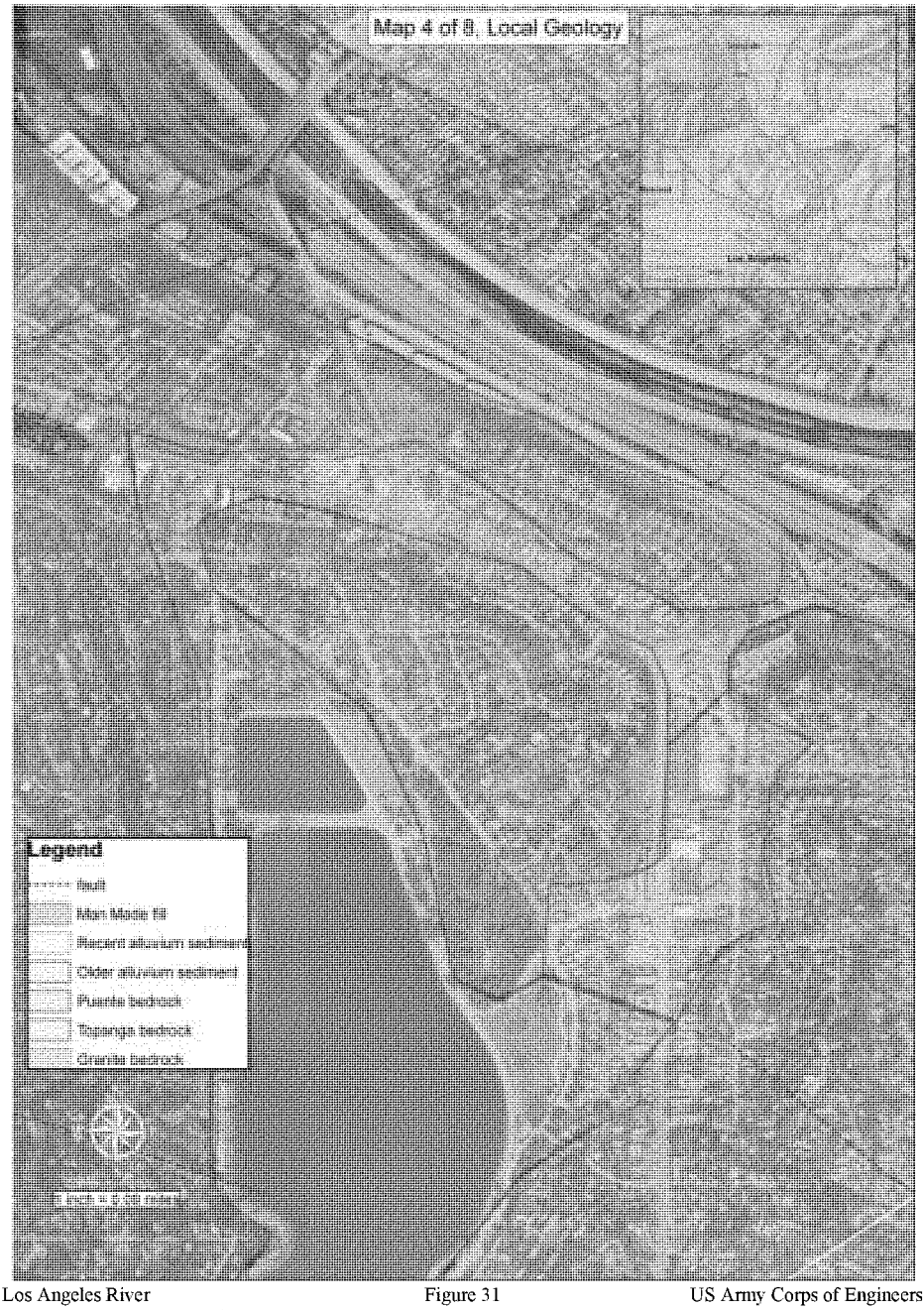
US Army Corps of Engineers
Los Angeles District
Geotech Branch



Los Angeles River
Ecosystem Restoration Study
Geotechnical Feasibility Study

Figure 30
Local Geology Map

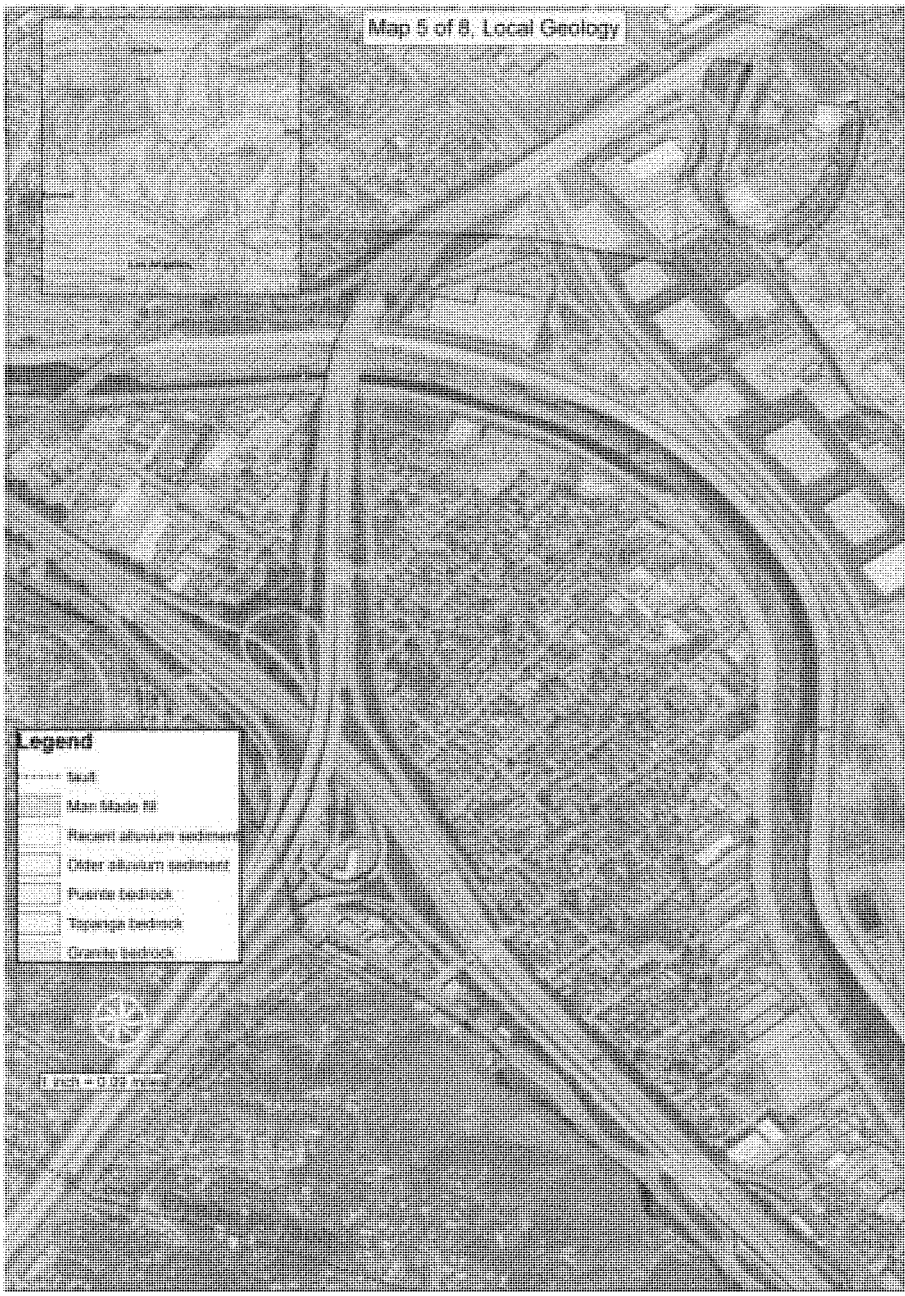
US Army Corps of Engineers
Los Angeles District
Geotech Branch



Los Angeles River
Ecosystem Restoration Study
Geotechnical Feasibility Study

Figure 31
Local Geology Map

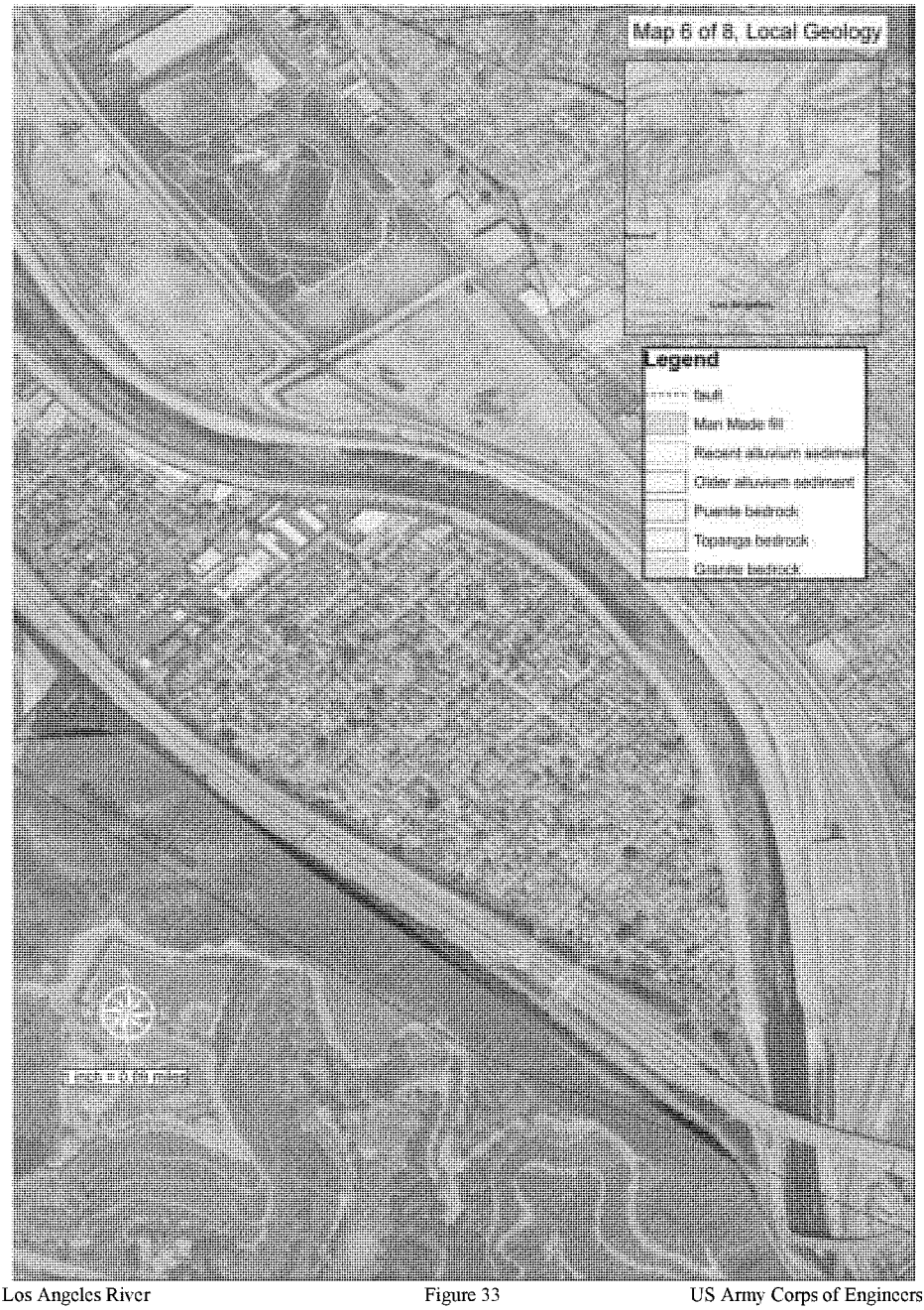
US Army Corps of Engineers
Los Angeles District
Geotech Branch



Los Angeles River
Ecosystem Restoration Study
Geotechnical Feasibility Study

Figure 32
Local Geology Map

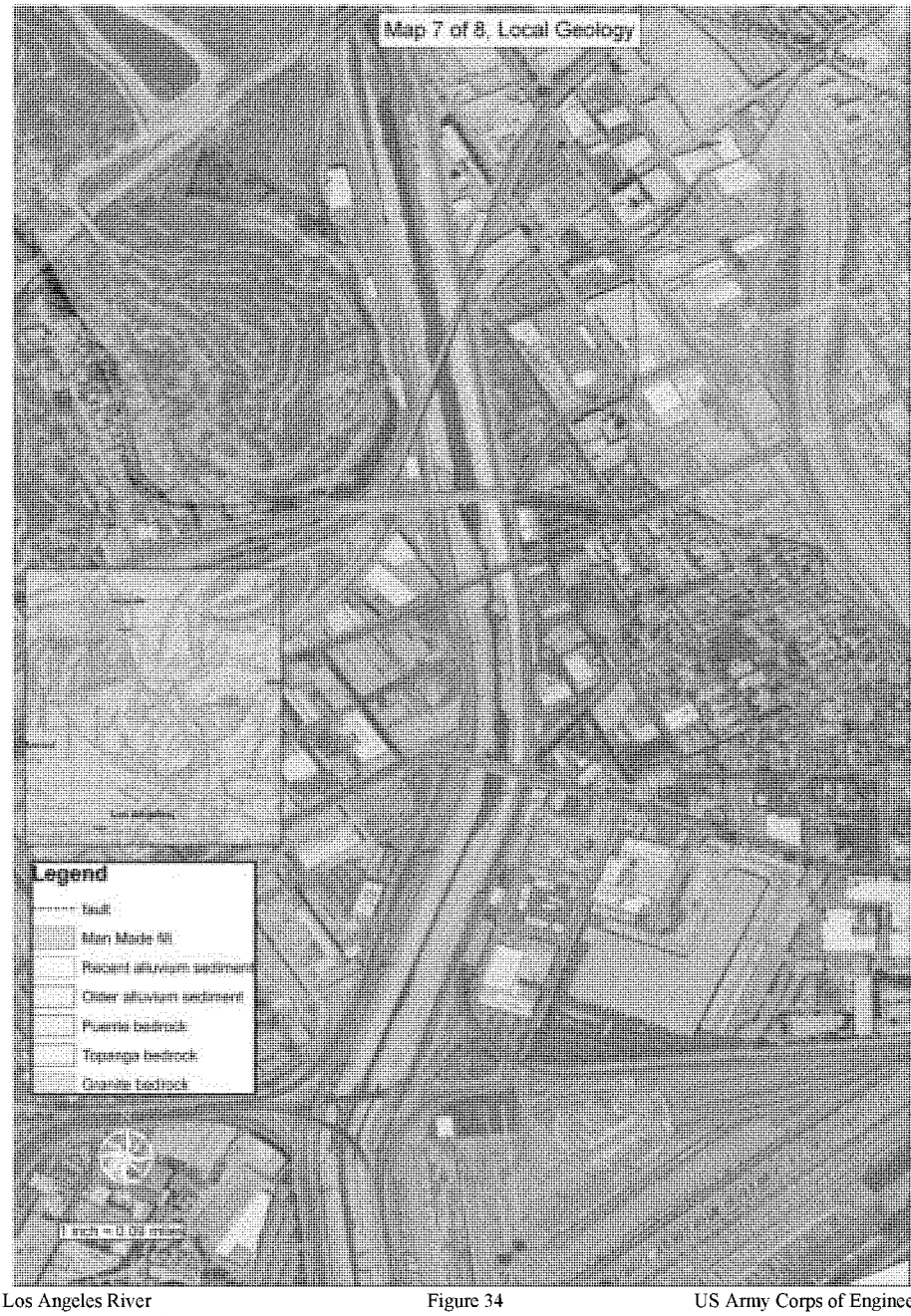
US Army Corps of Engineers
Los Angeles District
Geotech Branch



Los Angeles River
Ecosystem Restoration Study
Geotechnical Feasibility Study

Figure 33
Local Geology Map

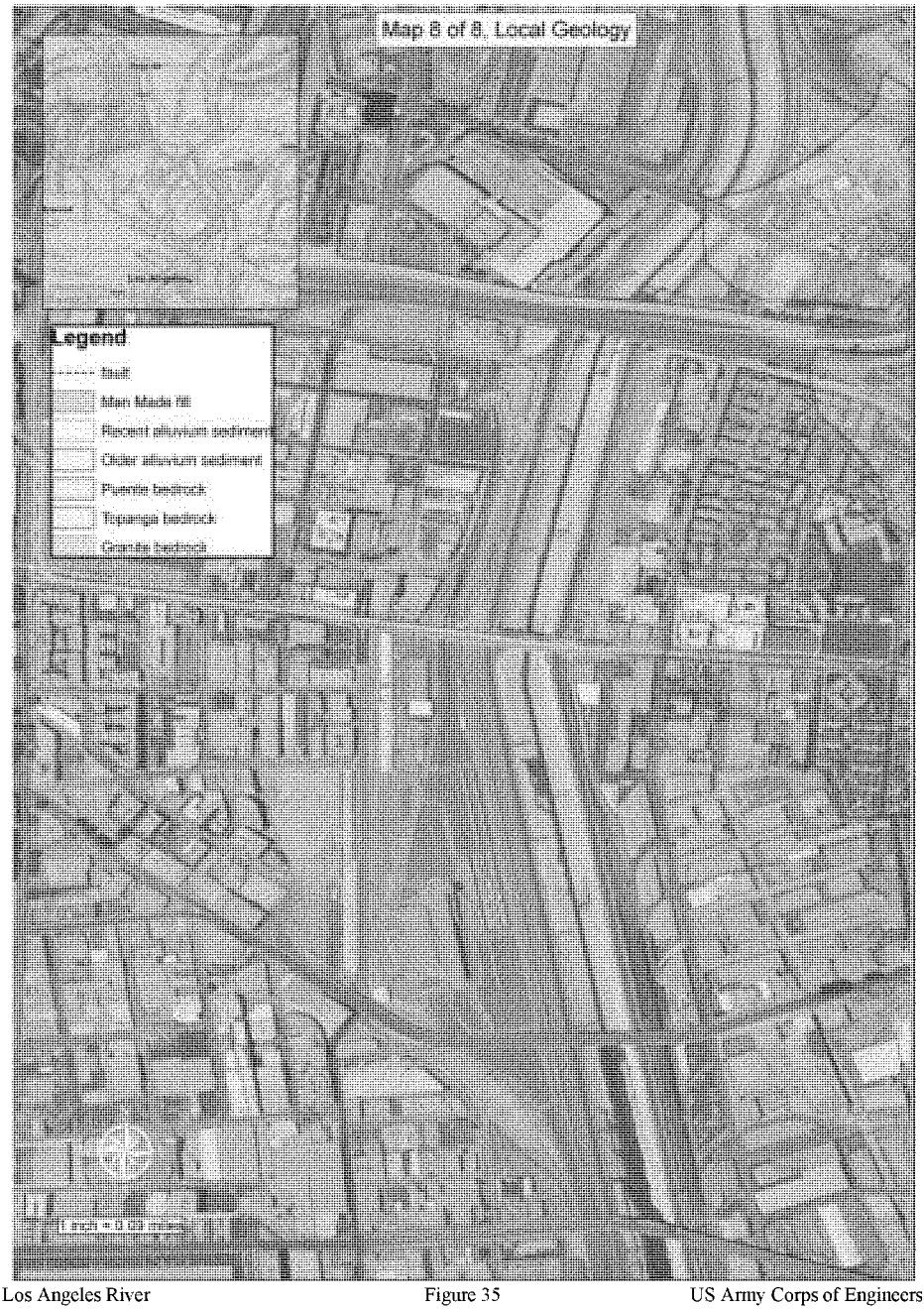
US Army Corps of Engineers
Los Angeles District
Geotech Branch



Los Angeles River
Ecosystem Restoration Study
Geotechnical Feasibility Study

Figure 34
Local Geology Map

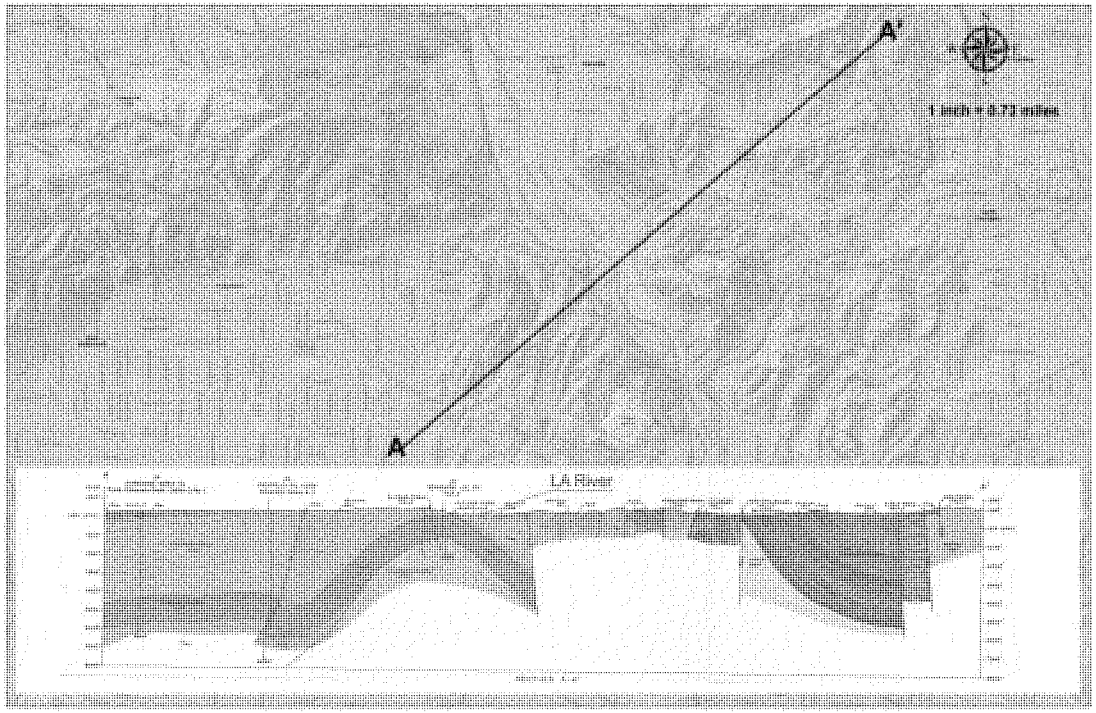
US Army Corps of Engineers
Los Angeles District
Geotech Branch



Los Angeles River
Ecosystem Restoration Study
Geotechnical Feasibility Study

Figure 35
Local Geology Map

US Army Corps of Engineers
Los Angeles District
Geotech Branch



LA River Geologic Profile A to A'
"looking northwest"

Los Angeles River
Ecosystem Restoration Study
Geotechnical Feasibility Study

Figure 36
Local Geologic Cross Section

US Army Corps of Engineers
Los Angeles District
Geotech Branch

CESPL-ED-GD (1110) 10 May 2013

MEMORANDUM FOR RECORD

SUBJECT: Los Angeles River Ecosystem Restoration Study
Levee Condition Inspection and Issue Discussion

1. Reference:

ETL 1110-2-571, Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures, 10 April 2009. Hereafter referred to as "the ETL".

2. General Background and Purpose:

a. As part of the Los Angeles River Ecosystem Restoration Study, the existing Los Angeles County Drainage Area (LACDA) flood risk management project within the study area along the Los Angeles River needed to be evaluated for areas that have leveed conditions. This memorandum is included as an attachment to the geotechnical portion of the study.

b. The National Levee Database (NLD) indicated that five levees are within the study area. These levees, known as LAR 2, LAR 3, LAR 5, LAR 6, and LAR 7, are depicted on Figure A1. This listing was made based on as-built documents and may not be reflective of current conditions.

c. Alternatives being studied as part of the ecosystem restoration will impact these levees by modifying or altering the original designed condition and will need to be designed and constructed in accordance with the latest guidance including but not limited to the ETL as referenced.

d. Existing field conditions of the levees were evaluated to determine if modifications had been made such that some river reaches were no longer levees in contrast to the conditions reflected in the NLD. Site visits were made on 23 and 25 October 2012 by Mr. Chris Spitzer of Soils Design and Materials Section, and Mr. Kelly Howard of the Operations and Maintenance Branch. The general conditions encountered, specifically whether a levee condition was present, are depicted on Figures A1 through A5. The locations and delineations of the conditions depicted on the figures are approximate.

e. Current assessment procedures for levees involve three steps. The steps can be generalized into 1) periodic inspection, 2) evaluation, and 3) delisting or deficiency correcting steps. Following construction of the levee, periodic inspection of the levee is to occur during which all deficiencies of the levee are noted and documented. Following the inspection, an evaluation of the deficiencies with respect to the Corps policies regarding vegetation, encroachments, and field conditions is made. From the evaluation, delisting recommendations or deficiency correcting actions are made. This procedure is independent of the ecosystem restoration project. It should be noted that the Los Angeles District is currently in the assessment process for the levees within the study area and actions regarding the levees will likely occur prior to completion of the ecosystem restoration project.

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3. Observations:

Conditions were observed during the site visit and are described and depicted in the attached Photos. These conditions can be summarized in general as follows:

a. Landside conditions were observed as the landside was visually lower than the levee crest. As such, a levee condition still exists in these locations as delineated in the NLD. The approximate locations of these conditions are depicted in green on Figures A1 through A5.

b. Levee conditions were observed with limited overflow areas on the landside where drainage is directed immediately back to the river via storm drains (bathtub). The approximate locations of these conditions are depicted in yellow on Figures A1 through A5. These portions of the levee may have no residences or structures behind the crest and seemingly have no consequences.. However, if these portions were to overtop or fail, significant vehicular traffic impairment, property damage, or life loss could occur as a result. Additionally this failure may result in the shutdown of major thoroughfares (e.g. I-5) and significantly impact transportation and subsequently have significant economic impacts.

c. Landside encroachments (permitted or unpermitted) consisting of backfill or retaining walls that raised the adjoining property to a height at or above the levee crest were observed at several locations depicted in orange on Figures A1 through A5. This condition effectively makes these areas a non-levee condition. However, these areas and lengths may be required to function as part of a levee system (i.e. as a high ground tie in or hydraulically required for water surface elevations) and, if delisting is desired, will need to be evaluated on a case by case basis.

d. Landside encroachments (e.g., grading after as-builts) consisting of development that created a short leveed condition in order to provide interior drainage were observed on the right bank between LAR 2 and LAR 3. These locations are not shown on the map, but if they are part of new construction for the ecosystem restoration project, they will be evaluated for approval as if they were a levee.

4. Vegetation Guidance:

a. Existing vegetation issues were observed during the site visit. As stated above, these issues are being addressed by the assessment of the levees and not under the ecosystem restoration study. However, the study PDT needs to ensure that the features proposed under the study alternatives would be consistent with the vegetation guidance. The ETL applies to levees only and would not be applicable to channels that act as flood risk management structures except where engineering judgment dictates that such channel is an appurtenant structure to a levee. In addition, regardless of the ETL, if vegetation poses a threat to the integrity or maintainability of any flood risk management structure, such vegetation shall not be allowed in the design.

b. The ETL, in part, provides guidelines for maintaining levees, floodwalls,

embankment dams, and appurtenant structures free of vegetation other than grasses within a designated zone because "trees and other woody vegetation, such as shrubs and vines, can create both structural and seepage instabilities, prevent adequate inspection, and create obstacles to maintenance and flood-fighting/flood-control activities." Relevant figures from the ETL illustrating these VFZs are attached.

1. The ETL requires a vegetation free zone (VFZ) for levees as follows: "The vegetation-free zone is a three- dimensional corridor surrounding all levees, floodwalls, embankment dams, and critical appurtenant structures in all flood damage reduction systems. The vegetation-free zone applies to all vegetation except grass." The minimum width of such zone is the width of the levee, floodwall, or embankment dam, including all critical appurtenant structures, plus 15 feet on either side. Employing a lesser width of VFZ requires a variance unless the existing real estate rights do not provide the minimum width. Under specific site conditions, a greater width than the minimum may be required. (ETL, Sec. 2-2).
2. The ETL addresses environmental improvements and considerations for urban levees: "All levees must have effective and reliable erosion protection; the appropriate use of grasses is described in Paragraph 4-8. Where opportunities exist, environmental improvements should be considered. Project design shall address the following criteria: (1) Urban levees. Because levee projects have the potential to dominate these high-visibility landscapes, planting is often desirable, particularly in high-visibility locations, such as at and along major thoroughfares, parks, and waterfront developments." (ETL Sec 3).
3. The ETL addresses additional vegetation considerations for floodwalls as follows:

   "The minimum vegetation-free zone provides for access, but there are two additional areas of concern with respect to floodwalls. (1) Large trees can be a threat to project reliability. Planting design and maintenance must take into account the potential for overturning trees to damage floodwalls. (2) Planting design and maintenance must also take into account the three potential means by which tree roots may damage floodwalls." (ETL Sec 3).

5. Conclusions:

a. Based on visual observations, portions of the existing configuration no longer appear to meet the criteria of a levee condition and may be removed from the NLD at a future date. These areas will need to be accurately delineated in location and extent and ultimately approved as a non-levee condition by the District Levee

Safety Officer.

b. Portions that are listed and confirmed as levee through field observation have been noted as part of this effort. Any modifications by ecosystem restoration study to the levees will be made in accordance with current design practices and guidance pertaining to design and construction of levees.

6. PDT Approach to Leveed Conditions Under Alternatives in the Final Array:

Ecosystem restoration alternatives propose to modify the levees and/or include features adjacent to the levees. All modifications that are to be made to levee segments, will be in conformance with levee safety program policies. Discussion for each of the levee systems, the proposed measures, and their impacts to the levee are as follows:

a. Planting along each of the observed levee systems will conform to the ETL and design will conform to other levee guidance (including but not limited to EM 1110-2-1913 - Design and Construction of Levees).
b. All culvert daylighting will tie in to high ground for levee protection and will conform to the ETL, and design will conform to other Levee Guidance.
c. The Los Feliz Golf Course proposed diversion in the RIVER alternative (Alternative 20) would require the effective removal of the levee by using ungated pipes of restricted flow. As a result, property adjacent to the golf course may require flood reduction measure(s), which will be identified after Hydrology and Hydraulics analyses are performed during the F5 effort.
d. Proposed measures at the upstream end of LAR 6 in the RIVER alternative (Alternative 20) would remove portions of the levee toe by widening the river at the confluence of the river and Verdugo Wash. The resulting confluence will eliminate the need for a levee at the upstream end, create a tie-in with the adjacent landside topography, and will create a levee condition beginning at some location downstream of the confluence. Planting within this segment will conform to the ETL and other levee guidance.
e. Along LAR 3, in Griffith Park and Ferraro Fields, proposed diversions will result in a levee condition. This will require the new diversions/levees to conform to the ETL and design to conform to other levee guidance.
f. With respect to the segments that are listed in the NLD but were observed not to have levee conditions (portions of LAR 2 and LAR 5), the proposed project would treat them as levees subject to the ETL until delisting or HQUSACE direction that they can be treated as a non-levee condition. The application of the ETL would affect the type of vegetation that can be planted. The District has requested clarification from HQ about the application of the ETL for NLD-listed segments that do not have a levee condition. One direction from HQ stated that until LAR 5 and

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LAR 2 are delisted, planting would need to conform to the ETL and design would need to conform to other Levee Guidance. HQ does not have a process for delisting yet, but this concern is being posed up the chain. Other HQ advisement has indicated that, if no levee condition exists, the ETL does not apply. This study is taking the approach that following levee assessment, if a portion of one of these levee reaches is determined to be a non-levee condition, as shown on Figures A1 through A5, then the ETL may not apply and a specified vegetation plan may be approved by the District Levee Safety Officer.

7. Current Levee Assessment Status

Currently the levees within the ARBOR Reach are being or are planned to be assessed in the next few years. Field inspection as part of the periodic inspection process was recently conducted for LAR 6. The Periodic Inspection Report is being prepared at this time for LAR 6. The other levees, LAR 2, LAR 3, LAR 5, and LAR 7, are scheduled to be inspected by 2016.

8. Limitations:

All of the above discussion is for planning and consideration purposes only. Further evaluation, analysis, and design will be required during future stages. In addition, conditions and guidance may change and may not be applicable at the time of design or during future studies.

Chris A. Spitzer, P.E.
Soils Design & Materials Section

Jody L. Fischer P.E.
Levee Safety Program Manager

Mark W. McLarty, C.E.G.
Geology & Investigation Section Chief

Encl: Selected Photos Showing Field Conditions
Relevant Figures from ETL 1110-2-571
Figures A1 through A5

CF: FAIRBANK (Dam Safety Program Manager
FARLEY (Geotechnical Branch)
LEIFIELD (Engineering Division)
BEAUCHAMP-HERNADEZ (Operations Branch)I

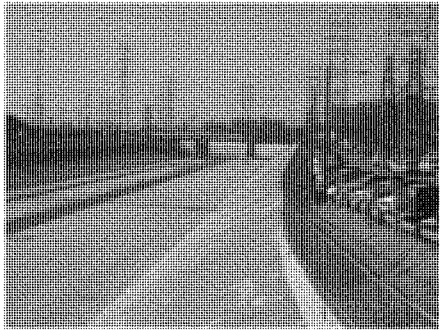

Photo 1: View looking downstream at N. Main Street. LAR 2 on right side. Not a levee condition. From top of wall and ascending slope approximately 5-feet in height with relatively level ground on landside.

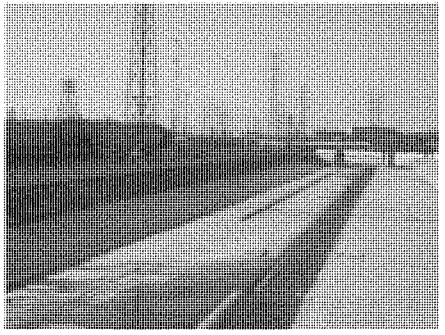

Photo 2: View looking downstream at N. Main Street. LAR 5 on left side. Not a levee condition. Railroad embankment with ascending slope above top of wall. Photo 3 depicts landside condition further.

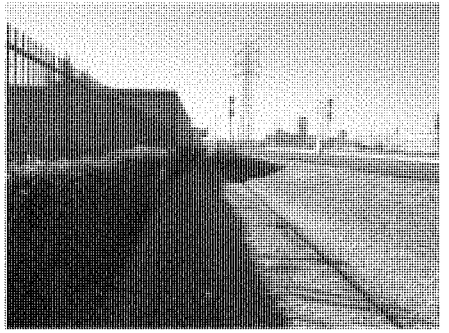

Photo 3: View looking downstream at N. Main Street. LAR 5 on right side. Not a levee condition. Ground in immediate foreground at approximately the same elevation of the wall depicted in Photo 2.

Photo 4: Looking upstream near downstream end of LAR 3. Not a levee condition. Ascending slope to high ground on landside. Vegetation would be within the VFZ if this portion is to remain listed as levee or is required for levee support upstream or downstream.

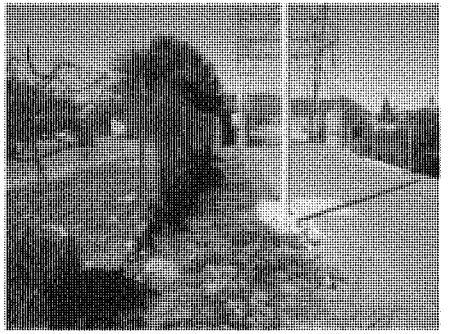

Photo 5: On crest of LAR 3 looking upstream. Not a levee condition. Although landside is slightly lower than crest. Flow would be directed along I-5 (on left) and the crest of the highway is above the crest of LAR 3.

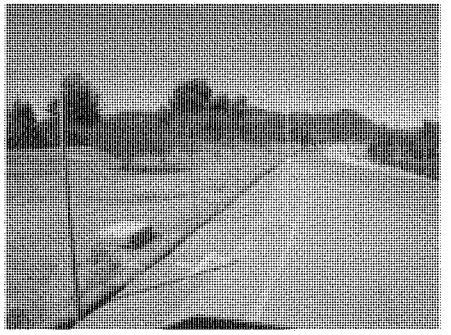

Photo 6: Looking upstream along LAR 3 just upstream of Hyperion Ave. Not a levee condition. Grades for park are above crest.

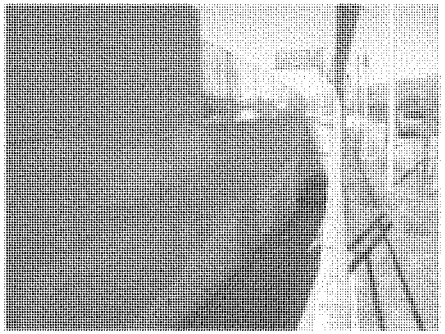

Photo 7: Equestrian ramp and tunnel entrance. Note crest on right, highway on left. Tunnel and culvert at base of down-ramp in center.

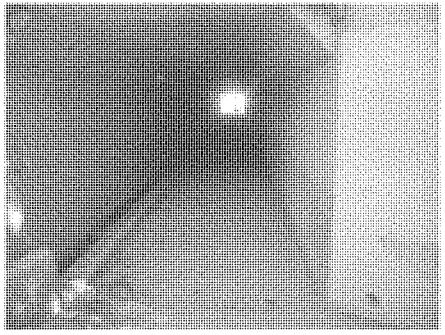

Photo 8: Landside of tunnel culvert at end of tunnel in background. Tunnel height allows horse and rider to pass through without rider bending over. Note small wall in foreground as it is the same wall depicted in Photo 9.

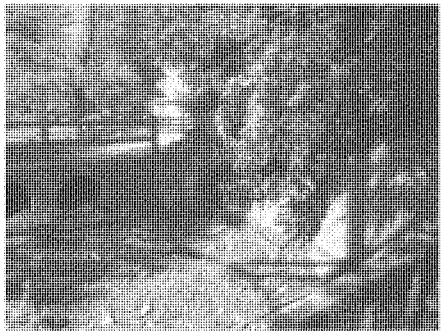

Photo 9: Landside of tunnel looking upstream. Wall in foreground is the wall depicted in Photo 8. The building in background is at approximately same grade as top of tunnel.

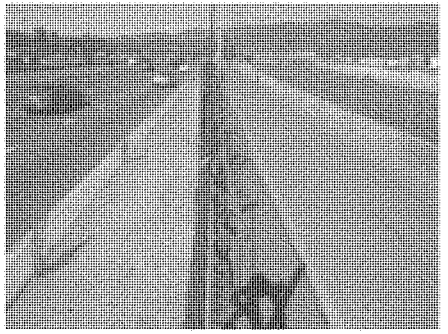

Photo 10: Looking upstream on LAR 3 near Gene Autry Museum. Levee condition of approximately 2 to 4-feet exists and flow would be directed on I-5 and along levee. Southbound lanes are higher than northbound lanes.

Photo 11. At Ferraro Fields looking downstream on LAR 3. Levee condition beyond right of photo and vegetation on landside crest.

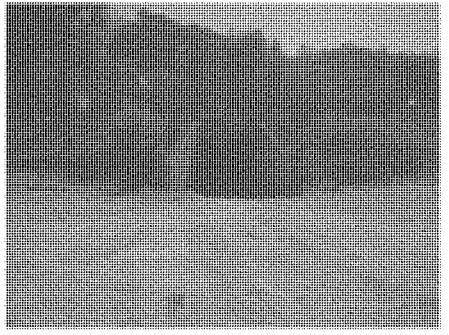

Photo 12: Equestrian undercrossing on landside of LAR 3. Photo taken at landside crest.

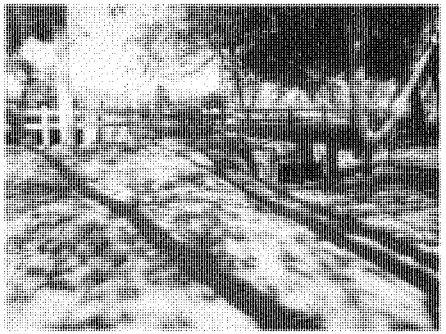

Photo 13: Landside of undercrossing on left side. Inlet of drain on right side.

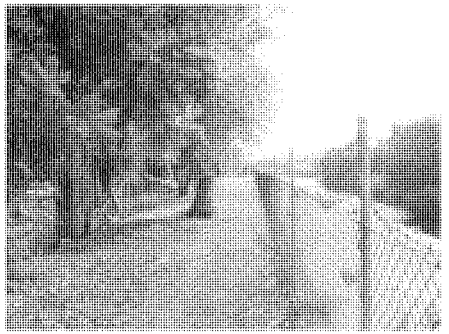

Photo 15: Downstream of Riverside Drive looking downstream on LAR 7. Vegetation on landside.

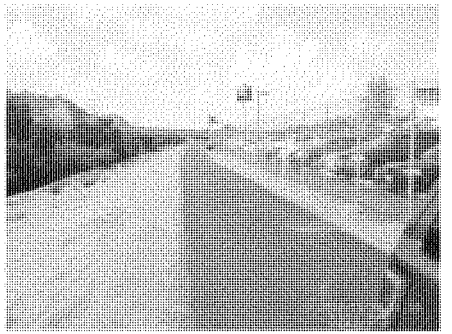

Photo17: Looking upstream on LAR 7. Landside backfilled and not a levee condition.

Photo 14: Upstream end of LAR 3 looking downstream. Vegetation on landside.

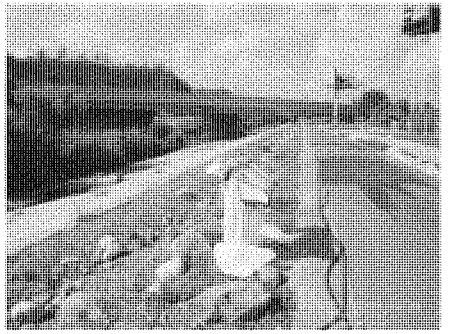

Photo 16: Looking upstream on LAR 7. Levee condition and irrigation lines at riverside crest and across entire landside slope.I-5 in background.

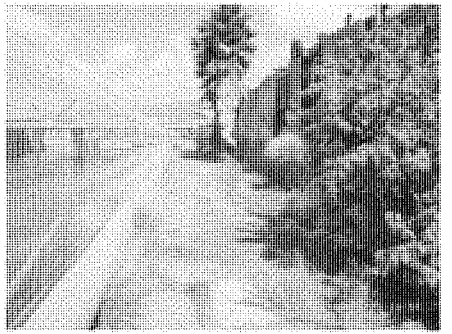

Photo 18: Looking upstream on LAR 6. Vegetation on levee and cannot inspect toe with fence.

Photo 19: Atwater Park. Not a levee condition on LAR 6 but needed as levee conditions exist upstream and downstream.

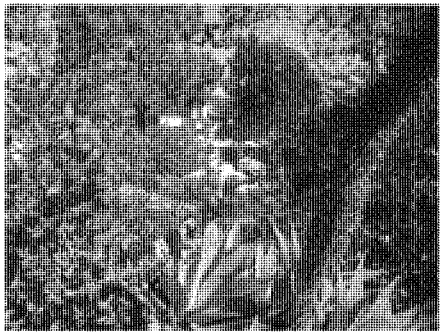

Photo 21: Vegetation on landside and levee condition on LAR 6.

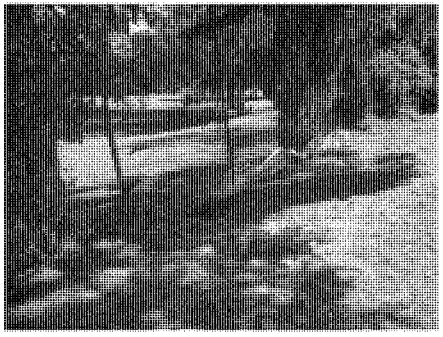

Photo 20: Los Feliz Golf Course. Vegetation on landside.

Photo 22: Taken in same vicinity of Photo 21 showing that this is a levee condition.

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Figures from ETL 1110-2-571

The following figures (with ETL figure numbering) are from ETL 1110-2-571 and are representative of current or potential reconfiguration of the levees along the Los Angeles River.

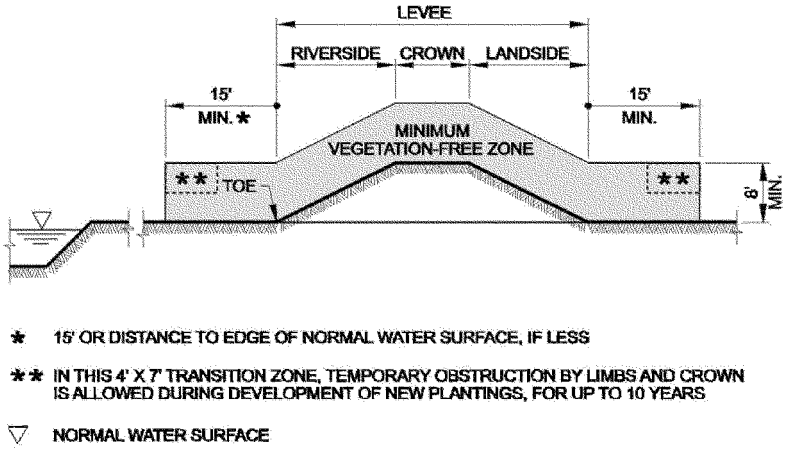

Figure 1: Levee Section – Basic

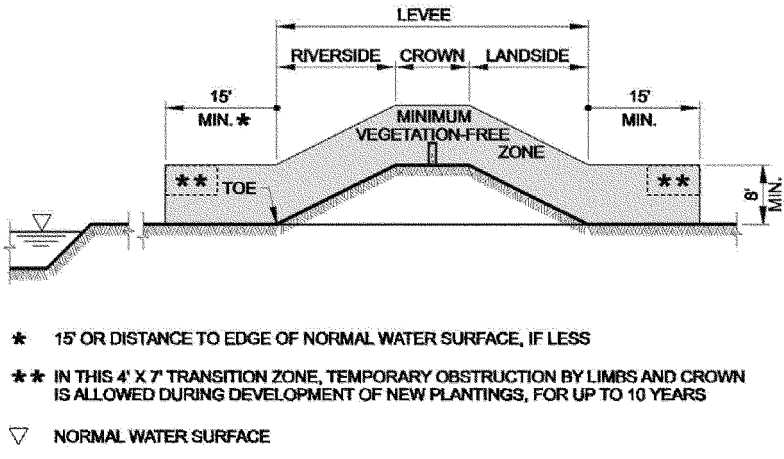

Figure 3: Levee Section – Basic, with Floodwall on Crown

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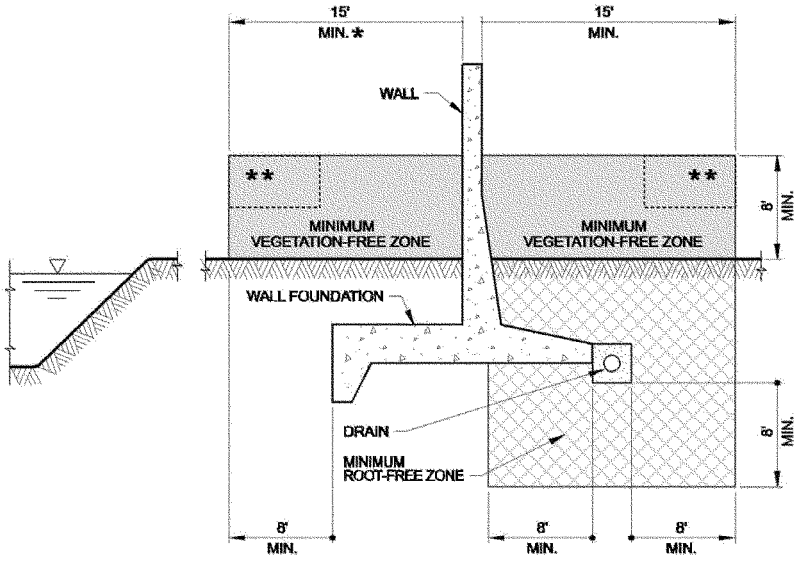
Figures from ETL 1110-2-571



* 15' OR DISTANCE TO EDGE OF NORMAL WATER SURFACE, IF LESS

** IN THIS 4' X 7' TRANSITION ZONE, TEMPORARY OBSTRUCTION BY LIMBS AND CROWN IS ALLOWED DURING DEVELOPMENT OF NEW PLANTINGS, FOR UP TO 10 YEARS

▽ NORMAL WATER SURFACE

NOTE: THE HORIZONTAL DIMENSION OF THE MINIMUM VEGETATION-FREE ZONE SHALL BE THE GREATER OF:
(A) THE 15-FOOT MINIMUM, AS DIMENSIONED ABOVE GRADE; OR
(B) AS DIMENSIONED FROM THE BELOW-GRADE STRUCTURE

Figure 17: Inverted-T Type Floodwall with Drain.

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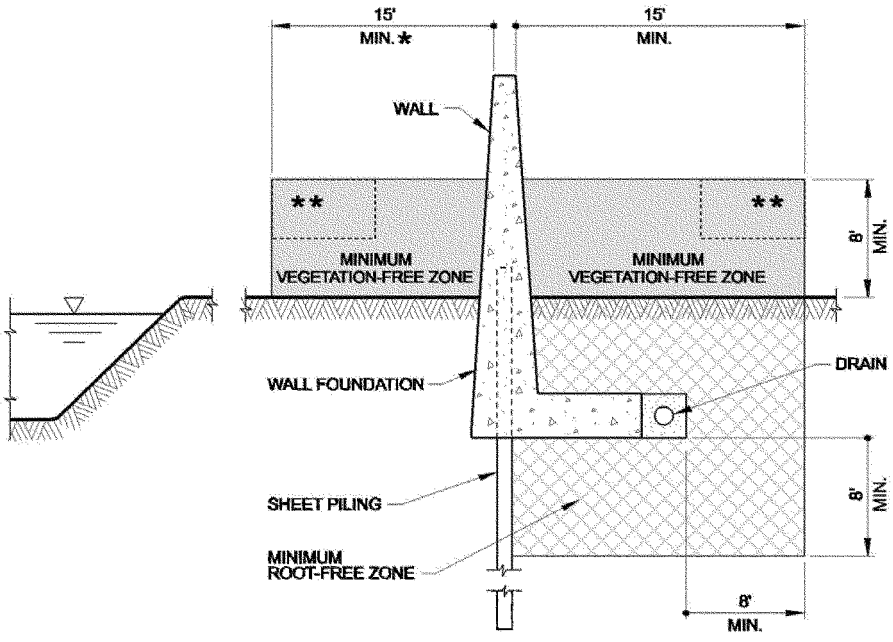
Levee Condition Inspection and Issue Discussion

Figures from ETL 1110-2-571



* 15' OR DISTANCE TO EDGE OF NORMAL WATER SURFACE, IF LESS

** IN THIS 4' X 7' TRANSITION ZONE, TEMPORARY OBSTRUCTION BY LIMBS AND CROWN IS ALLOWED DURING DEVELOPMENT OF NEW PLANTINGS, FOR UP TO 10 YEARS

▽ NORMAL WATER SURFACE

NOTE: THE HORIZONTAL DIMENSION OF THE MINIMUM VEGETATION-FREE ZONE SHALL BE THE GREATER OF:

(A) THE 15-FOOT MINIMUM, AS DIMENSIONED ABOVE GRADE; OR
(B) AS DIMENSIONED FROM THE BELOW-GRADE STRUCTURE

Figure 19: Cantilever-I Type Sheet-Piling Floodwall with Drain.

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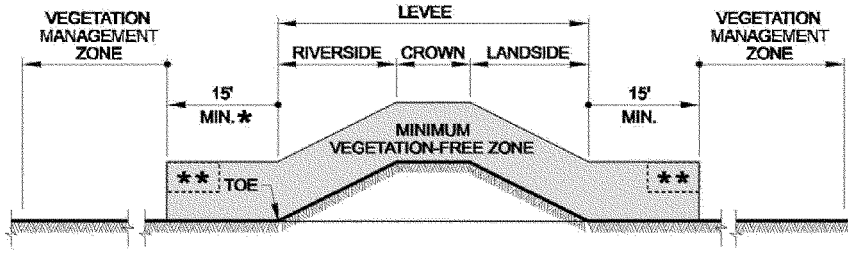
Figures from ETL 1110-2-571



* 15' OR DISTANCE TO EDGE OF NORMAL WATER SURFACE, IF LESS

** IN THIS 4' X 7' TRANSITION ZONE, TEMPORARY OBSTRUCTION BY LIMBS AND CROWN IS ALLOWED DURING DEVELOPMENT OF NEW PLANTINGS, FOR UP TO 10 YEARS

▽ NORMAL WATER SURFACE

NOTES:

1. THE VEGETATION-MANAGEMENT ZONE ALLOWS FOR ACCESS, FOR THE PURPOSE OF INSPECTION, AND MODIFICATION OR REMOVAL OF ANY PLANT WHOSE LIMB, FOILAGE, OR ROOT BEHAVIORS BECOME A THREAT TO PROJECT RELIABILITY.
2. THE APPROPRIATE WIDTH OF THE VEGETATION-MANAGEMENT ZONE SHALL BE DETERMINED BY THE DESIGN TEAM: 35 FEET WILL BE SUFFICIENT IN MOST CASES.
3. THE VEGETATION-MANAGEMENT ZONE MAY BE ESTABLISHED BY EASEMENT.
4. THIS FIGURE SHOWS THE VEGETATION-MANAGEMENT ZONE IN THE CASE OF A LEVEE; HOWEVER, IT IS EQUALLY APPROPRIATE IN THE CASE OF ANY OTHER FLOOD DAMAGE REDUCTION STRUCTURE OR APPURTENANCE: IT'S USUAL RELATIONSHIP IS TO THE VEGETATION-FREE ZONE.

Figure 22: Vegetation-Management Zone.

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Figures from ETL 1110-2-571

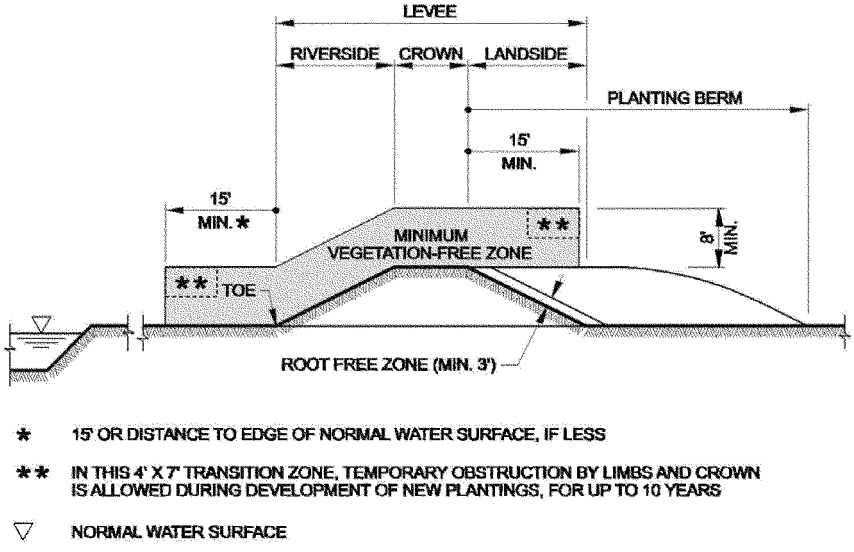
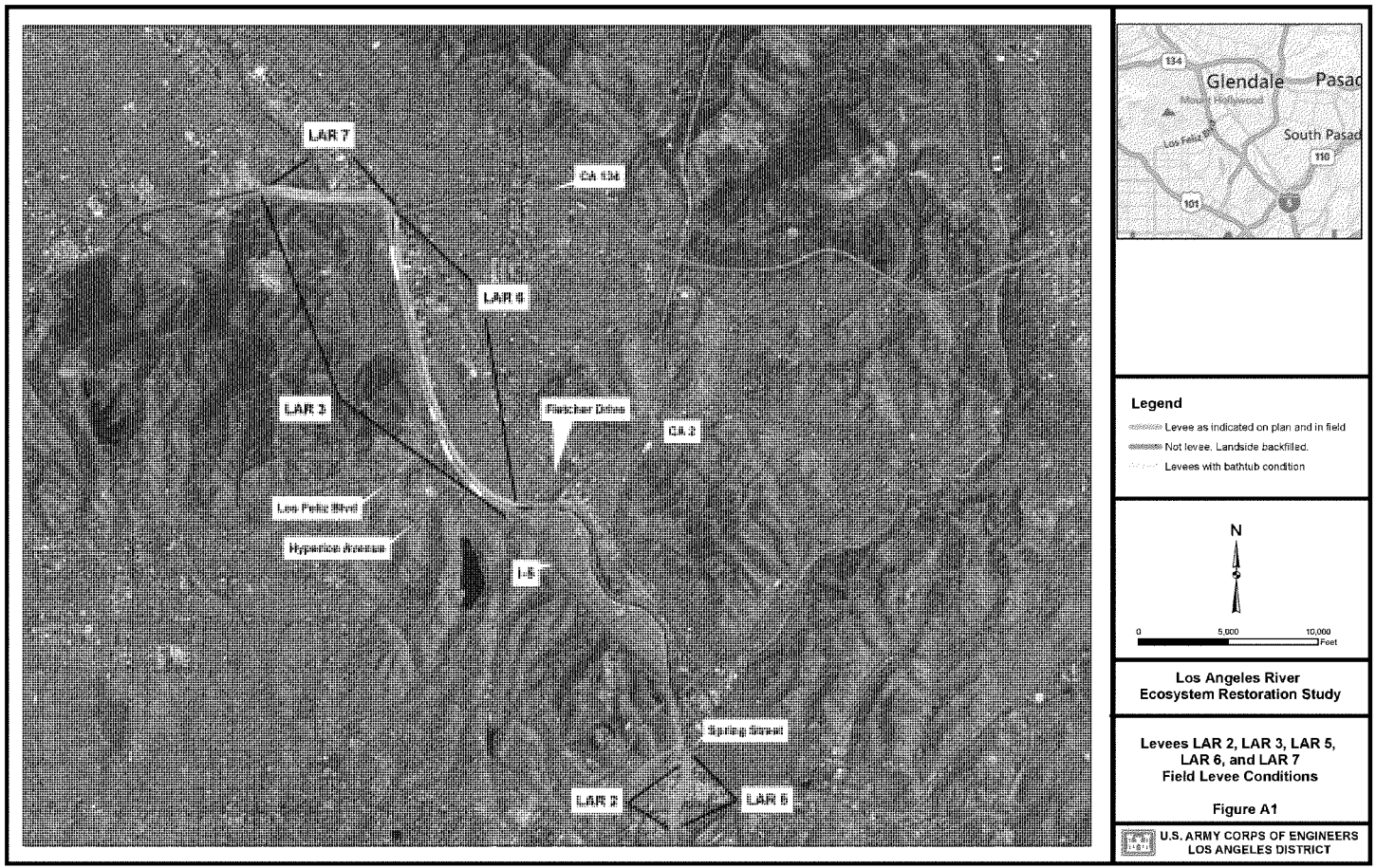
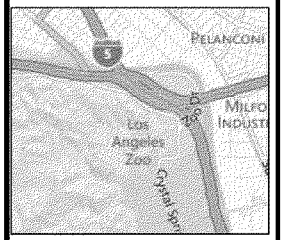


Figure 13: Levee Section with land side Planting Berm.


LAR 7
LAR 4
LAR 3
Fletcher Drive
Los Feliz Blvd
Hyperion Avenue
LAR 2
LAR 5
LAR 6
Glendale
Pasad
South Pasad
134
110
101
Legend
Levee as indicated on plan and in field
Not levee. Landside backfilled.
Levees with bathtub condition
N
0
5,000
10,000
Feet
Los Angeles River
Ecosystem Restoration Study
Levees LAR 2, LAR 3, LAR 5,
LAR 6, and LAR 7
Field Levee Conditions
Figure A1
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



Legend

Levee as indicated on plan and in field

Not levee. Landside backfilled.

Levees with bathtub condition

N

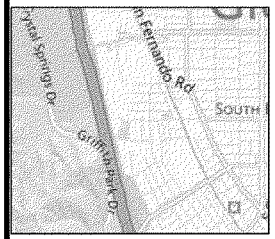
0 1,050 2,100 Feet

Los Angeles River
Ecosystem Restoration Study

Levees LAR 2, LAR 3, LAR 5, LAR 6, and LAR 7
Field Levee Conditions

Figure A2

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



Legend

- Levee as indicated on plan and in field
- Not levee. Landside backfilled.
- Levees with bathtub condition

N

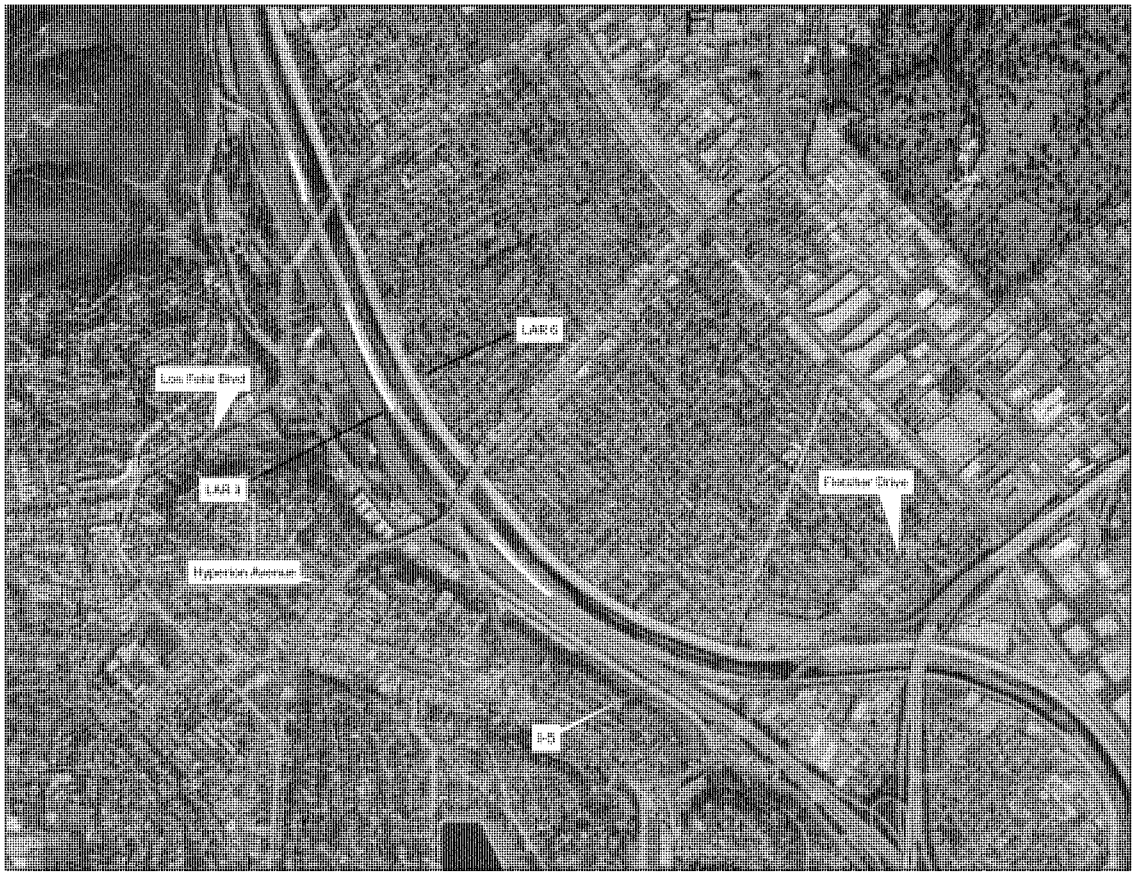
0 1,050 2,100 Feet

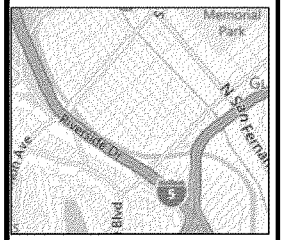
Los Angeles River
Ecosystem Restoration Study

Levees LAR 2, LAR 3, LAR 5,
LAR 6, and LAR 7
Field Levee Conditions

Figure **A**3

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT





Legend

- Levee as indicated on plan and in field
- Not levee. Landside backfilled.
- Levees with bathtub condition

N

0 1,050 2,100 Feet

Los Angeles River
Ecosystem Restoration Study

Levees LAR 2, LAR 3, LAR 5,
LAR 6, and LAR 7
Field Levee Conditions

Figure A4

U.S. ARMY CORPS OF ENGINEERS
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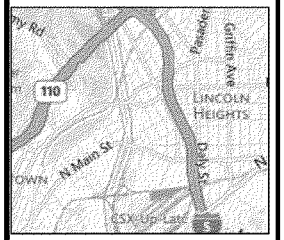


Legend

Levee as indicated on plan and in field

Not levee. Landside backfilled.

Levees with bathtub condition

N

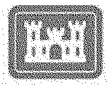
0 1,050 2,100 Feet

Los Angeles River
Ecosystem Restoration Study

Levees LAR 2, LAR 3, LAR 5, LAR 6, and LAR 7
Field Levee Conditions

Figure A5

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



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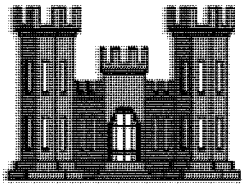
Los Angeles River Ecosystem Restoration

Feasibility Study

APPENDIX E

HYDROLOGY AND HYDRAULICS

September 2015



LOS ANGELES RIVER
Ecosystem Restoration Study

HYDROLOGY & HYDRAULICS APPENDIX

Prepared By:

US Army Corps of Engineers, Los Angeles District
Engineering Division, Hydrology and Hydraulics Branch

September 2015

Subject: Addendum No. 1 to Los Angeles River Ecosystem Restoration Feasibility Study, Hydrology and Hydraulics Appendix, February 2015.

1. Following public review, further analysis was performed that included a more detailed cost analysis using Mii software, real estate cost updates, and further modified contingencies based upon a full cost risk summary analysis.

2. This additional analysis identified a more cost effective variation on Alternative 13 (referred to throughout the IFR as "Alternative 13v") that is identical to Alternative 13 except for Reach 7, where it includes the reach plan included in Alternative 20 that provides 10 acres of marsh and a connection to the Los Angeles State Historic Park.

3. As described in the IFR, the previously identified NER plan has been modified to include the substitution of the Reach 7 plan on the basis of the analysis referenced above. Because the analyses in this Appendix included all of the components of Alternative 13v, no separate or additional analysis is necessary.

4. The descriptions for Reaches 1-6 and 8 of Alternative 13v do not change from Alternative 13 and are shown in Section 18.1, Alternative Descriptions included in this Appendix. For the description of Alternative 13v for Reach 7, see the description for Reach 7 of Alternative 20 included in this appendix in Section 18.1.

5. This revised configuration of Reach 7 has no negative impacts on the hydraulics of the channel as compared to the Reach 7 configuration used for Alternative 13. There is no adverse effect to the water surface elevation in Reach 7 for Alternative 13v, whereas the Reach 7 used in Alternative 13 does have an adverse effect due to the additional vegetation along the channel walls. A revised Table 20a to show this additional Alternative 13v is shown below. The typical cross section for Alternative 13v Reach 7 is the same as depicted on Plate 29 for Reach 7 of Alternative 20.

6. Alternative 13v is the NER plan; Alternative 20 is the Recommended Plan.

Table 20a: Alternative 13v Water Surface Elevation

Reach	River Station	Scenario I	Scenario II	Scenario III	Scenario IV
Reach 1	625+77 to 547+45				
Reach 2	546+45 to 510+05				
Reach 3a	504+93 to 477+85				
Reach 3b	475+68 to 452+58				
Reach 4	432+16 to 359+75				
Reach 5	358+63 to 271+89				
Reach 6a	270+28 to 262+73				
Reach 6b	257+85 to 144+23				
Reach 7a	142+91 to 131+22				
Reach 7b	128+71 to 86+81				
Reach 8	86+07 to 10+31				
Note: letters a & b in Reach name denote a break in the reach due to a confluence or flow change. Color Codes:					
Does not increase the water surface elevation					
Increases the water surface elevation					
No change from design conditions					

ABBREVIATIONS AND ACRONYMS USED IN THIS APPENDIX

2-yr event	50% Annual Chance Exceedance Event
5-yr event	20% Annual Chance Exceedance Event
10-yr event	10% Annual Chance Exceedance Event
25-yr event	4% Annual Chance Exceedance Event
50-yr event	2% Annual Chance Exceedance Event
100-yr event	1% Annual Chance Exceedance Event
200-yr event	0.5% Annual Chance Exceedance Event
500-yr event	0.2% Annual Chance Exceedance Event
ACE	Annual Chance Exceedance
AFB	Alternatives Formulation Briefing
ARBOR	Alternative with Restoration Benefits and Opportunities for Revitalization
CADWR	California Department of Water Resources
CE/ICA	Cost Estimate/Incremental Cost Analysis
CIMIS	California Irrigation Management Information System
COE	Corps of Engineers
EIS	Environmental Impact Statement
EM	Engineering Manual
ER	Engineering Regulation
ETo	Evapotranspiration
FEMA	Federal Emergency Management Agency
GIS	Geographic Information System
HEC	Hydrologic Engineering Center
HEC-RAS	River Analysis System computer program from HEC
LACDA	Los Angeles County Drainage Area
LACDPW	Los Angeles County Department of Public Works
LATC	Los Angeles Transfer Container Facility
MSL	Mean Sea Level
NAD	North American Datum
NAVD	North American Vertical Datum
NED	National Economic Development
NGVD	National Geodetic Vertical Datum
NOAA	National Oceanic and Atmospheric Administration
RS	River Station
SPF	Standard Project Flood
SPS	Standard Project Storm
SWMP	Stormwater Management Plan
TIN	Triangulated Irregular Network
TSP	Tentatively Selected Plan
WRP	Water Reclamation Plant (Tillman)
WSE	Water Surface Elevation

UNITS USED IN THIS APPENDIX

ac	acres	ft/s	feet per second
af/yr	acre-feet per year	ft^3/s	cubic feet per second
af	acre-feet	ft/mi	feet per mile
cy	cubic yards	in	inch
ft	feet	mi^2	square miles

DISCLAIMER:

This Hydrology and Hydraulics Appendix is intended to supplement the Main Report and associated Appendices for the Los Angeles River Ecosystem Restoration Feasibility Study. This Appendix has been through all required levels of review and public comment.

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LOS ANGELES RIVER ECOSYSTEM RESTORATION STUDY

1. Introduction.

The purpose of this study is to investigate alternatives to improve the ecosystem function of the Los Angeles River specifically within the Los Angeles city limits. The Hydrology and Hydraulic Appendix contains a description of the existing and future hydrologic conditions and a description of the existing channel and appurtenant features. In addition, this appendix covers the modeling inputs and results for the with-project conditions for four selected alternatives. All elevations are based on the 1929 National Geodetic Vertical Datum (NGVD), unless otherwise noted.

The Corps of Engineers (COE) completed a feasibility level flood control review for the Los Angeles County Drainage Area (LACDA) in 1992 and summarized the results in a Main Report and Appendices. The main report and EIS for the Los Angeles County Drainage Area Review Final Feasibility Report was dated Dec. 1991, with revisions in Feb. 1992. There are separate Hydrology and Hydraulics Appendices, each dated Dec. 1991 (along with appendices for Economics, Recreation Inventory, Real Estate, Geotechnical, and Design). These documents went through extensive technical and independent review and were approved and certified prior to the final report date. The proposed project resulting from the Feasibility Study was completed in the late 1990s. The level of detail and adequacy of results is still sufficient for use in the current ecosystem restoration study. This document includes pertinent sections from the previous documents.

Currently, there is considerable public interest in the "revitalization" of the Los Angeles River. This Ecosystem Restoration study is running concurrently with several efforts from private and public interests, including the city of Los Angeles. It is important to note up front that the primary premise from the hydrology and hydraulics perspective is that any ecosystem project evaluated in this study must not negatively impact the flood risk management function of the system. This means any effort to alter the existing Los Angeles River channel must provide mitigation to offset any loss of conveyance. The existing flood risks are presented in this appendix as well as the methodology used to show the proposed alternatives will not increase the flood risks along the river.

The Los Angeles River Channel, for the most part, is a prismatic concrete channel. There are two stretches within the project extent that have natural inverts. These areas currently have a significant amount of vegetation growing along the invert. Funding for removal of vegetation has always been uncertain. In addition there are negative environmental impacts with removal. Thus, it was decided for this ecosystem restoration study the Existing Condition will include the vegetation and would be the condition against which all alternatives are compared. This decision does not imply there is any effort to change the design discharges for the channel.

2. Project Location.

A series of preliminary studies and decisions led to establishment of the project location for this study. Initially, the study covered the entire 32 mile stretch of the river within the city of Los Angeles. The portion of the Los Angeles River ultimately decided to focus on is called the ARBOR reach, which stands for the Alternative with Restoration Benefits and Opportunities for Restoration. The reasons for this decision are addressed in the main report. The location of the ARBOR reach is shown on Plate 1.

The modeling limits for the project extend approximately 11 miles from the western side of Forest Lawn Cemetery at Barham Blvd. downstream to the 1st St. bridge in downtown Los Angeles. The Los Angeles River channel configuration is primarily trapezoidal or rectangular prismatic reaches with concrete side slopes and concrete invert. However, some reaches within the study area are trapezoidal channels with grouted riprap side slopes and an earthen invert, or "soft" bottom, with vegetation. The soft bottom reaches include a 0.9 mile reach that begins about 500 feet downstream of the Burbank Western confluence and ends approximately 1,000 feet downstream of the 5 Freeway crossing, and an approximately 5.9 mile reach that begins 2,000 feet downstream of the Verdugo Wash confluence and ends at the 5 Freeway's second crossing over the Los Angeles River.

3. General Description of the Drainage Area.

The LACDA watershed lies mostly in Los Angeles County, California, although portions lie in San Bernardino and Orange Counties. See Plate 2 for location of ARBOR in relation to LACDA. The watershed is abutted on the east by the Santa Ana River Watershed, on the north by the Antelope Valley and Santa Clara River Watersheds, and on the west by the Calleguas Creek Watershed. The project area is located along the mainstem Los Angeles River within the Los Angeles city limits.

Elevations in the San Gabriel and Santa Susana Mountains, which form the northern boundary of the watershed, vary from 3,000 feet in the west to over 9,000 feet in the east. The Santa Monica Mountains, Montebello Hills, and Puente Hills separate the San Fernando and San Gabriel valleys from the coastal plain, and range from 500 to 1,500 feet in height.

Principal streams in LACDA are the Los Angeles River, which has a drainage area of 824 mi^2 at the mouth (including the Rio Hondo above Whittier Narrows Dam and its tributaries), and the San Gabriel River, which has a drainage area of 635 mi^2 at the mouth. The Rio Hondo Diversion Channel brings water from the San Gabriel River system to the lower Los Angeles River by way of Whittier Narrows Dam and may effectively increase the drainage area of the Los Angeles River during periods of high runoff. The principal tributaries of the Los Angeles River include: Pacoima and Tujunga Washes, both of which drain portions of the Santa Susana Mountains and the San Fernando Valley, Verdugo Wash, which drains portions of the Verdugo Hills; and the Arroyo Seco, which starts in the San Gabriel Mountains and then heads south to the

Los Angeles River. The main channel of the Los Angeles River is approximately 51 miles long and its tributaries have an aggregate length of about 225 miles. Operations and maintenance for specific channel reaches is divided between the COE and Los Angeles County Department of Public Works (LACDPW).

4. Soils.

Soils in the LACDA watershed can be generally classified as either mountain or valley. Mountain soils consist of a relatively thin mantle of residual soils, which are coarse, porous, and rocky. The valley soils, classified as recent alluvium and older alluvium, vary from coarse sand and gravel at canyon mouths to silty clay, and clay in the lower areas. The soils underlying the project location fall primarily into Hydrologic Soil Group D (see Plate 3).

5. Vegetation.

Well-developed growths of ponderosa pine, incense cedar, juniper, and oak occur along the summits and in the higher ravines of the mountains. Cottonwoods, box elders, sycamores, oaks, willows, and alders grow along the watercourses at lower mountain elevations. In general, the remainder of the mountains is covered with chaparral, consisting of California lilac, scrub oak, mountain mahogany, sumac, laurel, sage, and manzanita. The chaparral is extremely susceptible to fires during the long, dry summers, and large areas of mountain watersheds are frequently denuded by fire. This causes a dramatic increase in the runoff and debris production potential in these areas. Few areas of native vegetation exist in the highly developed valleys. The pervious areas that remain are mostly landscaped.

6. Structures Affecting Runoff.

Most streams in the valleys and coastal plain are improved, while most mountain streams are natural. Channel improvements have significantly affected runoff: straightening and lining have reduced the amount of flood peak attenuation due to routing and have shortened flood flow travel time. Before manmade improvements, most of the water courses were poorly defined upon leaving the mouths of the mountain canyons. Stream alignments on the alluvial fans and coastal plain shifted with appreciable lateral movement in response to floods. Progressive stabilization has defined many of the present day stream alignments.

The water resources in LACDA are very intensely managed. Numerous multipurpose and special purpose dams and diversion structures, debris basins, channel improvements, and levees exist in the watershed. Leveed areas from the National Levee Database within the ARBOR reach are shown on Plate 4. The functions of major structures include flood control, water supply, water conservation, recreation, and debris control. There is an elaborate stormwater collection system in place that delivers interior runoff to the channels. Flood and debris flows are regulated at existing dams and debris basins. Debris pools exist at several reservoirs in the system.

Seven dams within LACDA are owned and operated by the Corps of Engineers. All were originally authorized as single purpose flood control projects. None have a permanent pool. Of the seven, only Whittier Narrows Dam currently has approved water conservation activities. Hansen, Lopez, and Santa Fe Dams at one time had water conservation activities, but difficulties with excessive reservoir sedimentation, along with funding from local agencies, have caused suspension of the programs. The remainder, Sepulveda, Brea, and Fullerton Dams are strictly flood control and have no water conservation activities. Lopez Dam is relatively small and currently the reservoir is almost filled with sediment. It offers little in the way of peak flow attenuation. Recently, there has been renewed interest in re-evaluating water conservation at several of these dams. There are 15 non-Federal dams within LACDA which are operated by LACDPW. All are multipurpose, most having both water conservation and some flood control functions. Hansen and Sepulveda Dams are operated by the Corps of Engineers and have the biggest impact on flows reaching the project area. Pertinent information for these two dams are listed below.

6.1. Hansen Dam.

Pertinent Information. The Hansen Dam (see Plate 2 for location) drainage area is 151.9 mi^2, and is formed by the San Gabriel Mountains on the north and west, and by the Verdugo Mountains and a secondary range of the San Gabriel Mountains on the south and east. The watershed above Hansen Dam is about 24 miles in length, is irregular in shape, and varies from 5.5 to 9 miles in width. Elevations in the watershed range from about 6,000 ft at the upper edge of the watershed to 980 ft at the dam site. Big Tujunga Creek originates on the southern slope of the San Gabriel Mountains; it flows in a winding course through canyons to the base of the mountains, then joins with Little Tujunga Creek to form Tujunga Wash. Tujunga Wash flows through Hansen Dam, then southward to the Los Angeles River. The Los Angeles River flows into the Pacific Ocean about 38 miles downstream of its confluence with Tujunga Wash.

Hansen Dam was completed in September 1940 as a single purpose flood control structure. It is an earth fill dam, 97 feet high with a top elevation of 1087.0 ft. The spillway is an ogee type with a crest elevation of 1060.0 ft and a net crest length of 284 feet. The outlet works consist of eight 5' x 8' gated conduits, 265 feet in length, with an entrance invert elevation of 990.0 ft and two 8' x 6' uncontrolled conduits, 265 feet in length, with an entrance invert elevation of 1011.0 ft. The capacity of the improved channel downstream is 21,000 ft^3/s. The original allocation for sedimentation at Hansen Dam was estimated at 5,000 af over a period of 50 years. This amount has already been exceeded (10,000 af of sediment had been deposited by 1977) and a revised 50-year sediment allowance of 10,500 af has been determined. Pertinent data for Hansen Dam is shown in Table 1. Hydrologic routing information is presented in Table 2.

6.2. Sepulveda Dam.

Pertinent Information. The Sepulveda Dam (see Plate 2 for location) drainage area is 152.0 mi², which is highly urbanized and responds quickly to rainfall. Sepulveda Dam is located across the Los Angeles River, 44 miles above the mouth of the river, and 6 miles above the confluence of Tujunga Wash and the Los Angeles River. The dam is in the south-central portion of the San Fernando Valley, just northwest of the junction of the Ventura Freeway (U.S. Highway 101) and the San Diego Freeway (Interstate Highway 405).

The drainage area boundary on the south is formed by the Santa Monica Mountains; on the west, by the Simi Hills; on the north, by the Santa Susana Mountains; and on the east by a line extending approximately north and south across the valley and generally along the San Diego Freeway.

The headwaters of the Los Angeles River are in the Simi Hills on the west, formed by Chatsworth Creek, Dayton Canyon Wash, Bell Creek, and Arroyo Calabasas. Other major tributaries above Sepulveda Dam include Devil Canyon, Brown's Canyon, Limekiln Canyon, Wilbur, and Aliso Canyon Washes; and Caballero and Bull Creeks. The longest watercourse above the dam is Devil Canyon-Brown's Canyon-Los Angeles River. This watercourse is about 19 miles long with an average slope of 143 ft/mi.

Approximately 85 mi² of the watershed above Sepulveda Dam is of relatively steep, mountainous terrain, and about 67 mi² is of comparatively flat valley floor. Elevations in the valley vary from 668 feet at the base of the dam to about 1,200 feet at the base of the foothills. The average elevation of the Santa Monica Mountains is about 1,700 feet; that of the Simi Hills is about 1,800 feet; and that of the Santa Susana Mountains is about 2,000 feet. The highest point in the drainage area is San Fernando Peak, in the Santa Susana Mountains, having an elevation of 3,741 feet.

Sepulveda Dam was completed in September 1941 as a single purpose flood control structure. It is an earth fill dam, 57 feet high, with a top elevation of 725.0 ft. The spillway is an ogee type with spillway gates. The elevation with the gates raised is 710.0 ft. The outlet works consist of four 6 ft W x 6.5 ft H ungated outlets, with an invert elevation at 668.0 ft and four 6 ft W x 9 ft H gated outlets, also with an invert elevation of 668.0 ft. The capacity of the improved channel downstream is 17,000 ft³/s. There is no allocation for sedimentation at Sepulveda Dam. Pertinent data for Sepulveda Dam is shown in Table 3. Hydrologic routing information is presented in Table 4.

7. Runoff Characteristics.

In the mountains, runoff concentrates quickly from the steep slopes; hydrographs show that the stream flow increases rapidly in response to effective rainfall. High rainfall rates,

in combination with the effects of shallow surface soils, impervious bedrock, fan-shaped stream systems, steep gradients, and occasional denudation of the area by fire, result in intense debris-laden floods. However, flood and debris flows are regulated at existing dams and debris basins.

Runoff from urban watersheds is characterized by high flood peaks of short duration that result from high-intensity rainfall on watersheds that have a high percentage of impervious cover. Flood hydrographs from single storm events are typically of less than 12 hours duration and are almost always less than 48 hours duration.

8. Climate.

The climate of LACDA varies considerably with elevation and distance from the coast. The entire region is Mediterranean, with dry summers and mildly wet winters. The coastal zone is subtropical, with cool summers and mild winters. The intermediate valleys and foothills are temperate, with warm summers and mild winters. The climate in the mountains ranges from temperate, with warm summers and cool winters at the resort levels (5,000 - 6,000 ft), to alpine, with cool summers, and cold winters over the highest peaks (9,000 - 10,000 ft).

8.1. Temperature.

In Los Angeles County, the average daily minimum/maximum temperatures range from about 48/64 (degrees Fahrenheit) in winter to 65/75 in summer along the coast. In the intermediate valleys, the range is from about 42/66 in winter to about 62/95 in summer. Over the higher mountains, the respective seasonal values are about 22/40 and 50/70. All-time low/high extremes of temperature are about 26/113 along the coast, 22/118 in the valleys and foothills, 5/105 at mountain resort levels, and -10/85 over the highest peaks. The coastal area does not experience significant frosts, but freezing temperatures are common in the higher mountains from November through March and occur on occasion during the winter in the intermediate valleys.

At the city of Burbank, located near the upstream limit of the ARBOR reach at an elevation of 655 feet above sea level, the average temperature is about 65° F, with extremes of 22° F and 113° F on record. Pertinent daily data and monthly average temperature for the Burbank weather station are shown in Table 5.

8.2. Precipitation.

Precipitation characteristically occurs in the form of rainfall, although in the higher elevations, some falls as snow. In general, the quantity of precipitation increases with elevation. Normal annual precipitation in LACDA ranges from about 12 inches along the coast in Long Beach to more than 44 inches over Mt. Baden-Powell and Mt. San Antonio (Old Baldy) in the East Fork drainage of the San Gabriel River. About 90 percent of the season's total precipitation normally falls

from November through April, with December-March as the wettest months. Extreme monthly precipitation totals in the drainage range from zero at every location to more than 50 inches atop the wettest mountain peaks. As can be seen by these extremes, and as can be computed from NOAA Atlas 14 for any duration up to 24 hours or for any return period (out to well beyond 100 years), the rainfall depth over the higher mountains is considerably greater than the corresponding depth on the coastal plains. The mountain/coastline ratios can be as high as 3 to 1 for durations of 6 hours and as high as 4 to 1 for 24 hours.

The mean seasonal precipitation at the project location is about 17.5 inches. The Burbank weather station recorded a maximum daily precipitation of 7.76 in. in Jan 1943. Nearly all precipitation occurs during the months of November through April. Rainless periods of several months during the summer are common. Pertinent data and monthly average precipitation values for the weather station are shown in Table 6.

Frequency point precipitation estimates for selected frequencies are available from NOAA Atlas 14. Specific estimates for the project location are presented in Table 7. Note: For comparison, the 100-year 24-hour point precipitation for the entire LACDA area from the 1992 LACDA Review Study was 9.78 inches.

8.3. General Winter Storms.

Most precipitation in southern California coastal drainages occurs during the cool season, primarily from November through early April, as mid-latitude cyclones from the north Pacific Ocean occasionally move across the West Coast of the United States to bring precipitation to southern California. Most of these storms are of the general winter type, with hours of light to moderate steady precipitation, but with occasionally heavy showers or thunderstorms embedded. These storms frequently produce significant snow above 6,000 feet, with snow falling below 2,000 feet on rare occasions. Snowmelt can at times contribute to runoff in LACDA streams, but the amount of high-elevation area which receives snowfall is not sufficient to generate large peak flows on the upper San Gabriel or Los Angeles Rivers; snowmelt is not a factor in the low-elevation Rio Hondo drainage.

8.4. Local Thunderstorms.

Local thunderstorms can occur in southern California at any time of the year, but are least common and least intense during the late spring. These types of storms occur fairly frequently in the coastal areas during or just after general winter storms. They can also occur between early July and early October, when desert thunderstorms occasionally drift westward across the mountains into coastal areas, sometimes enhanced by moisture drifting northward from tropical storms off the west coast of Mexico. Local thunderstorms can also occur throughout the fall, as upper-level low-pressure centers sometimes trigger left-over summer

moisture. These local thunderstorms can at times result in very heavy rain for short periods of time over small areas, causing very rapid runoff from small drainages. Some of the smaller watersheds within LACDA are especially vulnerable to this type of storm.

8.5. General Summer Storms

General summer storms in southern California are quite rare; but on occasion a tropical storm from off the west coast of Mexico can drift far enough northward to bring rain, occasionally heavy, to southern California, sometimes with very heavy thunderstorms embedded. The season in which these storms are the most likely to significantly affect southern California is mid-August through early October, although there have been some effects in southern California from tropical storms as early as late June and as late as early November.

On rare occasions, southern California has received light rain from non-tropical general summer storms, some of which have exhibited characteristics of general winter storms.

8.6. Wind.

The prevailing wind in LACDA is the sea breeze. This gentle onshore wind is normally strongest during late spring and summer afternoons, with speeds of 10 to 15 miles per hour. The Santa Ana is a dry desert wind that blows from out of the northeast, most frequently during late fall and winter. It can be especially strong below mountain canyons, with peak gusts to more than 80 miles per hour at times. This type of wind can create very high fire hazards, but can also be instrumental in drying a saturated watershed, thus reducing the flood potential.

Rainstorm-related winds are the next most common type in southern California. Winds from the southeast ahead of an approaching storm average 20-30 mph, with occasional gusts to more than 40 mph. West to northwest winds behind storms can sometimes exceed 35 mph, with higher gusts.

9. Climate Change.

Climate change is a global-scale concern, but can be particularly important in the western United States where potential impacts on water resources can be significant to supplies for water agencies. The city of Los Angeles Department of Water and Power (LADWP) is considering impacts of climate change during development of its long-term water supply plan. LADWP prepared a report entitled "Draft 2010 Urban Water Management Plan" in January 2011. Chapter 12 of the report presents a discussion of the impact of climate change to the LADWP service area.

Scientists predict future climate change scenarios using highly complex computer global climate models to simulate climate systems. Although most of the scientific community

agrees that climate change is occurring and, as a result, mean temperatures for the planet will increase, the specific degree of this temperature increase cannot be accurately predicted. Predictions of changes in precipitation are even more speculative, with some scenarios showing precipitation increasing in the future and others showing the opposite, although the general consensus for climate change in the project area is that the region will experience longer droughts intermixed with less frequent but larger floods. Because there are only speculative precipitation changes estimated and no specific increases or decreases in precipitation or flood events available, no adjustments due to climate change were made to Future Condition discharges for this analysis. The project area is located far enough upstream that potential sea level changes are not a factor; thus no changes were made for downstream boundary conditions in the hydraulic models. Qualitative consideration of possible effects of climate change on water availability and larger flood events are described further in Section 7.1.12 of the IFR.

10. Water Budget.

The water budget characterizes the current conditions along the ARBOR reach of the Los Angeles River and provides comparison to each of the four alternatives. The methodology is consistent with the guidance presented in "The Guide Manual for Preparation of Water Balances," RD-16, U.S. Army Corps of Engineers, Hydrologic Engineering Center, dated April 1983. It is a systematic presentation of the data and use of water for specific periods of time. The pertinent factors presented in the guidance are included and both an annual and a seasonal period were analyzed. Water budget parameters were applied in a water budget analysis in order to confirm the long-term and seasonal availability of water to restore and sustain the vegetation and open water areas.

The water budget was calculated by determining the volume of water available from the sources and comparing to the water demands. The water sources include surface water and precipitation. The water demands include infiltration, evaporation, and evapotranspiration. Groundwater, although very important, was not included at this time so a conservative estimate of the water sources and demands could be assessed.

As part of the CHAP analysis described in the environmental sections of this report, the existing habitat areas within the ARBOR reach were delineated using GIS. Separate polygons were drawn for each habitat type including impervious areas, open areas, marsh/wetland areas, and areas for other types of vegetation. Proposed habitat features for each of the alternatives were then delineated using GIS. All polygons were assigned a value based on habitat type. The water demand of vegetation varies depending on the individual and combination of plant species within a habitat unit. Readily available information was used to determine average vegetation intake volumes. The water demand volumes were summed by type and by reach and then accumulated for all eight reaches. The total water source volumes were then compared against the total water demand volumes for each alternative.

For those features of the alternatives that have a direct connection to the Los Angeles River, there is enough flow in the Los Angeles River even during low flow periods, to support the proposed vegetation. For those features that derive their water source from local runoff and precipitation, the type, size, and density of vegetation will be driven by frequency, size, and duration of storms and excess urban runoff that enters the storm drain system from other sources. The LATC parcel, being the largest single parcel included in the alternatives, was subsequently evaluated separately since Alternatives 10 and 13 do not provide a direct hydrologic connection to the Los Angeles River. For Alternatives 10 and 13, precipitation by itself, will not support the proposed vegetated areas; there must be a connection to an adjacent storm drain to redirect storm flow through the LATC area. The direct connection to the river for Alternative 16 and 20 provides more than enough water to support the proposed vegetation. The water budgets for the selected alternatives are presented in Table 8.

10.1. Streamflow.

Streamflow in the Los Angeles River at the project location is perennial due to upstream urban runoff and treatment plant releases. During storm events, runoff concentrates quickly from the steep slopes in the mountains and rushes through the improved Los Angeles River channel. Flood hydrographs from single storm events are typically of less than 12-hours duration and are almost always less than 48-hours duration. High rainfall rates, in combination with the effects of shallow surface soils, impervious bedrock, fan-shaped stream systems, steep gradients, and occasional denudation of the area by fire, result in intense debris-laden floods. However, flood and debris flows are regulated at existing dams and debris basins. The downstream area is almost entirely developed and relatively little sediment enters the channel downstream from the dams aside from the fine material carried in suspension. At the project location, a large portion of the contributing drainage lies downstream from dams.

10.2. Stream Gages.

There are four stream gages located along the Los Angeles River. These gages used to be maintained by the USGS but are now under the operation of LACDPW. There is also a gage just downstream from Sepulveda Dam that measures outflow from the dam. The Los Angeles River gages from upstream to downstream are:

Los Angeles River at Tujunga Ave., Station no. F300-R (1950-present)
Los Angeles River above Arroyo Seco, Station no. F57C-R (1929-present)
Los Angeles River below Firestone Blvd., Station no. F34D-R (1928-present)
Los Angeles River below Wardlow Rd., Station no. F319 (1931-present)

The Los Angeles River above Arroyo Seco stream gage is closest to the project location and best represents the flow conditions for the project. The gage is located 800 feet above the confluence with the Arroyo Seco. The location has

changed 3 times during period of record with no significant impact on recorded flows. The drainage area at the gage is 511 mi^2. The period of record is from 1929 to present. Flow is partially regulated by Sepulveda, Pacoima, Big Tujunga, and Hansen Dams. Flow data for this stream gage is presented in Table 9.

For the period of record, the average annual daily flow at this location is 164 ft^3/s. During the summer months the average daily flow is 61 ft^3/s, but can be less than 10 and has been as low as 1-2 ft^3/s during some summer months. Subsequent to the Donald C. Tillman Water Reclamation Plant (WRP) coming online in 1985, the average daily flow at the project area has increased to 291 ft^3/s annually and 134 ft^3/s during the non-flood season.

Graphs of average daily flows for stream gages F300-R, F57C-R, and F34D-R are shown on Plates 5 to 7.

10.3. Local Runoff

The drainage area of the Los Angeles River at the upstream end of the project location is about 465 mi^2. At the downstream end, the drainage area of the Los Angeles River is approximately 580 mi^2. The total controlled drainage area for Hansen and Sepulveda dams is 304 mi^2. Therefore, there is about 276 mi^2 of uncontrolled area contributing flow to the project location (about half). Surface runoff from uncontrolled area enters the local drainage system and flows at relatively high velocities towards the Los Angeles River. The local storm drain system is operated and maintained primarily by LACDPW and some individual cities and is very efficient.

10.4. Recycled Water.

The Bureau of Sanitation under the City of Los Angeles Department of Public Works operates the Donald C. Tillman WRP located in the Sepulveda Flood Control Reservoir in Van Nuys, California. After leaving homes and businesses, most San Fernando Valley wastewater travels along some of the sanitation system's 6,400 miles of sewers on its way to the Donald C. Tillman WRP. The plant carries out tertiary treatment on much of the liquid sewage and sends the solid as a slurry to Hyperion Treatment Plant near Dockweiler Beach. After approximately 11 hours of treatment at the Tillman WRP, the water is ready to be reused. This water is used to fill Lake Balboa, water a golf course and Japanese gardens, and used by a company to grow lawns; excess water is released through Sepulveda Dam down the Los Angeles River. Before completion of Lake Balboa, most of the treated wastewater ended up flowing down the Los Angeles River to the harbor. The plant, which opened in 1985, operates around the clock and processes 65 million to 70 million gallons of raw sewage daily.

10.5. Imported Water.

There is currently no imported water passing the project site. There is a turnout located on Tujunga Wash that may potentially be used to offset or supplement Los Angeles River flows at the project location.

10.6. Precipitation.

General precipitation for the project location is summarized above in the Climate section. The mean seasonal precipitation at the project location is about 17.5 inches as recorded at the Burbank weather station.

10.7. Infiltration.

The infiltration capacity is the maximum or potential rate at which water can enter the soil at any point in time. Water losses due to infiltration can be a significant factor in the water budget, especially if ponded areas are to be included in the proposed project. Normally, you can expect channel infiltration to be about 0.3 – 2.0 feet per day in Southern California streams. These values were estimated during previous studies and are based on infiltration volumes from previous reports, measuring the stream widths and lengths, and calculating the rates. If the soil is not saturated, moisture will infiltrate into the ground at a rate controlled by the soil texture, vegetal cover, and degree of saturation. Infiltration rates are variable with time. Rates are highest when the soil is dry and lower after it is wetted. Infiltration rates decrease with time during a rainstorm and finally assume a uniform and minimum value. A large amount of rainfall on silt or clay surface will usually have limited infiltration. The presence of organic matter (loam) and vegetation will generally increase infiltration.

Soils are classified by the Natural Resource Conservation Service into four Hydrologic Soil Groups based on the soil's runoff potential. The four Hydrologic Soils Groups are A, B, C and D, where group A generally has the highest infiltration rate and smallest runoff potential while group D has the lowest infiltration rate and greatest runoff potential. Details of this classification can be found in 'Urban Hydrology for Small Watersheds' published by the Engineering Division of the Natural Resource Conservation Service, United States Department of Agriculture, Technical Release 55 (TR-55).

Group A is sand, loamy sand or sandy loam types of soils. It has low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or gravels and have a high rate of water transmission.

Group B is silt loam or loam. It has a moderate infiltration rate when thoroughly wetted and consists chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures.

Group C soils are sandy clay loam. They have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine structure.

Group D soils are clay loam, silty clay loam, sandy clay, silty clay or clay. This HSG has the highest runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface and shallow soils over nearly impervious material.

The soils underlying the project location fall primarily into Hydrologic Soil Group D (see Plate 3). The minimum infiltration rates for Hydrologic Soil Group D are shown in Table 10. For the project site, an average infiltration loss of 0.3 feet per day was used in the water budget.

10.8. Evaporation.

Evaporation, as used here, represents that portion of the water balance that evaporates from open water sources. Few formal studies of evaporation have been made in Los Angeles County; and, since most Corps of Engineers reservoirs are normally dry, with impoundments generally lasting only a few hours to a few days, evaporation is not typically measured. Studies from around the area indicate that mean daily evaporation ranges from about one-quarter inch in winter to more than one-half inch in summer. On days of very strong, dry Santa Ana winds, evaporation can be considerably greater than one inch.

For alternatives that incorporate ponding of water, evaporation may be an important factor. Evaporation rates were obtained in previous studies for nearby reservoirs, lakes, and spreading grounds in the region where measurements have been taken. Calculations for evaporation were made by LACDPW for the 2011 water year and published in their 2010-2011 Hydrologic Report. The average monthly evaporation rates for the Los Angeles area are shown in Table 11. As shown in the table, the rates are more significant during the non-flood season than during the flood season. Descanso Gardens are located closest to the project location. The average annual evaporation rate of 2.31 feet per year was used for this study.

10.9. Evapotranspiration.

The water demand of vegetation varies depending on the individual and combination of plant species within a habitat unit. The Department of Water Resources for California (CADWR) provides evapotranspiration data through the California Irrigation Management Information System (CIMIS; http://wwwcimis.water.ca.gov/). Reference evapotranspiration (ETo) is a term used to describe the evapotranspiration rate of a reference crop expressed in

inches. The reference crop used for the CIMIS program is grass, which is closely clipped, actively growing, completely shading the soil, and well watered. ETo varies by location, time, and weather conditions. The main factors that influence ETo include incoming radiation (energy from the sun), outgoing radiation (sensible energy leaving the earth), and the amount of moisture in the air, air temperature, and wind speed. ETo can be estimated quite accurately through the use of a "model" (a series of complex mathematical equations). Evapotranspiration rates were computed using the Glendale, Los Angeles Basin dataset as shown in Table 12.

The Corps of Engineers previously undertook a study for the Rio Salado (Salt River) in Arizona. During that study, the State Arizona Game and Fish Department provide plant consumption values for riparian vegetation. These estimates can be used for planning purposes to develop the final water budget for the proposed project. The original data sources are listed in Table 13.

For the project site, average evapotranspiration rates for Sycamores of 3.6 feet per year, for Valley Oak Woodland of 5.0 feet per year, and for Cottonwood-Willow of 8 feet per year were used.

11. Existing Conditions Discharges.

The Corps of Engineers, Los Angeles District completed a hydrologic analysis of the entire Los Angeles River watershed as part of the Los Angeles County Drainage Area (LACDA) Feasibility Study. A report was published in 1992 and included detailed Hydrology and Hydraulics Appendices. Hydrologic models were set up using the HEC-1 and HEC-5 computer programs.

Frequency discharges were adopted from the 1992 LACDA Review Study. As noted in that report and in the Future Conditions Hydrology section below, the Los Angeles River drainage area is essentially "built-out"; thus discharges from that report are still applicable. Frequency discharges at selected locations, including main tributaries, are included in Table 14. The design discharges are also included in Table 14.

12. Future Conditions Discharges.

The discharges presented in Table 14 are applicable for Future Conditions. Most new development occurring within the city limits is re-development. The few remaining developable properties are small and far enough away as to have an insignificant impact on mainstem flows (low flows or high flows). The undeveloped areas outside the city limits, but within the drainage area, are primarily public lands consisting of national forest and state or local parks. These areas will not be developed.

As presented in the 1992 LACDA Review Study, the impact of expected future development was addressed by estimating the likely urbanization and the associated increase in impervious area, and second, by determining the change in system runoff

attributed to that development. Future condition discharges were computed in an identical manner to present condition discharges, using estimated future impervious cover in determining subarea hydrographs. Future condition effective impervious cover was determined for all areas from land use planning maps for the year 2030 and then converting the total impervious cover using the relationship developed between total and effective impervious cover. The discharge-frequency determinations made for future conditions in the 1992 LACDA Review Study indicated no appreciable increase in peak runoff through the major reaches including the mainstem of the Los Angeles River.

13. LACDA Design Storm.

In general, the LACDA system was designed on a component basis (a flood control dam with an accompanying downstream channel) using 50-year frequency rainfall in older portions of the upper Los Angeles River, and a Standard Project Storm (SPS) based on the January 1943 SPS for San Gabriel components, including the Rio Hondo Diversion Channel and lower Los Angeles River. The rainfall depths from the SPS centered over the watershed are very similar to 24-hour, 50-year frequency rainfall determined during the 1992 LACDA Review Study. No evaluation of discharge-frequency was made during those early design phases because of short streamflow records upon which to base a statistical analysis and confidence that a high degree of protection would result from using the frequency-based design storm concept. The objective was to produce a Standard Project Flood (SPF; a large flood, one that is the largest event reasonably characteristic of the drainage area). However, the rainfall from the SPS, as indicated above, was not severe enough when measured during the 1992 hydrologic frequency analysis of the resulting runoff based on today's development. Design discharges for the Los Angeles River and Tujunga Wash within the project extent are shown on Plate 8. Velocities associated with the design discharges are shown on Plate 9.

14. Channel Hydraulics.

The main channel of the Los Angeles River is approximately 51 miles long and its tributaries have an aggregate length of about 225 miles. Most of the runoff from precipitation originates in the San Gabriel Mountains. The river flows through industrial and commercial areas and is bordered by railyards, freeways, and major commercial, industrial, and government buildings. The Los Angeles River, which once flowed freely over the coastal plain, was channelized between 1914 and 1970 to control the runoff and reduce the impacts of major flood events in the region. Construction on the stretch of the Los Angeles River within the ARBOR reach was started in the late 1930s and completed in the mid 1950s. The Corps of Engineers is responsible for operations and maintenance within the ARBOR reach. Today, the Los Angeles River is lined for most of its length. There are several stretches where the channel invert is not lined with concrete reinforcement: within the Sepulveda Flood Control Basin, through the Glendale Narrows, and south of Willow Street in Long Beach.

The Corps of Engineers, Los Angeles District completed a review of the entire LACDA system and published a Feasibility Report in 1992. Included with this was a Hydraulics Appendix (dated Dec. 1991) which documented the hydraulic analyses which were performed in support of the LACDA Review Study. The analyses included with- and without-project overflow analyses, preliminary alternative formulation and design, analyses to support the selection of the NED plan, and the final feasibility level design of the project. The HEC-2 computer program was used to calculate the water surface elevations under steady flow conditions for the channels and overbank areas. Cross sections were generated using 1:24,000 scale USGS quad maps.[1]

Essentially all of the upper Los Angeles River and most of Tujunga Wash have contiguous overflow conditions. For these watercourses, when flows exceed the channel capacity, flooding is confined relatively close to the channel by fairly narrow floodplains with significant cross slope back towards the channel, resulting in a water surface elevation that can be assumed constant across the channel and both overbanks.

The proposed project (now completed) from the 1992 LACDA study consisted of improvements to the lower Los Angeles River and the Rio Hondo Diversion Channel. These improvements do not impact the flood protection along the Los Angeles River within the current ARBOR ecosystem project extents; the ecosystem project limits are upstream from the LACDA improvements. It is important to note there are several locations within the ARBOR reach where the probability of flows breaking out from the channel within the ecosystem project area is greater than 1% in any given year (equivalent to the 100-yr flood), i.e., the channel has less than 100-yr level of protection in some locations.

There are two main stretches of the Los Angeles River within the ARBOR reach that do not have concrete inverts. These locations are shown on Plate 10 (they are interrupted briefly with concrete sections under some of the bridges). The two main sections without concrete inverts have mostly grouted riprap side slopes with some grouted rock paving and some concrete slab side walls. There are several rock stabilizers within the channel and along the outside curves of the channel, but the integrity of these structures is unknown since they are covered with a significant amount of vegetation.

15. Hydraulic Modeling.

Subsequent to the 1992 LACDA Review Study, the Corps of Engineers, Los Angeles District generated design models using HEC-RAS and prepared a report in July 2005 to present the updated hydraulic analyses. This report is referred to as the Stormwater Management Plan (SWMP). The 2005 LACDA Upper Los Angeles River HEC-RAS Hydraulic Models used as-built construction plans to develop the HEC-RAS model geometry. The geometries for these models only covered the channel area. An initial

[1] These cross sections were not used in the current HEC-RAS modeling, which is described in detail below in Section 15.

attempt at georeferencing the models was made at that time. The effort was to create HEC-RAS models for the channels and determine the water surface elevations for the design discharges. These are referred to in this report as the Design Conditions models. In addition, the 2005 report establishes the regulatory water surface elevations that are used as the basis against which all hydraulic impacts to the Upper Los Angeles River and Tujunga Wash are evaluated. These models include the Los Angeles River ARBOR reach.

In 2008, as part of an initial phase of the ecosystem restoration study, the Corps of Engineers used updated geospatial techniques and re-georeferenced a portion of the design models within the City of Los Angeles limits. The cross sections were extended to cover a portion of the overbank area which ultimately covered the 0.2% ACE event (500-yr) floodplain.

This study encompasses the development of hydraulic models for the portion of the Upper Los Angeles River called the ARBOR reach. The hydraulic models encompass the reach from Barham Blvd. to First St., as well as the downstream reaches of Burbank Western Channel, Verdugo Wash, and the Arroyo Seco.

For the current analyses, the first step in the hydraulic modeling was to generate models and floodplains for the Design Conditions and the Existing Conditions to understand the impact of the vegetation within the channel. This required two different model geometries; for the Design Conditions and the Existing Conditions (which includes vegetation). Both were analyzed under a steady, mixed flow regime. The Existing Conditions geometric data only varied from the Design Conditions geometry within the channel. This was due to increased roughness from vegetation growth in "soft" bottom stretches along the Los Angeles River as well the channel invert conditions based on the 2005 survey described below.

15.1. Mapping.

The Los Angeles District Corps of Engineers, through contract services, developed digital terrain models (DTMs and TINs) and ortho-rectified photographs for the project area are based on a 2005 aerial survey flight. The 2005 survey is based on the 1983 NAD horizontal datum, State Plane Zone 5 for California; units are in feet. Elevations are also in feet and based on the 1988 NAVD. The scale of the survey data was 1" = 200' with a 2-foot contour interval.

The hydraulic models are based on topographic data obtained from the 2005 survey by the COE supplemented with 2008 topographic data based on LiDAR from the City of Los Angeles. The City of Los Angeles' 2008 data was of similar accuracy and resolution. The additional 2008 data was required to cover the floodplain for the 0.2% ACE event.

15.2. Numeric Models.

The U.S. Army Corps of Engineers Hydrologic Engineering Center's River Analysis System (HEC-RAS) version 4.2 beta was used for the hydraulic modeling. The current HEC-RAS version, 4.2 beta, allows the user to perform one-dimensional steady and unsteady flow river hydraulics calculations to determine water surface profiles and velocities. The system is comprised of graphical user interface (GUI), separate hydraulic analysis components, data storage and management capabilities as well as graphic output capabilities.

HEC-GeoRAS, is an ArcGIS v. 10 extension that provides the user with a set of procedures, tools, and utilities for the preparation of GIS data for import into the HEC-RAS and generation of GIS data from RAS output. The user can also export HEC-RAS results back to ArcGIS using HECGeoRAS to develop spatial datasets of the results.

15.3. River Stationing.

The Los Angeles River Channel was constructed in non-contiguous sections at different periods in time. As a result, river stations (RS) were not consecutive from Pacific Ocean all the way to the upstream end of the Los Angeles River channel. During development of the 2005 SWMP design models, the LACDA project was broken into separate sections and river stations were assigned to closely match the design as-builts drawings. In 2008, an attempt was made to update the stationing, but the models still broke the channel into three sections (there were still some computer memory limitations working with such large terrain files) within the City of Los Angeles limits and carried over the inconsistent river stationing from the earlier models.

The 2008 HEC-RAS model entitled 'Reach 1' detailed the portion of the Los Angeles River from 250 feet upstream of the Glendale Freeway at RS 1420+55.6 to just downstream of 26th St. at RS 1026+39.5. RS 1420+55.6 indicates that it is located 142055.6 feet above the outlet. For this reach of the Los Angeles River the 2008 model river stations match the 2005 models and correspond to the pertinent data tables.

The 2008 HEC-RAS model entitled 'Reach 2' extends from 607.06 feet downstream of Fletcher Dr. at RS 00+00 to Sepulveda Dam. RS 00+00 is the point where the 'Reach 1' model ends and the 'Reach 2' model begins. At this point, the river stationing no longer matches the 2005 SWMP models or the pertinent data tables.

The ARBOR reach of the Los Angeles River includes a portion of 'Reach 1' and a portion of "Reach 2'. These portions were extracted from the 2008 models and combined to form models covering the ARBOR reach. To update the models, river stations were initially copied from the 2008 HEC-RAS models. The 2008

models could not be used for this feasibility study because the cross sections did not extend far enough to capture the terrain required to cover the 0.2% ACE floodplain. The two different digital terrain models did not match up at their intersection because of the different level of detail and the different methods used to develop the surfaces. Therefore, cross sections could not be cut from the two surfaces and a work-around was developed to incorporate cross section information from both surveys. However, it was ideal to initially use the same river station locations as the 2008 models so the bridge and cross section data could be copied to the current ARBOR HEC-RAS model.

River stations for the ARBOR models were developed independently of the 2005 and the 2008 models. It was decided that the ARBOR reach river stations would be numbered according to cumulative stream length within the project area. RS 692+94 upstream of Barham Blvd. is the upstream cross section and RS 10+31 at First St. is the downstream cross section. Interpolated cross sections were added where needed to remove instabilities in the hydraulic calculations. The ARBOR project reaches are shown on Plate 11.The river stations corresponding to the ARBOR study reaches are as follows:

Reach 1: Pollywog Park/Headworks (RS 625+77)) to midpoint of Bette Davis Park (RS 547+45). See Plate 12.

Reach 2: Midpoint of Bette Davis Park (RS 546+45) to upstream edge of Ferraro Fields (RS 510+05). See Plate 13.

Reach 3: Ferraro Fields (RS 504+93) to Brazil Street (RS 452+58). See Plate 14.

Reach 4: Brazil Street (RS 432+16) to Los Feliz Boulevard (RS 359+75). See Plate 15.

Reach 5: Los Feliz Boulevard (RS 358+63) to Glendale (2) Freeway (RS 271+89). See Plate 16.

Reach 6: Glendale (2) Freeway (RS 270+28) to I-5 Freeway (RS 144+23). See Plate 17.

Reach 7: I-5 Freeway (RS 142+91) to Main Street (RS 86+81). See Plate 18.

Reach 8: Main Street (RS 86+07) to 1st Street (RS 10+31). See Plate 19.

15.4. Model Reach Assignments.

The feasibility study ARBOR reach is approximately 11 miles in length, however the hydraulic models cover a distance of about 13 miles along the Los Angeles

River to ensure smooth numeric transition into and out of the ARBOR reach. The models are divided into hydraulic reaches 1, 2, 3, and 4 according to the location of confluences with Burbank Western, Verdugo Wash, and the Arroyo Seco. These reach designations are for HEC-RAS model purposes only and do not correspond to the eight ARBOR study reaches. Model reach 4 is at the upstream end of the study area and reach 1 is at the downstream end of the study area. Burbank Western, Verdugo Wash, and Arroyo Seco are included as tributaries in the models.

15.5. Manning's N-Values.

15.5.1. Design Conditions Model.

The Manning's n-values for the main channel in the Design Conditions model were derived from the pertinent data tables for the Los Angeles River. The concrete portions of the channel were assigned a Manning's roughness coefficient of 0.014 (per the original design). The Manning's roughness coefficient for the soft bottom, grouted riprap side slope reaches was 0.03 (combined single n-value for the channel). There is a short reach with grouted riprap sides and concrete bottom where the channel n-value is 0.02. The Manning's n-values for the left and right overbanks in the Design Conditions models were set at 0.04 along the entire ARBOR reach. This value was estimated based on the topographic mapping, aerial photos and field reconnaissance. The overbanks of the Los Angeles River in the ARBOR reach are primarily urban, highly impervious areas and have dramatically varying horizontal n-values so it was ideal to simplify and group the n-values into a single value for the left- and right- overbank. The focus of the study was to ensure there is no increase in flood risk; i.e., no increase in water surface elevation. If the WSE for the with-project condition was greater than that for the existing condition then that restoration scenario was removed from further consideration. Therefore, the choice of Manning's n-value for the overbank is not important and does not affect the choice of the NER Plan and Recommended Plan.

15.5.2. Existing Conditions Model.

The Existing Conditions models use horizontally varying K values across the main channel. The geometry for these models were developed during a hydraulic analysis for Operations and Maintenance and documented in a memorandum entitled "Vegetation Clearing in Los Angeles River – Burbank Western Channel to Arroyo Seco", for COE Operations Branch, dated 17 March 2004. The hydraulic model was verified using high-water marks from a real-time event. The Existing Conditions models utilize the 2004 vegetation geometry as a reference for K values within the soft-

bottom portions of the channel. The vegetation model had K values for the channel portion, but not the overbanks.

As noted above, the Design Conditions models used an overbank Manning's n-value of 0.040 along the entire span of the ARBOR reach. The n-value of 0.040 was converted into a K value for a sample of cross-sections along the LA River by manipulating Manning's Equation for roughness.[2] The conversion yielded K values that ranged from approximately 1.5 to 2.5. A sensitivity analysis was performed using the Existing Conditions model where overbank K values of 1.5 and 2.5 were used. A 100-yr floodplain was created for the 1.5 value and then compared to a 100-yr floodplain generated for an overbank K value of 2.5. It was concluded that there was very little difference between the floodplains delimited for the two K values (only at RS 515+13, RS 388+25, and RS 418+25), so an average K value of 2.0 for the overbanks was selected.

15.6. Bridges.

All input parameters for bridges and culverts were based on the 2008 models. The parameters were determined from plan and profile drawings as well as from field measurements. See Table 15 for a list of the bridges, by reach, which cross the Los Angeles River within the ARBOR reach. Two feet of floating debris was added to each side of all piers that measure 6 feet or less in width (transverse direction). For piers with sloping noses, the debris depth was set to 6 feet below the water surface elevation. Floating debris was not added to piers greater than 6 feet in width. This complies with Hydrology & Hydraulics Policy Memorandum No. 4, dated August 2004. This practice is based on experience from past floods and physical model studies that indicate sloping pier extensions in high velocity flows are quite effective in moving debris up the slope out of the water and thereby preventing significant debris accumulation.

The bridge modeling approach for bridges without piers was set to the Energy Only (Standard Step) computational method. For bridges with piers, the highest energy solution between: (Energy Only (Standard Step), (2) Momentum, and (3) Yarnell (Class A only) was selected. Bridge locations are shown on the invert profiles presented on Plates 20 a & b.

15.7. Boundary Conditions.

Boundary conditions are necessary to establish the starting water surface at the ends of the river system (upstream and downstream). Table 16 summarizes the

[2] Manning's n values were converted to equivalent absolute roughness K values since K remains relatively constant with changing hydraulic radius (R) while n varies with the one-sixth power of R. Therefore, it was preferred to extrapolate from known conditions to unknown by the use of K rather than n.

boundary conditions (starting water surface at upstream and downstream ends of the river reach) for the ARBOR reach. On both the upstream and downstream ends of the ARBOR reach, known water surface elevations with associated flows were used as boundary conditions. Numerous side drains enter the Los Angeles River within the ARBOR reach. Detailed design for side drains will be provided in the design phase. Pertinent data for all drains will be included at that time. Water surface elevations in the Los Angeles River may impact storm drain hydraulics.

15.8. Flow Regime.

The project reach has mixed flow regimes wherein the concrete lined segments tend to flow supercritical and the segments with cobble bed inverts and vegetation tend to flow subcritical. The HEC-RAS output, which was used to define the flood profiles and the overflow boundaries, reflects a mixed flow regime with both supercritical and subcritical flow. The existing conditions models include the current vegetation. The design channel models do not include any vegetation. Localized hydraulic jumps, where the water surface elevation passed through critical depth, occurred within the model, typically upstream of bridges. At these locations additional freeboard was included in the original design of the project. Water surface undulations are accounted for with additional freeboard.

15.9. Flow Data.

Since the vegetation analysis described in the 2004 memorandum identified flows with an ACE of 10% or greater exceeding the channel capacity under Existing Conditions, the HEC-RAS models were set up to include discharges for the 10%, 4%, 2%, 1%, 0.5%, and 0.2% ACE events. These correspond to events from the 10-yr up to the 500-yr frequency. Discharges for the HEC-RAS models are included in Table 14.

16. Adequacy of the Hydraulic Models.

In applying the HEC-RAS numeric models, the flow is in a one-dimensional, uniform, steady state. The one-dimensional assumption is applicable for Without-Project Conditions since during high flows most of the flow travels downstream along the channel, allowing the model to analyze the flow in one direction. The uniform flow assumption is reasonable since in most instances flow is gradually changing. Steady flow assumes the change in depth is constant as a function of time.

Preliminary analyses of the alternatives using the one-dimensional HEC-RAS models to determine relative impacts and feasibility of a TSP was also determined to be justifiable. However, detailed numeric model evaluation of the TSP will require two-dimensional, and possibly, an unsteady flow model to more accurately simulate the proposed alterations in and adjacent to the channel. This can be done during a later phase of this study. For areas with significant modifications, physical modeling approach is highly recommended.

17. Floodplain Analyses.

Inundation maps were generated for the 4%, 2%, 1%, and 0.2% ACE events for both Existing and Design Conditions. The model results were exported from HEC-RAS into ESRI's ArcMap to automate the process of delineating the inundation boundaries using HEC-GeoRAS. The resulting inundation boundaries were then inspected and edited to remove spurious polygons and to ensure that all polygons contained other polygons with more frequent return periods. Floodplain delineations for Design and Existing Conditions are shown on Plates 21 a & b to 24 a & b. The Existing Conditions 100-year floodplain has two major breakout areas within the ARBOR reach. These correspond to the vegetated reaches of the Los Angeles River. The upstream area with extensive overbank flooding is between Barham Blvd. and the confluence with Verdugo Wash and has an average floodwater depth of 5.2 feet in the overbank areas. The downstream area with extensive overbank flooding is from the Verdugo Wash confluence to the Golden State Freeway, where the in-channel vegetation ends, and has an average floodwater depth of 3.9 feet in the overbank areas.
The 100-yr and 500-yr floodplains from the 1992 LACDA Review Study are shown on Plate 25 for comparison. The most noticeable difference is the large inundation area that has been removed in the current 1% ACE event (100-yr) in the downtown area from North Broadway to 1st St. The hydraulic model results were closely scrutinized and it was determined the volume and duration for flow exceeding the channel capacity was not sufficient to generate the relatively large inundation areas. The flow exceeding channel capacity was determined to cause street flooding close to the channel and be non-damaging. It should also be obvious the areas impacted due to vegetation within the channel. The current FEMA flood maps by contrast, show that all flow for the 100-yr event stays within the channel through the project reach. Portions of the FEMA maps have not been updated since the early 1980's and were determined to not represent current conditions.

18. With-Project Conditions.

The CE/ICA process documented in the Main Report and Economics Appendix utilized environmental and preliminary cost information to identify the top four alternatives for further analysis. The features in the alternatives were developed by a multidisciplinary team with consideration for riparian, floodplain, and fisheries values and needs. The four selected alternatives are identified as comprehensive alternatives 10, 13, 16, and 20 and denoted as such in this appendix. HEC-RAS was used to evaluate flood conveyance and flow velocities to confirm there would be no adverse flood impacts associated with the alternatives and determine which reaches were within target velocities for vegetation planting and in which reaches supplemental bank protection may be needed. The Combined Habitat Assessment Protocol (CHAP) was used to evaluate habitat impacts and benefits instead of a model such as HEC-EFM. The HEC-EFM model was not used because the proposed features will not have an effect on the overall flow regime, which is the focus of that model. CHAP was a better method for evaluation of habitat benefits. The use of CHAP is further described in IFR Section 4.9 and Appendix G.

18.1. Alternative Descriptions. These alternatives are described in detail in the Main Report, but are summarized as they pertain to the hydraulic modeling process below. Where a reach plan description states, "There are no modifications to the hydraulic models within this reach," it indicates that there are no physical reconfigurations of the channel for that reach plan. Adjustments in the model were made for each alternative as described in Section 18.2 below.

Alternative 10.

Reach 1 - Restore riparian habitat corridors outside of the channel along the tops of both banks. There are no modifications to the hydraulic models within this reach.

Reach 2 - Restore riparian habitat corridors outside of the channel along the top of both banks. There are no modifications to the hydraulic models within this reach.

Reach 3 - Daylight large storm drain just downstream of Ferraro Fields on right bank in the Zoo Drive Area; freshwater marsh will be located in the daylighted area outside of the channel. Daylight two small storm drains on left bank. There are no modifications to the hydraulic models within this reach. Daylighted storm drains will be evaluated separately to ensure they meet all appropriate Corps regulations and guidance.

Reach 4 - Restore riparian habitat corridor outside of the channel along the top of left bank. Implement a side channel along right bank. Daylight one storm drain on right bank. Daylight six storm drains on left bank. There are no modifications to the hydraulic models within this reach. Daylighted storm drains will be evaluated separately to ensure they meet all appropriate Corps regulations and guidance.

Reach 5 - Restore riparian habitat corridor outside of the channel along the top of left bank. Daylight one storm drain on left bank. There are no modifications to the hydraulic models within this reach. Daylighted storm drains will be evaluated separately to ensure they meet all appropriate Corps regulations and guidance.

Reach 6 - Restore riparian habitat corridor outside of the channel along the top of left bank. Include a small terraced area along the left bank with vegetation from RS 261+80 to RS 256+00. The Los Angeles River channel is re-configured to take advantage of the Taylor Yard 'bowtie' parcel. At RS 243+17, the channel invert starts to widen into the left bank. The invert width increases to more than 100 feet before it contracts back to the original channel size at RS 201+76. The eastern edge of the widened invert is sloped back up at a 4:1 slope to the original ground elevation. Restore riparian habitat along the sloped channel wall of the widened channel.

Reach 7 - Daylight two storm drains on right bank. Daylight one storm drain on left bank. There are no modifications to the hydraulic models within this reach. Daylighted storm drains will be evaluated separately to ensure they meet all appropriate Corps regulations and guidance.

Reach 8 - Restore riparian habitat at LATC outside of the channel. There are no modifications to the hydraulic models within this reach.

Alternative 13.

Reach 1 - Restore riparian habitat corridors outside of the channel along the top of both banks. There are no modifications to the hydraulic models within this reach.

Reach 2 - Restore riparian habitat corridors outside of the channel along the top of both banks. There are no modifications to the hydraulic models within this reach.

Reach 3 - Restore riparian habitat corridors outside of the channel along the top of right bank. Implements a side channel along the right bank behind Ferraro Fields. Connect side channel to daylighted storm drain just downstream of Ferraro Fields on the right bank in the Zoo Drive Area; freshwater marsh will be located in the daylighted area outside of the channel. Daylight three small storm drains on left bank. There are no modifications to the hydraulic models within this reach. Daylighted storm drains will be evaluated separately to ensure they meet all appropriate Corps regulations and guidance. Water sources for the side channel will be determined and evaluated during the design phase.

Reach 4 - Restore riparian habitat corridor outside of the channel along the top of left bank. Implement a side channel along right bank. Daylight one storm drain on right bank. Daylight six storm drains on left bank. There are no modifications to the hydraulic models within this reach. Daylighted storm drains will be evaluated separately to ensure they meet all appropriate Corps regulations and guidance. Water sources for the side channel are evaluated separately.

Reach 5 - Restore riparian habitat corridor outside of the channel along the top of left bank. Daylight one storm drain on left bank. There are no modifications to the hydraulic models within this reach. Daylighted storm drains will be evaluated separately to ensure they meet all appropriate Corps regulations and guidance.

Reach 6 - Allow vegetation on right channel wall through entire reach. Allow vegetation on left channel wall from RS 270+28 to RS 262+72 and from RS 191+61 to RS 144+23. The Manning's roughness coefficients in the hydraulic models were adjusted to account for vegetation on the walls within the channel. Include a small area of widening up to 150 feet to accommodate in-channel geomorphology and vegetation along the left bank from RS 265+38 to RS

251+78. The Los Angeles River channel is re-configured to take advantage of the Taylor Yard 'bowtie' parcel. At RS 243+17, the channel invert starts to widen into the left bank. The invert width increases to more than 620 feet before it contracts back to the original channel size at RS 201+76. The eastern edge of the widened invert is sloped back at a 3:1 slope to the original ground elevation approximately 15 feet from the railroad tracks. Restore riparian habitat along the sloped channel wall of the widened channel.

Reach 7 - Allow vegetation on channel wall along right bank through entire reach and on left bank from RS 128+71 to downstream end of reach. Restore riparian habitat outside of the channel at the Arroyo Seco confluence along the top of both banks. The hydraulic model channel geometry was not changed, but the Manning's roughness coefficients were adjusted to account for vegetation on the walls within the channel. Restore riparian habitat along the Arroyo Seco Channel by removing concrete and re-configuring the channel cross section.

Reach 8 - Restore riparian habitat at LATC outside of the channel. There are no modifications to the hydraulic models within this reach.

Alternative 16.

Reach 1 - Restore riparian habitat corridors outside of the channel along the top of both banks. There are no modifications to the hydraulic models within this reach.

Reach 2 - Restore riparian habitat corridors outside of the channel along the top of both banks. There are no modifications to the hydraulic models within this reach.

Reach 3 - Restore riparian habitat corridors outside of the channel along the top of right bank. Implements a side channel along the right bank behind Ferraro Fields. Connect side channel to daylighted large storm drain just downstream of Ferraro Fields on the right bank in the Zoo Drive Area; freshwater marsh will be located in the daylighted area outside of the channel. Daylight two small storm drains on left bank. There are no modifications to the hydraulic models within this reach. Daylighted storm drains will be evaluated separately to ensure they meet all appropriate Corps regulations and guidance. Water sources for the side channel are evaluated separately.

Reach 4 - Restore riparian habitat corridors outside of the channel along the top of bank. Implement a side channel along right bank. Daylight one storm drain on right bank. Daylight six storm drains on left bank. There are no modifications to the hydraulic models within this reach. Daylighted storm drains will be evaluated separately to ensure they meet all appropriate Corps regulations and guidance. Water sources for the side channel are evaluated separately.

Reach 5 - Restore riparian habitat corridor outside of the channel along the top of left bank. Daylight one storm drain on left bank. Daylighted storm drains will be evaluated separately to ensure they meet all appropriate Corps regulations and guidance. The right bank of the channel changes from trapezoidal to vertical configuration for entire reach. A 2-foot by 2-foot notch along the top of right channel wall is added for hanging vines. The left bank of the channel transitions from trapezoidal to vegetated terraces from RS 356+22 to RS 286+05. The five terraces are 12-feet wide by 4-feet deep and tie into the existing ground elevation at a 3:1 slope. The left bank then transitions from terraces to a vertical configuration from RS 286+05 to RS 271+89 and then transitions back into the design channel configuration starting at RS 274+78.29, before the channel passes under the Glendale Freeway.

Reach 6 - Allow vegetation on right channel wall through entire reach. Allow vegetation on left channel wall from RS 270+28 to RS 262+72 and from RS 191+61 to RS 144+23. The Manning's roughness coefficients in the hydraulic models were adjusted to account for vegetation on the walls within the channel. Include a small area of widening up to 150 feet to accommodate in-channel geomorphology and vegetation along the left bank from RS 265+38 to RS 251+78. The Los Angeles River channel is re-configured to take advantage of the Taylor Yard 'bowtie' parcel. At RS 243+17, the channel invert starts to widen into the left bank. The invert width increases to more than 620 feet before it contracts back to the original channel size at RS 201+76. The eastern edge of the widened invert is sloped back at a 3:1 slope to the original ground elevation approximately 15 feet from the railroad tracks. Restore riparian habitat along the sloped channel wall of the widened channel.

Reach 7 - Allow vegetation on channel wall along right bank through entire reach and on left bank from RS 128+71 to downstream end of reach. Restore riparian habitat outside of the channel at the Arroyo Seco confluence along the top of both banks. The hydraulic model channel geometry was not changed, but the Manning's roughness coefficients were adjusted to account for vegetation on the walls within the channel. Restore riparian habitat along the Arroyo Seco Channel by removing concrete and re-configuring the channel cross section.

Reach 8 - Include 3-foot deep terraces along the right bank within the extent of the LADWP parking lot and tie into the existing ground with a 3:1 slope. The terraced area begins with one 3-foot deep terrace at RS 83+61 and ends with seven 3-foot deep terraces at RS 68+38. The Los Angeles River channel is re-configured to take advantage of the LATC parcel. At RS 69+93, the channel invert starts to widen into the left bank. The invert width increases to more than 500 feet before it contracts back to the original channel size at RS 38+47. Within the LATC extent, a bench up to 1000-feet wide extends from RS 64+92 to RS 50+15. The bench is established at approximately the 2-year water surface elevation and includes marsh vegetation. The eastern edge of the bench is sloped back up to the original ground elevation to a point about 1800 feet from

the channel. The hydraulic models include "dummy bridges" to represent the railroad trestles over the 'widened' channel from RS 68+38 to RS 40+13.

Alternative 20.

Reach 1 - Restore riparian habitat corridors outside of the channel along the top of both banks. There are no modifications to the hydraulic models within this reach.

Reach 2 - Restore riparian habitat corridors outside of the channel along the top of both banks. From RS 542+40 to RS 509+00, the right bank of the channel changes from trapezoidal to vertical configuration and includes a 2-foot by 2-foot notch along the top of the channel for hanging vines. Along the left bank, from RS 542+40 to RS 525+56, a 2-foot by 2-foot notch along the top of the channel is added to allow for hanging vines. The vegetation on both sides was assumed to have minimal hydraulic impacts and no adjustments were made to the Manning's roughness coefficients in the hydraulic models.

Reach 3 - Restore riparian habitat corridors outside of the channel along the top of bank. Implements a side channel along the right bank behind Ferraro Fields. Connect side channel to daylighted large storm drain just downstream of Ferraro Fields on the right bank in the Zoo Drive Area; freshwater marsh will be located in the daylighted area outside of the channel. Daylight two small storm drains on left bank. Daylighted storm drains will be evaluated separately to ensure they meet all appropriate Corps regulations and guidance. Verdugo Wash is changed to soft-bottom channel from the confluence of Verdugo Wash and the Los Angeles River to approximately 1,200 feet upstream. Verdugo Wash is also widened to allow for marsh vegetation. Vegetation is included in the hydraulic models by a change in Manning's roughness coefficients. Water sources for the side channel are evaluated separately.

Reach 4 - Restore riparian habitat corridors outside of the channel along the top of bank. Implement a side channel along right bank. Daylight one storm drain on right bank. Daylight six storm drains on left bank. There are no modifications to the hydraulic models within this reach. Daylighted storm drains will be evaluated separately to ensure they meet all appropriate Corps regulations and guidance. Water sources for the side channel are evaluated separately.

Reach 5 - Restore riparian habitat corridor outside of the channel along the top of left bank. Daylight one storm drain on left bank. Daylighted storm drains will be evaluated separately to ensure they meet all appropriate Corps regulations and guidance. The right bank of the channel changes from trapezoidal to vertical configuration for entire reach. A 2-foot by 2-foot notch along the top of right channel wall is added for hanging vines. The left bank of the channel transitions from trapezoidal to vegetated terraces from RS 356+22 to RS 286+05. The five terraces are 12 feet wide by 4 feet deep and tie into the existing ground elevation

at along a 3:1 slope. The left bank then transitions from terraces to a vertical configuration from RS 286+05 to RS 271+89 and then transitions back into the design channel configuration starting at RS 274+78.29, before the channel passes under the Glendale Freeway.

Reach 6 - Allow vegetation on right channel wall through entire reach. Allow vegetation on left channel wall from RS 270+28 to RS 262+72 and from RS 191+61 to RS 144+23. The Manning's roughness coefficients in the hydraulic models were adjusted to account for vegetation on the walls within the channel. Include a small area of widening up to 150 feet to accommodate in-channel geomorphology and vegetation along the left bank from RS 265+38 to RS 251+78. The Los Angeles River channel is re-configured to take advantage of the Taylor Yard 'bowtie' parcel. At RS 243+17, the channel invert starts to widen into the left bank. The invert width increases to more than 620 feet before it contracts back to the original channel size at RS 201+76. The eastern edge of the widened invert is sloped back at a 3:1 slope to the original ground elevation approximately 15 feet from the railroad tracks. Restore riparian habitat along the sloped channel wall of the widened channel.

Reach 7 - Daylight one storm drain on right bank. Daylighted storm drains will be evaluated separately to ensure they meet all appropriate Corps regulations and guidance. Four 4-foot deep terraces on the right bank from RS 102+15 to 97+99 are added adjacent to the Cornfields site. At Cornfields, the western edge of the terrace is sloped back up to the original ground elevation. The hydraulic models include “dummy bridges” to represent the railroad trestles from RS 102+15 to 98+98. Restore riparian habitat outside of the channel at the Arroyo Seco confluence along the top of both banks. Restore riparian habitat along the Arroyo Seco Channel by removing concrete and re-configuring the channel cross section.

Reach 8 - Includes 3-foot deep terraces along the right bank within the extent of the LADWP parking lot and ties into the existing ground with a 3:1 slope. The terraced area begins with one 3-foot deep terrace at RS 83+61 and ends with seven 3-foot deep terraces at RS 68+38. The Los Angeles River channel is re-configured to take advantage of the LATC parcel. At RS 69+93, the channel invert starts to widen into the left bank. The invert width increases to more than 500 feet before it contracts back to the original channel size at RS 38+47. Within the LATC extent, a bench up to 1000-feet wide extends from RS 64+92 to RS 50+15. The bench is established at approximately the 2-year water surface elevation and includes marsh vegetation. The eastern edge of the bench is sloped back up to the original ground elevation to a point about 1800 feet from the channel. The hydraulic models include "dummy bridges" to represent the railroad trestles over the 'widened' channel from RS 68+38 to RS 40+13.

18.2. Model Adjustments.

For With-Project Conditions, the geometry files for the HEC-RAS model were adjusted to best represent the selected alternatives. The geospatial files representing the selected alternatives were overlain on the cross sections in Arc-GIS. The cross sections impacted were then modified in HEC-RAS to account for any channel re-configurations and vegetated areas. Typical cross sections for selected reaches that include channel re-configuration are shown on Plates 26 to 30.

18.2.1. Manning's N-Values.

After the cross sections were adjusted spatially to account for any channel re-configurations, four scenarios of HEC-RAS model geometries were created with different Manning's n-values to reflect a range of vegetation densities and sizes. Manning's n-values representing 'heavy" (n=0.08), "moderate" (n=0.06), and "minimal" (n=0.045) vegetation were used. Manning's n-values were varied horizontally across the cross sections to reflect the proposed alternatives. Further detail on the selection of n-values is included in section 20.1 of this appendix. The scenarios are described as follows:

Scenario I consists of moderate vegetation along the channel invert with moderate vegetation on channel side slopes and heavy vegetation in expanded channel areas.

Scenario II consists of minimal vegetation along the channel invert with moderate vegetation on channel side slopes and heavy vegetation in expanded areas.

Scenario III consists of moderate vegetation along the channel invert with minimal vegetation on channel side slopes and minimal vegetation in expanded channel areas.

Scenario IV consists of heavy vegetation along the channel invert with heavy vegetation on channel side slopes and heavy vegetation in expanded channel areas.

18.2.2. Contraction/expansion.

Contraction/expansion loss coefficients were set to 0.3 and 0.5, respectively, in the cross sections near the bridges, based on standard coefficients used for one-dimensional hydraulic modeling. During PED, coefficients for each bridge would be verified or refined as needed.

18.2.3. Ineffective Flow Areas.

Ineffective flow areas were used in the models to account for non-conveying flow areas. These locations were determined to be areas where the flow has zero velocity. Ineffective areas were modeled due to backwater behind bridges, abrupt changes in channel geometry, tributaries, and in locations that experienced sudden contraction or expansion of flow. Such areas were determined using the alternative conceptual geospatial layouts, aerial photography, contours files, and site visits. Each cross section for the hydraulic models was meticulously reviewed and coded to include the necessary ineffective areas to ensure proper conveyance and water surface results.

19. Storm Drain Daylighting.

Storm drain "daylighting," as used herein, is the intentional re-exposing of storm drains that connect to the Los Angeles River Channel within the ARBOR reach. Several locations were pre-selected and included in the selected alternatives.

In urban design and urban planning, daylighting is the redirection of a stream into an above-ground channel. Typically, the goal is to restore a stream to a more natural state. Daylighting is intended to improve the riparian environment for a stream which had been previously diverted into a culvert, pipe, or a drainage system. Daylighting sections of storm drains allows for an increase in habitat, increased infiltration, and cleaning of flows by bioremediation processes. An example of a “daylighted” storm drain is shown on Figures 1 and 2.

No adjustments to the hydraulic models were made at this time for daylighted storm drains. Detailed hydraulic design for daylighted storm drains will be performed during PED. PED analysis will determine effective and ineffective flow areas. It is assumed any adverse impacts on the mainstem flows will be alleviated. This may include a 'hard' connection to the channel and/or flapgates. The hydraulic design will ensure the storm drain connection still meets the height above the invert, submergence, and angle of entry criteria as described in the "Hydrology and Hydraulics Policy Memorandum Number 1, Side Drain Connections into Flood Control Channels," dated 29 Dec. 1998. Opportunities to "daylight" sections of the storm drain system will be evaluated on a drain by drain basis.

Figure 1: Atwater Park - 'daylighted' storm drain, just after construction, Nov. 2011

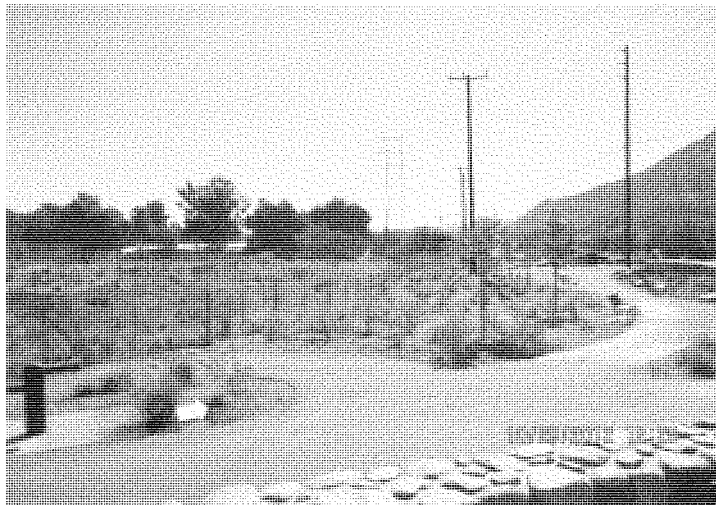

Figure 2: Atwater Park - 'daylighted' storm drain, one year later, Oct. 2012

20. Evaluation of Alternatives.

One of the critical constraints for this ecosystem restoration study was that the proposed alternatives would have no impact on the flood control functions of the Los Angeles River Channel. In addition to the impacts on flood control, it is imperative the proposed alternatives do not create any adverse conditions related to high velocities.

Since the proposed alternatives are quite elaborate and extensive, the COE needed an efficient process for determining impacts and feasibility for each of the proposed alternatives. To evaluate the hydraulic impacts, it was decided to base the impacts on two factors: the change in maximum water surface elevation and the maximum velocity.[3]

20.1. Water Surface Elevation.

The primary focus was to compare the changes to the maximum water surface elevation during the design event for each reach. A major portion of the ARBOR reach has an unlined invert. These sections of the channel include significant amounts of vegetation. Although the COE has made several attempts to remove non-native vegetation, the amount of native riparian vegetation remaining has a significant impact on the channel capacity. Since it was decided to use the current channel configuration, with vegetation, as the Existing Condition, revised channel capacities needed to be determined. This decision was so the impacts of alternatives could be determined and does not imply there is any effort to change the design discharges for the channel.

Channel capacities were evaluated for two cases that include vegetation: (1) using an appropriate value of minimum freeboard according to present-day design standards, and (2) with no freeboard. The discharges corresponding to the two cases are referred to in this report as the "revised channel capacity" and the "bankfull discharge", respectively. The present-day freeboard standards used are as follows: 2 feet for rectangular channels, 2.5 feet or trapezoidal channels, and 3 feet for leveed channel sections. These values are provided in EM 1110-2-1601, "Hydraulic Design of Flood Control Channels". In some limited reaches the revised channel capacity increased from the original design discharge because more than adequate freeboard was included in the original design. The revised channel capacities and bankfull discharges were computed because the carrying capacity of the channel is significantly impacted by the amount of vegetation in the river. The river design discharge, along with the revised channel capacity and equivalent return periods of both, are based on results from the 1992 LACDA Feasibility Study for each reach and are shown in Table 17. Discharge frequency relationships were verified by a spot check of the period of record subsequent to the 1992 study, and the historic relationship remained the same.

The channel geometry files were modified to reflect the selected alternatives. In addition, Manning's n-values were adjusted to correspond to the vegetation within the channel. Each reach of each alternative was evaluated for a range of vegetation densities and sizes represented by Manning's n-values in the hydraulic models. Although the alternative descriptions may state "riparian" or "marsh," etc., these terms do not equate to a specific n-value and it is important

[3] These two factors were considered sufficient for the feasibility phase. Energy grade line, shear stress, and possibly stream power will be considered in PED for determination of vegetation size, density and extent.

to understand the hydraulic effects of unrestricted growth within the channel sections. Manning's n-values representing "heavy," "moderate," and "minimal" vegetation were selected based on guidelines in Chow's Open Channel Hydraulics, Open Channel Flow by Henderson, Roughness Characteristics of Natural Channels from the USGS, and engineering judgment. A Manning's n-value of 0.08 was assigned for "heavy" vegetation. For "moderate" vegetation, a Manning's n-value of 0.06 was used, and a Manning's n-value of 0.045 was used to represent "minimal" vegetation within a reach. Specific vegetation species types, sizes, and densities, and associated bending and/or breaking or washing out, would be further assessed during PED. Detailed analysis of vegetation roughness would include use of an appropriate tool such as ERDC's HYDROCAL. Representative cross sections showing Manning's n-values and maximum water surface elevation for selected reaches are shown on Plates 31 to 38. Water surface profiles for the selected reaches and the selected alternatives are displayed on Plates 39 to 46. The discharge is the revised channel capacity.

20.2. Target Velocity.

The existing Los Angeles River is for the most part, a high-velocity, prismatic concrete-lined channel. Velocities in the unlined invert sections are also relatively high. Restoration projects must be designed to ensure that the vegetation placed within the channel or on the banks will be stable for the full range of conditions expected during the design life of the project. It can be acceptable if during the natural cycle of flows some of the vegetation washes out as long as the integrity of the channel is maintained. Traditionally, shear stress and/or velocity have been used to evaluate the erosion potential for various channel lining materials including vegetation. Theoretical and empirical data on shear stress and velocities are limited as related to differing types of vegetation. In order to evaluate the selected alternatives on their impact on vegetation within the channel, a 'maximum permissible' velocity, or 'target' velocity, was selected. The target velocity for the ARBOR reach used was based on COE engineering regulations and guidance, supplemented by other available information.

A cursory review of the available publications showed the range of permissible velocities depending on the source intents and goals as well as the channel lining material. Table 2-5 from EM 1110-2-1601 (Hydraulic Design of Flood Control Channels, U.S. Army Corps of Engineers, 1 July 1991), gives a set of permissible velocities that can be used as a guide to design non-scouring flood control channels.

EM 1110-2-1205 (Environmental Engineering for Flood Control Channels, U.S. Army Corps of Engineers, Nov. 1989) states that herbaceous or woody vegetation may be used to protect channel side slope areas (depending on the frequency of inundation, velocity, and geotechnical constraints to infrequent

flooding) and other bank areas where velocities are not expected to exceed 6 to 8 ft/s.

Hoag (1993) suggested that maximum flow velocities should not exceed 3 ft/s for herbaceous plantings, 3-5 ft/s for woody and herbaceous mixed plantings, 5-8 ft/s for woody plantings alone, and that maximum flows above 8 ft/s require soil-bioengineering approaches.

Lane (1955) presents curves showing permissible channel shear stress to be used for design, and the Soil Conservation Service (1954) presents similar information on grass-lined channels.

The designer should consider the maximum allowable velocity based on site specific conditions such as duration of flow, soils, temperature, debris load, plant species, as well as channel shape and planform (Streambank Soil Bioengineering Field Guide, NRCS, Dec. 2002).

Table 2-5
Suggested Maximum Permissible Mean Channel Velocities

Channel Material	Mean Channel Velocity, fps
Fine Sand	2.0
Coarse Sand	4.0
Fine Gravel[1]	6.0
Earth	
Sandy Silt	2.0
Silt Clay	3.5
Clay	6.0
Grass-lined Earth (slopes less than 5%)[2]	
Bermuda Grass	
Sandy Silt	6.0
Silt Clay	8.0
Kentucky Blue Grass	
Sandy Silt	5.0
Silt Clay	7.0
Poor Rock (usually sedimentary)	10.0
Soft Sandstone	8.0
Soft Shale	3.5
Good Rock (usually igneous or hard metamorphic)	20.0

Notes:
1. For particles larger than fine gravel (about 20 millimetres (mm) = 3/4 in.), see Plates 29 and 30.
2. Keep velocities less than 5.0 fps unless good cover and proper maintenance can be obtained.

The 2007 LARRMP from the city of Los Angeles suggested reducing flow velocities to less than 12 ft/s. This velocity was determined as a threshold necessary to maintain a vegetated channel (LARRMP, Hydraulics Appendix, Dec. 2006). Velocities of 12 ft/s are still very fast and it is unclear whether

vegetation could actually establish and/or remain for an extended period. Soils conducive to growing vegetation would definitely be erodible at such a velocity. If the vegetation could get established, it would contribute to slowing the flows at the tradeoff of a higher water surface elevation. Impacts from vegetation on terraces or sited above a water surface corresponding to an infrequent frequency event can be estimated using quasi-2D in HEC-RAS, but some areas may require a true 2-dimensional model to evaluate the velocities.

After the event of January 2001 along the Los Angeles River, COE personnel went out and measured high water marks. Using a peak flow of 37,000 ft^3/s (since updated to 37,500 ft^3/s from LACDPW data), roughness coefficients were back-calculated (Memorandum for CESPL-ED, Subject: Vegetation in Los Angeles River Channel, April 2001). From the HEC-RAS runs, the peak flow corresponded to an average velocity of about 8-9 ft/s through the Taylor Yard reach. Photographs showed significant portions of the smaller to moderate size vegetation had been completely bent over or washed away. However, many moderate to large-size trees still remained in the channel. Vegetation tends to bend over and may recover if flow duration is not too long or if the velocity is slow enough.

The permissible values of velocity should be determined so that damage exceeding normal maintenance will not result from any event that could be reasonably expected to occur during the service life of the channel (EM1110-2-1601, Hydraulic Design of Flood Control Channels, U.S. Army Corps of Engineers, 1 July 1991). Based on this information, it was decided to use 8 ft/s as the maximum permissible velocity for the unlined portions of the project reach without supplemental protection measures. Departures from suggested permissible velocity values should be based on reliable field experience or laboratory tests. Channels whose velocities exceed permissible values will require some kind of channel and/or bank protection. Both rigid and flexible armor systems can be used in or adjacent to the channel to protect the channel bed and/or banks from erosion and to stabilize side slopes. A wide array of different armor materials is available. Reaches where velocities exceed 12 ft/s are not recommended for planting. In areas where vegetated walls (planter boxes) are considered, any proposed vegetation should be sized appropriately to not affect the integrity of the channel walls and assumed to wash out at regular intervals. Areas with high velocities will need more detailed analyses for scour and deposition to ensure sufficient protective measures are incorporated into the design. The original design for the existing soft-bottom stretches of the Los Angeles River within the ARBOR reach included grade stabilizers and large quantities of dumped derrick stone in areas susceptible to scour.

21. Results.

The results of applying the above criteria for water surface elevation and target velocities on the proposed alternatives are as follows:

Alternative 10

In Reach 1, there is no adverse effect to the water surface elevation. The velocities in this reach are typically greater than 12 feet per second (ft/s). The water surface elevation results are shown in Table 18. The velocities can be found in Table 19.

In Reach 2, there is no adverse effect to the water surface elevation except in Scenario IV. The velocities in this reach are typically greater than 12 ft/s.

In Reach 3, there is no adverse effect to the water surface elevation. The velocities in this reach are typically greater than 8 ft/s.

In Reach 4, there is no adverse effect to the water surface elevation except in Scenario IV. The velocities in this reach are typically greater than 8 ft/s.

In Reach 5, there is no adverse effect to the water surface elevation except in Scenario IV. The velocities in this reach are typically greater than 8 ft/s.

In Reach 6, there is adverse effect to the water surface elevation at the downstream section of Taylor Yard as it transitions back to the existing channel configuration (see Plate 39). This adverse effect can be attributed to the contraction of the river. The velocities in this reach are typically less than 12 ft/s.

In Reach 7, there is no adverse effect to the water surface elevation. The velocities in this reach are typically greater than 12 ft/s because the reach has a concrete invert.

In Reach 8, there is no adverse effect to the water surface elevation. The velocities in this reach are typically greater than 12 ft/s because the reach has a concrete invert.

Alternative 13

In Reach 1, there is no adverse effect to the water surface elevation. The velocities in this reach are typically greater than 12 feet per second (ft/s). The water surface elevation results are shown in Table 20. The velocities can be found in Table 21.

In Reach 2, there is no adverse effect to the water surface elevation except in Scenario IV. The velocities in this reach are typically greater than 12 ft/s.

In Reach 3, there is no adverse effect to the water surface elevation. The velocities in this reach are typically greater than 8 ft/s.

In Reach 4, there is no adverse effect to the water surface elevation except in Scenario IV. The velocities in this reach are typically greater than 8 ft/s.

In Reach 5, there is no adverse effect to the water surface elevation except in Scenario IV. The velocities in this reach are typically greater than 8 ft/s.

In Reach 6, there is adverse effect to the water surface elevation at the downstream section of Taylor Yard as it transitions back to the existing channel configuration (see Plate 40). This adverse effect can be attributed to the contraction of the river. The velocities in this reach are typically less than 12 ft/s.

In Reach 7, there is adverse effect to the water surface elevation due to the vegetation on the channel walls. The velocities in this reach are typically greater than 12 ft/s because the reach has a concrete invert.

In Reach 8, there is no adverse effect to the water surface elevation.. The velocities in this reach are typically greater than 12 ft/s because the reach has a concrete invert.

Alternative 16

In Reach 1, there is no adverse effect to the water surface elevation. The velocities in this reach are typically greater than 12 feet per second. The water surface elevation results are shown in Table 22. The velocities can be found in Table 23.

In Reach 2, there is no adverse effect to the water surface elevation except in Scenario IV. The velocities in this reach are typically greater than 12 ft/s.

In Reach 3, there is no adverse effect to the water surface elevation. The velocities in this reach are typically greater than 8 ft/s.

In Reach 4, there is no adverse effect to the water surface elevation except in Scenario IV. The velocities in this reach are typically greater than 8 ft/s.

In Reach 5, there is adverse effect to the water surface elevation in the upstream end of the reach (see Plate 41). The velocities in this reach are typically between 8 to 12 ft/s.

In Reach 6, there is adverse effect to the water surface elevation at the downstream section of Taylor Yard as it transitions back to the existing channel configuration (see Plate 42). This adverse effect can be attributed to the contraction of the river. The velocities in this reach are typically less than 12 ft/s.

In Reach 7, there is adverse effect to the water surface elevation due to the vegetation on the channel walls. The velocities in this reach are typically greater than 12 ft/s because the reach has a concrete invert.

In Reach 8, there is no adverse effect to the water surface elevation except in Scenario IV (see Plate 43). From River Station 83+61 to River Station 76+68, the velocities are typically greater than 12 ft/s because of the concrete invert. Whereas, the velocities are typically between 8 and 12 ft/s for the soft bottom invert from River Station 74+43 to 40+13. Downstream of River Station 40+13 to the project limits, the velocities are greater than 12 ft/s because of the concrete invert.

Alternative 20

In Reach 1, there is no adverse effect to the water surface elevation. The velocities in this reach are typically greater than 12 feet per second. The water surface elevation results are shown in Table 24. The velocities can be found in Table 25.

In Reach 2, there is no adverse effect to the water surface elevation except in Scenario IV. The velocities in this reach are typically between 8 to 12 ft/s.

In Reach 3, there is no adverse effect to the water surface elevation. The velocities in this reach are typically greater than 8 ft/s.

In Reach 4, there is no adverse effect to the water surface elevation except in Scenario IV. The velocities in this reach are typically greater than 8 ft/s.

In Reach 5, there is adverse effect to the water surface elevation in the upstream end of the reach (see Plate 44). The velocities in this reach are typically between 8 to 12 ft/s.

In Reach 6, there is adverse effect to the water surface elevation at the downstream section of Taylor Yard as it transitions back to the existing channel configuration (see Plate 45). This adverse effect can be attributed to the contraction of the river. The velocities in this reach are typically less than 12 ft/s.

In Reach 7, there is no adverse effect to the water surface elevation. The velocities in this reach are typically greater than 12 ft/s because the reach has a concrete invert.

In Reach 8, there is no adverse effect to the water surface elevation except in Scenario IV (see Plate 46). From River Station 83+61 to River Station 76+68, the velocities are typically greater than 12 ft/s because of the concrete invert. Whereas, the velocities are typically between 8 and 12 ft/s for the soft bottom

invert from River Station 74+43 to 40+13. Downstream of River Station 40+13 to the project limits, the velocities are greater than 12 ft/s because of the concrete invert.

22. Flood Risks.

Existing vegetation within the channel has a significant impact on conveyance of the design flood within the ARBOR reach. If allowed to grow unchecked under either the Without- or With-Project Conditions, such vegetation could eventually create an adverse condition with respect to flood risk. The District plans to adopt a course of action that allows for ecosystem restoration while not significantly altering conveyance of the previously authorized design flood within the Los Angeles River. Under this approach, Los Angeles District would modify the existing Operation, Maintenance, Rehabilitation, Repair and Replacement (OMRRR) Plan for the Los Angeles County Drainage Area (LACDA) project within the study area to accommodate the restoration features of the proposed project and to allow some vegetation to remain in the Los Angeles River channel within the study area to the extent that there no more than minor effects on the channel's ability to convey the design flood.

22.1. Authorization of the Existing Flood Risk Management Project.

The Los Angeles River is a central component in the LACDA project, a flood risk management project constructed through a massive undertaking by the Corps and the Los Angeles County Flood Control District (now the Los Angeles County Department of Public Works - LACDPW). Federal construction efforts occurred from the 1930s through the 1950s. Construction of the Los Angeles River portion of LACDA was authorized and amended under several laws. The reach of the Los Angeles River being studied in this Feasibility Study, was first authorized for construction under Emergency Relief Acts, then authorized by the Flood Control Act of June 1936, as amended by the Flood Control Acts of 1937 and 1938. Modifications to the Los Angeles River channel have been addressed in later Flood Control Acts. Design discharges of the Los Angeles River for the authorized project range from 40,000 ft^3/s to 104,000 ft^3/s within the study area.

22.2. LACDA 1992 Review.

The Los Angeles River as originally constructed within the study area from the 1930s to the 1950s was designed to convey a design flood, not a specific frequency event such as the 1% ACE event. The Corps studied improvements to flood risk management conveyance capacity along the Los Angeles River in the 1992 LACDA Review. The 1992 LACDA Review Feasibility Study showed that the LACDA channel and dam flood control system had a relatively low level of flood protection for a metropolitan area. This low level of protection was and is attributable to the following factors: (1) the original design storm, which was based upon the Capital Flood/Standard Project Flood concept in use in the 1930s, generated floods with a magnitude that has an approximately 50-year

return period for portions of Los Angeles River when compared to the 1992 frequency curves; (2) modern day freeboard requirements for flood control channel design means that the safe conveyance capacity of a portion of the Los Angeles River is significantly lower than the original design capacity with a lesser freeboard; and (3) the increased runoff response of the watershed due to intensive urbanization produces a higher peak discharge for the same rainfall event. As a consequence of the 1992 LACDA Review Study, the Corps was eventually authorized to upgrade flood risk management features for the Los Angeles River downstream of the Rio Hondo confluence to provide 133-year level of protection (0.8% ACE), but no upgrades were authorized for the upper Los Angeles River including the ARBOR reach. Flood risk management upgrades within the study area were not found to be economically justified in the 1992 review.

22.3. Design Conditions.

Two scenarios of the Los Angeles River were evaluated as part of the ongoing ecosystem restoration feasibility study. The first, referred to as the original authorized project or "Design" Conditions, represents a clean channel with no vegetation within the river channel. The original design was developed to address specific conveyance capacities, in other words, a specific design discharge for a designated reach within the ARBOR, and was not intended to specifically provide protection for a probability-based event such as the 1% ACE event. Based on the updated frequency analysis, the minimum level of protection for the ARBOR reach under Design Conditions is about a 4% ACE event (25-yr). This lowest level of flood conveyance occurs in an entrenched section of the Los Angeles River upstream from the Verdugo Wash confluence.

22.4. Existing Conditions.

The second scenario, referred to as the present or "Existing" Conditions, represents the current channel including the existing amount of vegetation growing within the soft-bottom reaches of the Los Angeles River. The original design did not contemplate allowing any sediment and vegetation to establish in the channel, and the existing vegetation and the sediment held in place by the vegetation has reduced the conveyance capacity of the originally authorized project (see Table 17). Lack of OMRRR funding for many years to remove this vegetation and eventually the environmental issues associated with removing the well-established vegetation have resulted in this reduced conveyance capacity becoming the current Existing Condition. The minimum level of protection for the ARBOR reach under Existing Conditions is about an 11% ACE event (9-yr), which occurs in the soft-bottom section downstream from the Verdugo Wash confluence. At the same time, and despite its degraded condition, the existing vegetation in the channel provides important habitat and connections for wildlife, provides connections between proposed restoration features, and is favored by many in the community. The environmental baseline for the Study assumes that

existing vegetation remains in the river because of the Corps' lack of funding for regular channel maintenance and the environmental considerations involved with vegetation removal.

22.5. Sedimentation.

Given the existence of the Hansen and Sepulveda Dams, several LACDPW dams, numerous debris basins, and lined channels upstream of the project reach, sediment inflow (i.e., bed material load) to the project reach for the existing condition is minimal. Additionally, given the presence of grouted riprap sideslopes, a 'semi-armored' cobble bed with grade control structures, and dense stands of vegetation, bed material transport within the existing project reach is also minimal. The dominant sediment transport processes are limited to suspended transport of sand and smaller sized material during moderate to large discharges. The existing vegetation does trap some sediment during low to moderate events, but tends to wash out during larger events.

22.6. Other Important Points.

The conditions described above raise a number of issues regarding flood risks and the relationship to proposed ecosystem restoration along the Los Angeles River. Several related points were considered during the feasibility study. These points are included for consideration:

Point 1. Improvements to flood risk management is not within the scope of the current Ecosystem Restoration Feasibility Study. The Corps is not studying flood risk management options under the current study, as there is no interested sponsor.

Point 2. Under Design Conditions, the 1% ACE event cannot be contained within the channel in the ARBOR reach, but current FEMA mapping does not accurately represent these conditions. This generates a responsibility to alert FEMA and the public by way of a Letter of Map Revision (LOMR). The current FEMA mapping of the 100-yr (1% ACE event) floodplain indicates that the 100-yr event can be totally contained within the channel for the entire ARBOR reach. These 'old' FEMA floodplains are based on data from the early 1980s, which we have not been able to obtain. Although the Corps presented floodplain maps for the 1% ACE event as part of the 1992 study (which are consistent with those which we have produced more recently for use in the current Feasibility Study) FEMA did not update its maps for the upper Los Angeles River including the ARBOR reach. FEMA only elected to use the Corps' floodplain mapping for the lower Los Angeles River and the Rio Hondo Diversion Channel. This is a long-standing issue because FEMA has not remapped with current data. In summary, the Corps indicated over 20 years ago that the 1% ACE event cannot be contained within the channel in the ARBOR reach and is different than shown on FEMA maps, but FEMA mapping has not been updated.

Point 3. The vegetation growing within the channel in the ARBOR reach under Existing Conditions represents a significant decrease in flood protection compared to Design Conditions. Within the ARBOR reach, the level of protection is decreased from a little over a 4% ACE event (25-yr) to about an 11% ACE event (9-yr) by the present level of vegetation and sediment. The area of inundation from the 1% ACE event increases significantly, compared to the Design Conditions, at specific locations. That is, the depth of flooding and the area of flooding under the 1% ACE event are both changed by the existing vegetation and sediment in the channel compared to Design Conditions.

Point 4. Although the current Feasibility Study focuses on ecosystem restoration and has no flood risk management purpose, the impact on flood risk management from a recommendation to modify the OMRRR plan to authorize existing sediment and vegetation to remain consistent with Existing Conditions could trigger FEMA mitigation requirements. A memorandum dated June 2012 between FEMA and USACE entitled "Federal Emergency Management Agency (FEMA)/U.S. Army Corps of Engineers (USACE), Joint Actions on Planning for Flood Risk Management Projects" addresses the requirement to perform mitigation when proposed USACE flood risk reduction projects increase the Base (1-percent-annual-chance) Flood Elevation (BFE). An original constraint of the Feasibility Study is that the recommended project will have no negative impacts on the flood risk reduction capability of the Los Angeles River as compared to the Existing Conditions scenario. The proposed restoration features (new structures and vegetation put in place under the proposed project) will be designed to minimize impacts to conveyance capacity. The H&H analyses in PED will allow the District to assess whether and how the new features may result in minor differences to channel conveyance compared to Design Conditions, and existing vegetation and sediment not associated with the restoration features will also be considered to determine to what extent some of the existing vegetation can remain without having more than minor impacts upon Design Conditions.

22.7. Recommendations.

Based on the above and although the restoration project and a modified OMRRR plan for flood risk management to leave vegetation in the channel would not induce flooding compared with Existing Conditions, the Los Angeles District proposes to adopt a course of action that would not significantly alter the ability to achieve conveyance of the original design flood. That is, the District would adopt a plan that will minimize any uncertainty about the need to mitigate for induced flooding. The proposed restoration features would be designed to avoid any negative impacts on the conveyance capacity compared to the original Design Conditions. In addition, the LACDA OMRRR plan would be modified to allow some vegetation in the channel where existing vegetation grows as well as part of new features, but only to the extent that such vegetation would have no more than minor impacts upon Design Conditions.

23. Summary and Conclusions.

This appendix documents the hydrologic and hydraulic analyses that were performed in support of the Ecosystem Restoration Feasibility Study for the Los Angeles River. The focus of the study is the ARBOR reach which extends from Barham Blvd. upstream to 1st St. in downtown Los Angeles. Since there is no flood risk management component to this study, no risk and uncertainty analyses were performed. During PED, the Recommended Plan will be designed in more detail and risk and uncertainty will be documented to ensure there is no adverse impacts to existing conditions and also to quantify any incidental benefits that may possibly occur.

The Without-Project Condition is defined as the Existing Conditions, which incorporates the vegetation currently growing within the channel. The hydraulic impact of the vegetation in the channel causes a substantial reduction in channel capacity. Photographic evidence suggests that most of the grasses, reeds, shrubs, and smaller trees either bent over or washed out during moderate size events but many moderate to large-sized trees still remained in the channel. The smaller vegetation, including non-native plants, grew back rather quickly. The main governing criteria for conveyance is vegetation size and density and ability to bend with water flow. Even if the trees were to wash out, they could become lodged on bridge piers downstream and could create an obstruction greater than was allowed in that portion of the channel.

The Los Angeles River Channel was originally designed to convey a design flood, not a specific frequency event such as the 1% ACE event, with no vegetation within the channel. Even without vegetation in the channel, there are several locations within the ARBOR reach where the probability of flows breaking out from the channel within the ecosystem project area is greater than 1% in any given year (equivalent to the 100-yr flood), i.e., the channel has less than 100-yr level of protection in some locations. This is due to several factors including: the original design event was too small, the amount of urbanization was not anticipated to be so vast, and updated hydrologic and hydraulic criteria.

The alternatives that were analyzed are compared to the Existing Conditions to determine their impacts on the flood control function of the channel. If the WSE for the with-project condition was greater than that for the existing condition then that restoration scenario was removed from further consideration. Any of the four alternatives can work hydraulically given the constraint on maintaining vegetation to acceptable limits. Since the proposed alternatives are quite elaborate and extensive, the Corps of Engineers needed a expeditious method for determining impacts and decided to evaluate the impacts on two factors: the change in maximum water surface elevation and the maximum velocity.

For the most part, the reaches that showed an increase in water surface elevation for the design event were at transition areas, either geometric (trapezoidal to rectangular or from a widened section to a narrow section) or construction material (soft-bottom to concrete or vice-versa). These areas can be mitigated by including OMRRR plan

requirements to prevent vegetation from getting established in these transition areas and to remove it as soon as possible. The LACDA OMRRR Plan will be revised to accommodate the restoration features of the proposed project and to allow some vegetation to remain in the Los Angeles River channel within the study area to the extent that there are no more than minor effects on the channel's ability to convey the design flood.

Another option may be to include open water areas within the transition zones. Open water would reduce the amount of vegetation, but brings up other concerns such as vector control and water quality. Studies for the Tres Rios project in Arizona show that if the open water area is long enough, wind fetch keeps enough circulation to prevent mosquito proliferation. Also, if the open water area is deep enough, vegetation does not get established. Open water areas could be designed with circulation pumps to prevent adverse water quality impacts and mosquito control. Detailed modeling and design for the Recommended Plan to include the n-value limitations based on vegetation for these transition areas will be conducted during PED.

Several reaches exhibited average velocities in excess of 12 ft/s. It is not recommended that any alternative that requires planting be allowed in these areas. Reaches with maximum velocities greater than 8 ft/s need to include supplemental protection measures to ensure no adverse impacts to the channel itself or appurtenant features such as bridge piers. The current soft-bottom stretches of the Los Angeles River include invert protection features. These stretches have exhibited a strong disposition for vegetation to get established on its own and also vegetation recovers very quickly after a flood event. These areas of high velocity need to be evaluated more thoroughly for scour erosion to ensure the structural integrity of the channel and appurtenant features are not compromised. Scour and erosion are very important parts of the hydraulic analyses. The study team determined these detailed calculations can be done in PED. Revised channel design discharges, including tributaries and storm drains will be provided in PED.

It should be clearly understood, the results in this Hydrology & Hydraulics Appendix are based on one-dimensional, steady flow HEC-RAS models and that the Recommended Plan will require two-dimensional, and possibly, unsteady flow models during PED to more accurately simulate the proposed alterations in and adjacent to the channel during PED. For areas with significant modifications, a physical modeling approach is highly recommended.

The PED work will include analysis of perennial effluent base flow, the channel-forming discharge, and flow duration. In addition, in PED the COE will clarify the hydrologic and hydraulic design of existing low flow channels, including the intended flow conveyance, and analyze impacts from the proposed project on the low flow channels in modified reaches. The PED analysis will also include sediment transport modeling, and development of a detailed sediment management plan for the recommended alternative to protect the project against failure from sedimentation and scour.

The water budget analysis shows the proposed vegetation scenarios for the alternatives can be supported with the available sources of water. Several features require new connections to the Los Angeles River or existing storm drains in order to support the proposed vegetation. Under Alternatives 10 and 13 there is no direct hydrologic connection from the Los Angeles River to the LATC parcel. Storm water must be redirected though the LATC area to support the proposed vegetation. The direct connection for Alternative 16 and 20 to LATC provides more than enough water to support the proposed vegetation. During PED, the COE will look for additional sources of existing data on groundwater-surface water interaction to include in the water budget.

24. References.

Los Angeles District, U.S. Army Corps of Engineers, Flood Control in the Los Angeles County Drainage Area. Los Angeles, CA, May 1938.

Los Angeles District, U.S. Army Corps of Engineers, Hydrology in the Los Angeles County Drainage Area, Los Angeles, CA, 1939.

Los Angeles District, U.S. Army Corps of Engineers, Dec. 1946. Restudy.

Open Channel Hydraulics, Chow, 1959.

Open Channel Flow, Henderson, 1966.

Roughness Characteristics of Natural Channels, USGS, 1967.

EM1110-2-1601, *Hydraulic Design of Flood Control Channels*, U.S. Army Corps of Engineers, 1 July 1991.

U.S. Army Corps of Engineers, Los Angeles District: Los Angeles County Drainage Area Final Feasibility Final Report, December 1991.

U.S. Army Corps of Engineers, Los Angeles District: Los Angeles County Drainage Area Final Feasibility Final Report, Appendix A Part I & II Hydrology, December 1991.

U.S. Army Corps of Engineers, Los Angeles District: Los Angeles County Drainage Area Final Feasibility Final Report, Appendix B Hydraulics, December 1991.

Slope Stabilization & Erosion Control, A Bioengineering Approach, Morgan & Rickson, 1995.

Verification of Roughness Coefficients for Selected Natural and Constructed Stream Channels in Arizona, USGS, PP 1584, 1998.

Operations, Maintenance, Repair, Replacement, and Rehabilitation Manual, Los Angeles County Drainage Area, California, December 1999.

Stability Thresholds for Stream Restoration Materials, Fischenich, USACE Research and Development Center, Environmental Laboratory, ERDC TN-EMRRP-SR-29, May 2001.

Los Angeles River Revitalization Master Plan, City of Los Angeles. April 2007.

Design of Roadside Channels with Flexible Linings, FHWA, DOT, HEC-1502, 2005.

U.S. Army Corps of Engineers, Hydrologic Engineering Center: HEC-RAS, River Analysis System, User's Manual, version 4.1, January 2010.

U.S. Army Corps of Engineers, Hydrologic Engineering Center: Hydrologic Modeling System, HEC-HMS, User's Manual, version 3.5, August 2010.

U.S. Army Corps of Engineers, Hydrologic Engineering Center: HEC-GeoHMS, Geospatial Hydrologic Modeling Extension, User's Manual, version 5.0, October2010.

City of Los Angeles, Department of Water and Power: Draft 2010 Urban Water Management Plan, January 2011.

U.S. Army Corps of Engineers, Hydrologic Engineering Center: HEC-GeoRAS, GIS Tools for Support of HEC-RAS using ArcGIS, User's Manual, version 4.3.93,February 2011.

Table 1: Hansen Dam Pertinent Data

Drainage Area	151.9 mi^2
Reservoir Elevation	
Debris Pool	1,010.5 ft
Flood Control Pool (spillway crest)	1,060.0 ft
100-yr Flood Event	1,043.7 ft
Top of Dam	1,087.0 ft
Reservoir Area	
Debris Pool	372 ac
Spillway Crest	826 ac
Top of Dam	1,154 ac
Reservoir Gross Capacity	
Debris Pool	3,756 af
Spillway Crest	33,348 af
Top of Dam	59,299 af
Allowance for Sediment (100-yr)	21,000 af
Dam: - Type	Earthfill
Height above Original Streambed	97 ft
Top Length	15,440 ft
Top Width	30 ft
Outlets:	
Uncontrolled	
Number and Size of Gates	2 - 8 ft W x 6 ft H
Gate Sill Elevation	1,011.0 ft
Controlled	
Type of Gates	Vertical Lift
Number and Size of Gates	8 - 5 ft W x 8 ft H
Gate Sill Elevation	990.0 ft
Maximum Capacity at Spillway Crest	22,000 ft^3/s
Regulated Capacity at Spillway Crest	21,000 ft^3/s
Spillway:	
Type	Concrete Ogee
Crest Length	284 ft
Design Discharge	99,700 ft^3/s

Sources: Water Conservation and Supply Feasibility Study, Hansen Dam, dated April 1999, Hansen Dam Water Control Manual dated November 1990, LACDA Feasibility Study and appendices dated 1992, and updated survey dated Nov. 2004.

Table 2: Hansen Dam Hydrologic Data

Standard Project Flood	
Duration (inflow)	4 days
Total Inflow Volume (excl. base flow)	57,200 af
Inflow Peak	53,000 ft³/s
Max. Storage	19,560 af
Max. Elevation	1065.50 ft
Probable Maximum Flood	
Duration (inflow)	5 days
Total Inflow Volume	246,000 af
Inflow Peak	105,000 ft³/s
Peak. Outflow	99,700 ft³/s
Max. Elevation	1081.22 ft
100-yr Flood	
Duration (inflow)	1 day
Inflow Peak	47,900 ft³/s
Outflow Peak	18,900 ft³/s
Max Storage	15,500 af
Max. Elevation	1043.7 ft

Sources: Hansen Dam Analysis of Design dated June 1940, H&H Review of Hansen Dam dated June 1978, Hansen Dam Water Control Manual dated November 1990, and LACDA Feasibility Study and appendices dated 1992.

Table 3: Sepulveda Dam Pertinent Data

Drainage Area	152.0 mi^2
Reservoir Elevation	
Spillway Crest (gates lowered)	700.0 ft
Flood Control Pool (spillway gates raised)	710.0 ft
100-yr Flood Event	712.1 ft
Top of Dam	725.0 ft
Reservoir Area	
Spillway Crest (gates lowered)	794 ac
Top of Spillway Gates (raised position)	1,348 ac
Top of Dam	2,591 ac
Reservoir Gross Capacity	
Spillway Crest (gates lowered)	7,280 af
Top of Spillway Gates (raised position)	18,129 af
Top of Dam	46,764 af
Allowance for Sediment	0 af
Dam: - Type	Earthfill
Height above Original Streambed	57 ft
Top Length	15,440 ft
Outlets:	
Uncontrolled	
Number and Size of Gates	4 - 6 ft W x 6.5 ft H
Gate Sill Elevation	668 ft
Controlled	
Type of Gates	Vertical Lift
Number and Size of Gates	4 - 6 ft W x 9 ft H
Gate Sill Elevation	668 ft
Maximum Capacity at Spillway Crest	16,500 ft^3/s
Regulated Capacity at Spillway Crest	16,500 ft^3/s
Spillway:	
Type	Concrete Ogee
Crest Length	399 ft
Design Discharge	99,540 ft^3/s

Sources: Sepulveda Dam Water Control Manual dated May 1989, LACDA Feasibility Study and appendices dated 1992, and updated survey dated Nov. 2004.

Table 4: Sepulveda Dam Hydrologic Data

Standard Project Flood	
Duration (inflow)	3 days
Total Inflow Volume	68,200 af
Inflow Peak	50,000 ft³/s
Max. Storage	22,493 af
Max. Area	1,529 ac
Max. Elevation	713.52 ft
Probable Maximum Flood	
Duration (inflow)	4 days
Total Inflow Volume	163,200 af
Inflow Peak	114,000 ft³/s
Peak Outflow	99,300 ft³/s
Max. Storage	27,563 af
Max. Area	1,710 ac
Max. Elevation	716.66 ft
100-yr Flood	
Duration (inflow)	1 day
Total Rainfall	8.84 in
Rainfall Loss	3.77 in
Rainfall Excess	5.07 in
Inflow Peak	82,500 ft³/s
Inflow Volume	41,100 af
Outflow Peak	17,000 ft³/s
Max Storage	20,300 af
Max. Elevation	712.1 ft

Sources: Sepulveda Dam Analysis of Design dated August 1939, H&H Review of Sepulveda Dam dated June 1978, Sepulveda Dam Water Control Manual dated May 1989, and LACDA Feasibility Study and appendices dated 1992.

Table 5: Monthly Temperatures

Station Name: Burbank Valley Pump Plant									Station Number: 41194				
Period of Record: 1939 to 2001									Latitude: 34:11:00				
Elevation: 655 feet									Longitude: 118:20:00				
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Max.	67.5	69.5	70.6	74.9	77.5	83.2	88.9	89.9	87.1	81.5	73.5	67.9	77.7
Min.	42.0	44.3	46.2	49.5	54.2	58.3	62.1	62.4	59.9	53.6	45.4	41.3	51.6
Avg.	54.8	56.9	58.4	62.2	65.9	70.8	75.5	76.2	73.5	67.6	59.5	54.6	64.7

Mean daily temperatures in degrees Fahrenheit (F)

Data from Monthly Station Climate Summaries, 1971-2000, NWS, National Climatic Data Center (NCDC), Western Regional Climate Center.

Table 6: Monthly Precipitation

Station Name: Burbank Valley Pump Plant												Station Number: 41194
Period of Record: 1939 to 2001												Latitude: 34:11:00
Elevation: 655 feet												Longitude: 118:20:00
Average Total Precipitation												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
3.56	4.29	3.88	1.02	0.37	0.12	0.02	0.18	0.30	0.55	1.05	2.15	17.49

Mean precipitation in inches

Data from Monthly Station Climate Summaries, 1971-2000, NWS, National Climatic Data Center (NCDC), Western Regional Climate Center

Table 7: Precipitation Frequency Estimates (Point Estimates)

Duration	1-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	200-yr	500-yr	1000-yr
5-min:	0.14	0.20	0.27	0.33	0.41	0.48	0.56	0.64	0.75	0.84
10-min:	0.21	0.28	0.38	0.47	0.59	0.69	0.80	0.92	1.08	1.21
15-min:	0.25	0.34	0.46	0.57	0.72	0.84	0.97	1.11	1.30	1.46
30-min:	0.34	0.46	0.63	0.77	0.97	1.14	1.31	1.50	1.76	1.97
60-min:	0.48	0.66	0.90	1.11	1.40	1.64	1.89	2.15	2.53	2.84
2-hr:	0.71	0.96	1.31	1.61	2.03	2.37	2.73	3.12	3.67	4.11
3-hr:	0.89	1.20	1.64	2.00	2.52	2.95	3.39	3.87	4.55	5.10
6-hr:	1.26	1.71	2.31	2.83	3.56	4.15	4.78	5.45	6.41	7.19
12-hr:	1.68	2.27	3.08	3.77	4.76	5.56	6.40	7.31	8.60	9.66
24-hr:	2.19	2.99	4.09	5.02	6.37	7.45	8.61	9.86	11.63	13.08
2-day:	2.75	3.79	5.24	6.49	8.29	9.75	11.31	13.00	15.43	17.43
3-day:	3.13	4.37	6.09	7.58	9.74	11.50	13.39	15.45	18.41	20.86
4-day:	3.39	4.77	6.70	8.37	10.80	12.79	14.93	17.26	20.63	23.42
7-day:	3.88	5.53	7.86	9.88	12.84	15.28	17.91	20.79	24.98	28.46
10-day:	4.16	5.98	8.55	10.79	14.07	16.80	19.74	22.97	27.70	31.64
20-day:	4.90	7.07	10.17	12.89	16.92	20.27	23.94	27.99	33.96	38.99
30-day:	5.78	8.27	11.85	15.02	19.71	23.66	27.98	32.79	39.91	45.94
45-day:	6.89	9.69	13.71	17.29	22.64	27.16	32.15	37.71	46.00	53.08
60-day:	8.01	11.02	15.38	19.27	25.11	30.07	35.56	41.72	50.93	58.82

Point precipitation frequency estimates (inches)
NOAA Atlas 14, Volume 6, Version 2
Data type: Precipitation depth
Time series type: Partial duration
Project area: Southwest
Latitude (decimal degrees): 34.1091
Longitude (decimal degrees): -118.2497

Table 8: Water Budget for Selected Alternatives

Alternative	Channel Streamflow			Water Sources	
	Annual (af/yr)	Summer (af/yr)	Precip (af/yr)	Annual (af/yr)	Summer (af/yr)
10	210,479	96,852	832	211,310	97,684
13	210,479	96,852	832	211,310	97,684
16	210,479	96,852	869	211,348	97,722
20	210,479	96,852	869	211,348	97,722

Summer = Apr thru Sep

Alternative	Infiltration (af/yr)	Evaporation (af/yr)	ETo (af/yr)	Water Demand (af/yr)	Flow Out	
					Annual (af/yr)	Summer (af/yr)
10	62,435	91	3,037	65,562	145,748	32,122
13	62,435	101	3,357	65,893	145,418	31,791
16	65,272	139	3,145	68,556	142,793	29,166
20	65,272	139	3,118	68,529	142,819	29,193

ETo - evapotranspiration
Flow Out = Water Source - Water Demand

For Alternatives 10 and 13, there is no direct hydrologic connection from the Los Angeles River to the LATC; therefore there must be a daylighted storm drain connection along the northeast side of the LATC.

Table 9: Average Daily Flows for ARBOR Reach of Los Angeles River

Period of Record (WY1932-2012)											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
162	120	780	271	65	44	42	32	33	73	64	74
Average daily flow Jan - Dec = 164 ft^3/s Average daily flow Apr - Sep = 61 ft^3/s											
Record Post - W.C. Tillman Treatment Plant (WY1985-2012)											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
156	128	187	208	103	97	101	78	77	86	130	121
Average daily flow Jan - Dec = 291 ft^3/s Average daily flow Apr - Sep = 134 ft^3/s											
Flows in ft^3/s Daily flows from LACDPW stream gage F57C-R; Los Angeles River at Figueroa St. Bridge											

Table 10: Infiltration Rate Criteria for SCS Hydrologic Soil Groups

Group	Minimum Infiltration	
	(in/hr)	(ft/day)
A	0.30 – 0.45	0.6 – 0.9
B	0.15 – 0.30	0.3 – 0.6
C	0.05 – 0.15	0.1 – 0.3
D	0.0 – 0.15	0.0 – 0.3
Source: McCuen, R. H., *Hydrologic Analysis and Design*, 2nd ed., Prentice Hall, Upper Saddle River, New Jersey, 07458, 1998		

Table 11: Monthly Summary of Evaporation Rates

ID	Station Name	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
33-A	Pacoima Dam	6.83	[7.59]	5.80	8.06	5.31	[5.38]	7.56	8.03	5.98	9.25	[9.68]	8.72	[88.19]
46-D	Big Tujunga Dam	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	6.63	8.24	[11.60]	[13.26]	[9.70]	[49.43]
63-C	Santa Anita Dam	2.96	3.96	2.30	3.25	2.48	2.53	3.20	[2.64]	[0.48]	[0.58]	[0.88]	[0.69]	[25.95]
89-B	San Dimas Dam	[2.74]	[1.96]	[2.67]	[1.52]	[1.59]	[2.64]	4.00	6.08	5.93	9.20	[8.11]	6.55	[52.98]
96-C	Puddingstone Dam	3.25	2.70	[0.99]	1.67	1.62	2.22	3.86	5.24	5.28	[7.64]	7.48	5.81	[47.76]
223-C	Big Dalton Dam	3.03	2.41	[0.95]	1.52	[1.77]	[2.53]	3.62	4.48	5.16	7.47	7.46	5.97	[46.37]
252-C*	Castaic Dam	8.20	3.98	2.57	3..81	3.26	5.34	11.03	10.35	7.83	11.02	11.81	8.85	88.05
334-B	Cogswell Dam	3.64	2.67	[1.94]	1.64	[1.96]	2.54	3.21	4.94	6.16	7.76	7.66	6.01	[50.10]
390-B	Morris Dam	4.86	4.83	3.22	4.62	4.10	5.42	6.85	[7.75]	8.69	11.03	10.67	8.58	[80.62]
409-B*	Pyramid Reservoir	[6.69]	4.29	3.50	[4.77]	4.01	6.02	[5.98]	11.39	10.53	18.15	14.96	[5.72]	[96.01]
425-B	San Gabriel Dam	5.05	4.92	[2.58]	3.60	[3.26]	3.74	5.14	6.95	6.86	9.22	9.77	8.41	[69.48]
598-D*	Check 43	[8.08]	[5.50]	[4.19]	[3.67]	5.22	[6.81]	[8.55]	[13.79]	[2.84]	[ ]	[ ]	[ ]	[58.65]
1058-B	Pamdale	3.25	2.72	1.47	1.67	1.62	3.30	3.86	5.24	10.65	13.20	12.85	7.70	[58.65]
1071-b	Descanso Gardens	[1.77]	[1.65]	[0.47]	[1.17]	[0.77]	[1.03]	[2.24]	[2.88]	[3.80]	[4.72]	4.24	2.92	67.53
1240*	Pearblosson	[7.49]	12.68	10.92	5.44	[6.85]	9.02	[11.00]	13.94	[14.67]	17.77	[11.57]	12.68	[134.03]

Source: LACDPW Hydrologic Report 2010 - 2011
Evaporation in inches
[ ] Records Incomplete
* CA Department of Water Resources

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Table 12: Monthly Evapotranspiration Rates

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
3.95	2.73	2.31	2.20	2.45	3.64	4.74	5.31	6.06	6.75	6.66	5.01	51.81

Monthly evapotranspiration rates in inches
Data from CADWR, CIMIS database
Data for Glendale, Los Angeles Basin

Table 13. Vegetation Evapotranspiration Values

Vegetation Type	Evapotranspiration Range (feet/year)	Evapotranspiration Average (feet/year)
Cottonwood Willow	4.1 – 8.5	8*
Salt Cedar	3 – 9.2	6.1
Honey Mesquite	3	3
Marsh	7.5 – 16	9*
Quailbush-Saltbush	3.2	3.2
Desert	2	2
Desert Wash (Xericriparian)	2	2

Source: Greeley and Hansen, 1998, Tres Rios, Arizona Feasibility Study Salt/Gila Groundwater Analysis. * Re-published in Rio Salado Oeste Feasibility Report and adjusted by COE, Mar. 2005.

Table 14: Frequency Discharges Used in HEC-RAS Models

ARBOR Reach	RS	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	200-yr	500-yr	Design
Reach 1	692+94	16,200	27,200	31,800	42,000	54,300	71,400	81,200	96,800	55,000
Reach 1	691+24	17,500	30,200	35,600	47,500	59,700	76,800	87,600	103,000	57,000
Reach 1	639+73	18,400	32,700	38,600	51,800	63,900	81,000	92,700	109,000	40,000
Reach 2	546+45	20,300	37,200	44,200	59,900	71,800	88,900	102,000	118,000	40,000
Reach 3a	475+68	20,300	37,200	44,200	59,900	71,800	88,900	102,000	118,000	40,000
Reach 3b	474+07	21,600	40,500	48,200	65,800	77,500	94,600	109,000	125,000	78,000
Reach 4	432+16	21,600	40,500	48,200	65,800	77,500	94,600	109,000	125,000	78,000
Reach 5	358+63	21,600	40,500	48,200	65,800	77,500	94,600	109,000	125,000	78,000
Reach 6a	270+28	21,600	40,500	48,200	65,800	77,500	94,600	109,000	125,000	78,000
Reach 6b	257+85	21,400	41,000	49,400	69,600	82,000	93,800	106,000	118,000	83,700
Reach 7a	142+91	21,400	41,000	49,400	69,600	82,000	93,800	106,000	118,000	83,700
Reach 7b	128+71	22,900	44,200	53,600	79,800	94,400	109,000	124,000	141,000	104,000
Reach 8	86+07	22,900	44,200	53,600	79,800	94,400	109,000	124,000	141,000	104,000
Burbank Western	18+04	2,150	4,320	4,990	7,040	8,360	12,400	14,200	16,900	15,000
Verdugo Wash	12+62	3,790	7,550	8,720	12,700	15,100	23,200	26,500	30,300	42,900
Arroyo Seco	9+26	1,500	3,200	4,190	10,200	12,500	17,700	22,200	26,400	43,000

River, Reach, and River Station (RS) from HEC-RAS Models
There are 3 discharge locations for Reach 1 because the HEC-RAS models extended upstream from the ARBOR reach.
Discharges in ft^3/s from 1992 LACDA Feasibility Study Hydrology Appendix

Table 15: Bridges

River Station	Bridge
682+24	Barham Boulevard
661+97	Warner Brothers Studio Gate
596+22	Ventura Freeway (State Route 134)
529+43	Victory Boulevard
515+90	Golden State Freeway (Interstate Highway 5)
431+85	Colorado Boulevard
359+31	Los Feliz Boulevard
336+95	Sunnynook Drive (Pedestrian bridge)
283+78	Fletcher Drive
271+11	Glendale Freeway (State Route 2)
143+64	Golden State Freeway (Interstate Highway 5)
136+76	Riverside Drive
134+04	UPPR u/s of State Route 110
131+38	Pasadena Freeway (State Route 110)
110+96	MTA Bridge
102+52	N. Broadway
97+78	Spring Street
86+42	Main Street
65+75	UPPR d/s of Main Street
63+38	UPPR u/s of Cesar Chavez Avenue
38+15	Cesar Chavez Avenue
30+13	Santa Ana Freeway (U.S. 101)
10+69	First Street

Table 16: Boundary Conditions For HEC-RAS Models

Location	River Station	Flow Regime	Discharge (ft^3/s)	WSE (ft)
Upstream End of ARBOR Reach	692+94	Mixed	54,300	525.94
			71,400	528.50
			81,200	529.71
			96,800	531.71
			55,000	526.04
Downstream End of ARBOR Reach	10+31	Mixed	94,400	254.01
			109,000	255.38
			124,000	256.51
			141,000	257.83
			104,000	254.85

Table 17: Original Design Discharge and Existing Channel Capacity

Reach[a]	River Stations	Design[b] Discharge ft^3/s	Design Return Period[e] yr	Current Freeboard Criteria[c] ft	Existing[d] Channel Capacity ft^3/s	Existing Return Period[e] yr	100-Year Discharge[e] ft^3/s
Reach 1	625+77 to 547+45	40,000	12	3	29,300	4	81,000
Reach 2	546+45 to 510+05	40,000	7	3	25,800	3	88,900
Reach 3a	504+93 to 477+85	40,000	7	3	63,000[f]	32	88,900
Reach 3b	475+68 to 452+58	78,000	51	3	84,000[f]	69	94,600
Reach 4	432+16 to 359+75	78,000	51	3	34,700	4	94,600
Reach 5	358+63 to 271+89	78,000	51	3	34,000	4	94,600
Reach 6a	270+28 to 262+73	78,000	51	2.5	64,500	24	94,600
Reach 6b	257+85 to 144+23	83,700	57	2.5	50,500	11	93,800
Reach 7a	142+91 to 131+22	83,700	57	2.5	135,400[f]	>500	93,800
Reach 7b	128+71 to 86+61	104,000	83	3	83,700	32	109,000
Reach 8	86+07 to 10+31	104,000	83	3	89,600	42	109,000

Notes:

(a) Letters a & b in Reach names denote a change in the river due to a confluence or change in channel dimensions.
(b) Original design discharge for clean prismatic channel.
(c) Freeboard from EM 1110-2-1601; 3 feet for leveed sections and 2.5 feet for trapezoidal entrenched sections.
(d) Existing channel capacity with vegetation, sedimentation and freeboard. The values shown are the minimum within the reach. Discharges above these listed do not necessarily cause damages.
(e) Return periods for Design Discharge and Existing Channel Capacity are based on discharge frequency analysis for the 1992 LACDA Feasibility Study.
(f) In some limited reaches the existing channel capacity is greater than the original design discharge because of more than adequate freeboard.
(g) Refer to Plates 21a through 24b to see the floodplains for various return frequency flows within the study limits.

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Table 18: Alternative 10 Water Surface Elevation

Reach	River Station	Scenario I	Scenario II	Scenario III	Scenario IV
Reach 1	625+77 to 547+45				
Reach 2	546+45 to 510+05				
Reach 3a	504+93 to 477+85				
Reach 3b	475+68 to 452+58				
Reach 4	432+16 to 359+75				
Reach 5	358+63 to 271+89				
Reach 6a	270+28 to 262+73				
Reach 6b	257+85 to 144+23				
Reach 7a	142+91 to 131+22				
Reach 7b	128+71 to 86+81				
Reach 8	86+07 to 10+31				

Note: letters a & b in Reach name denote a break in the reach due to a confluence or flow change.

Color Codes:

Does not increase the water surface elevation

Increases the water surface elevation

No change from design conditions

Table 19: Alternative 10 Velocities

Reach	River Station	Scenario I						Scenario II						Scenario III					
		Bank full	2-yr	5 yr	10-yr	25-yr	50-yr	Bank full	2-yr	5-yr	10-yr	25-yr	50-yr	Bank full	2-yr	5-yr	10-yr	25-yr	50-yr
Reach 2	546+45 to 510+05																		
Reach 3a	504+93 to 477+85																		
Reach 3b	475+68 to 452+58																		
Reach 4	432+16 to 359+75																		
Reach 5	358+63 to 271+89																		
Reach 6a	270+28 to 262+73																		
Reach 6b	257+85 to 144+23																		
Reach 7a	142+91 to 131+22																		
Reach 7b	128+71 to 86+61																		
Reach 8	86+07 to 10+31																		
Arroyo Seco	n/a																		

Note: Letters a & b in Reach name denote a break in the reach due to a confluence or flow change.
n/a = not applicable

Color Codes:

0-8 ft/s
8 to 12 ft/s
> 12 ft/s

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Table 20: Alternative 13 Water Surface Elevation

Reach	River Station	Scenario I	Scenario II	Scenario III	Scenario IV
Reach 1	625+77 to 547+45				
Reach 2	546+45 to 510+05				
Reach 3a	504+93 to 477+85				
Reach 3b	475+68 to 452+58				
Reach 4	432+16 to 359+75				
Reach 5	358+63 to 271+89				
Reach 6a	270+28 to 262+73				
Reach 6b	257+85 to 144+23				
Reach 7a	142+91 to 131+22				
Reach 7b	128+71 to 86+81				
Reach 8	86+07 to 10+31				

Note: letters a & b in Reach name denote a break in the reach due to a confluence or flow change.

Color Codes:

Does not increase the water surface elevation

Increases the water surface elevation

No change from design conditions

Table 21: Alternative 13 Velocities

Reach	River Station	Scenario I						Scenario II						Scenario III					
		Bank full	2-yr	5-yr	10-yr	25-yr	50-yr	Bank full	2-yr	5-yr	10-yr	25-yr	50-yr	Bank full	2-yr	5-yr	10-yr	25-yr	50-yr
Reach 2	546+45 to 510+05																		
Reach 3a	504+93 to 477+85																		
Reach 3b	475+68 to 452+58																		
Reach 4	432+16 to 359+75																		
Reach 5	358+63 to 271+89																		
Reach 6a	270+28 to 262+73																		
Reach 6b	257+85 to 144+23																		
Reach 7a	142+91 to 131+22																		
Reach 7b	128+71 to 86+61																		
Reach 8	86+07 to 10+31																		
Arroyo Seco	n/a																		

Note: Letters a & b in Reach name denote a break in the reach due to a confluence or flow change.
n/a = not applicable

Color Codes:

0-8 ft/s
8 to 12 ft/s
> 12 ft/s

Table 22: Alternative 16 Water Surface Elevation

Reach	River Station	Scenario I	Scenario II	Scenario III	Scenario IV
Reach 1	625+77 to 547+45				
Reach 2	546+45 to 510+05				
Reach 3a	504+93 to 477+85				
Reach 3b	475+68 to 452+58				
Reach 4	432+16 to 359+75				
Reach 5	358+63 to 271+89				
Reach 6a	270+28 to 262+73				
Reach 6b	257+85 to 144+23				
Reach 7a	142+91 to 131+22				
Reach 7b	128+71 to 86+81				
Reach 8	86+07 to 10+31				

Note: letters a & b in Reach name denote a break in the reach due to a confluence or flow change.

Color Codes:

Does not increase the water surface elevation

Increases the water surface elevation

No change from design conditions

Table 23: Alternative 16 Velocities

Reach	River Station	Scenario I						Scenario II						Scenario III					
		Bank full	2-yr	5-yr	10-yr	25-yr	50-yr	Bank full	2-yr	5-yr	10-yr	25-yr	50-yr	Bank full	2-yr	5-yr	10-yr	25-yr	50-yr
Reach 2	546+45 to 510+05																		
Reach 3a	504+93 to 477+85																		
Reach 3b	475+68 to 452+58																		
Reach 4	432+16 to 359+75																		
Reach 5	358+63 to 271+89																		
Reach 6a	270+28 to 262+73																		
Reach 6b	257+85 to 144+23																		
Reach 7a	142+91 to 131+22																		
Reach 7b	128+71 to 86+61																		
Reach 8	86+07 to 10+31																		
Arroyo Seco	n/a																		

Note: Letters a & b in Reach name denote a break in the reach due to a confluence or flow change.
n/a = not applicable

Color Codes:

0-8 ft/s
8 to 12 ft/s
> 12 ft/s

Table 24: Alternative 20 Water Surface Elevation

Reach	River Station	Scenario I	Scenario II	Scenario III	Scenario IV
Reach 1	625+77 to 547+45				
Reach 2	546+45 to 510+05				
Reach 3a	504+93 to 477+85				
Reach 3b	475+68 to 452+58				
Reach 4	432+16 to 359+75				
Reach 5	358+63 to 271+89				
Reach 6a	270+28 to 262+73				
Reach 6b	257+85 to 144+23				
Reach 7a	142+91 to 131+22				
Reach 7b	128+71 to 86+81				
Reach 8	86+07 to 10+31				

Note: letters a & b in Reach name denote a break in the reach due to a confluence or flow change.

Color Codes:

Does not increase the water surface elevation

Increases the water surface elevation

No change from design conditions

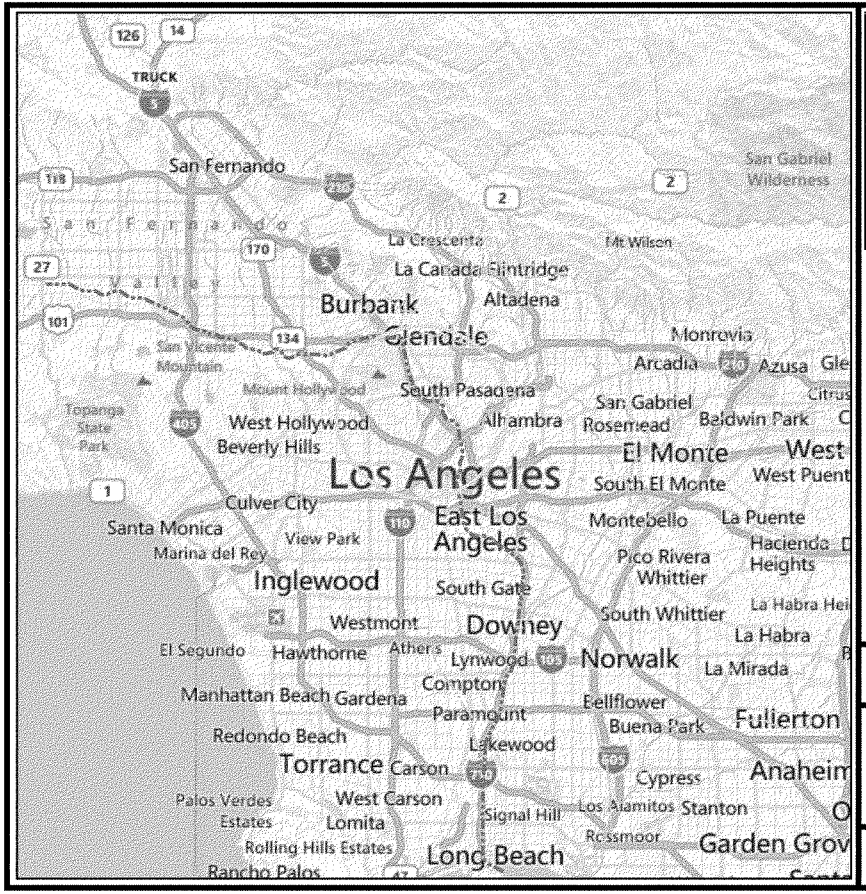
Table 25: Alternative 20 Velocities

Reach	River Station	Scenario I						Scenario II						Scenario III					
		Bank full	2-yr	5-yr	10-yr	25-yr	50-yr	Bank full	2-yr	5-yr	10-yr	25-yr	50-yr	Bank full	2-yr	5-yr	10-yr	25-yr	50-yr
Reach 2	546+45 to 510+05																		
Reach 3a	504+93 to 477+85																		
Reach 3b	475+68 to 452+58																		
Reach 4	432+16 to 359+75																		
Reach 5	358+63 to 271+89																		
Reach 6a	270+28 to 262+73																		
Reach 6b	257+85 to 144+23																		
Reach 7a	142+91 to 131+22																		
Reach 7b	128+71 to 86+61																		
Reach 8	86+07 to 10+31																		
Arroyo Seco	n/a																		
Verdugo Wash	n/a																		

Note: Letters a & b in Reach name denote a break in the reach due to a confluence or flow change.
n/a = not applicable

Color Codes:

0-8 ft/s
8 to 12 ft/s
> 12 ft/s

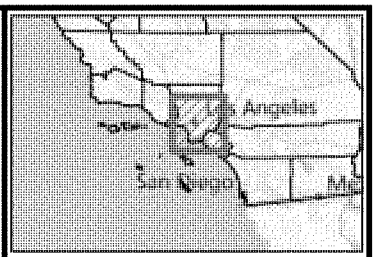


LOS ANGELES RIVER
ECOSYSTEM RESTORATION STUDY

LOS ANGELES RIVER
ARBOR REACH
LOCATION MAP

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 1



N

Legend

- LACDA Watershed Boundary
- Los Angeles River
- Watercourse
- Corps Dam
- Study Area

0 5 10
Miles

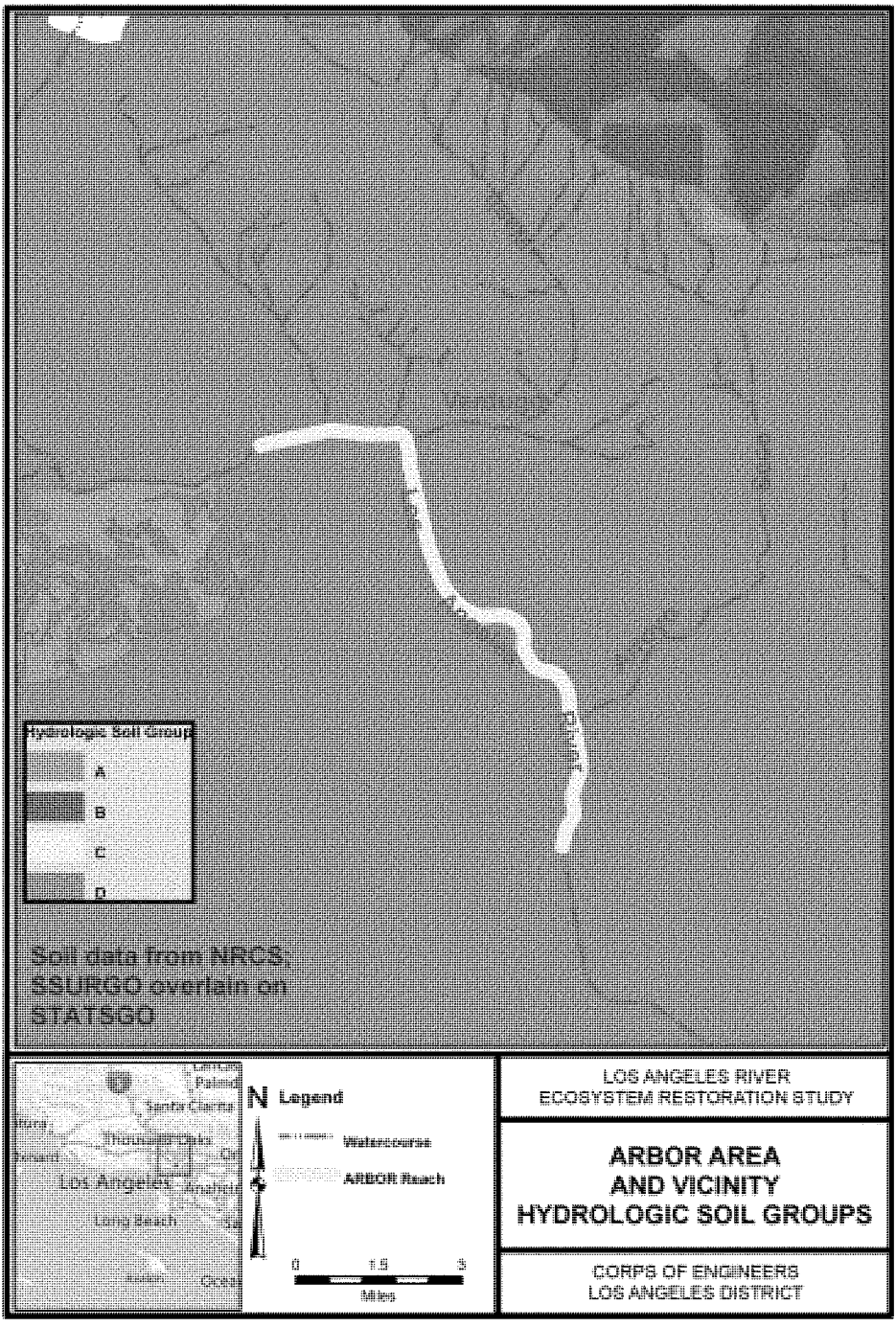
LOS ANGELES RIVER
ECOSYSTEM RESTORATION STUDY

LOS ANGELES COUNTY DRAINAGE AREA (LACDA)

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 2

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



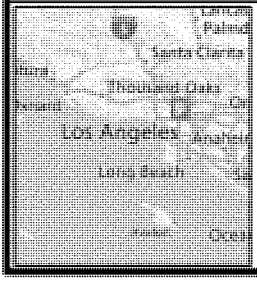
LOS ANGELES RIVER
ECOSYSTEM RESTORATION STUDY

ARBOR AREA AND VICINITY HYDROLOGIC SOIL GROUPS

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 3

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



N

Legend

Watercourse

Levee

Floodwall

Leveed reaches from National Levee Database (NLD) July 2012

0 0.5 1

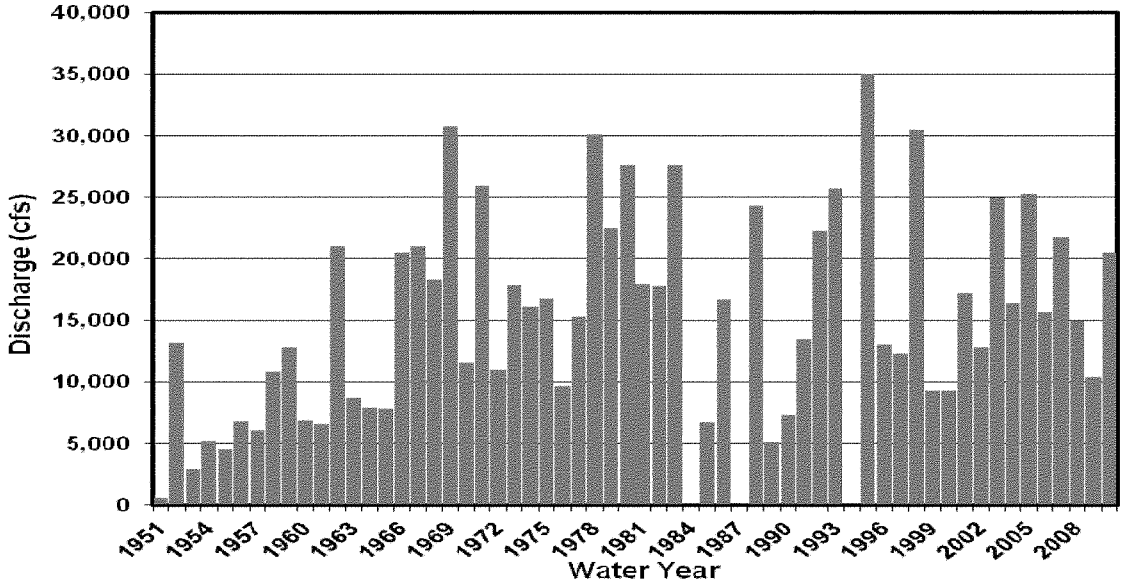
Miles

LOS ANGELES RIVER ECOSYSTEM RESTORATION STUDY

LOS ANGELES RIVER LEVEED REACHES ARBOR AREA

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 4



Peak annual flows for period of record.

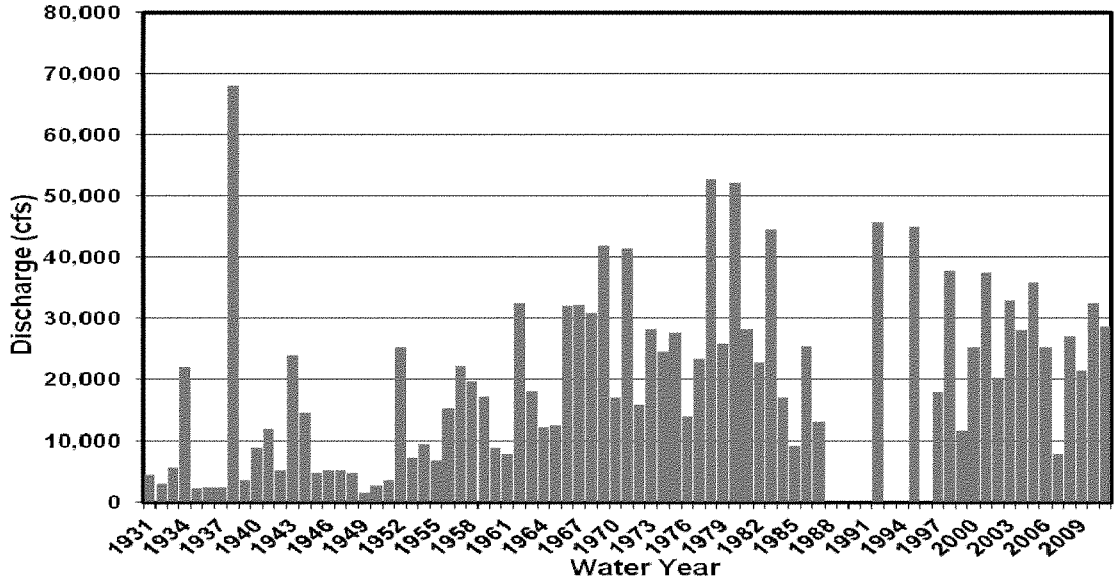
Ref: Los Angeles County Department of Public Works (LACDPW) Gage F300-R; Los Angles River at Tujunga Ave.

LOS ANGELES RIVER
ECOSYSTEM RESTORATION STUDY

LOS ANGELES RIVER AT TUJUNGA AVE.
PERIOD OF RECORD FLOWS

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 5



Peak annual flows for period of record.

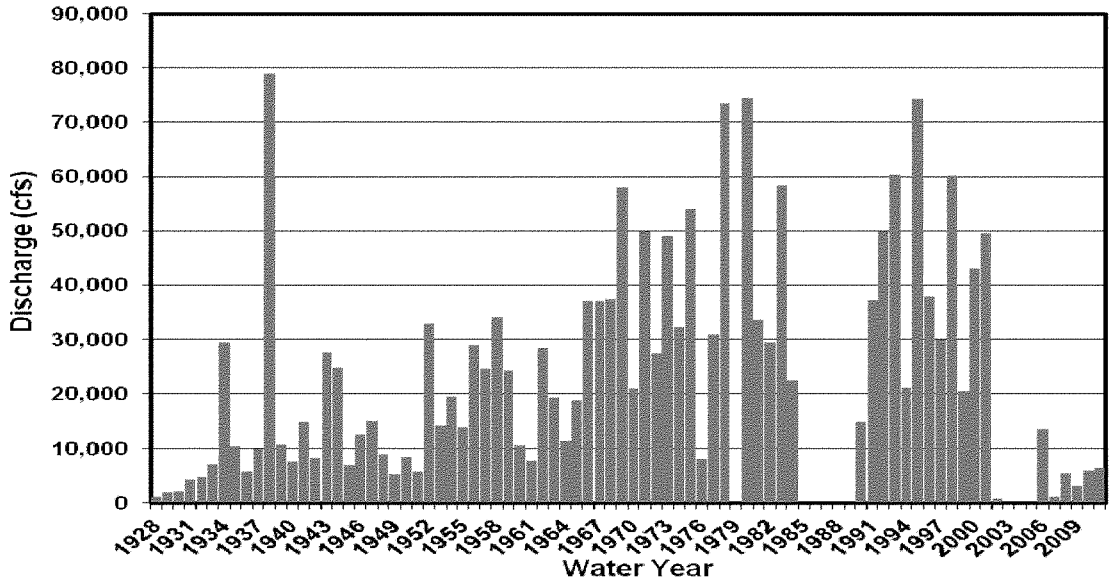
Ref: Los Angeles County Department of Public Works (LACDPW) Gage F57C-R; Los Angles River above Arroyo Seco.

LOS ANGELES RIVER ECOSYSTEM RESTORATION STUDY

LOS ANGELES RIVER ABOVE ARROYO SECO
PERIOD OF RECORD FLOWS

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 6



Peak annual flows for period of record.

Ref: Los Angeles County Department of Public Works (LACDPW) Gage F34D-R; Los Angles River below Firestone Blvd.

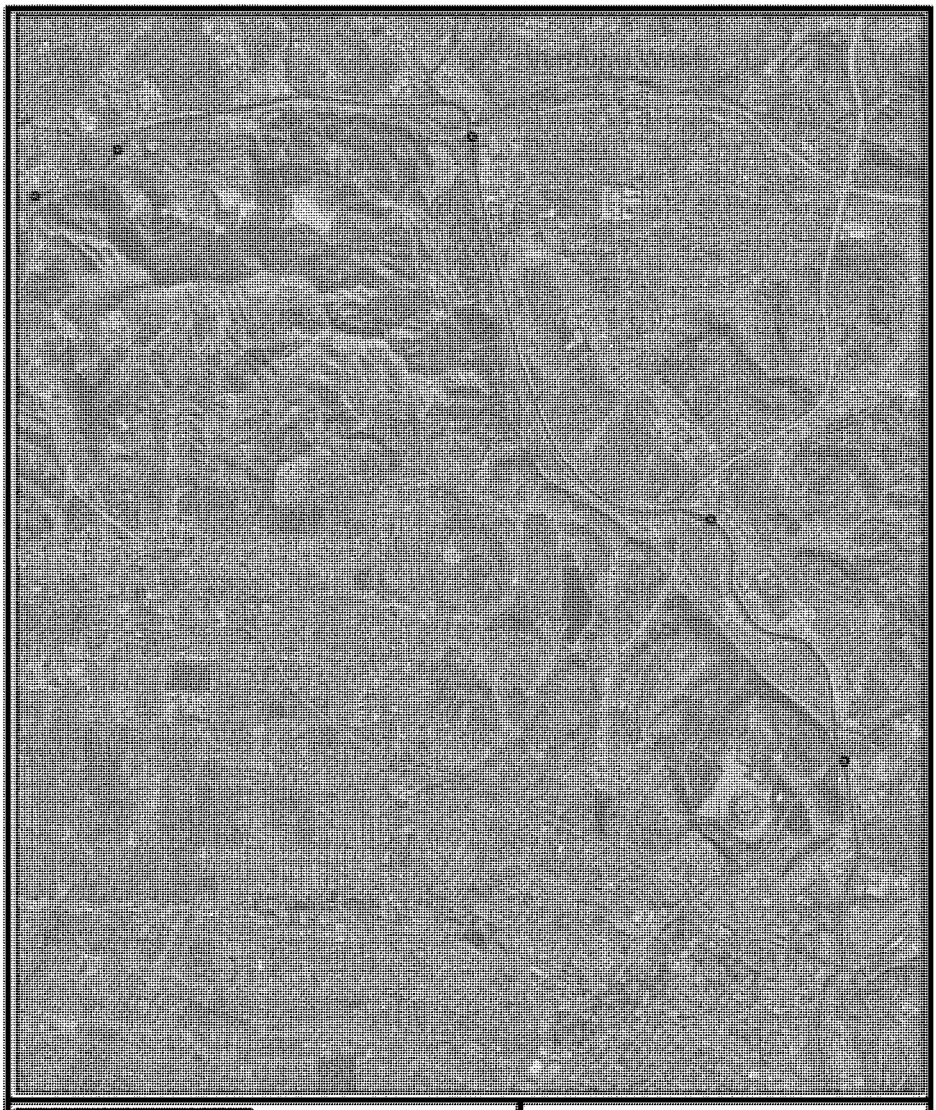
LOS ANGELES RIVER
ECOSYSTEM RESTORATION STUDY

LOS ANGELES RIVER BELOW FIRESTONE BLVD.
PERIOD OF RECORD FLOWS

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 7

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



N Legend

Watercourse

Design Discharge

0 0.5 1

Miles

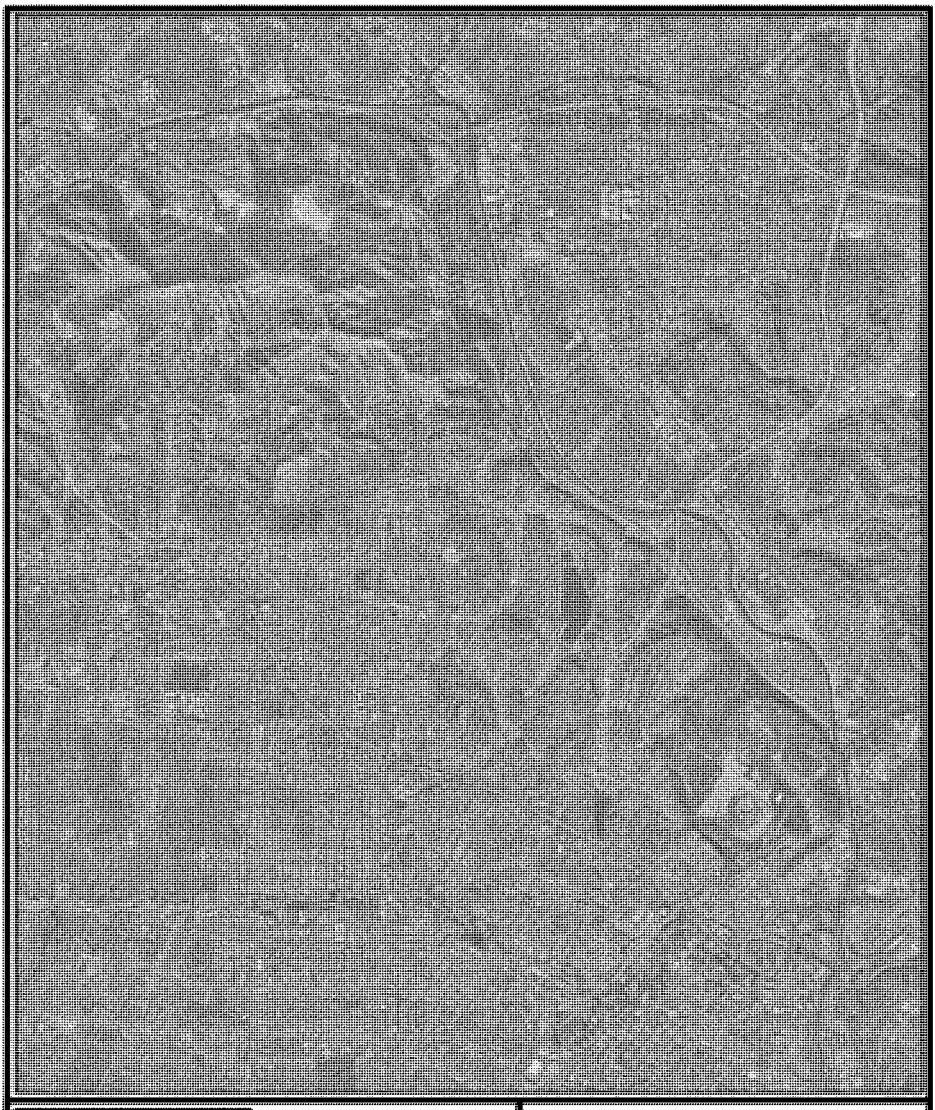
LOS ANGELES RIVER
ECOSYSTEM RESTORATION STUDY

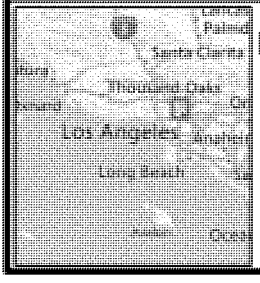
LOS ANGELES RIVER DESIGN DISCHARGE ARBOR AREA

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 8

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS





N Legend

Watercourse

Design Velocity

0 0.5 1

Miles

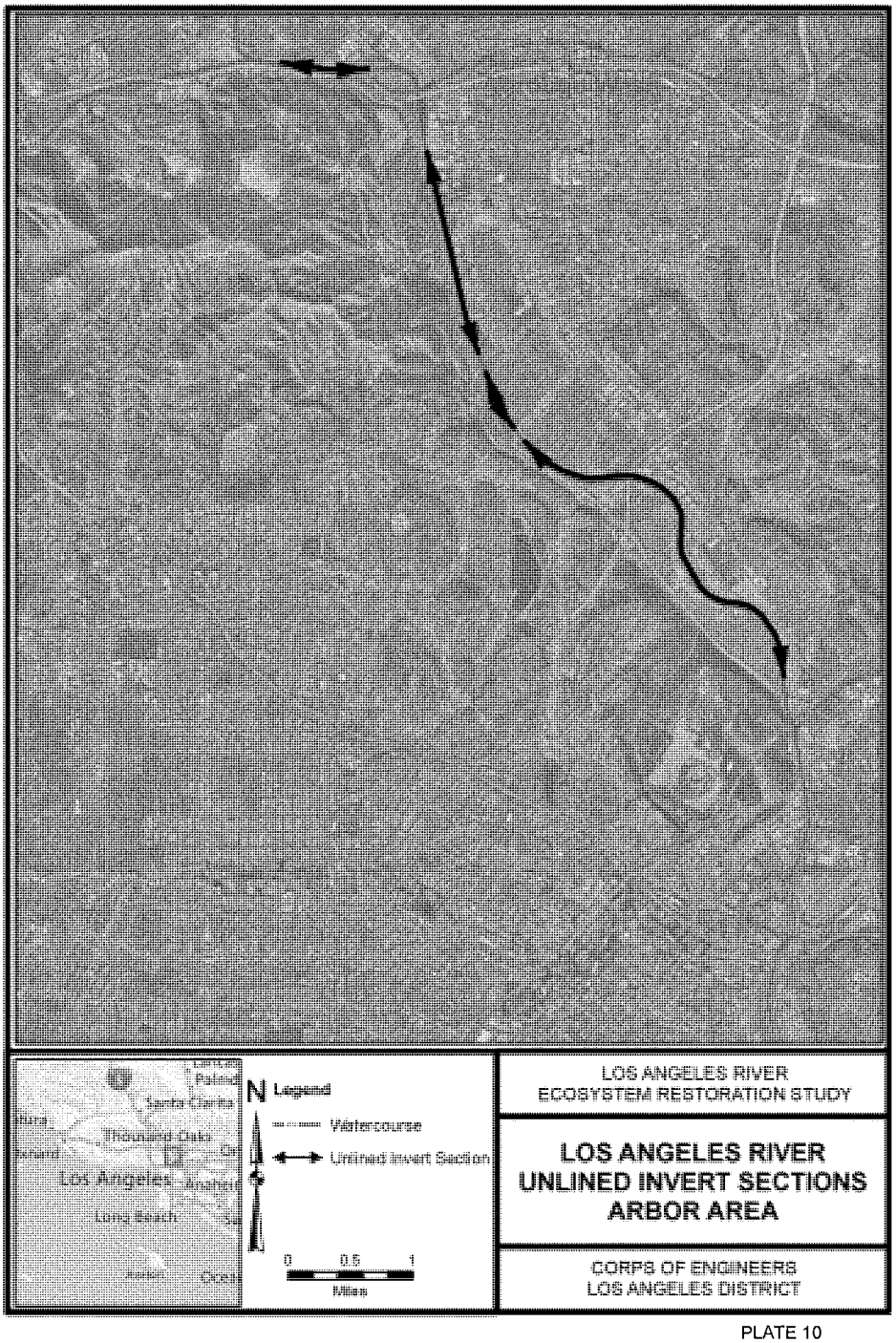
LOS ANGELES RIVER
ECOSYSTEM RESTORATION STUDY

LOS ANGELES RIVER DESIGN VELOCITY ARBOR AREA

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 9

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



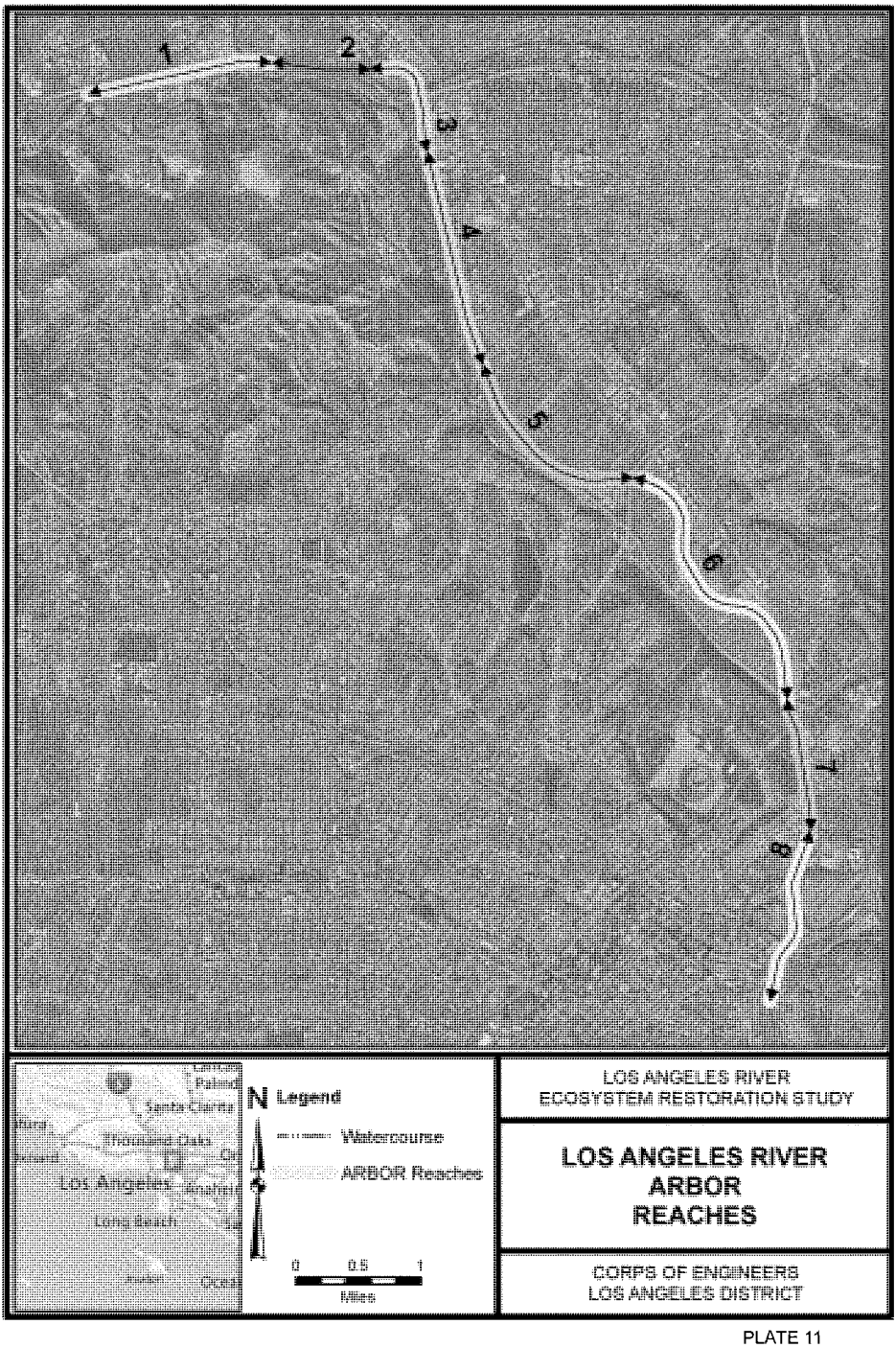
LOS ANGELES RIVER
ECOSYSTEM RESTORATION STUDY

LOS ANGELES RIVER UNLINED INVERT SECTIONS ARBOR AREA

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 10

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



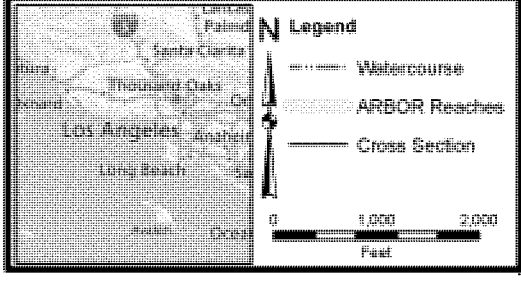
LOS ANGELES RIVER
ECOSYSTEM RESTORATION STUDY

LOS ANGELES RIVER ARBOR REACHES

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 11

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



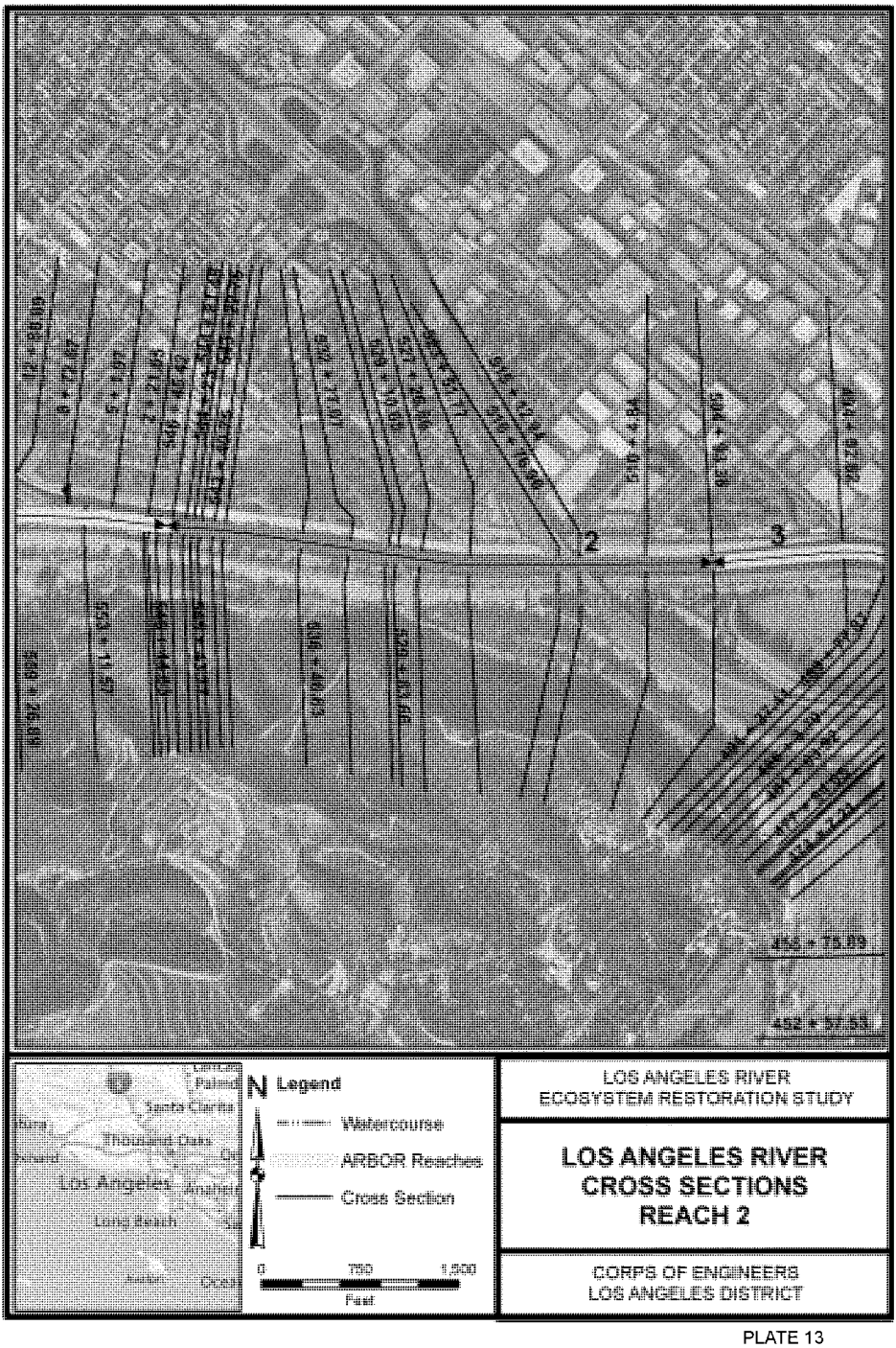
LOS ANGELES RIVER
ECOSYSTEM RESTORATION STUDY

LOS ANGELES RIVER CROSS SECTIONS REACH 1

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 12

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



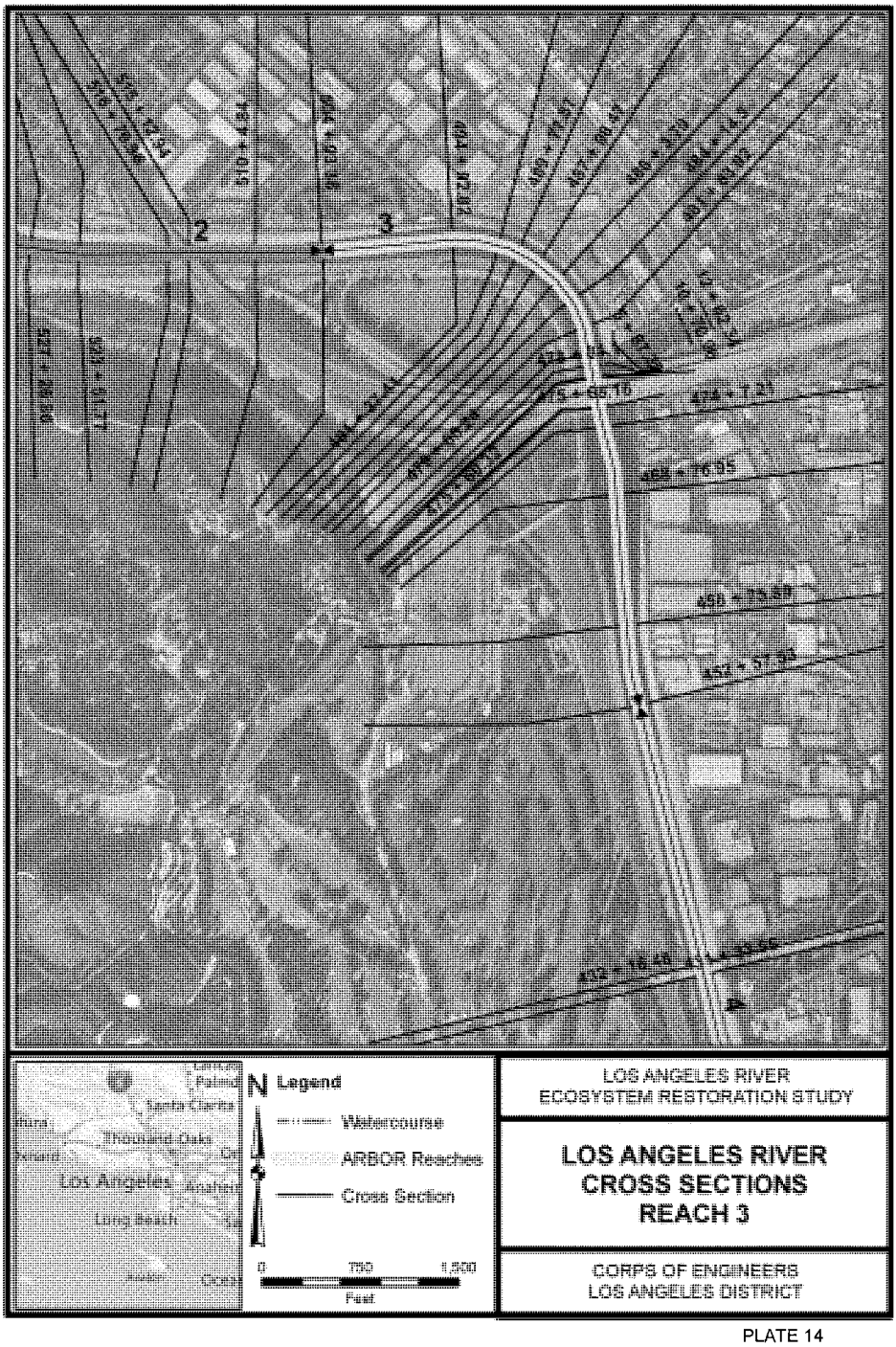
LOS ANGELES RIVER
ECOSYSTEM RESTORATION STUDY

LOS ANGELES RIVER CROSS SECTIONS REACH 2

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 13

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



LOS ANGELES RIVER ECOSYSTEM RESTORATION STUDY

LOS ANGELES RIVER CROSS SECTIONS REACH 3

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 14

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS

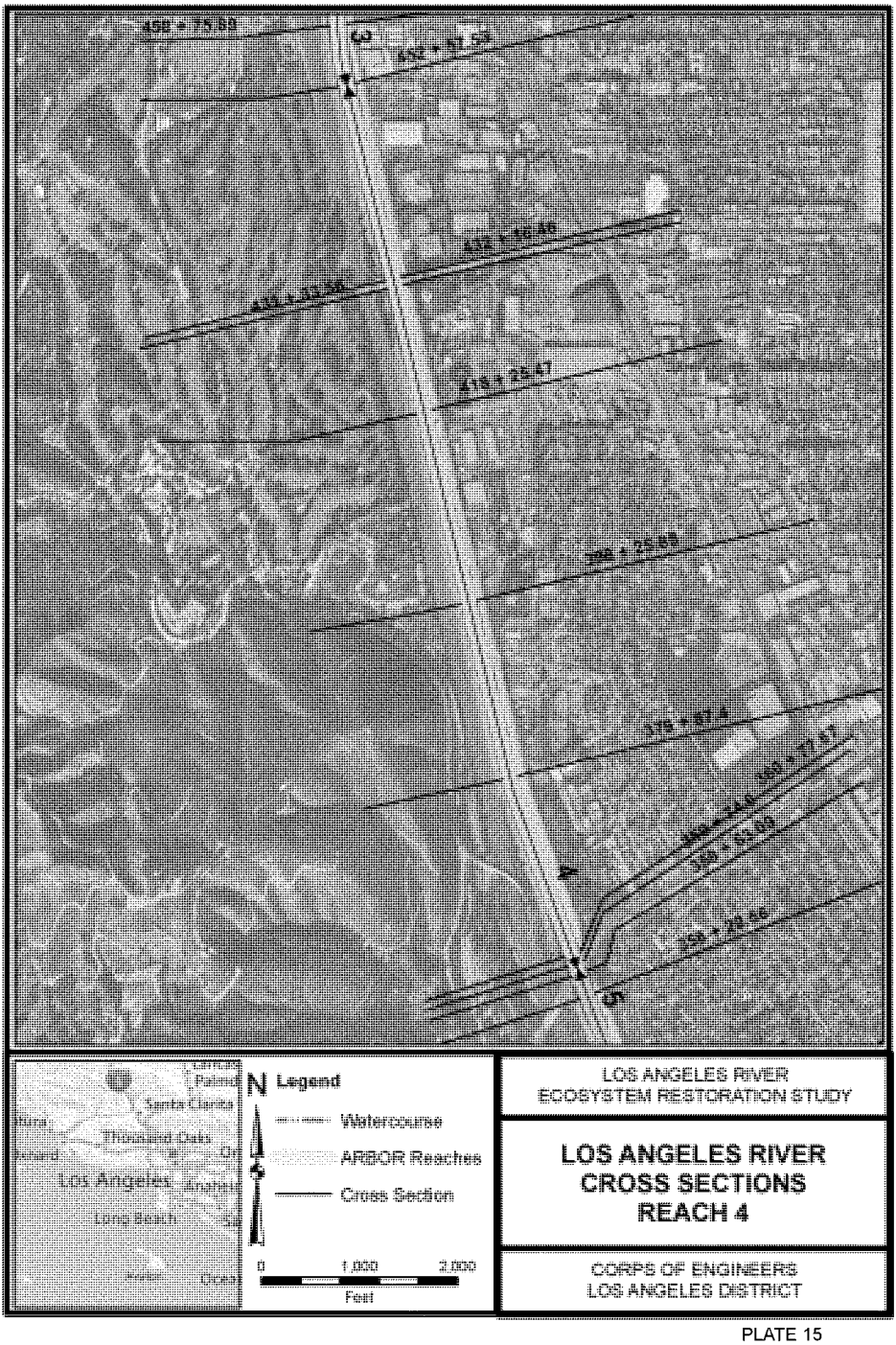


PLATE 15

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS

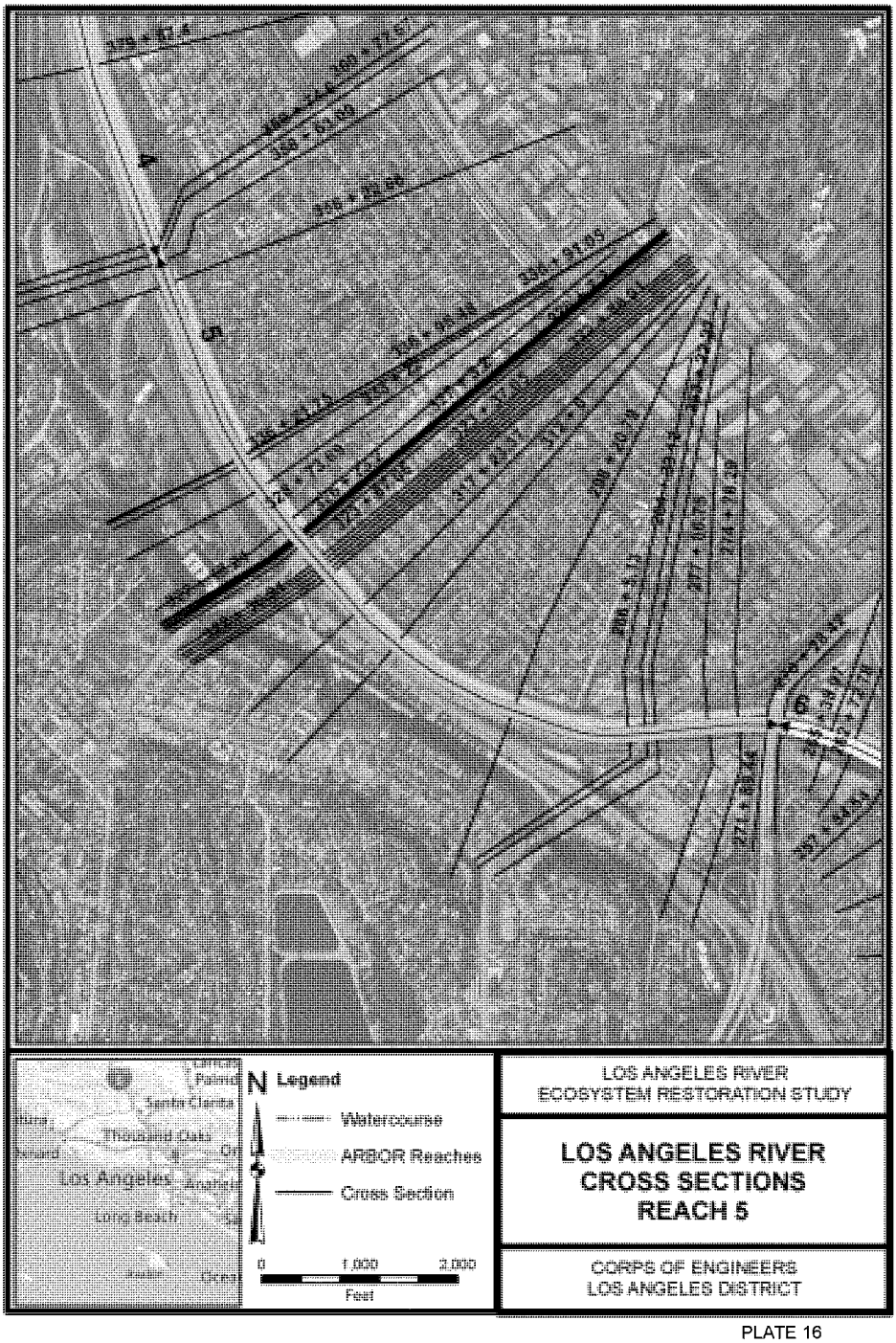


PLATE 16

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS

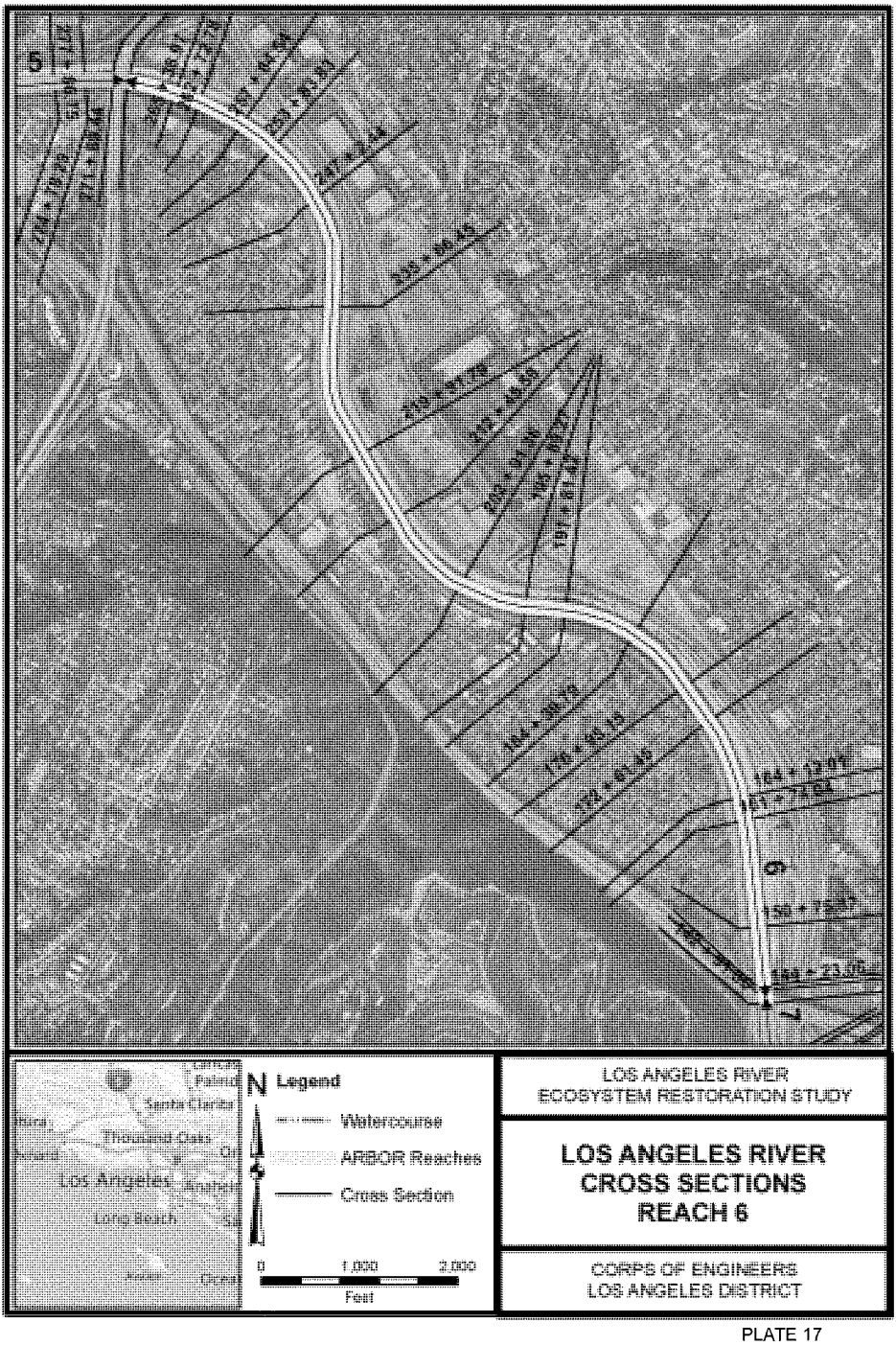


PLATE 17

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS

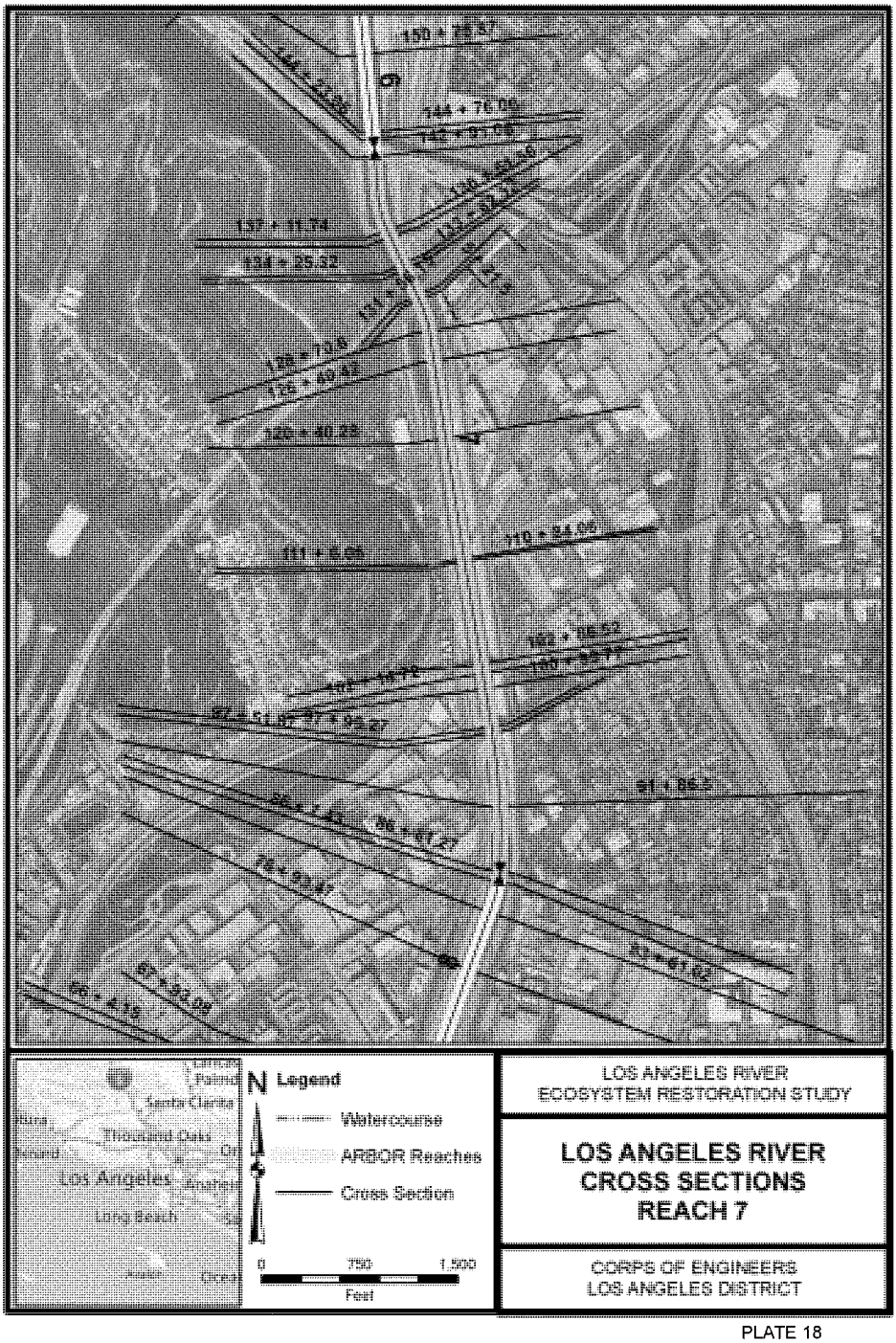


PLATE 18

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS

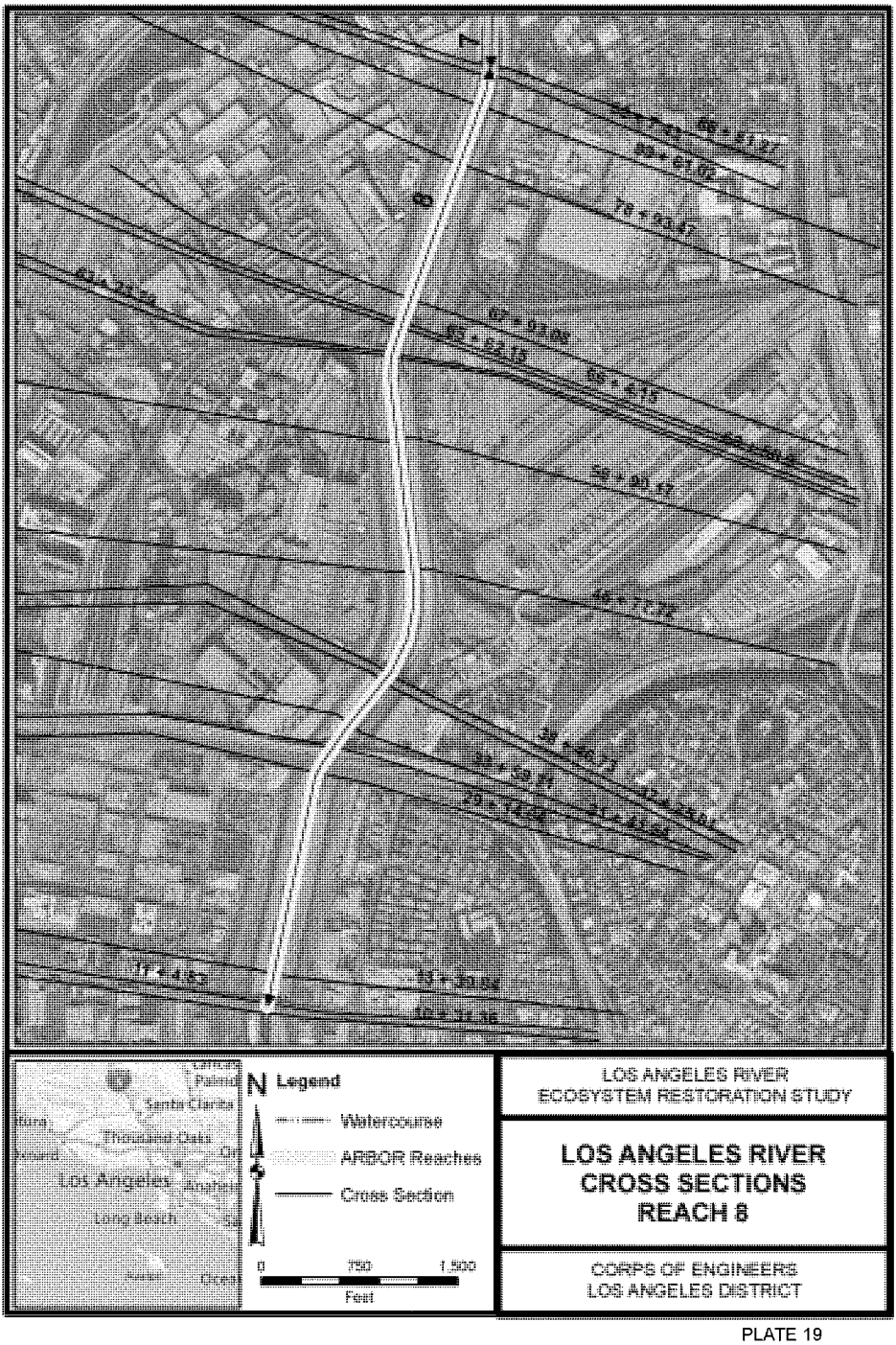
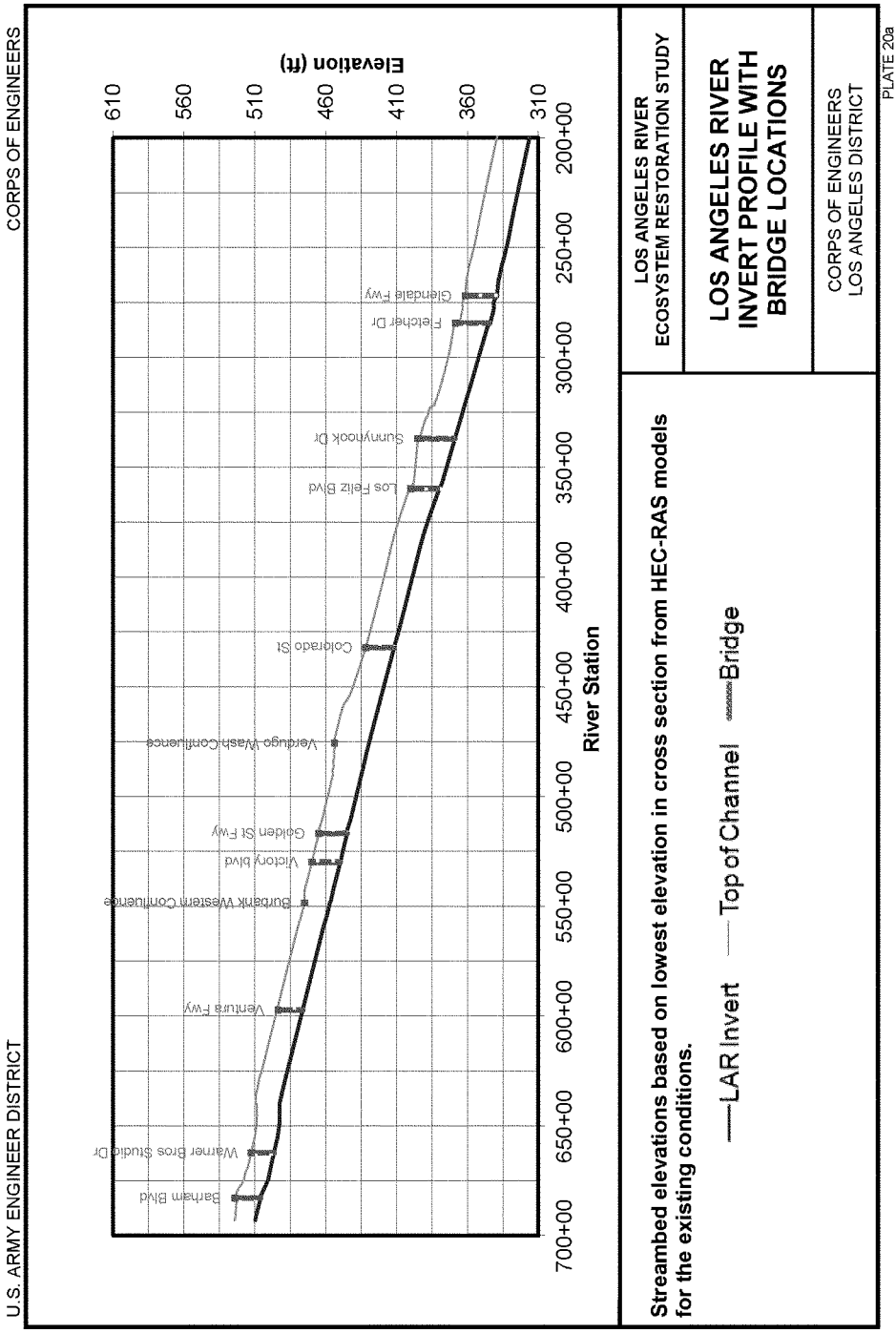
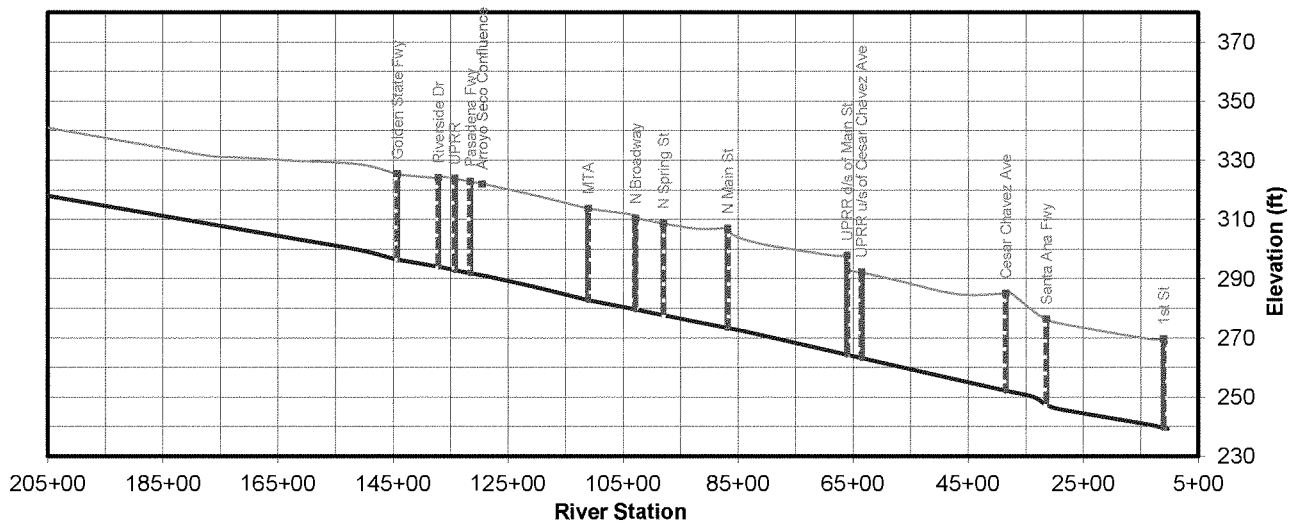


PLATE 19


U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
Elevation (ft)
610
560
510
460
410
360
310
River Station
700+00
650+00
600+00
550+00
500+00
450+00
400+00
350+00
300+00
250+00
200+00
Barham Blvd
Warner Bros Studio Dr
Ventura Fwy
Burbank Western Confluence
Victory blvd
Golden St Fwy
Verdugo Wash Confluence
Colorado St
Los Feliz Blvd
Sunnynook Dr
Fletcher Dr
Glendale Fwy
Streambed elevations based on lowest elevation in cross section from HEC-RAS models for the existing conditions.
LAR Invert
Top of Channel
Bridge
LOS ANGELES RIVER ECOSYSTEM RESTORATION STUDY
LOS ANGELES RIVER INVERT PROFILE WITH BRIDGE LOCATIONS
CORPS OF ENGINEERS
LOS ANGELES DISTRICT
PLATE 20a



Streambed elevations based on lowest elevation in cross section from HEC-RAS models for the existing conditions.

—LAR Invert —Top of Channel —Bridge

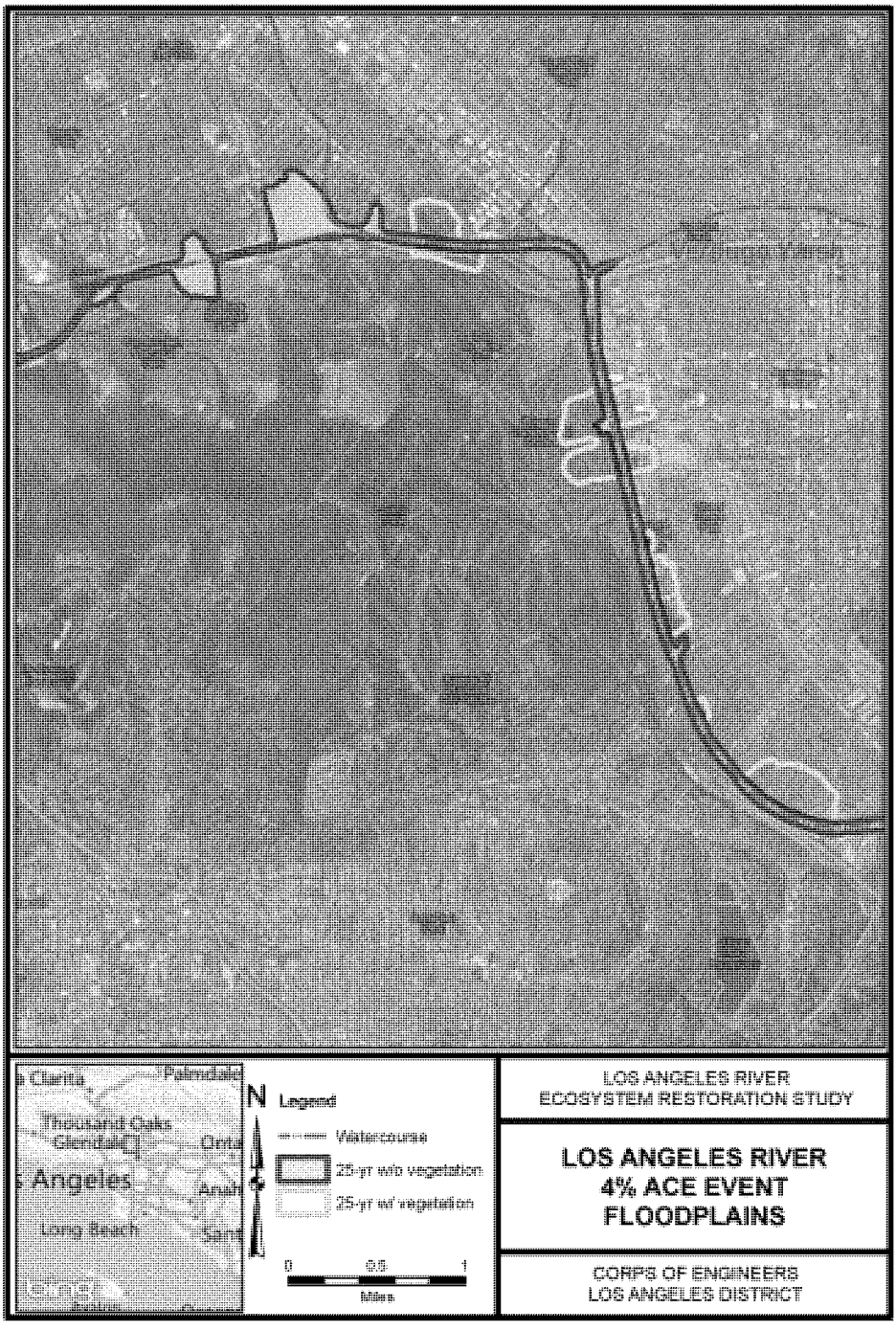
LOS ANGELES RIVER ECOSYSTEM RESTORATION STUDY

LOS ANGELES RIVER INVERT PROFILE WITH BRIDGE LOCATIONS

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 20b

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



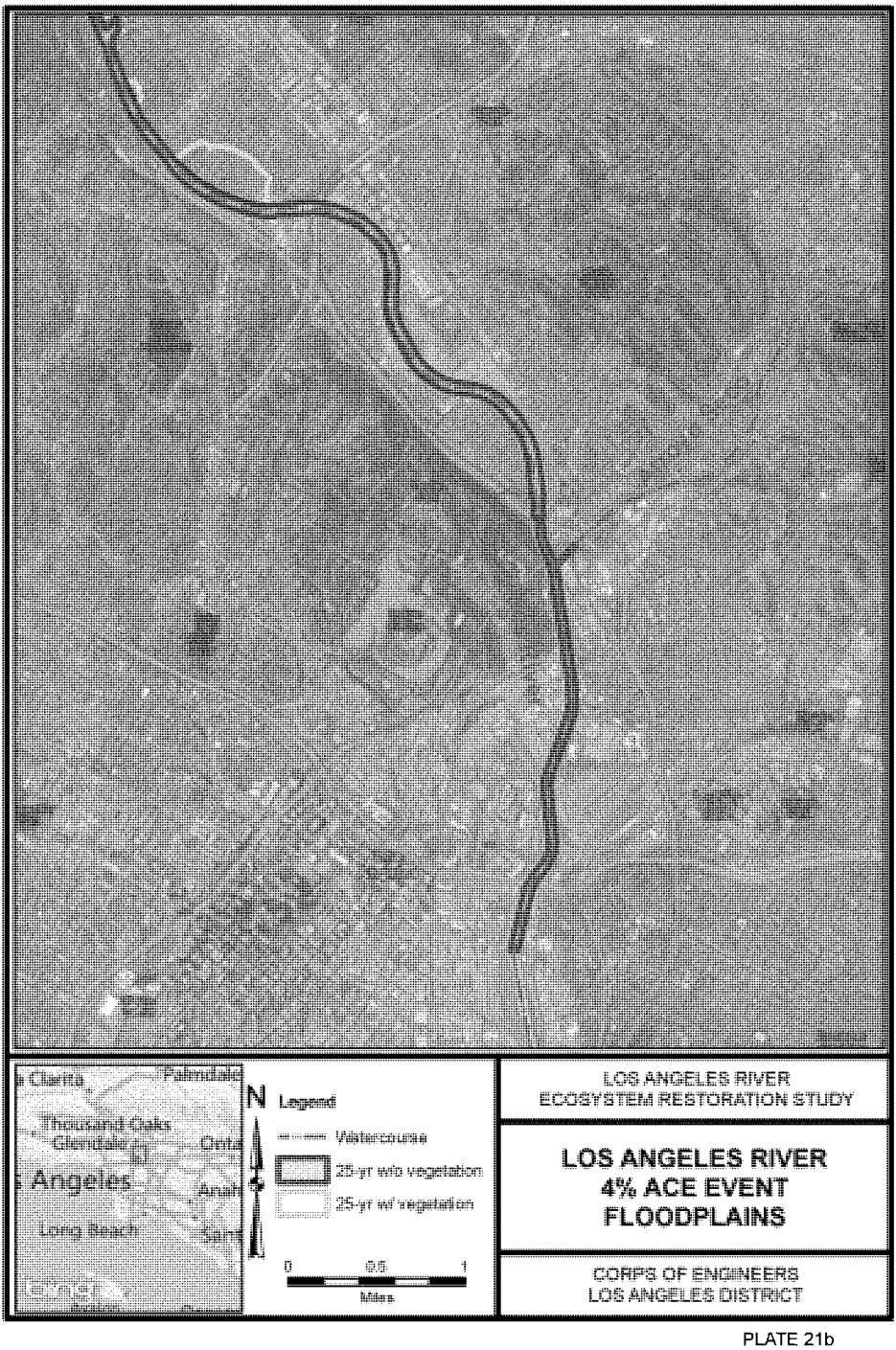
LOS ANGELES RIVER
ECOSYSTEM RESTORATION STUDY

LOS ANGELES RIVER
4% ACE EVENT
FLOODPLAINS

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 21a

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



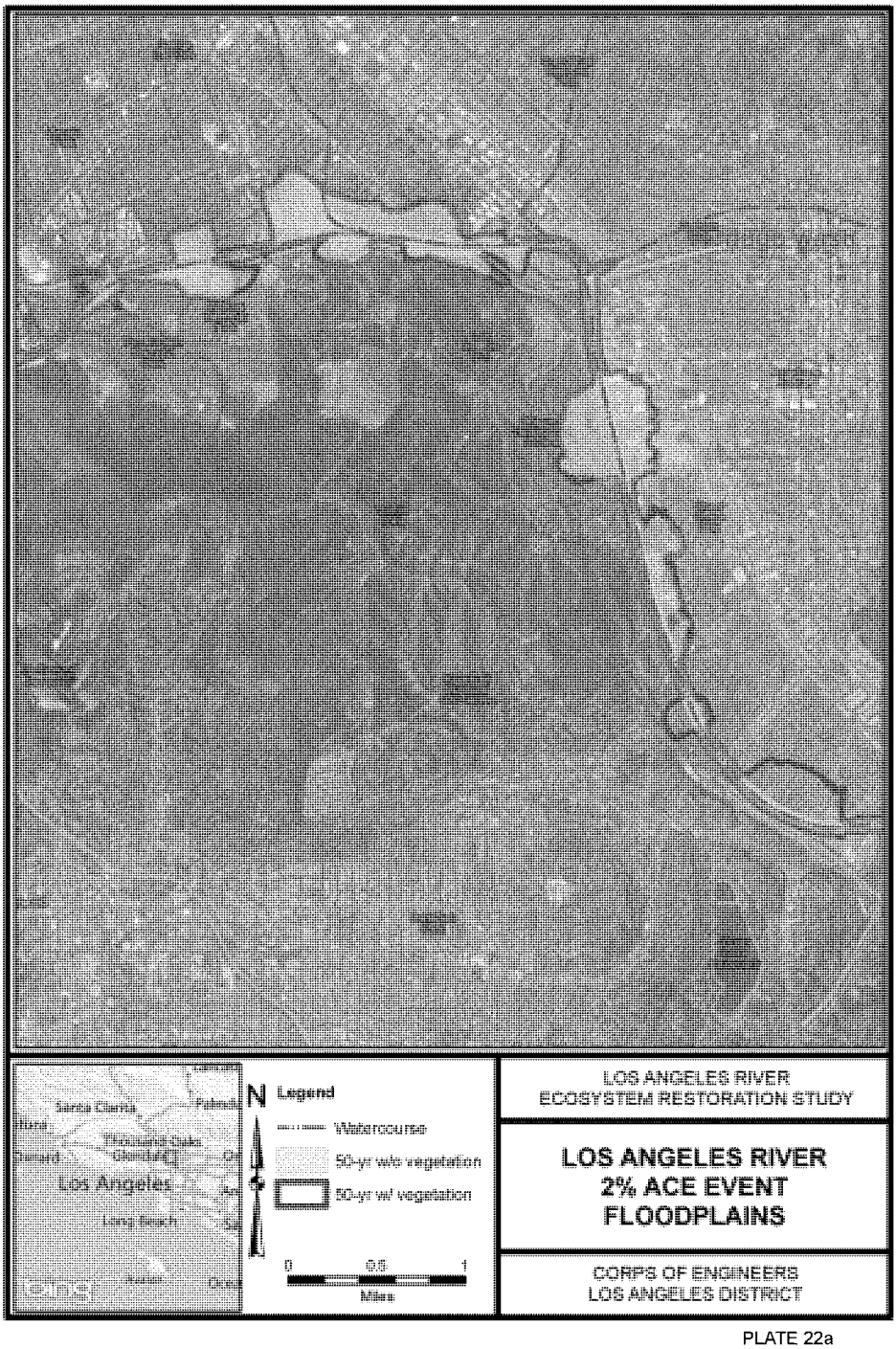
LOS ANGELES RIVER
ECOSYSTEM RESTORATION STUDY

LOS ANGELES RIVER
4% ACE EVENT
FLOODPLAINS

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 21b

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



LOS ANGELES RIVER
ECOSYSTEM RESTORATION STUDY

LOS ANGELES RIVER
2% ACE EVENT
FLOODPLAINS

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 22a

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS

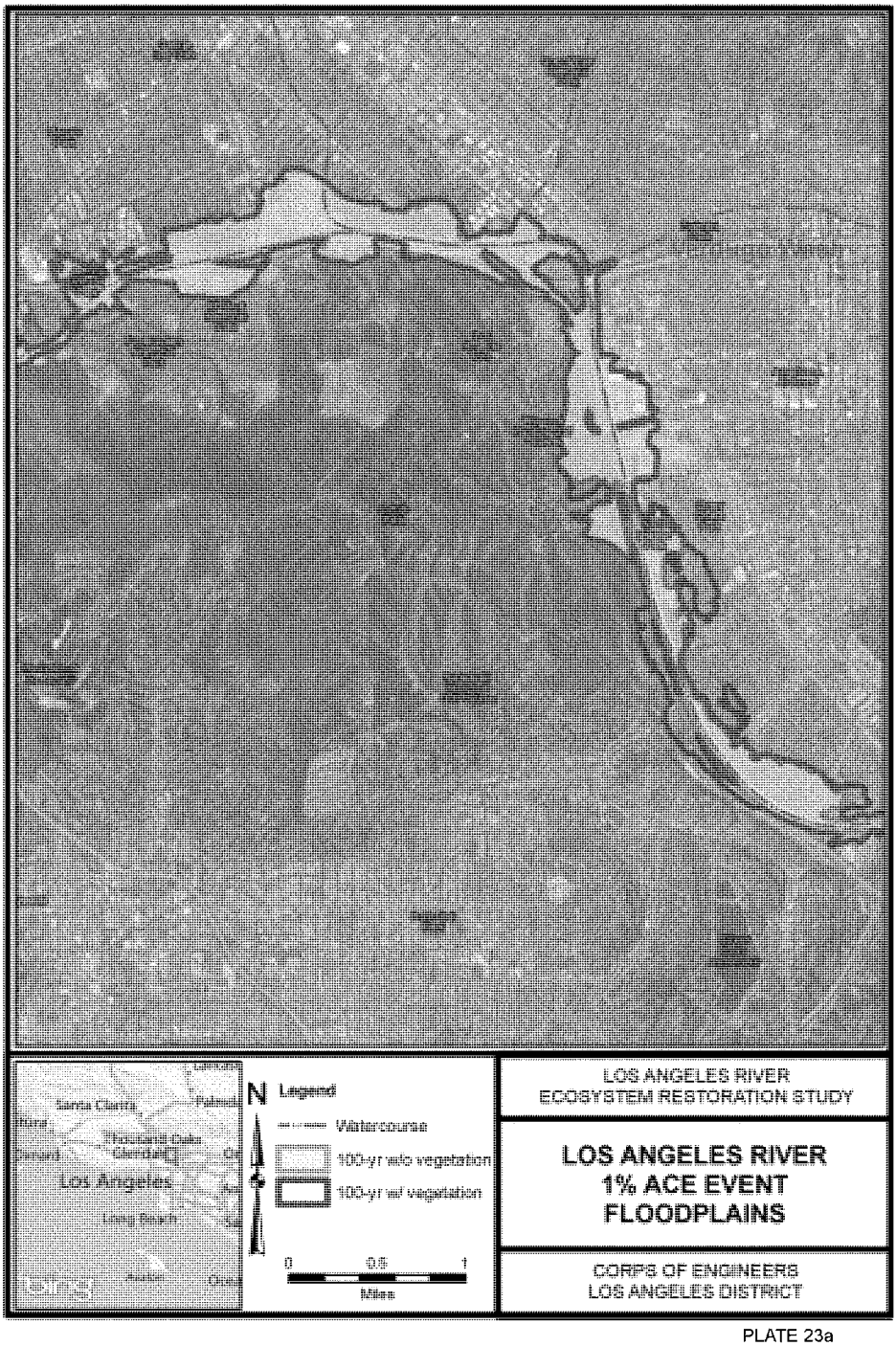
LOS ANGELES RIVER
ECOSYSTEM RESTORATION STUDY

LOS ANGELES RIVER
2% ACE EVENT
FLOODPLAINS

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 22b

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



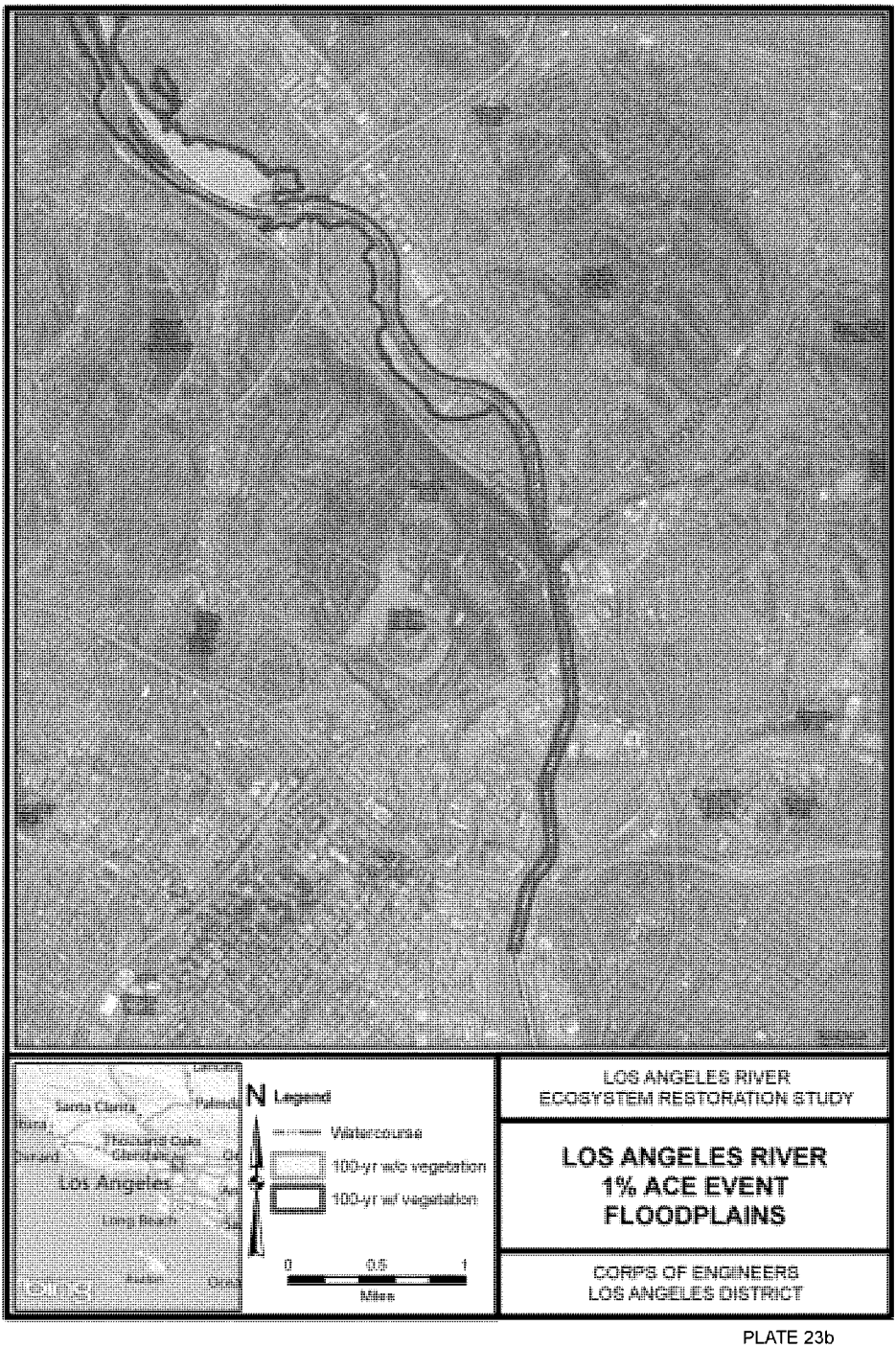
LOS ANGELES RIVER
ECOSYSTEM RESTORATION STUDY

LOS ANGELES RIVER
1% ACE EVENT
FLOODPLAINS

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 23a

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



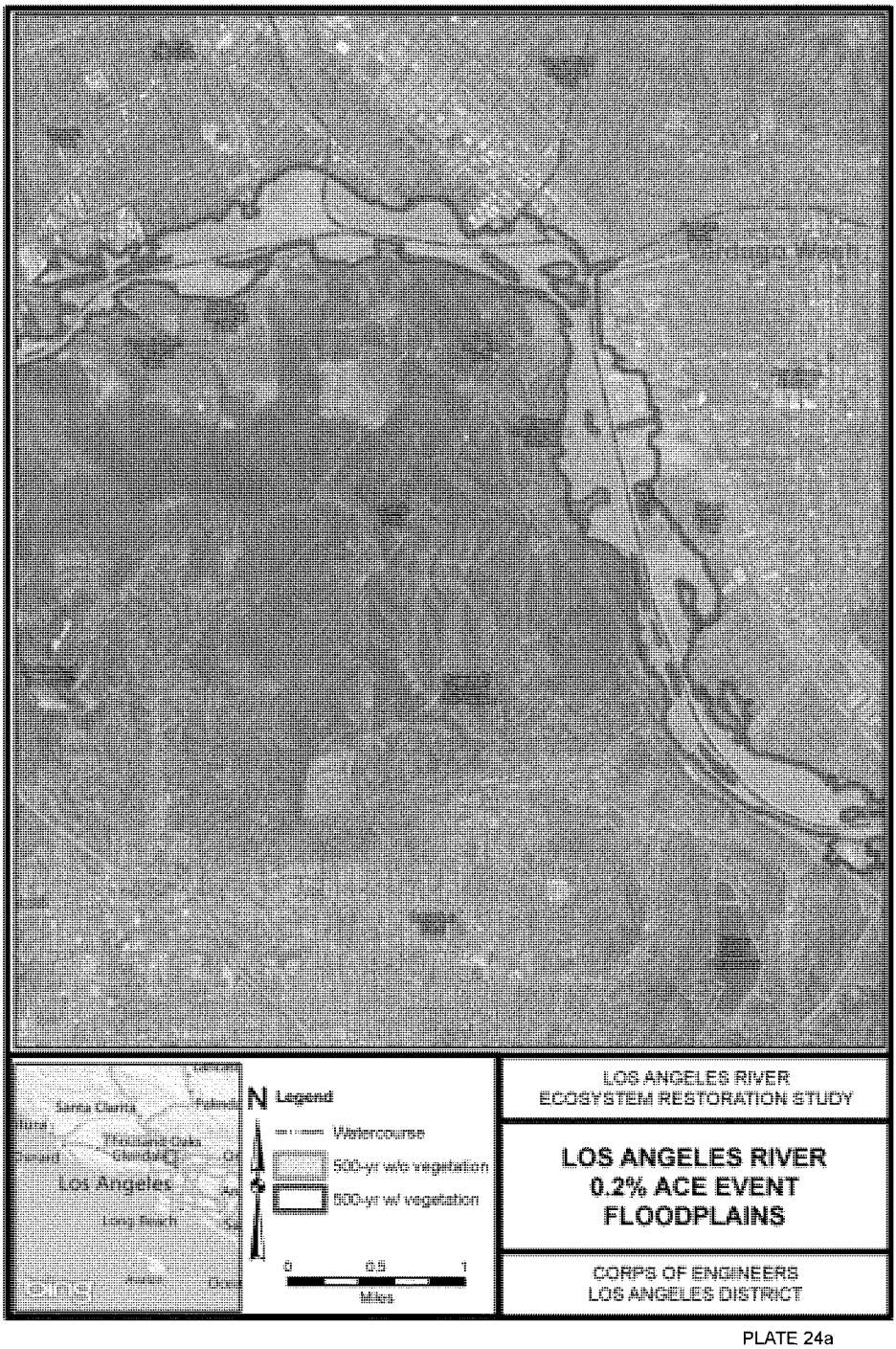
LOS ANGELES RIVER
ECOSYSTEM RESTORATION STUDY

LOS ANGELES RIVER
1% ACE EVENT
FLOODPLAINS

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 23b

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



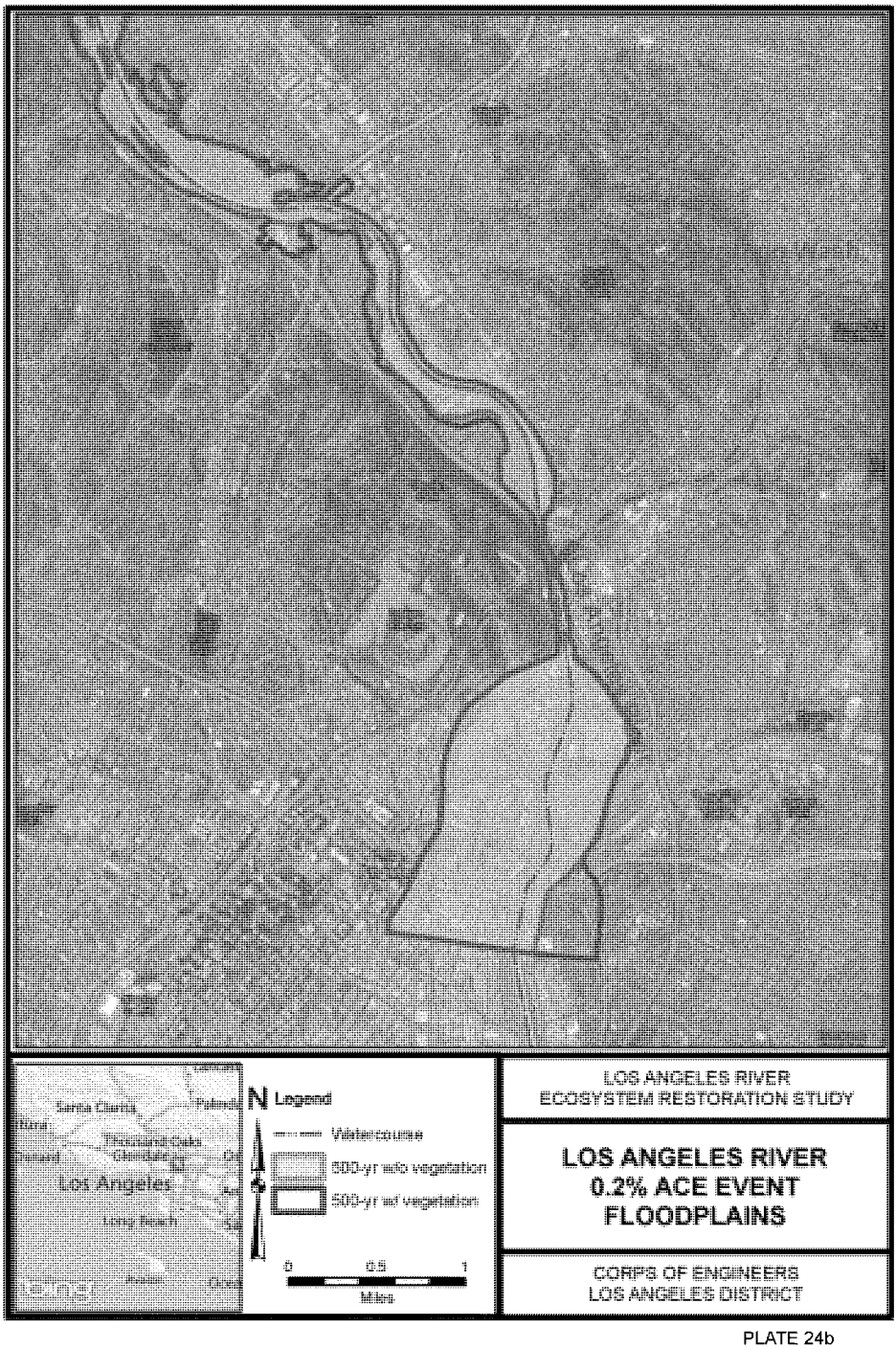
LOS ANGELES RIVER
ECOSYSTEM RESTORATION STUDY

LOS ANGELES RIVER
0.2% ACE EVENT
FLOODPLAINS

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 24a

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



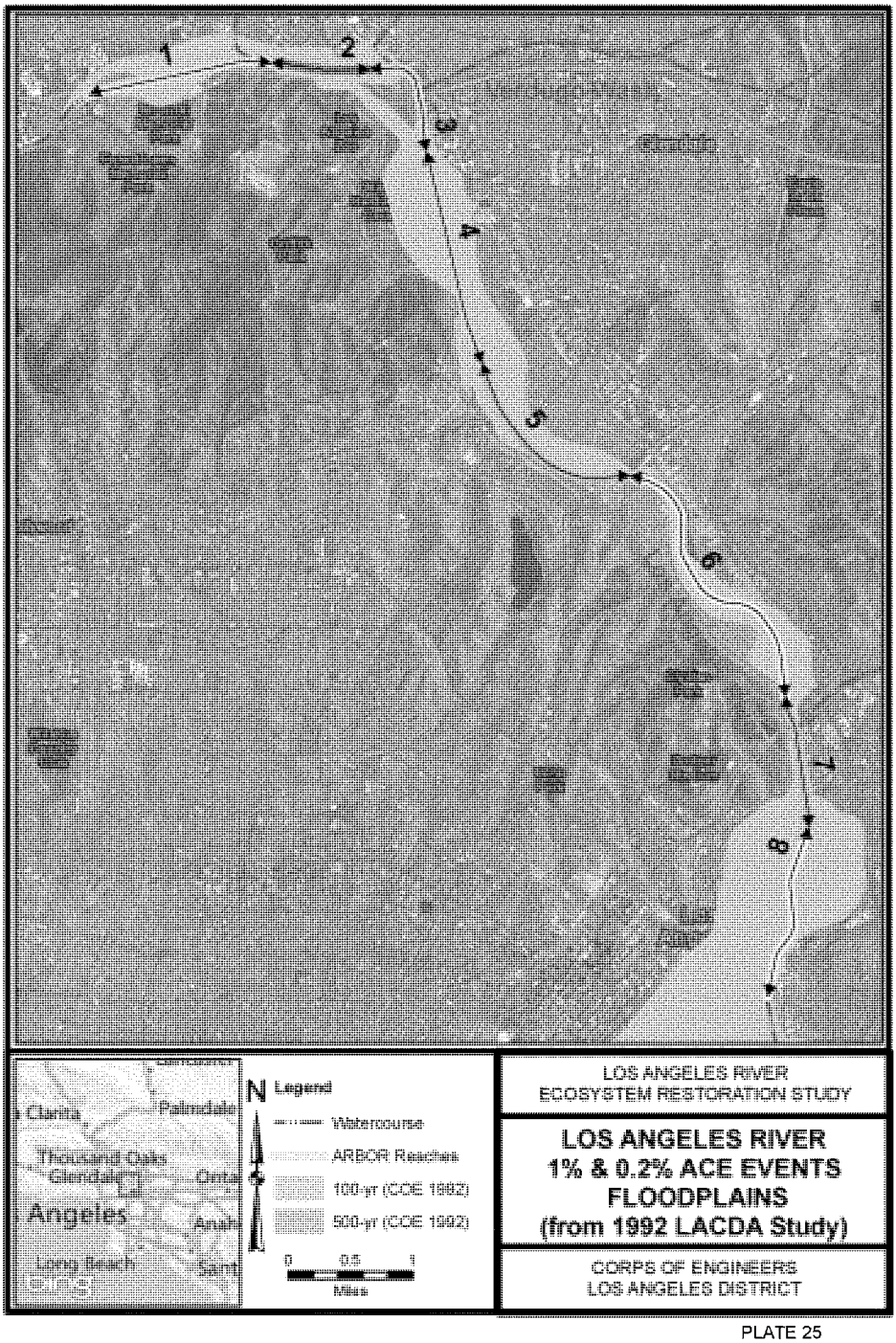
LOS ANGELES RIVER
ECOSYSTEM RESTORATION STUDY

LOS ANGELES RIVER
0.2% ACE EVENT
FLOODPLAINS

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 24b

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



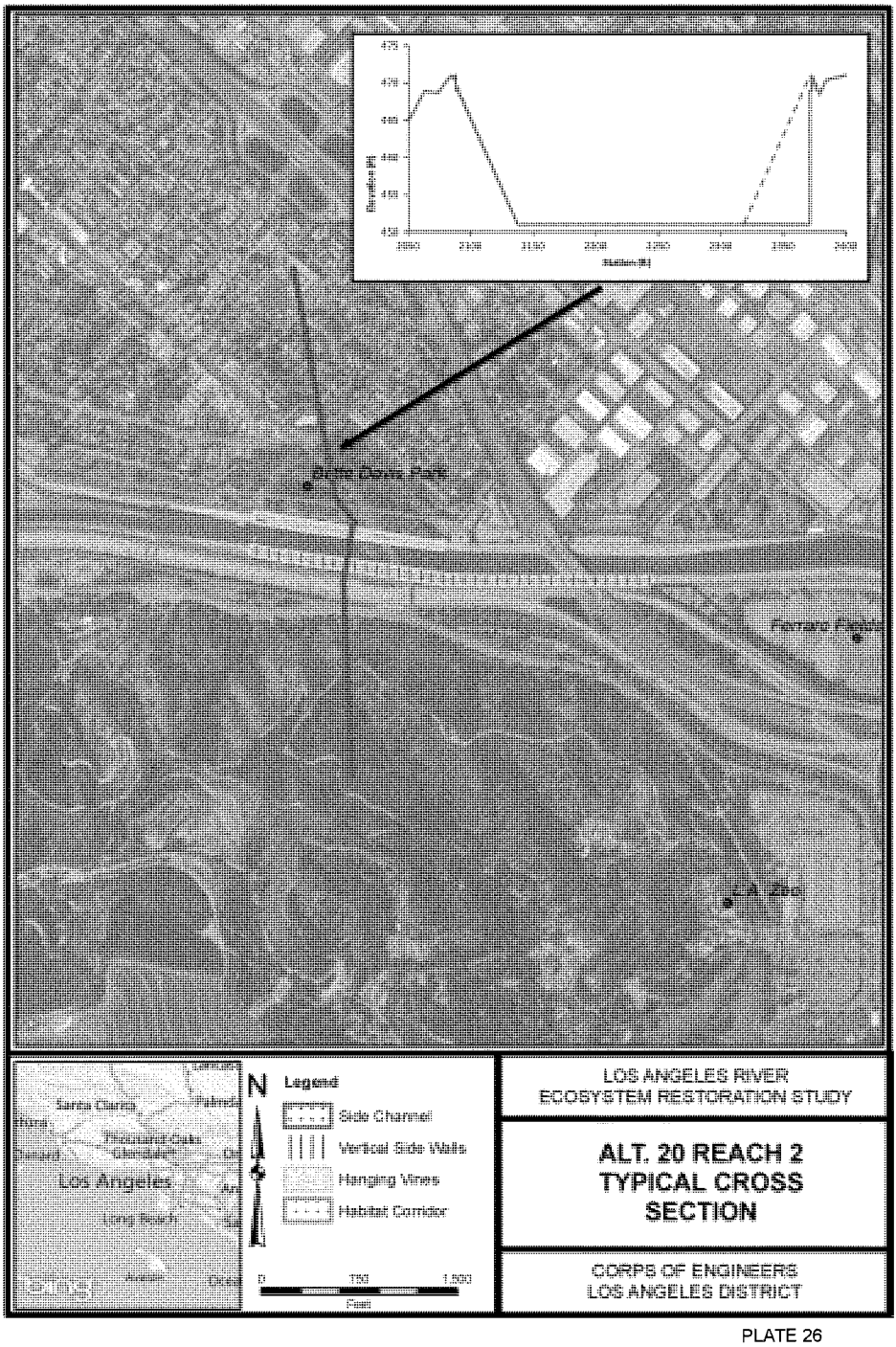
LOS ANGELES RIVER
ECOSYSTEM RESTORATION STUDY

LOS ANGELES RIVER
1% & 0.2% ACE EVENTS
FLOODPLAINS
(from 1992 LACDA Study)

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 25

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



LOS ANGELES RIVER
ECOSYSTEM RESTORATION STUDY

ALT. 20 REACH 2
TYPICAL CROSS SECTION

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 26

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS

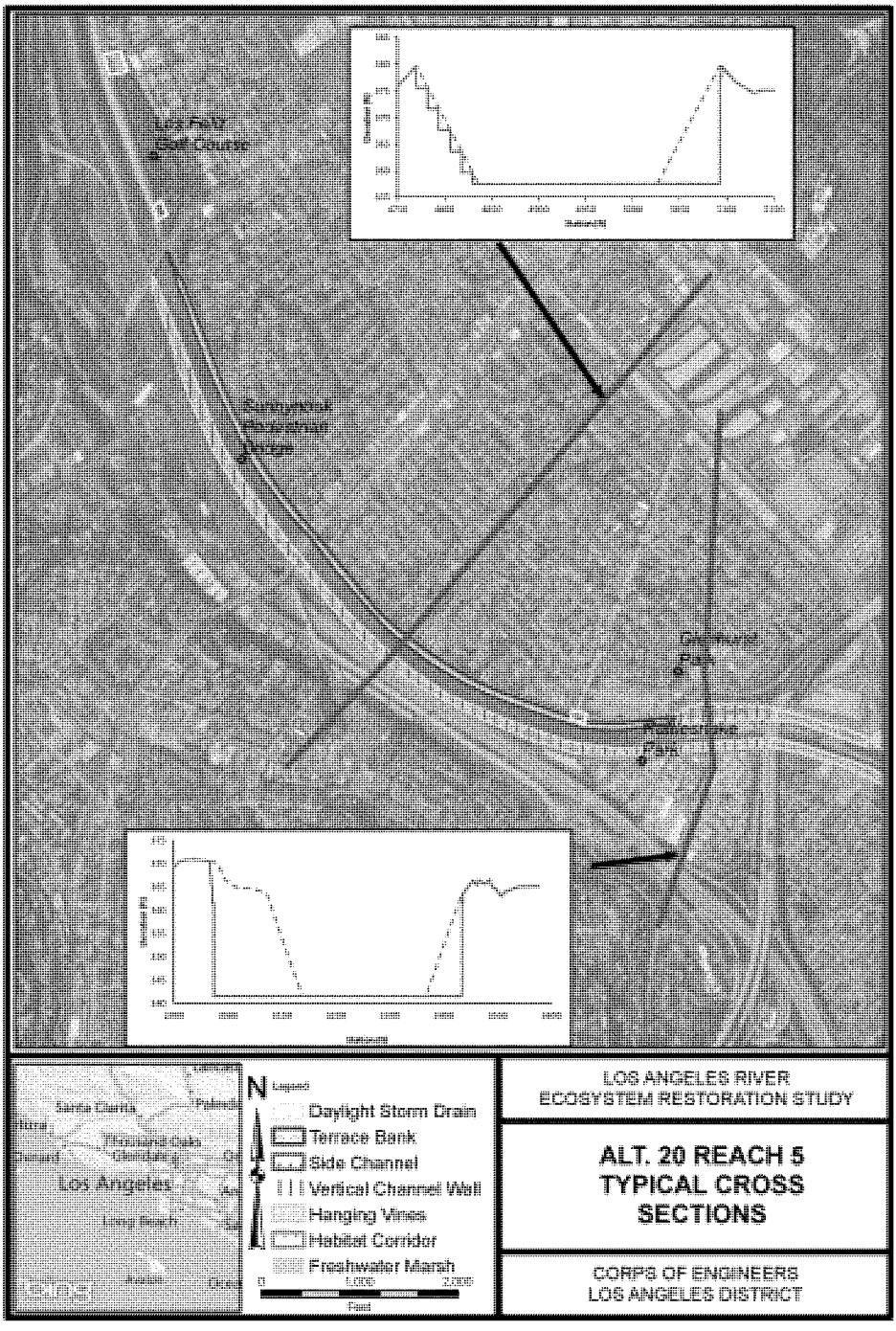
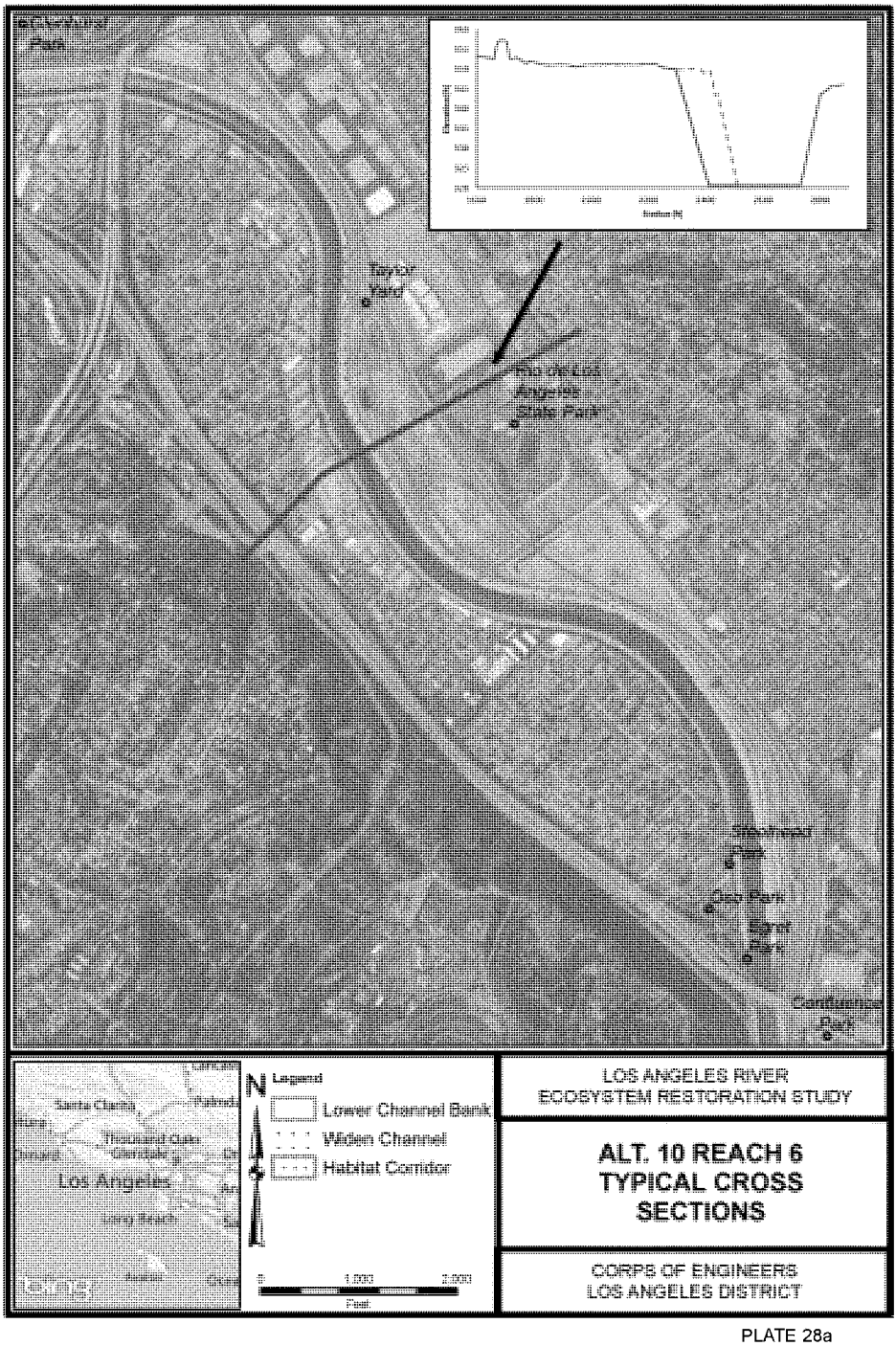


PLATE 27

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



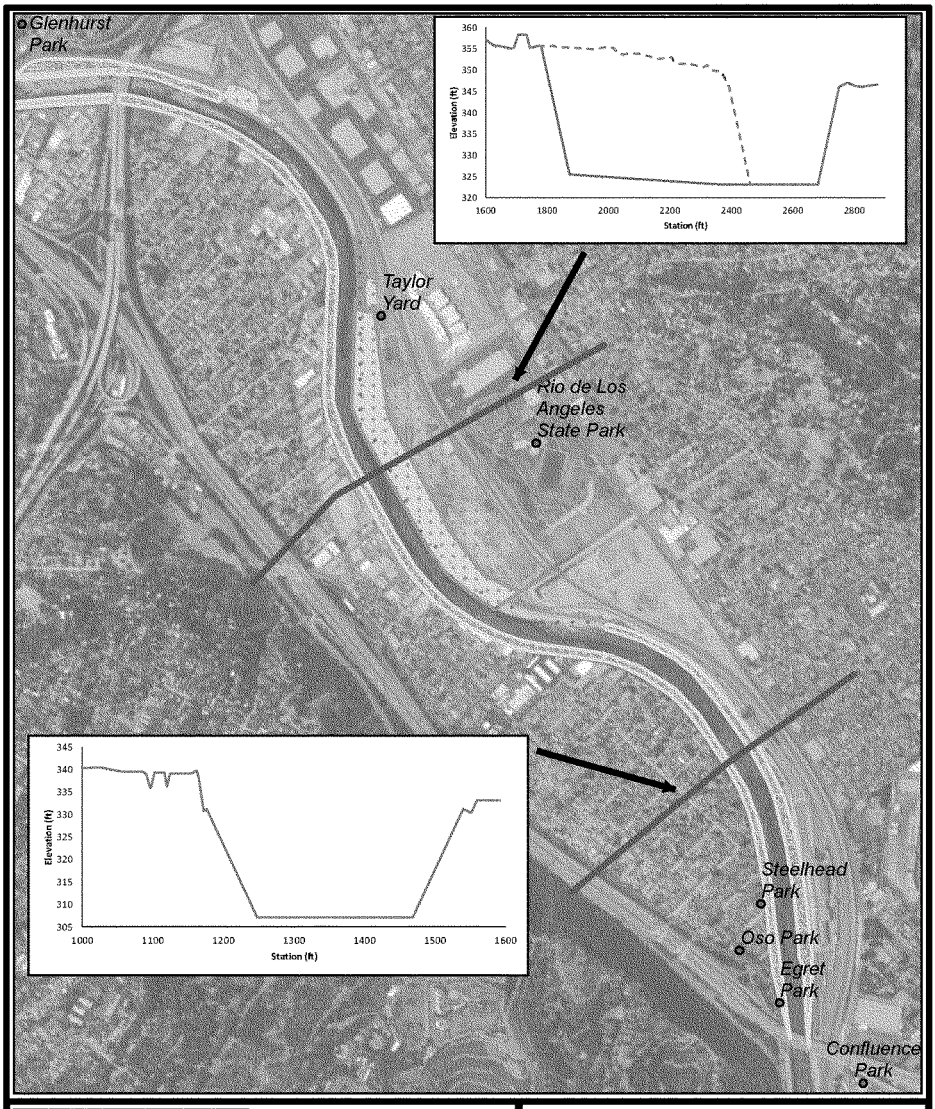
LOS ANGELES RIVER
ECOSYSTEM RESTORATION STUDY

ALT. 10 REACH 6 TYPICAL CROSS SECTIONS

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 28a

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



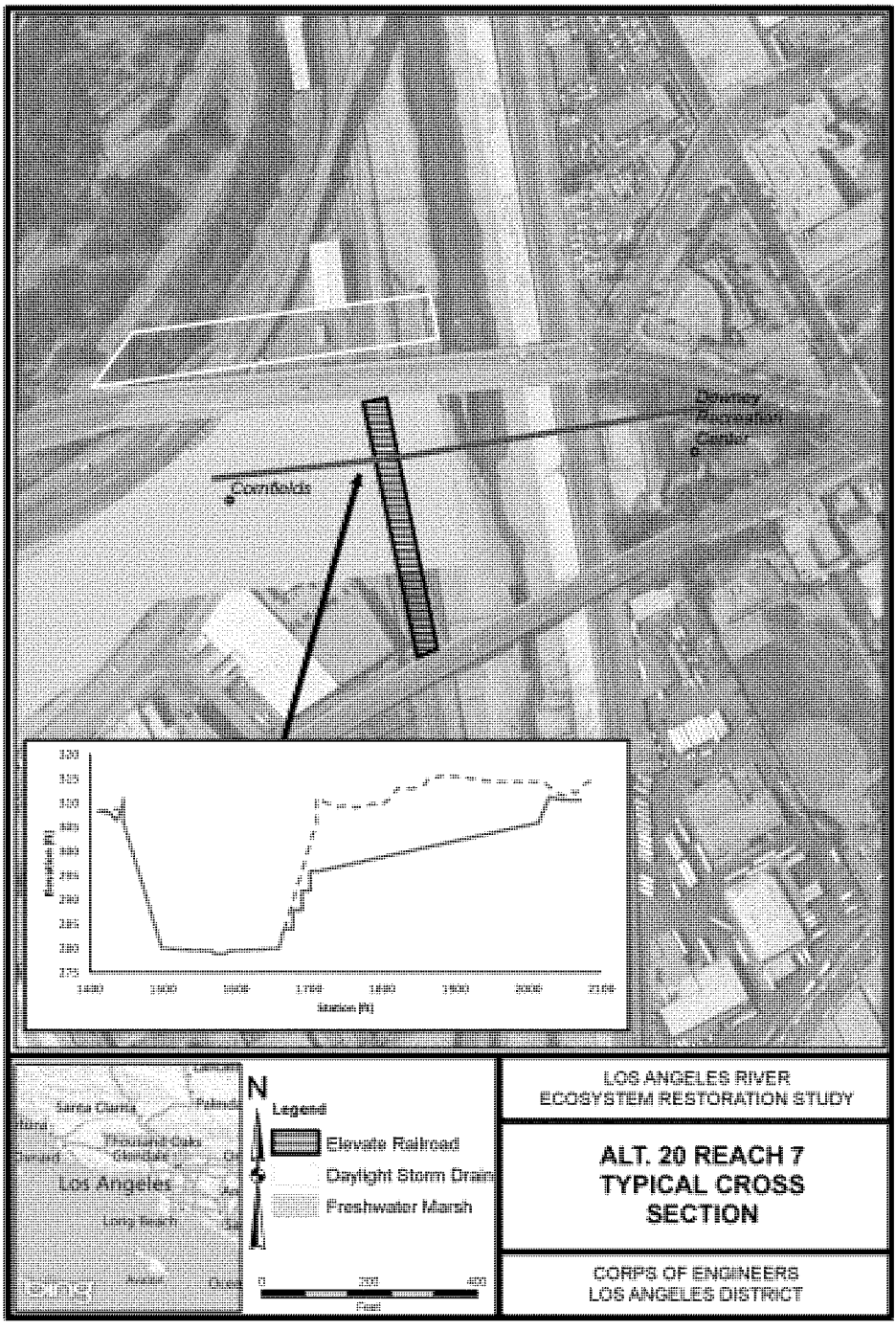
LOS ANGELES RIVER
ECOSYSTEM RESTORATION STUDY

ALT. 20 REACH 6
TYPICAL CROSS SECTIONS

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 28b

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



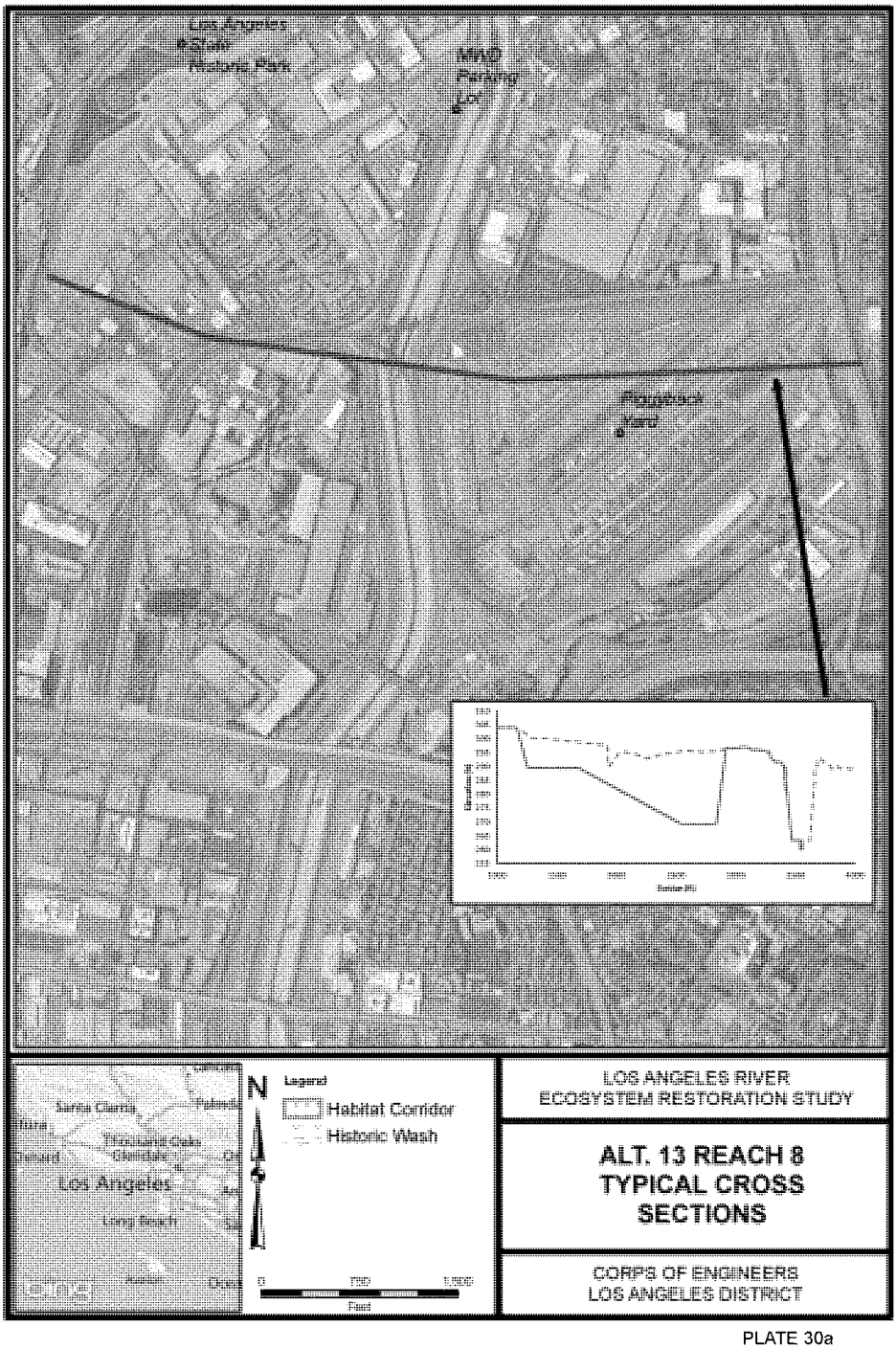
LOS ANGELES RIVER
ECOSYSTEM RESTORATION STUDY

ALT. 20 REACH 7
TYPICAL CROSS SECTION

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 29

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



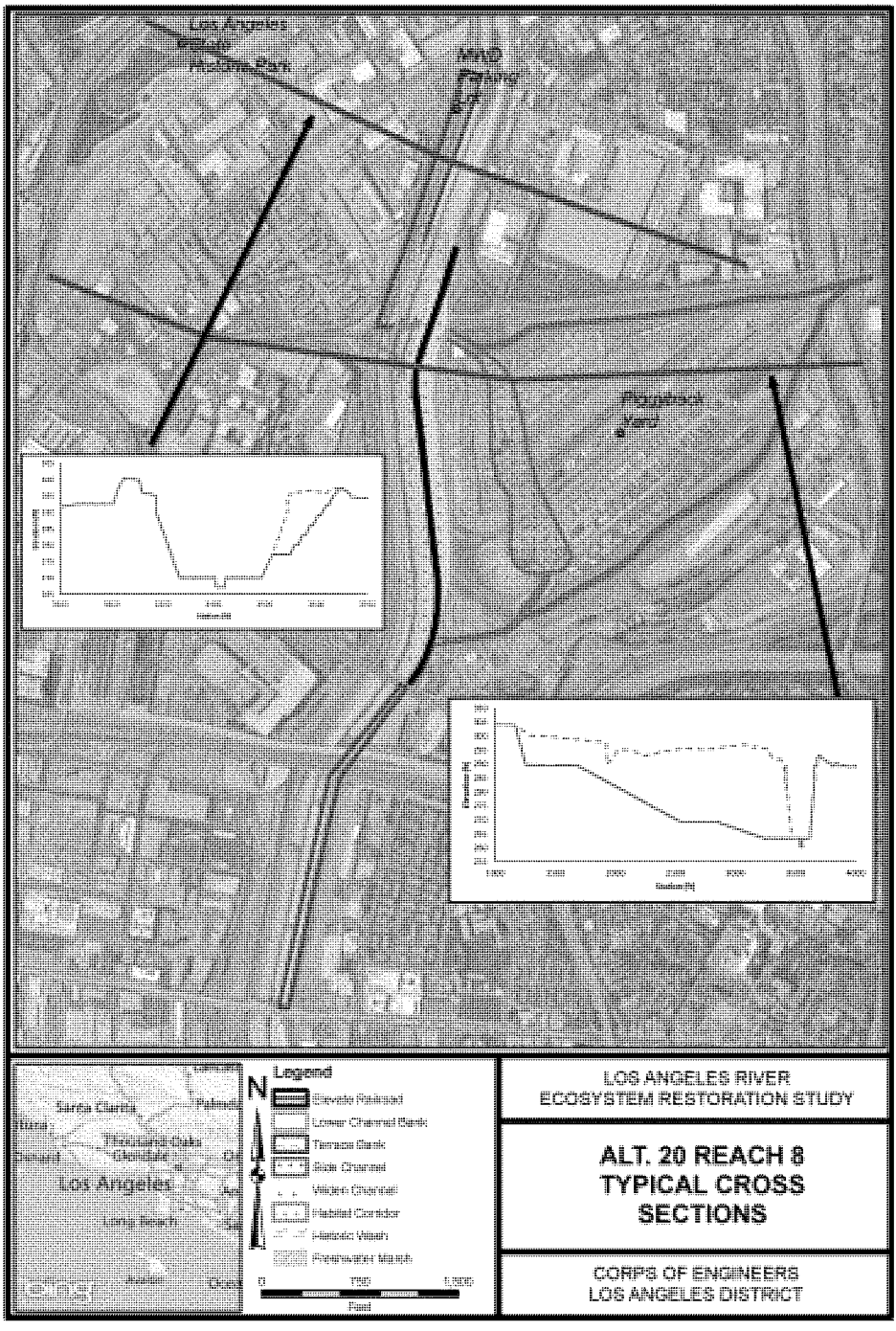
LOS ANGELES RIVER ECOSYSTEM RESTORATION STUDY

ALT. 13 REACH 8 TYPICAL CROSS SECTIONS

CORPS OF ENGINEERS LOS ANGELES DISTRICT

PLATE 30a

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



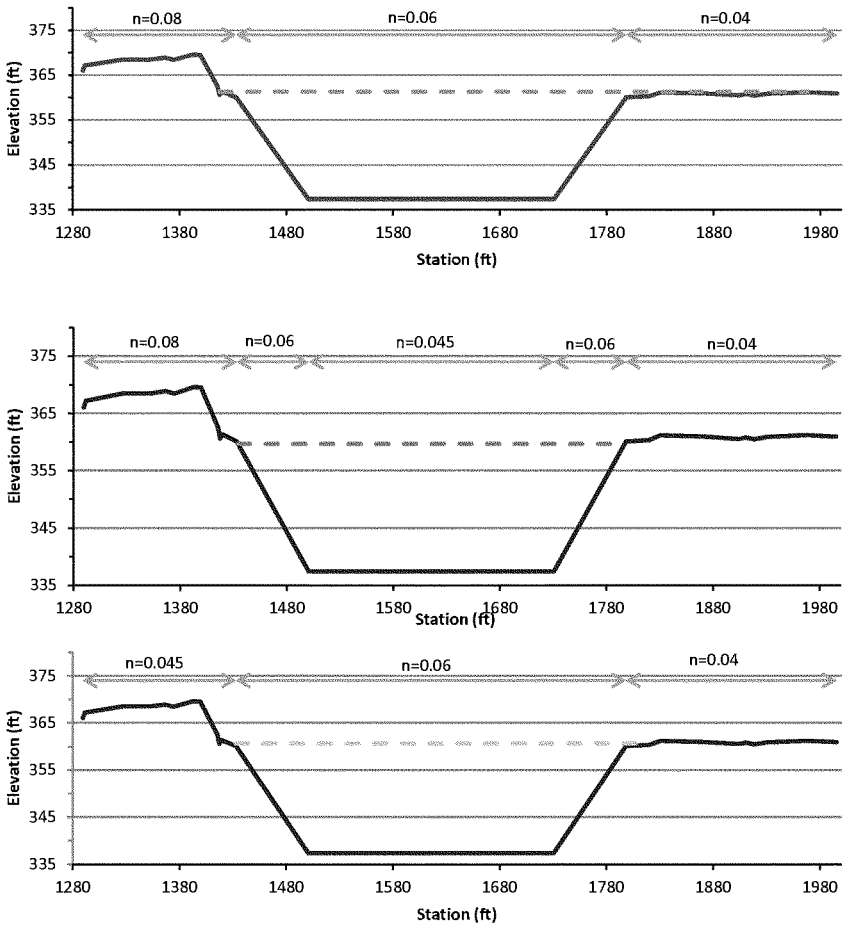
LOS ANGELES RIVER
ECOSYSTEM RESTORATION STUDY

ALT. 20 REACH 8
TYPICAL CROSS SECTIONS

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 30b

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



Heavy Overbank Vegetation, Moderate Channel Vegetation

Heavy Overbank Vegetation, Minimal Channel Vegetation

Minimal Overbank Vegetation, Moderate Channel Vegetation

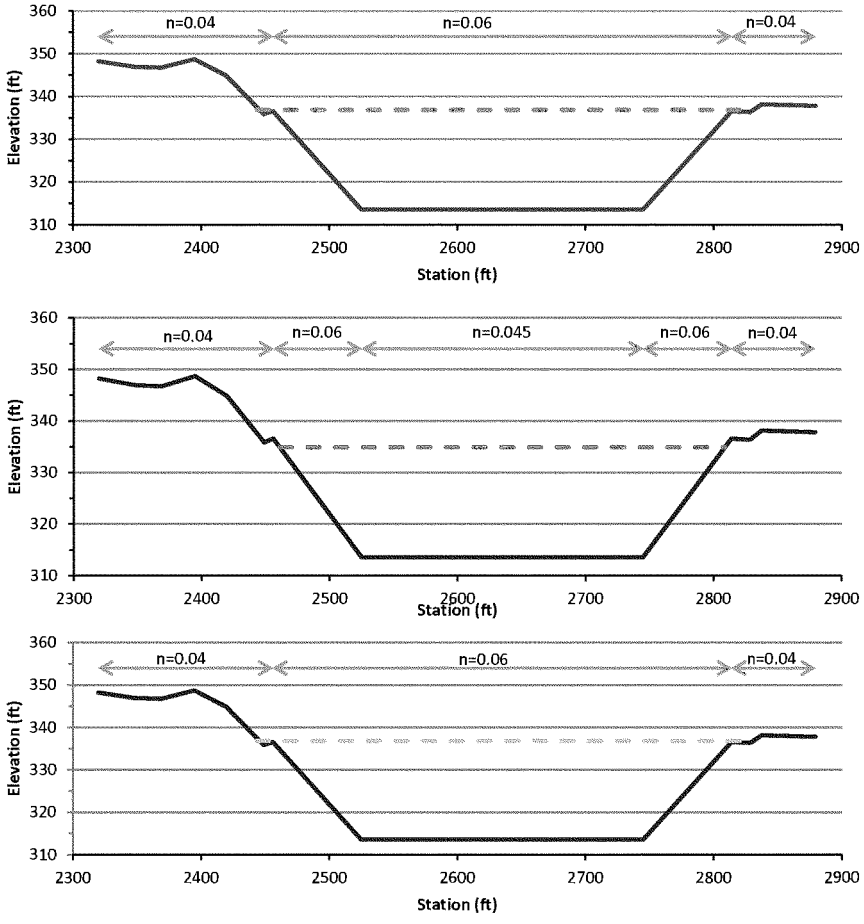
LOS ANGELES RIVER
ECOSYSTEM RESTORATION STUDY

ALT. 10 REACH 6
WSE COMPARISON
CROSS SECTION 262+72

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 31

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



Heavy Overbank Vegetation, Moderate Channel Vegetation
Heavy Overbank Vegetation, Minimal Channel Vegetation
Minimal Overbank Vegetation, Moderate Channel Vegetation

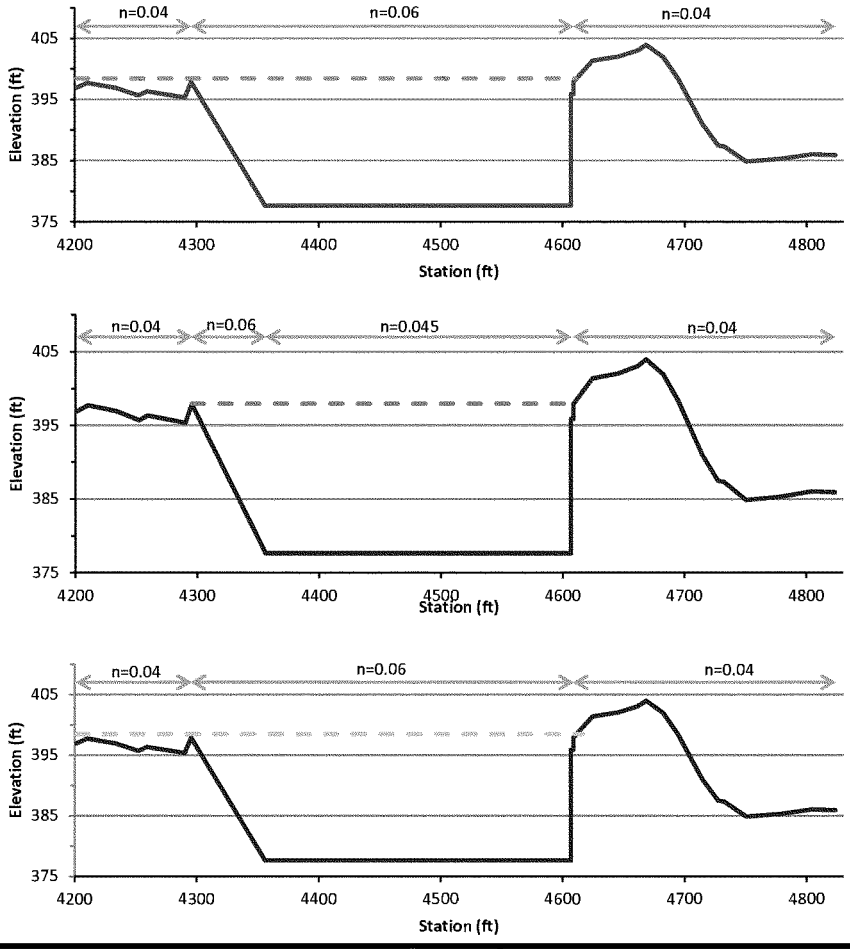
LOS ANGELES RIVER
ECOSYSTEM RESTORATION STUDY

ALT. 13 REACH 6
WSE COMPARISON
CROSS SECTION 191+81

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 32

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



Heavy Overbank Vegetation, Moderate Channel Vegetation
Heavy Overbank Vegetation, Minimal Channel Vegetation
Minimal Overbank Vegetation, Moderate Channel Vegetation

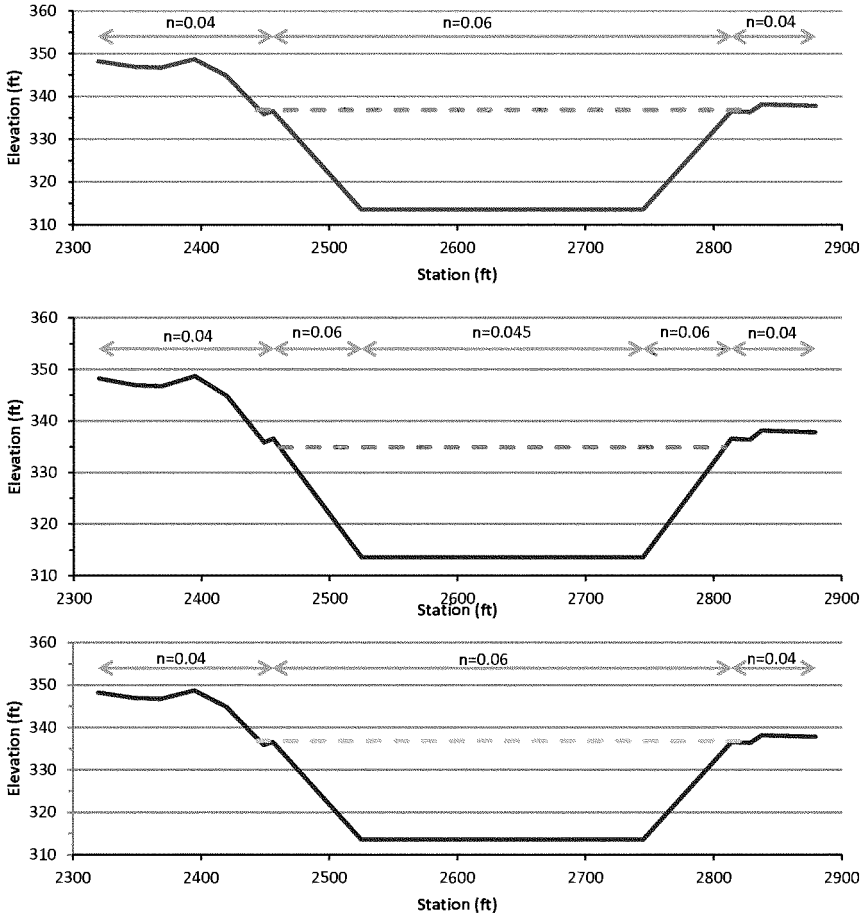
LOS ANGELES RIVER
ECOSYSTEM RESTORATION STUDY

ALT. 16 REACH 5
WSE COMPARISON
CROSS SECTION 356+22

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 33

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



Heavy Overbank Vegetation, Moderate Channel Vegetation

Heavy Overbank Vegetation, Minimal Channel Vegetation

Minimal Overbank Vegetation, Moderate Channel Vegetation

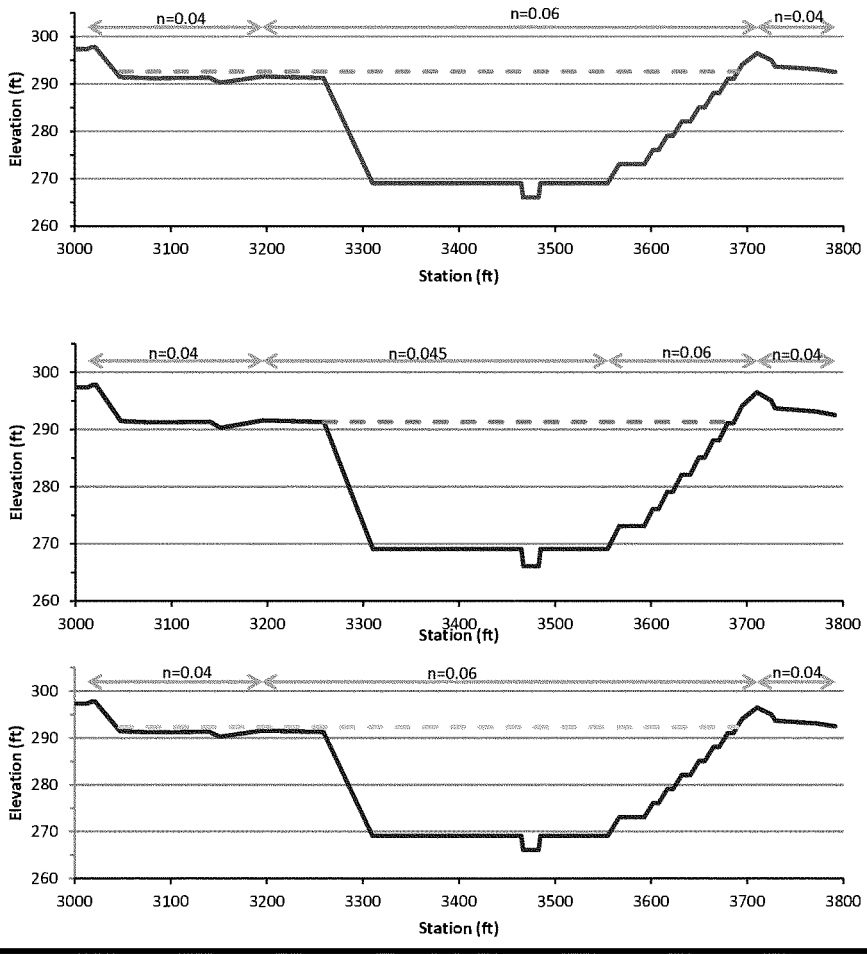
LOS ANGELES RIVER
ECOSYSTEM RESTORATION STUDY

ALT. 16 REACH 6
WSE COMPARISON
CROSS SECTION 191+81

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 34

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



Heavy Overbank Vegetation, Moderate Channel Vegetation
Heavy Overbank Vegetation, Minimal Channel Vegetation
Minimal Overbank Vegetation, Moderate Channel Vegetation

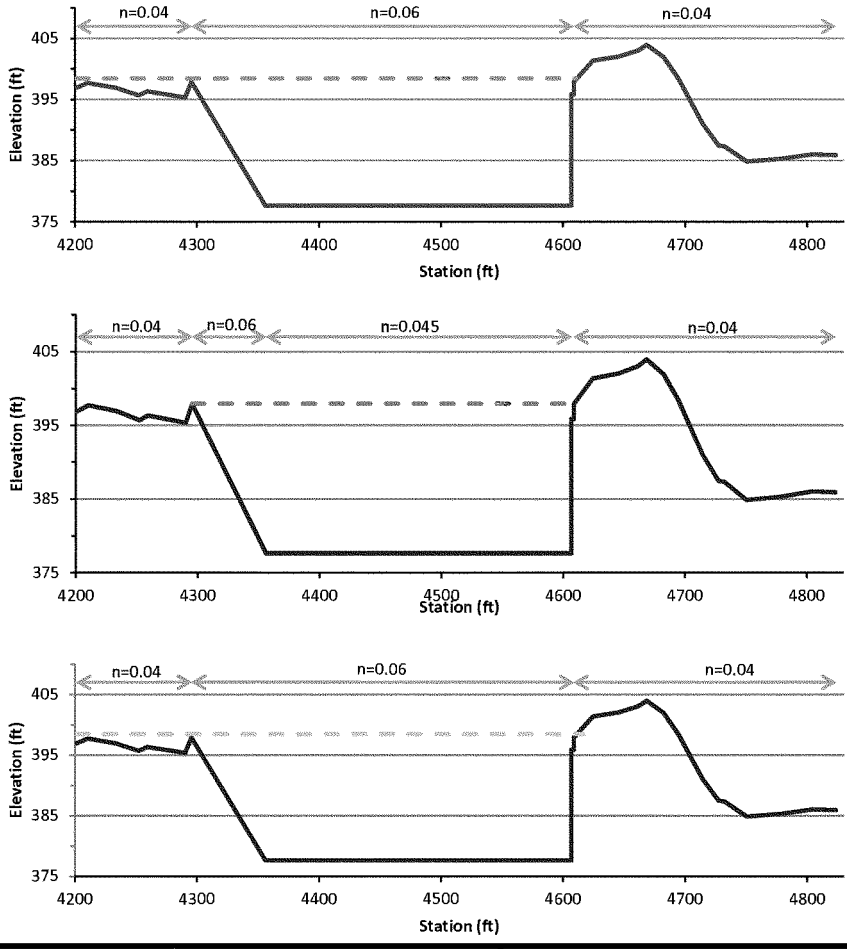
LOS ANGELES RIVER
ECOSYSTEM RESTORATION STUDY

ALT. 16 REACH 8
WSE COMPARISON
CROSS SECTION 69+93

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 35

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



Heavy Overbank Vegetation, Moderate Channel Vegetation
Heavy Overbank Vegetation, Minimal Channel Vegetation
Minimal Overbank Vegetation, Moderate Channel Vegetation

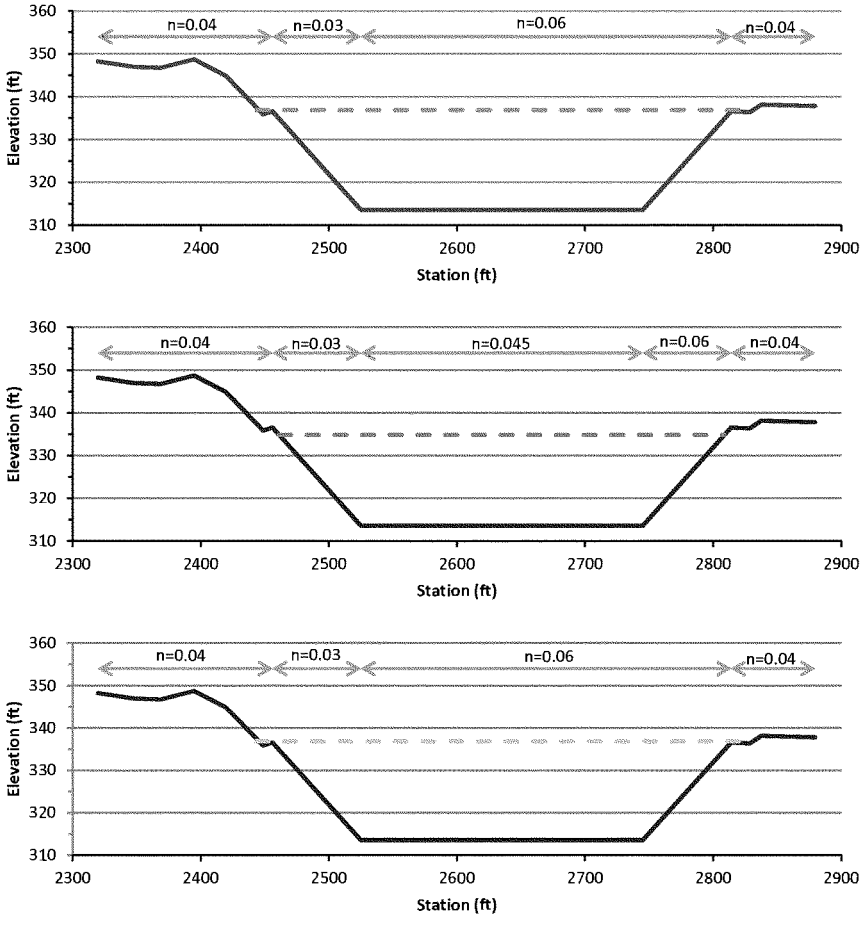
LOS ANGELES RIVER
ECOSYSTEM RESTORATION STUDY

ALT. 20 REACH 5
WSE COMPARISON
CROSS SECTION 356+22

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 36

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



Heavy Overbank Vegetation, Moderate Channel Vegetation
Heavy Overbank Vegetation, Minimal Channel Vegetation
Minimal Overbank Vegetation, Moderate Channel Vegetation

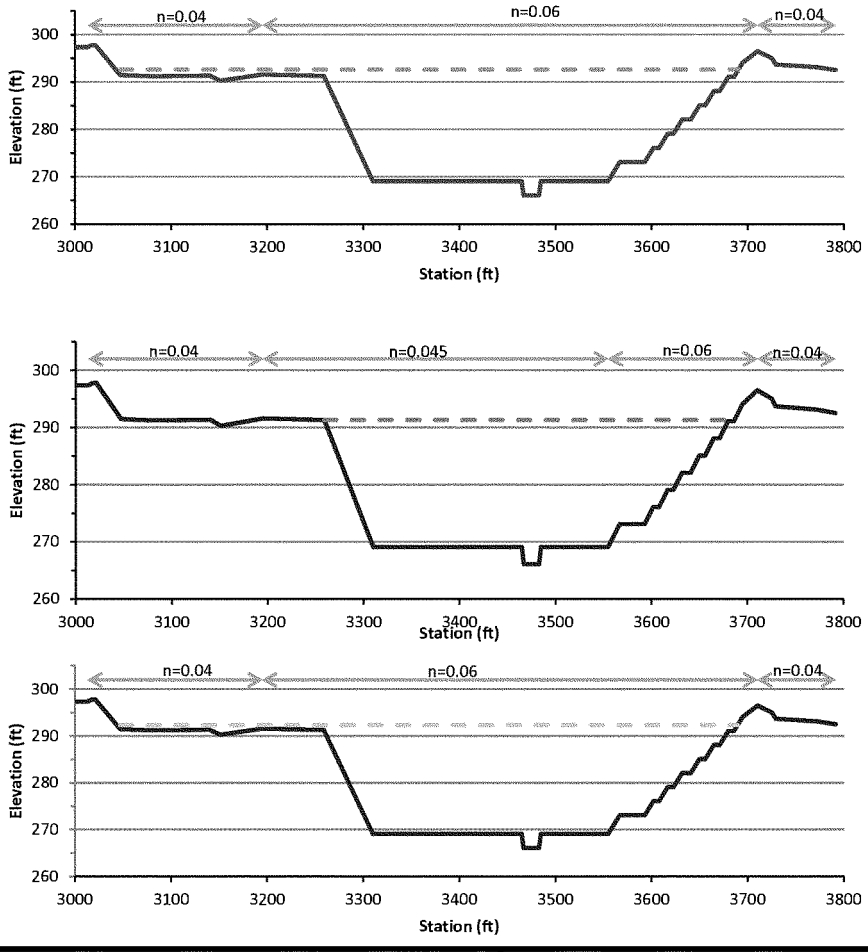
LOS ANGELES RIVER
ECOSYSTEM RESTORATION STUDY

ALT.20 REACH 6
WSE COMPARISON
CROSS SECTION 191+81

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 37

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



Heavy Overbank Vegetation, Moderate Channel Vegetation

Heavy Overbank Vegetation, Minimal Channel Vegetation

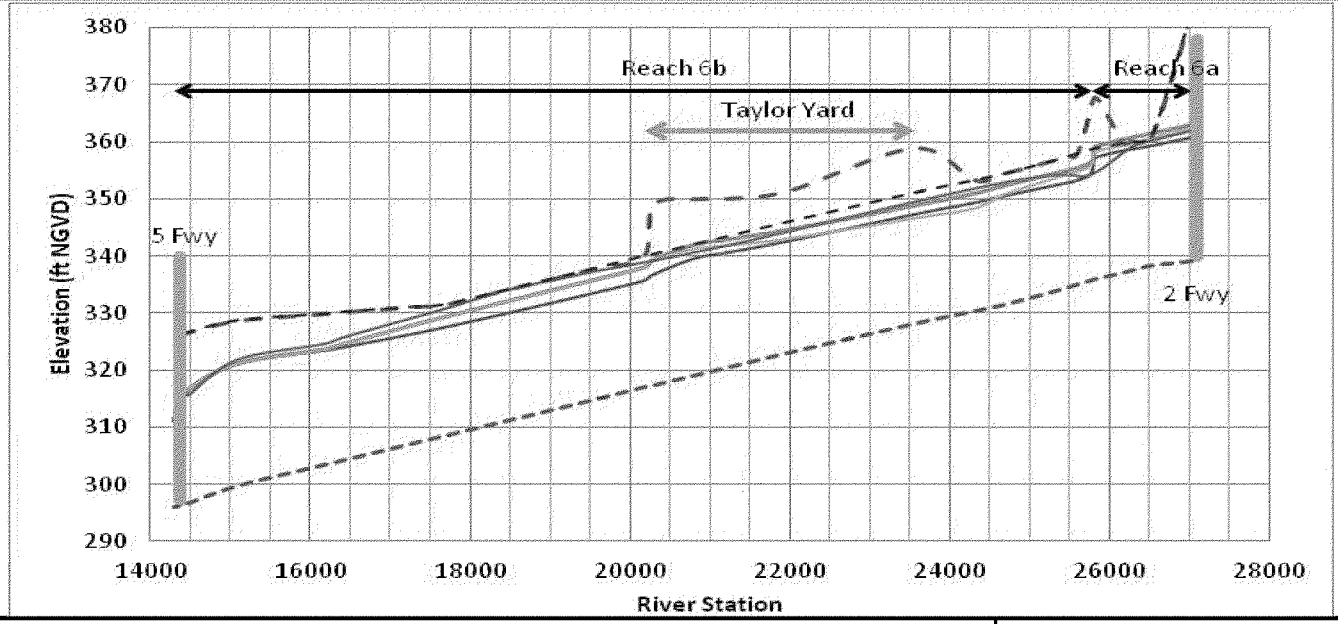
Minimal Overbank Vegetation, Moderate Channel Vegetation

LOS ANGELES RIVER
ECOSYSTEM RESTORATION STUDY

ALT. 20 REACH 8
WSE COMPARISON
CROSS SECTION 69+93

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 38



Streambed elevations based on lowest elevation in cross section from HEC-RAS models for shown alternative.

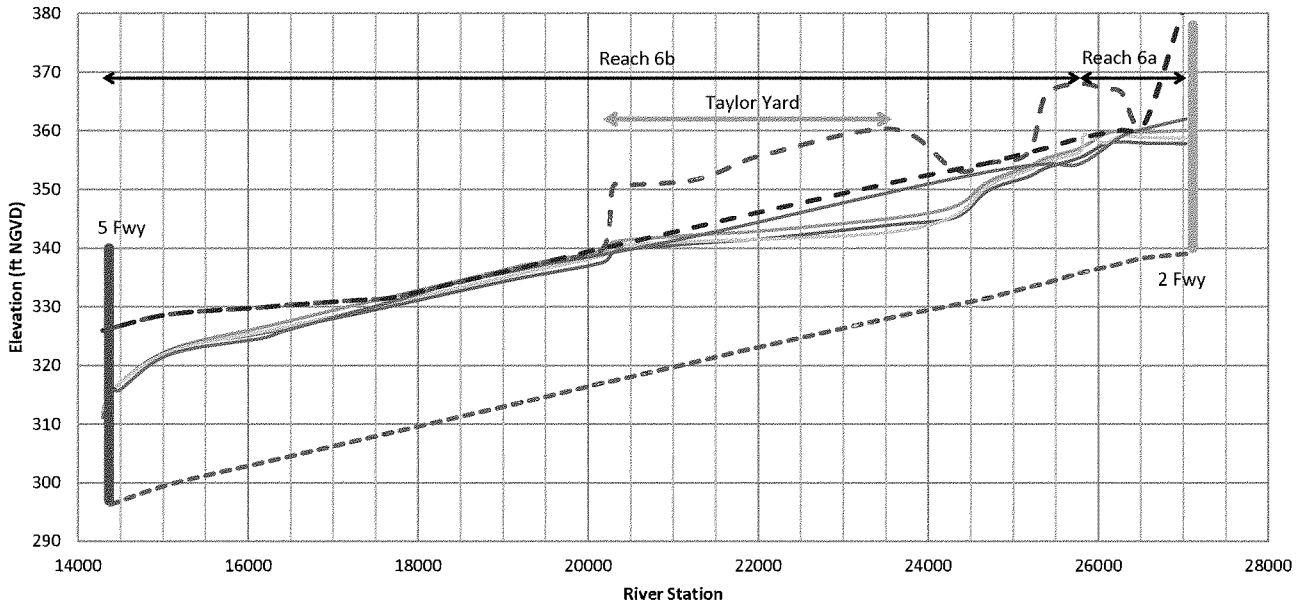
- Moderate Vegetation Channel, Heavy Vegetation Overbank
- Minimum Vegetation Channel, Heavy Vegetation Overbank
- Moderate Vegetation Channel, Minimum Vegetation Overbank
- Existing Conditions With Vegetation
- Left Bank
- Right Bank
- Channel Invert

LOS ANGELES RIVER ECOSYSTEM RESTORATION STUDY

ALT. 10 REACH 6 LOS ANGELES RIVER WATER SURFACE PROFILES

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 39



Streambed elevations based on lowest elevation in cross section from HEC-RAS models for shown alternative.

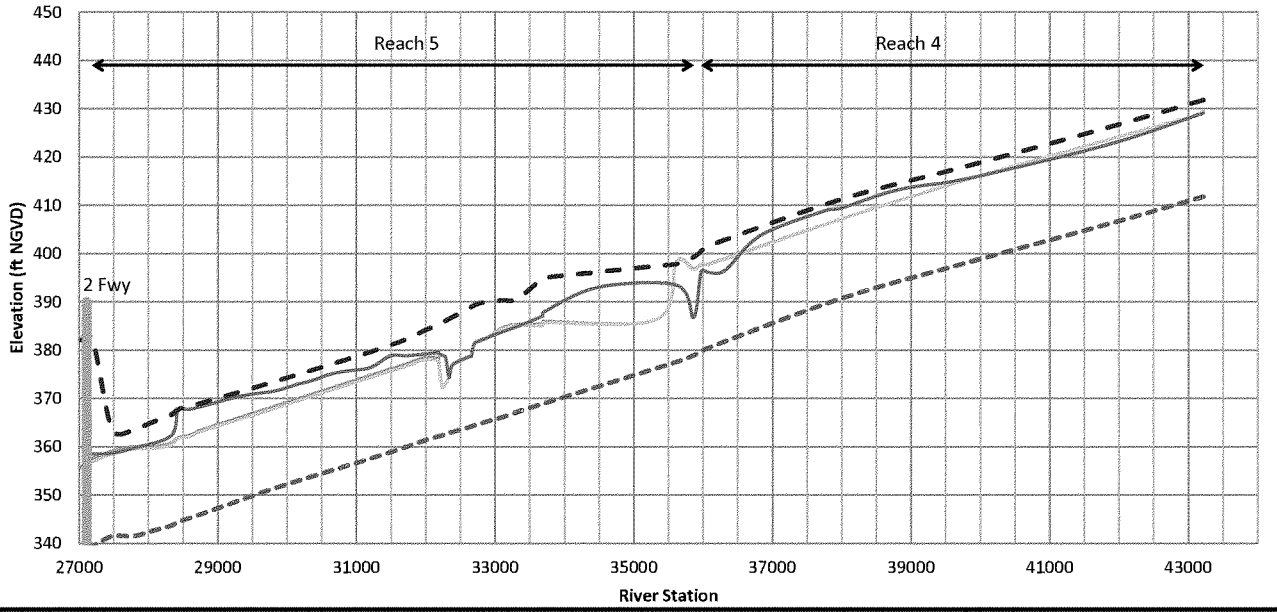
- Moderate Vegetation Channel, Heavy Vegetation Overbank
- Moderate Vegetation Channel, Minimum Vegetation Overbank
- Left Bank
- Channel Invert
- Minimum Vegetation Channel, Heavy Vegetation Overbank
- Existing Conditions With Vegetation
- Right Bank

LOS ANGELES RIVER ECOSYSTEM RESTORATION STUDY

ALT. 13 REACH 6 LOS ANGELES RIVER WATER SURFACE PROFILES

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 40



Streambed elevations based on lowest elevation in cross section from HEC-RAS models for shown alternative.

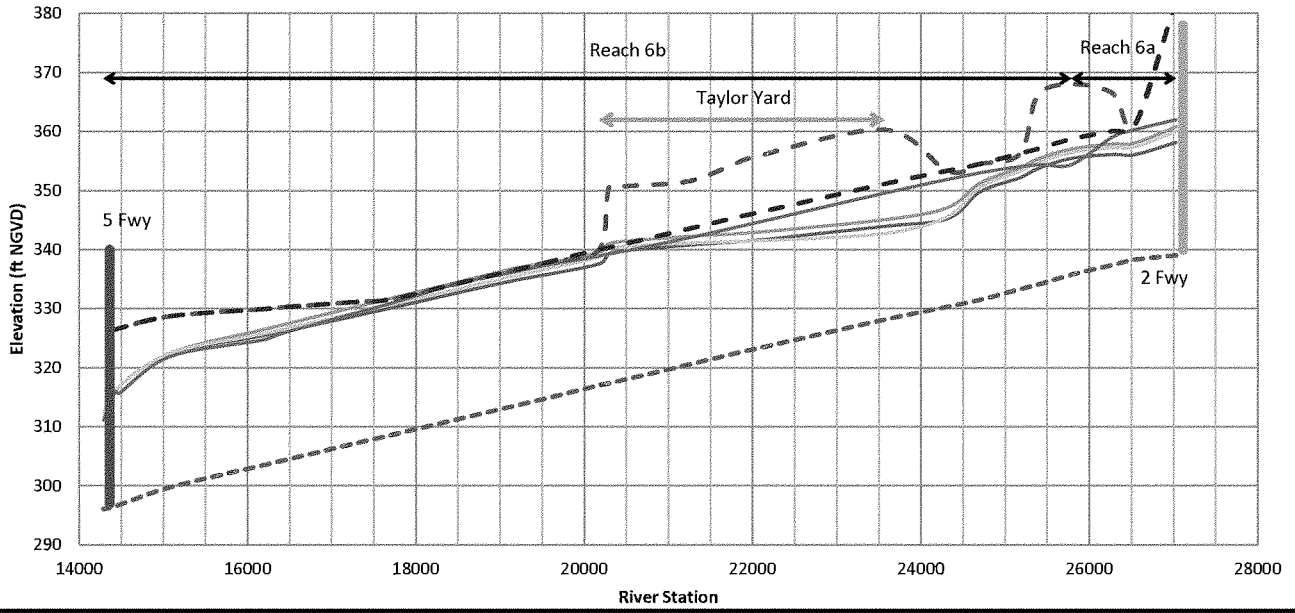
- Moderate Vegetation Channel, Heavy Vegetation Overbank
- Moderate Vegetation Channel, Minimum Vegetation Overbank
- Left Bank
- Channel Invert
- Minimum Vegetation Channel, Heavy Vegetation Overbank
- Existing Conditions With Vegetation
- Right Bank

LOS ANGELES RIVER ECOSYSTEM RESTORATION STUDY

ALT. 16 REACH 5 LOS ANGELES RIVER WATER SURFACE PROFILES

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 41



Streambed elevations based on lowest elevation in cross section from HEC-RAS models for shown alternative.

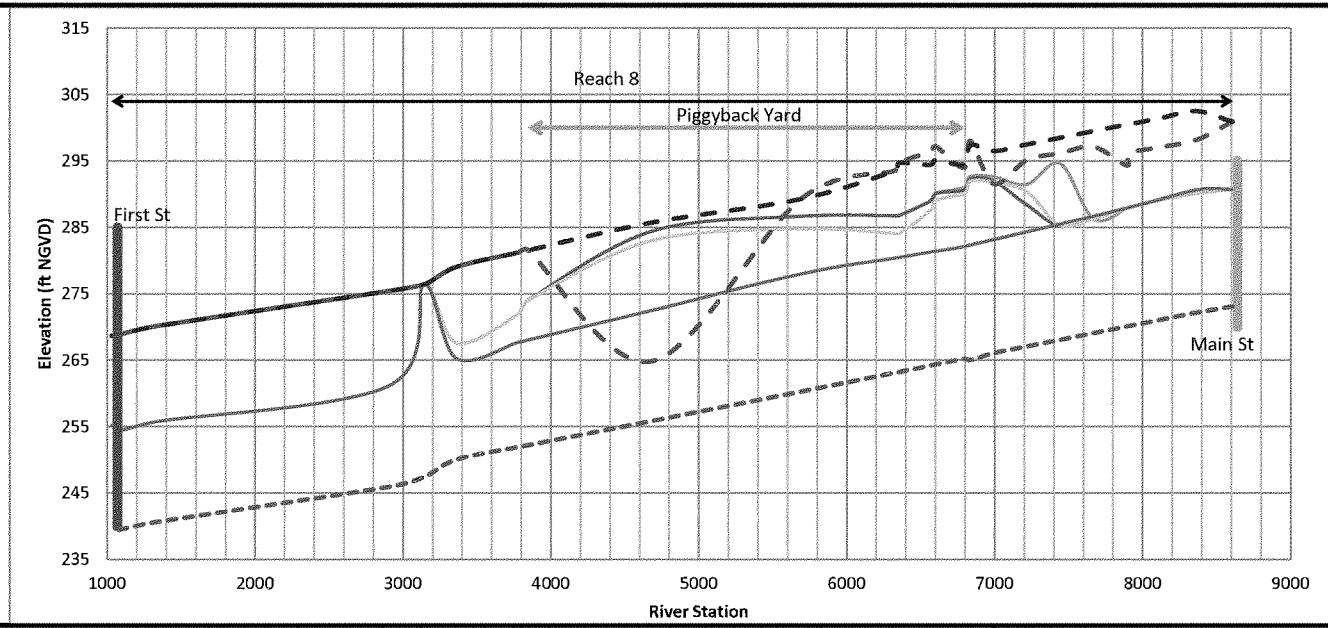
- Moderate Vegetation Channel, Heavy Vegetation Overbank
- Moderate Vegetation Channel, Minimum Vegetation Overbank
- Left Bank
- Channel Invert
- Minimum Vegetation Channel, Heavy Vegetation Overbank
- Existing Conditions With Vegetation
- Right Bank

LOS ANGELES RIVER ECOSYSTEM RESTORATION STUDY

ALT. 16 REACH 6 LOS ANGELES RIVER WATER SURFACE PROFILES

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 42



Streambed elevations based on lowest elevation in cross section from HEC-RAS models for shown alternative.

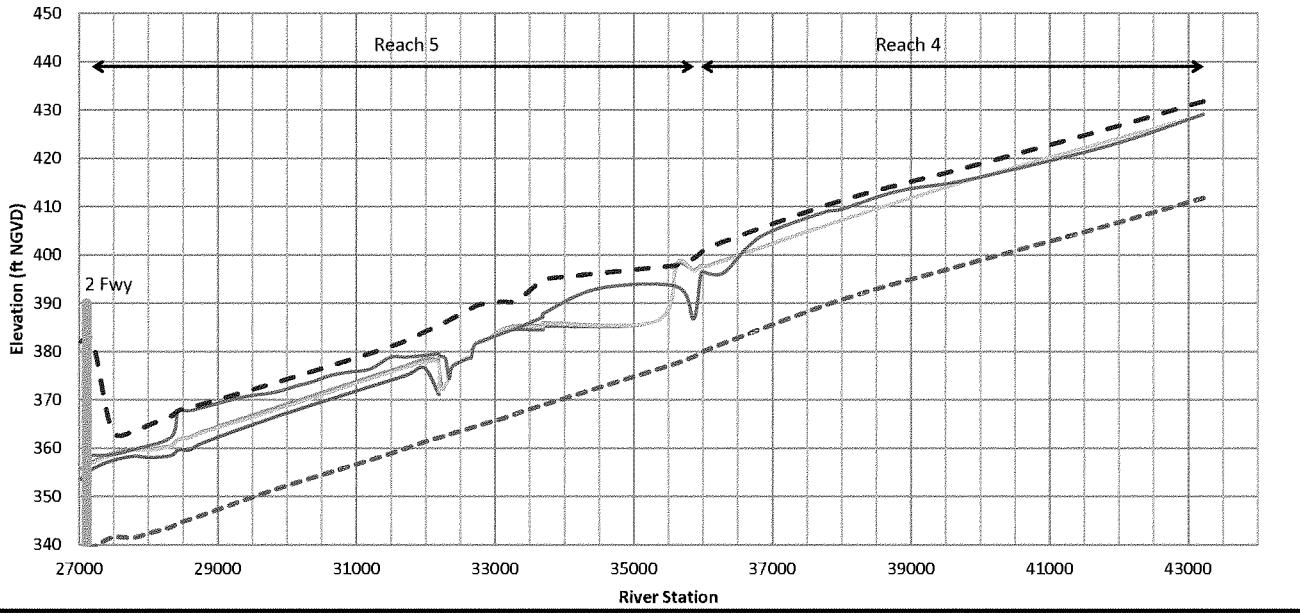
- Moderate Vegetation Channel, Heavy Vegetation Overbank
- Moderate Vegetation Channel, Minimum Vegetation Overbank
- Left Bank
- Channel Invert
- Minimum Vegetation Channel, Heavy Vegetation Overbank
- Existing Conditions With Vegetation
- Right Bank

LOS ANGELES RIVER ECOSYSTEM RESTORATION STUDY

ALT. 16 REACH 8 LOS ANGELES RIVER WATER SURFACE PROFILES

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 43



Streambed elevations based on lowest elevation in cross section from HEC-RAS models for shown alternative.

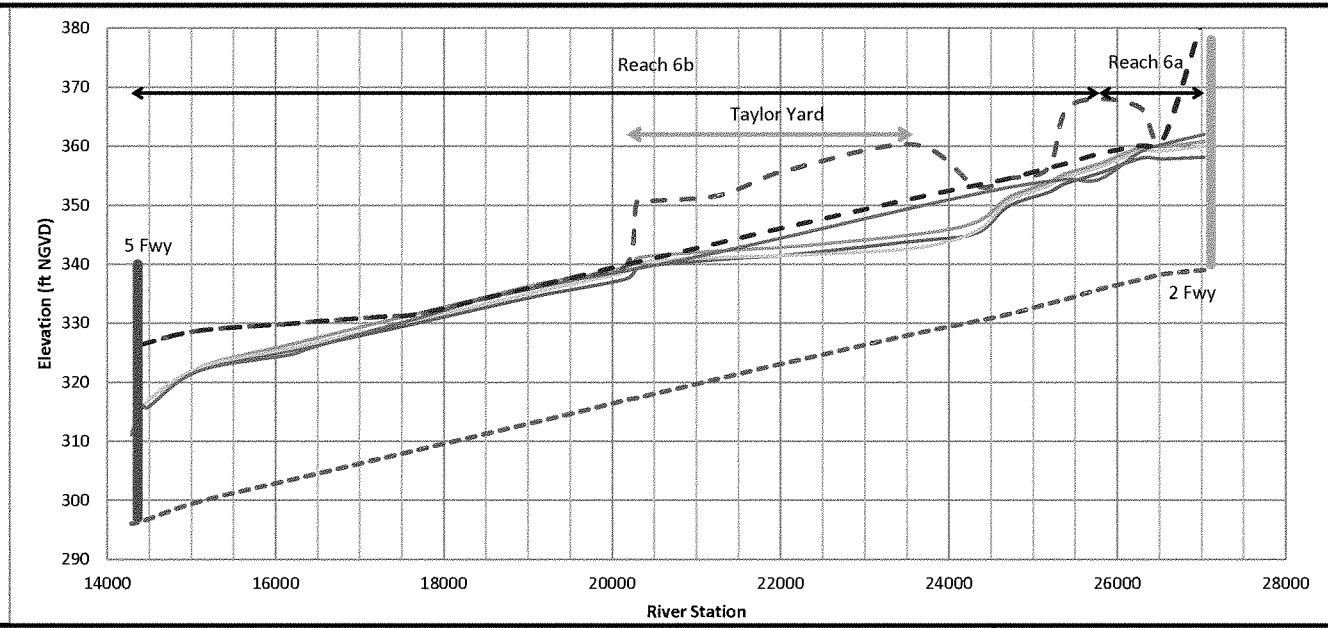
- Moderate Vegetation Channel, Heavy Vegetation Overbank
- Moderate Vegetation Channel, Minimum Vegetation Overbank
- Left Bank
- Channel Invert
- Minimum Vegetation Channel, Heavy Vegetation Overbank
- Existing Conditions With Vegetation
- Right Bank

LOS ANGELES RIVER ECOSYSTEM RESTORATION STUDY

ALT. 20 REACH 5 LOS ANGELES RIVER WATER SURFACE PROFILES

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 44



Streambed elevations based on lowest elevation in cross section from HEC-RAS models for shown alternative.

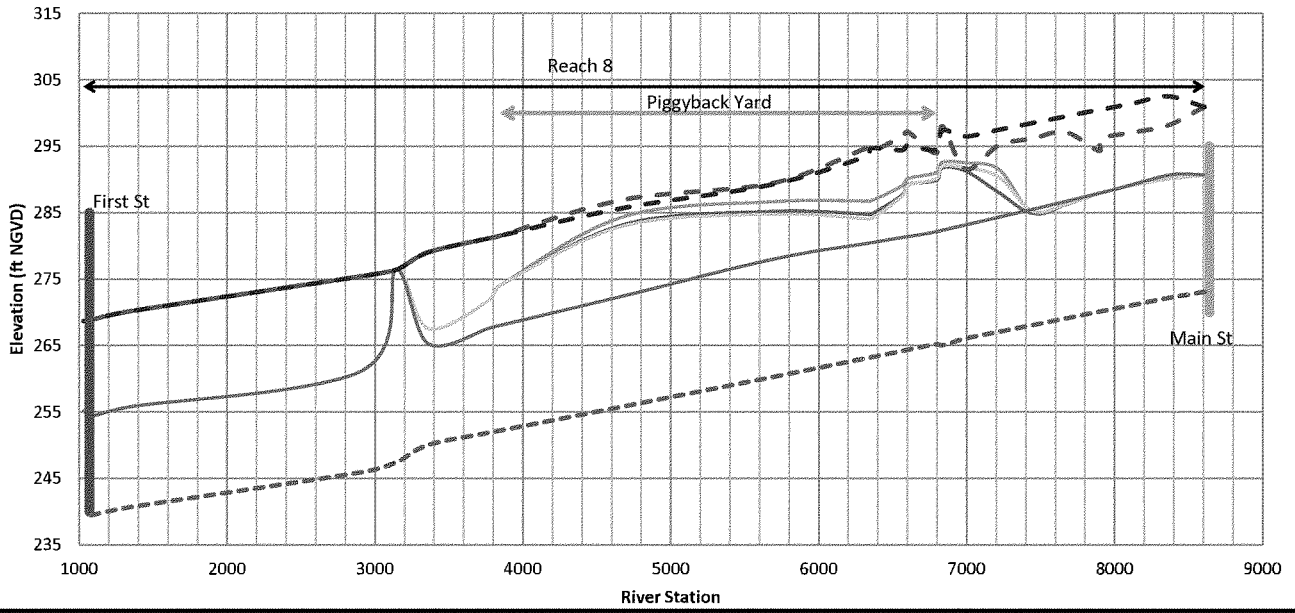
- Moderate Vegetation Channel, Heavy Vegetation Overbank
- Moderate Vegetation Channel, Minimum Vegetation Overbank
- Left Bank
- Channel Invert
- Minimum Vegetation Channel, Heavy Vegetation Overbank
- Existing Conditions With Vegetation
- Right Bank

LOS ANGELES RIVER ECOSYSTEM RESTORATION STUDY

ALT. 20 REACH 6 LOS ANGELES RIVER WATER SURFACE PROFILES

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 45



Streambed elevations based on lowest elevation in cross section from HEC-RAS models for shown alternative.

- Moderate Vegetation Channel, Heavy Vegetation Overbank
- Moderate Vegetation Channel, Minimum Vegetation Overbank
- Left Bank
- Channel Invert
- Minimum Vegetation Channel, Heavy Vegetation Overbank
- Existing Conditions With Vegetation
- Right Bank

LOS ANGELES RIVER ECOSYSTEM RESTORATION STUDY

ALT. 20 REACH 8 LOS ANGELES RIVER WATER SURFACE PROFILES

CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 46

Los Angeles River Ecosystem Restoration Integrated Feasibility Study

Appendix F
Air Quality

Appendix F-1: Clean Air Act Applicability Analysis

Appendix F-2: Air Quality Calculations Methodology and Data

Appendix F-1
Clean Air Act Applicability Analysis

1 Introduction

The General Conformity Rule at Section 176(c) of the Clean Air Act (CAA) ensures that federal actions comply with the national ambient air quality standards (NAAQS). In order to conform with the rule, a federal agency must demonstrate that an action it undertakes, approves, permits, or supports will conform to the appropriate state implementation plan (SIP). The conformity evaluation ensures that projects using federal funds or requiring federal approval not:

- cause or contribute to any new violation of a NAAQS,
- increase the frequency or severity of any existing violation, or
- delay the timely attainment of any standard, interim emission reduction, or other milestone.

A conformity determination is required for each criteria pollutant or precursor where the total of direct and indirect emissions of the criteria pollutant or precursor in a nonattainment or maintenance area caused by the Federal action would equal or exceed any of the rates listed in Table 2-1.

Direct emissions means those emissions of a criteria pollutant or its precursors that are caused or initiated by the Federal action and originate in a nonattainment or maintenance area and occur at the same time and place as the action and are reasonably foreseeable. 40 CFR 93.152.

Indirect emissions means those emissions of a criteria pollutant or its precursors:

1. That are caused or initiated by the Federal action and originate in the same nonattainment or maintenance area but occur at a different time or place as the action;
2. That are reasonably foreseeable;
3. That the agency can practically control; and
4. For which the agency has continuing program responsibility.

For the purposes of this definition, even if a Federal licensing, rulemaking or other approving action is a required initial step for a subsequent activity that causes emissions, such initial steps do not mean that a Federal agency can practically control any resulting emissions (40 CFR 93.152).

Total of direct and indirect emissions means the sum of direct and indirect emissions increases and decreases caused by the Federal action; i.e., the "net" emissions considering all direct and indirect emissions. The portion of emissions which are exempt or presumed to conform under § 93.153 (c), (d), (e), or (f) are not included in the "total of direct and indirect emissions." The "total of direct and indirect emissions" includes emissions of criteria pollutants and emissions of precursors of criteria pollutants (40 CFR 93.152).

Direct emissions include construction emissions and indirect emissions include operational emissions from maintenance activities. Maintenance activities are considered exempt under 40 CFR 93.153(c)(2)(iv), and are therefore not included in the total of direct and indirect emissions evaluated in this analysis. Emissions from increased visitation by the public as a result of construction of the project cannot be practically controlled by the USACE and are therefore not considered indirect emissions caused by the Federal action. Thus, this analysis is limited to construction emissions.

Because all build alternatives would convert the existing LATC site to restored habitat, a functionally equivalent facility is anticipated to be constructed elsewhere in the Los Angeles Basin. Emissions from

replacement of site functions elsewhere in the basin cannot be practically controlled by the Corps, and the Corps does not have continuing program responsibility; therefore, such emissions are not considered indirect emissions caused by the Federal action in the applicability analysis. Construction of replacement site functions would result in temporary increases in emissions. Operation of replacement site functions may increase localized emissions in and around the replacement site. However, the replacement of the site functions within the Los Angeles Air Basin would not transfer the operational impacts of the site functions to a different air basin. The CEQA lead sponsor will conduct a detailed CEQA analysis in analyzing the replacement of LATC site functions, including air emissions.

2 Applicability

An applicability analysis is the process of determining if a Federal action must be supported by a conformity determination (40 CFR 93.152). In this instance, the applicability analysis is applied to Alternative 13v, the National Ecosystem Restoration Plan and Alternative 20, the Recommended Plan.

Federal regulation at 40 CFR 93.153 prescribes rates for criteria pollutants based on area attainment status as presented in Table 2-1.

Table 2-1. General Conformity Rates

Pollutant	Federal Attainment Designation	Rates (Tons/Year)
Ozone (precursors: VOC or NO_x)[a]	Serious nonattainment	50
	Severe nonattainment	25
	Extreme nonattainment	10
	Other areas outside of an ozone transport region	100
CO, SO_2, and NO_2	All nonattainment and maintenance areas	100
PM_{10}	Serious nonattainment	70
	Moderate nonattainment and maintenance	100
$PM_{2.5}$	All nonattainment and maintenance areas	100
Pb (Lead)	All nonattainment and maintenance	25

Source: 40 CFR 93.153

[a] Ozone precursors (NOx and VOCs): Gasoline and diesel engines do not directly emit ozone. Ozone is a product of NOx and VOCs reacting in the presence of sunlight. Since engines directly emit NOx and VOCs, their values function as surrogates for ozone emissions.

The federal action will occur in the South Coast Air Basin (SCAB), which is currently in extreme nonattainment for ozone (precursors: VOC or NOx); nonattainment for PM2.5; maintenance for PM10; maintenance for NO2; attainment for SO2; and maintenance for CO; partial nonattainment for lead. Based on the present NAAQS attainment designation for the SCAB, implementation of Alternative 13v or Alternative 20 would conform to the SIP if annual emissions for ozone precursors (VOC or NOx), NO2, PM2.5, PM10, CO, and lead remain below the rates listed in Table 2-2.

Table 2-2. Federal Attainment Designations for the South Coast Air Basin and Applicable Rates

Air Pollutants	SCAB Federal Attainment Designation	Rates (Tons/Year)
Ozone (precursors: VOC or NO_x)	Extreme Nonattainment	10
PM2.5	Nonattainment	100
PM10	Maintenance	100
NO2	Maintenance	100
CO	Attainment/Maintenance	100
SO_2	Attainment	100
Pb (Lead)	Nonattainment (Partial)[a]	25

Source: USEPA, Green Book Nonattainment Areas (Accessed at http://www.epa.gov/airquality/greenbook/ on March 6, 2015)

[a] U.S. EPA designated the Los Angeles County portion of the SCAB (excluding the high desert areas, and San Clemente and Santa Catalina Islands) as nonattainment for the recently revised (2008) federal lead standard (0.15 µg/m3, rolling 3-month average). South Coast Air Quality Management District, 2012 Air Quality Management Plan, p. 2-10. Since the project is located within Los Angeles County, lead is Nonattainment for the purpose of this analysis.

Air quality analysis methodology and results for Alternative 13v and Alternative 20 are found in Appendix F – Methodology and Data Tables.

Annual construction emissions for Alternative 13v and Alternative 20 are shown in Tables 3-1 through 3-2, respectively.

Table 3-1. Alternative 13v Estimated Direct Annual Emissions (Construction)

Pollutants	General Conformity Rates (tons/yr)	2017 Estimated Emissions (tons/year)	2018 Estimated Emissions (tons/year)	2019 Estimated Emissions (tons/year)	2020 Estimated Emissions (tons/year)	2021 Estimated Emissions (tons/year)	2022 Estimated Emissions (tons/year)	2023 Estimated Emissions (tons/year)	2024 Estimated Emissions (tons/year)	2025 Estimated Emissions (tons/year)	2026 Estimated Emissions (tons/year)	2027 Estimated Emissions (tons/year)
Ozone (VOC)	10	0.007	0.11	0.07	0.10	0.11	0.09	0.04	0.08	0.06	0.09	0.05
Ozone (NOX)	10	0.08	1.32	0.78	1.09	1.18	0.98	0.44	0.80	0.08	0.21	0.14
NO2	100	0.08	1.32	0.78	1.09	1.18	0.98	0.44	0.80	0.08	0.21	0.14
CO	100	0.03	0.75	0.50	0.78	0.91	0.78	0.45	0.78	0.54	0.83	0.48
PM10	100	0.005	0.06	0.04	0.05	0.06	0.04	0.02	0.04	0.02	0.05	0.03
PM2.5	100	<0.005	0.05	0.03	0.04	0.05	0.03	0.01	0.03	0.02	0.04	0.02

Table 3-2. Alternative 20 Estimated Direct Annual Emissions (Construction)

Pollutants	General Conformity Rates (tons/yr)	2018 Estimated Emissions (tons/year)	2019 Estimated Emissions (tons/year)	2020 Estimated Emissions (tons/year)	2021 Estimated Emissions (tons/year)	2022 Estimated Emissions (tons/year)	2023 Estimated Emissions (tons/year)	2024 Estimated Emissions (tons/year)	2025 Estimated Emissions (tons/year)	2026 Estimated Emissions (tons/year)	2027 Estimated Emissions (tons/year)	2028 Estimated Emissions (tons/year)	2029 Estimated Emissions (tons/year)	2030 Estimated Emissions (tons/year)	2031 Estimated Emissions (tons/year)	2032 Estimated Emissions (tons/year)
Ozone (VOC)	10	<0.005	0.13	0.01	0.01	0.22	0.21	0.24	0.10	0.06	0.06	0.08	0.13	0.07	0.08	0.14
Ozone (NOX)	10	<0.005	1.38	1.17	1.14	2.14	1.92	2.16	0.83	0.50	0.51	0.71	1.14	0.27	0.32	0.56
NO2	100	<0.005	1.38	1.17	1.14	2.14	1.92	2.16	0.83	0.50	0.51	0.71	1.14	0.27	0.32	0.56
CO	100	<0.005	0.85	0.80	0.84	1.77	1.82	2.12	0.92	0.66	0.64	0.82	1.21	0.64	0.54	0.87
PM10	100	<0.005	0.07	0.07	0.06	0.11	0.10	0.12	0.04	0.03	0.03	0.04	0.06	0.02	0.02	0.03
PM2.5	100	<0.005	0.06	0.06	0.05	0.09	0.08	0.09	0.03	0.02	0.02	0.03	0.05	0.01	0.01	0.02

Estimates of lead emissions were not calculated for construction and operational phases. Lead emissions from mobile sources in California have significantly decreased due to the near elimination of lead in fuels. Thus, CalEEMod, the South Coast Air Quality Management District-approved emission modeling software, does not provide estimated emissions for lead. Little to no quantifiable and foreseeable lead emissions would be generated by the alternatives.

Based on the above, total direct and indirect emissions of ozone precursors (VOC or NOx), NO2, PM2.5, PM10, CO, and lead caused by the Federal action do not equal or exceed the emission levels listed in Table 2-2.

3 Conclusion

The applicability analysis shows that direct and indirect emissions for Alternative 13v, the NER Plan, and Alternative 20, the Locally Preferred Plan and Recommended Plan, would not equal or exceed the prescribed emission levels. Neither alternative would cause or contribute to any new violation of a NAAQS, increase the frequency or severity of any existing violation, or delay the timely attainment of any standard, interim emission reduction, or other milestones. Thus, a general conformity determination is not required.

Appendix F-2
Air Quality Calculations Methodology and Data

Following public review, further analysis was performed that included a more detailed cost analysis using Mii software, real estate cost updates, and further modified contingencies based upon a full cost risk summary analysis. This analysis identified a more cost effective variation on Alternative 13 [referred to throughout the Integrated Feasibility Report (IFR) and Appendices as "Alternative 13v"] that is identical to Alternative 13 except for Reach 7, where it includes the reach plan included in Alternative 20 that provides 10 acres of marsh and a connection to the Los Angeles State Historic Park. As described in the IFR, the previously identified NER plan has been modified to include the substitution of the Reach 7 plan on the basis of the analysis referenced above; Alternative 13v is the NER plan. Because the analysis in this Appendix included analysis of all of the components of Alt 13v, no separate or additional analysis is necessary. For the assessment of Alternative 13v for Reaches 1-6 and 8, see the Alternative 13 analysis included in this Appendix. For the assessment of Alternative 13v for Reach 7, see the Alternative 20 analysis included in this Appendix.

Alternative 20 is the Recommended Plan in the IFR.

Modeling Software

Air pollutant emissions associated with each alternative were estimated using CalEEMod Version 13.2.2 software. The air emissions modeling software developed by the Southern California Air Quality Management District (SCAQMD) in collaboration with other air districts in California to estimate criteria air pollutant and greenhouse gas emissions from various land use development projects. The emission modeling software is used by air districts within California.

Model Assumptions:

The "cascade defaults" option in CalEEMod was deselected for all data entry and report outputs.

- Project Characteristics: The project location is within the South Coast Air Basin with the following defaults within CalEEMod: 2.2 m/s wind speed, 31 days precipitation frequency, Climate Zone 9, and urban land use setting. No utility company was selected since construction and operational phases of the project are not expected to utilize electrical power on a long-term basis.
- Land Use: The land use type is Recreational (user-defined recreational) with 100 acre project area.

Construction Emissions

For construction emissions an equipment inventory was developed for specific tasks required to implement management measures listed in Section 4.4.5 of the Integrated Feasibility Report (See Attachment 1). Equipment information included off-road and on-road equipment types, quantity of equipment, hours of off-road equipment operation, and on-road transportation distances. For each alternative, a general multi-year construction schedule (Attachment 2) and detailed construction phasing for each management measure (Attachment 9 of the Cost Appendix) were entered into CalEEMod. Each measure entered into CalEEMod was correlated with information from the equipment inventory.

Maximum daily and annual emissions were estimated for each construction year for all alternatives. Results were compared to applicable regulatory thresholds in Chapter 5 of the Integrated Feasibility Report.

Operational Emissions (Maintenance)

Maintenance activities would likely entail annual vegetation maintenance activities over a 30 day period. Required equipment would include approximately five medium duty pickup trucks, two backhoes, two loaders, one excavator, two chippers, and two dump trucks. In so far as all build alternatives share many common restoration features, the scope, nature, and duration of maintenance activities are not expected to be notably different. As a result, operational emissions for all build alternatives are not expected to be substantially different. Furthermore, operational emissions are not expected to substantially change from year to year. As a result, maximum daily and annual emissions estimates were limited to one year.

Operational Emissions (Increased Visitations)

An increase of approximately 572 average daily visitors is projected with implementation of any build alternatives (See Recreational Analysis Appendix, Tables 3 and 4). It was not feasible to use CalEEMod to estimate emissions for vehicle trips not associated with recognized land uses and associated square footages. Emissions were estimated in Microsoft Excel using SCAQMD emissions factors for passenger vehicles (model years 1982-2026). Daily and annual CO2e emissions were calculated using U.S. Environmental Protection Agency's CO2e calculator at http://www.epa.gov/cleanenergy/energy-resources/calculator.html#results.

Lead (Pb) Emissions

Estimates of lead emissions were not calculated for construction and operational phases. Lead emissions from mobile sources in California have significantly decreased due to the near elimination of lead in fuels. Thus, CalEEMod does not provide estimated emissions for lead. Little to no quantifiable and foreseeable lead emissions would be generated by the alternatives.

Greenhouse Gas Emissions

The SCAQMD adopted a quantitative significance threshold of 10,000 metric tons (MT) per year for industrial (stationary source) projects. In the absence of applicable greenhouse gas (GHG) thresholds for ecosystem restoration projects, the 10,000 metric ton threshold for GHG is adopted for use in this analysis. GHG emissions are reported as CO2 equivalents (CO2e).

All three sources of GHG emissions were included: construction, maintenance, and increased visitation. Maintenance and increased are considered operational emissions. The SCAQMD recommends that the total construction emissions be amortized over the lifetime of the project and then added to annual operational emissions. If the lifetime of a project is not known, then a 30-year lifetime is assumed. Construction related GHG emissions were amortized over a 30 year period by summing the annual GHG emissions over the duration of construction and dividing by 30. The amortized values were added to operational GHG emissions. Unlike construction emissions, operational GHG emissions were assumed to remain the same from year to year.

General and Detailed Schedules

General schedules for each alternative are found in Attachment 2. Detailed construction schedules for Alternative 20 and 10 were developed (see Attachment 9 of the Cost Appendix). Detailed construction

schedules for Alternative 16 and 10 were not. However, Alternative 16 is a truncated variation of Alternative 20. Likewise, Alternative 10 is a truncated variation of Alternative 13. As a result, appropriate construction phases entered into CalEEMod for Alternative 20 were deleted to estimate emissions for Alternative 16. Likewise, appropriate construction phases entered into CalEEMod for Alternative 13 were deleted to estimate emissions for Alternative 10. Deleted construction phases for Alternative 13 and 16 are shown below:

Alternative 10 (model derivations from ALT 13 multi-year schedule):

1. The construction duration is a 10-year period between March 16, 2017 and December 25, 2026.

- REACH 7 only includes daylighting of 3 storm drains:
- Removed measure 21 – lower channel banks and provide setback levees or berms
- Removed measure 17 – habitat corridors/riparian planting on banks

2. REACH 6 includes primary riparian corridor planting in Taylor Yard and concrete removal on left bank.

- Removed measure 16 – bioengineering channel walls
- Removed measure 17 – habitat corridors/riparian planting on banks

3. REACH 3 only includes modification of 1 storm drain, and riparian planting along Zoo Drive.

- Removed measure 3/5 – create geomorphology and planting
- Removed measure 10 – divert tributary and river flow into side channel
- Moved mobilization and preparatory work (40 days) from February 2024 to February 2025.
- NO construction takes place in 2024

Alternative 16 (model derivations from ALT 20 multi-year schedule):

1. The construction duration is a 15-year period between October 21, 2018 and February 16, 2032.

2. Removed the following measures from Reach 7:

- Measure 8 – creation of wetland flood control basin (corn field)
- Measure 27 – tributary channels/widen channel (Arroyo Seco)
- Measure 26 – terrace banks

3. Reach 7: Added Measure 21 – Lower channel banks and provide setback levees or berms

4. Removed the following measures from Reach 2:

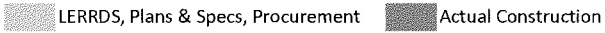
- Measure 27 – modify trapezoidal channel to vertical sides
- Measure 16 – bioengineer channel walls
- Reduced mobilization/prep from 30 days to 12 days.

Attachment 1: Equipment List

	Off Road			On Road		
	Equipment	Quantity	Hrs./Day	Equipment	Trips/Day	Mile/Trip
Aggregate Base & Asphalt	Loader	1	8	Haul: 15-cy trucks	6	30
	Grader	1	8	crew	6	14.7
	Roller	1	8			
Backfill & Compacted Fill	Loader	2	8	Haul:	1	8
	Dozer	1	8	Crew:	6	14.7
	Roller	1	8			
Chain link Fence	Backhoe	1	8	Haul: flatbed trucks	1	6
				crew	3	14.7
Clearing & Grubbing	Rubber-tired dozer	1	8	Haul: 15-cy trucks	6	30
				crew	3	14.7
Cofferdam Installation	Crane	1	8	Haul: flatbed trucks	1	15
	Excavator	1	1	crew	4	14.7
Concrete Planters	Forklift	1	8	Haul: flatbed trucks	4	30
Demolition concrete/riprap	Excavator	1	8	Haul: 15-cy trucks	4	30
	Rubber-tired loaders	2	8	crew	5	14.7
Demolition storm drain	excavator	1	8	Haul: flatbed trucks	1	20
Erosion Control	Backhoe	1	8	Haul: 0		
	Crane	1	8	crew	4	
Excavate Embankments	Scraper	1	8	Haul: 15-cy trucks	6	30
	Loader	1	8	Crew	5	14.7
Excavate, Grade Control	Excavator	1	8	Haul: 15-cy trucks	1	10
	Grader	1	8	Crew:	3	
Install storm drain	Fork lift	1	8	Haul: concrete truck	1	72
Impermeable Layer	Fork lift	1	8	Haul: flatbed trucks	1	25
	Crane	1	8	Crew:	5	
Irrigation	Ditch Digger	1	8	Haul	0	0
				Crew:	2	
Mobilization				Haul: flatbed trucks	1	30
				crew	3	14.7
Planting	Backhoe	1	8	Haul:	1	12
				Crew:	3	
Restrooms	Fork lift	1	8	Haul:	1	17
	crane	1	8	Crew:	4	
Riprap Placement	Loader	1	8	Haul: 15-cy trucks	6	30
	Excavator	1	8	Crew	5	
Sheet Pile & Asphalt Demolition	Excavator	1	8	Haul: 15-cy trucks	4	30
Stone placement & tie-in	Excavator	1	8	Haul: 15-cy trucks	1	17
	Loader	1	8	Crew:	3	
Topsoil	Grader	1	8	Haul:	1	15
	Loader	1	8	Crew:	5	14.7
	Dozer	1	8			
Trail, viewpoints, parking lots	Roller	1	8	Haul: 15-cy trucks	1	10
	Grader	1	8	Crew:	8	
	dozer	1	8			
	Loader	1	8			
Utility Towers	Crane	1	8	Haul: concrete truck	1	20
				Haul: flatbed trucks	2	20
				Crew:	6	

Attachment 2: General Multi-Year Schedule

Alternative 10

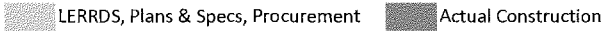


Reach Name	TOTAL #YRS	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Reach 8	0												
Reach 7	0												
Reach 6	0												
Reach 5	0												
Reach 4	0												
Reach 3	0												
Reach 2	0												
Reach 1	0												

Assumptions:

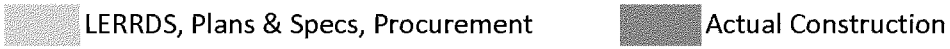
1. Prep time (P&S, procurement) is shown immediately preceeding construction

Alternative 13



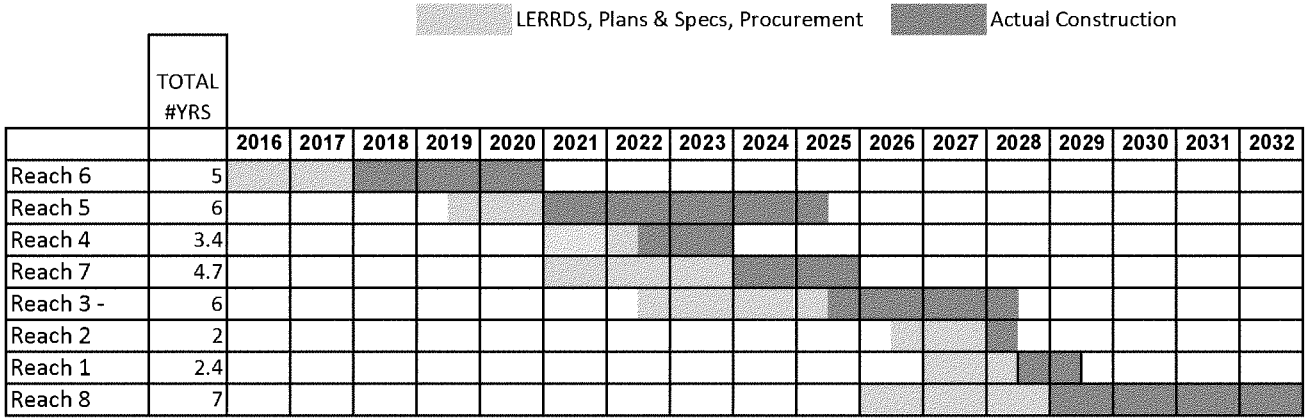
Reach Name	TOTAL #YRS	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Reach 8	0												
Reach 7	0												
Reach 6	0												
Reach 5	0												
Reach 4	0												
Reach 3	0												
Reach 2	0												
Reach 1	0												

Alternative 13V



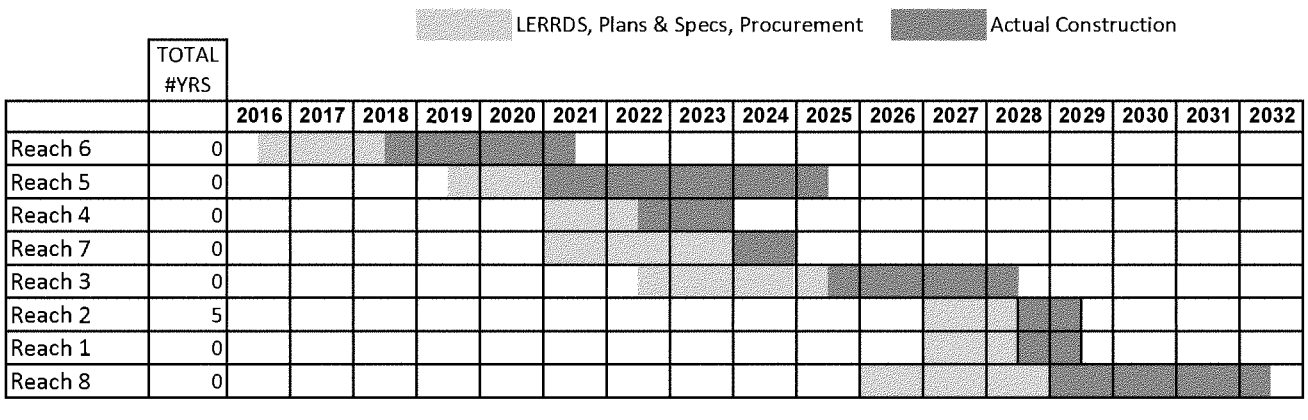
Reach Name	TOTAL #YRS	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Reach 6	4												
Reach 5	1.9												
Reach 4	3.4												
Reach 3	3.7												
Reach 2	2												
Reach 1	2.4												
Reach 8	3.7												
Reach 7	4												

Alternative 16



	TOTAL #YRS	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Reach 6	5																	
Reach 5	6																	
Reach 4	3.4																	
Reach 7	4.7																	
Reach 3 -	6																	
Reach 2	2																	
Reach 1	2.4																	
Reach 8	7																	

Alternative 20



	TOTAL #YRS	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Reach 6	0																	
Reach 5	0																	
Reach 4	0																	
Reach 7	0																	
Reach 3	0																	
Reach 2	5																	
Reach 1	0																	
Reach 8	0																	

Attachment 3: CalEEMod Data Tables (Annual and Daily) for Construction and Maintenance Emissions & Calculations for Visitation Emissions

Table 5-5: Alternative 10 Estimated Annual Emissions

Pollutants	General Conformity Rates (tons/yr)	2017 Estimated Emissions (tons/year)	2018 Estimated Emissions (tons/year)	2019 Estimated Emissions (tons/year)	2020 Estimated Emissions (tons/year)	2021 Estimated Emissions (tons/year)	2022 Estimated Emissions (tons/year)	2023 Estimated Emissions (tons/year)	2024 Estimated Emissions (tons/year)	2025 Estimated Emissions (tons/year)	2026 Estimated Emissions (tons/year)
Ozone (VOC)	10	0.12	0.12	0.06	0.11	0.05	0.07	0.07	0.00	0.06	0.06
Ozone (NOX)	10	1.38	1.21	0.62	1.20	0.49	0.66	0.64	0.00	0.50	0.51
NO2	100	1.38	1.21	0.62	1.20	0.49	0.66	0.64	0.00	0.50	0.51
CO	100	0.81	0.80	0.41	0.77	0.36	0.62	0.63	0.00	0.60	0.57
PM10	100	0.07	0.07	0.03	0.06	0.03	0.04	0.03	0.00	0.03	0.03
PM2.5	100	0.06	0.06	0.03	0.05	0.02	0.03	0.03	0.00	0.02	0.02
CO2e	10000	130	104	57	138	51	105	106	0.00	94	89

Table 5-6: Alternative 10 Estimated Daily Emissions

Pollutants	Regional Sigfinicant Rates (lbs/day)	Local Significant Rates (lbs/day)	2017 Estimated Emissions (lbs/day)	2018 Estimated Emissions (lbs/day)	2019 Estimated Emissions (lbs/day)	2020 Estimated Emissions (lbs/day)	2021 Estimated Emissions (lbs/day)	2022 Estimated Emissions (lbs/day)	2023 Estimated Emissions (lbs/day)	2026 Estimated Emissions (lbs/day)	2025 Estimated Emissions (lbs/day)	2026 Estimated Emissions (lbs/day)
VOC	75	n/a	2.90	5.97	5.69	2.53	4.14	2.50	1.74	0.00	1.72	1.87
NOX	100	46	32.47	63.55	58.21	26.89	41.99	23.89	16.69	0.00	14.95	16.90
CO	550	231	18.95	40.57	38.50	18.09	31.16	23.16	16.23	0.00	16.40	17.60
SO2	150	n/a	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.00	<0.005	<0.005
PM10	150	4	1.67	3.53	3.07	1.46	2.19	1.26	0.88	0.00	0.81	0.93
PM2.5	55	3	1.46	3.05	2.65	1.25	1.89	1.05	0.75	0.00	0.66	0.76
CO2e	n/a	n/a	3474	5909	5807	2844	4835	4153	3867	0.00	2995	3217

Table 5-7: OPERATIONS ANNUAL: MAINTENANCE AND VISITATIONS COMBINED (ALL ALTERNATIVES)

Pollutants	General Conformity Rates (tons/yr)	Estimated Emissions (tons/year)	Estimated Emissions (tons/year)
		Maintenance	Visitations
Ozone (VOC)	10	0.03	6.14
Ozone (NOX)	10	0.40	0.51
NO2	100	0.40	0.51
CO	100	0.28	0.78
PM10	100	0.02	0.18
PM2.5	100	0.02	0.11
CO2e	10000.00	48.00	2079.00

Table 5-8: OPERATIONS DAILY: MAINTENANCE AND VISITATIONS COMBINED (ALL ALTERNATIVES)

Pollutants	Regional Sigfinicant Rates (lbs/day)	Local Significant Rates (lbs/day)	Estimated Emissions (lbs/day)	Estimated Emissions (lbs/day)
			Maintenance	Visitations
VOC	55	n/a	2.40	4.80
NOX	55	46.00	26.60	3.10
CO	550	231.00	18.90	37.60
SO2	150	n/a	0.03	0.12
PM10	150	4.00	1.35	1.10
PM2.5	55	3.00	1.19	0.73
CO2e	n/a	n/a	3563.00	12720.00

Table 5-9: Alt 10 GHG

Annual CO2e Emissions Sources	SCAQMD GHG Rates (MT/yr)	Annual Estimated Emissions (MT/year)
Construction	n/a	29
Maintenance	n/a	48
Visitations	n/a	2079
Total CO2e	10,000	2156

Table 5-10: Alternative 13 Estimated Annual Emissions

Pollutants	General Conformity Rates (tons/yr)	2017 Estimated Emissions (tons/year)	2018 Estimated Emissions (tons/year)	2019 Estimated Emissions (tons/year)	2020 Estimated Emissions (tons/year)	2021 Estimated Emissions (tons/year)	2022 Estimated Emissions (tons/year)	2023 Estimated Emissions (tons/year)	2024 Estimated Emissions (tons/year)	2025 Estimated Emissions (tons/year)	2026 Estimated Emissions (tons/year)
Ozone (VOC)	10	0	0.22	0.16	0.11	0.10	0.07	0.07	0.09	0.06	0.06
Ozone (NOX)	10	1	2.28	1.69	1.20	1.02	0.66	0.64	0.87	0.50	0.51
NO2	100	1	2.28	1.69	1.20	1.02	0.66	0.64	0.87	0.50	0.51
CO	100	1	1.45	1.09	0.77	0.75	0.62	0.63	0.85	0.60	0.57
PM10	100	0	0.12	0.08	0.06	0.06	0.04	0.03	0.04	0.03	0.03
PM2.5	100	0	0.11	0.07	0.05	0.05	0.03	0.03	0.03	0.02	0.02
CO2e	10000	130	226	188	138	114	105	106	178	94	89

Table 5-11: Alternative 13 Estimated Daily Emissions

Pollutants	Regional Sigfinicant Rates (lbs/day)	Local Significant Rates (lbs/day)	2017 Estimated Emissions (lbs/day)	2018 Estimated Emissions (lbs/day)	2019 Estimated Emissions (lbs/day)	2020 Estimated Emissions (lbs/day)	2021 Estimated Emissions (lbs/day)	2022 Estimated Emissions (lbs/day)	2023 Estimated Emissions (lbs/day)	2024 Estimated Emissions (lbs/day)	2025 Estimated Emissions (lbs/day)	2026 Estimated Emissions (lbs/day)
VOC	75	n/a	2.90	7.45	5.68	2.53	4.57	2.50	1.74	3.31	1.72	1.87
NOX	100	46	32.47	77.96	58.18	26.89	45.97	23.89	16.69	30.75	14.95	16.90
CO	550	231	18.95	46.59	38.35	18.09	35.52	23.16	16.23	28.81	16.40	17.60
SO2	150	n/a	0.03	0.08	0.06	0.03	0.06	0.04	0.04	0.07	0.03	0.03
PM10	150	4	1.67	4.28	3.04	1.46	2.49	1.26	0.88	1.48	0.81	0.93
PM2.5	55	3	1.46	3.74	2.64	1.25	2.14	1.05	0.75	1.20	0.66	0.76
CO2e	n/a	n/a	3474	8142	5772	2844	5420	4153	3867	6841	2995	3217

Table 5-12: Alt 13 GHG

Annual CO2e Emissions Sources	SCAQMD GHG Rates (MT/yr)	Annual Estimated Emissions (MT/year)
Construction	n/a	46
Maintenance	n/a	48
Visitations	n/a	2079
Total CO2e	10,000	2173

Table 5-13: Alternative 13 V Estimated Annual Emissions

Pollutants	General Conformity Rates (tons/yr)	2017 Estimated Emissions (tons/year)	2018 Estimated Emissions (tons/year)	2019 Estimated Emissions (tons/year)	2020 Estimated Emissions (tons/year)	2021 Estimated Emissions (tons/year)	2022 Estimated Emissions (tons/year)	2023 Estimated Emissions (tons/year)	2024 Estimated Emissions (tons/year)	2025 Estimated Emissions (tons/year)	2026 Estimated Emissions (tons/year)	2027 Estimated Emissions (tons/year)
Ozone (VOC)	10	0.007	0.11	0.07	0.10	0.11	0.09	0.04	0.08	0.06	0.09	0.05
Ozone (NOX)	10	0.08	1.32	0.78	1.09	1.18	0.98	0.44	0.80	0.08	0.21	0.14
NO2	100	0.08	1.32	0.78	1.09	1.18	0.98	0.44	0.80	0.08	0.21	0.14
CO	100	0.03	0.75	0.50	0.78	0.91	0.78	0.45	0.78	0.54	0.83	0.48
PM10	100	0.005	0.06	0.04	0.05	0.06	0.04	0.02	0.04	0.02	0.05	0.03
PM2.5	100	<0.005	0.05	0.03	0.04	0.05	0.03	0.01	0.03	0.02	0.04	0.02
CO2e	10000	7	130	100	123	151	155	76	113	122	148	90

Table 5-14: Alternative 13 V Estimated Daily Emissions

Pollutants	Regional Sigfinicant Rates (lbs/day)	Local Significant Rates (lbs/day)	2017 Estimated Emissions (lbs/day)	2018 Estimated Emissions (lbs/day)	2019 Estimated Emissions (lbs/day)	2020 Estimated Emissions (lbs/day)	2021 Estimated Emissions (lbs/day)	2022 Estimated Emissions (lbs/day)	2023 Estimated Emissions (lbs/day)	2024 Estimated Emissions (lbs/day)	2025 Estimated Emissions (lbs/day)	2026 Estimated Emissions (lbs/day)	2027 Estimated Emissions (lbs/day)
VOC	75	n/a	0.67	1.56	1.04	2.27	2.26	1.58	1.47	3.80	0.09	2.34	1.44
NOX	100	46	7.75	19.22	11.15	23.56	22.88	16.21	14.65	36.33	8.15	20.93	12.76
CO	550	231	3.10	10.60	8.70	16.36	17.93	11.77	11.35	34.00	6.95	20.09	13.09
SO2	150	n/a	0.01	0.02	0.01	0.02	0.02	0.02	0.02	0.05	0.02	0.04	0.02
PM10	150	4	0.44	0.89	0.55	1.22	1.23	0.74	0.67	1.90	0.36	1.05	0.68
PM2.5	55	3	0.34	0.77	0.48	1.06	1.05	0.64	0.58	1.60	0.30	0.80	0.56
CO2e	n/a	n/a	1296	2187	1168	2449	2744	2312	2312	5141	2115	4529	2399

Table 5-15: Alt 13v GHG

Annual CO2e Emissions Sources	SCAQMD GHG Rates (MT/yr)	Annual Estimated Emissions (MT/year)
Construction	n/a	41
Maintenance	n/a	48
Visitations	n/a	2079
Total CO2e	10,000	2168

Table 5-16: Alternative 16 Estimated Annual Emissions

Pollutants	General Conformity Rates (tons/yr)	2018 Estimated Emissions (tons/year)	2019 Estimated Emissions (tons/year)	2020 Estimated Emissions (tons/year)	2021 Estimated Emissions (tons/year)	2022 Estimated Emissions (tons/year)	2023 Estimated Emissions (tons/year)	2024 Estimated Emissions (tons/year)	2025 Estimated Emissions (tons/year)	2026 Estimated Emissions (tons/year)	2027 Estimated Emissions (tons/year)	2028 Estimated Emissions (tons/year)	2029 Estimated Emissions (tons/year)	2030 Estimated Emissions (tons/year)	2031 Estimated Emissions (tons/year)	2032 Estimated Emissions (tons/year)
Ozone (VOC)	10	<0.005	0.13	0.01	0.01	0.22	0.21	0.10	0.10	0.06	0.06	0.05	0.10	0.07	0.08	0.14
Ozone (NOX)	10	<0.005	1.38	1.17	1.14	2.14	1.92	0.92	0.83	0.50	0.51	0.46	0.88	0.27	0.32	0.56
NO2	100	<0.005	1.38	1.17	1.14	2.14	1.92	0.92	0.83	0.50	0.51	0.46	0.88	0.27	0.32	0.56
CO	100	<0.005	0.85	0.80	0.84	1.77	1.82	0.90	0.92	0.66	0.64	0.50	0.96	0.64	0.54	0.87
PM10	100	<0.005	0.07	0.07	0.06	0.11	0.10	0.05	0.04	0.03	0.03	0.03	0.05	0.02	0.02	0.03
PM2.5	100	<0.005	0.06	0.06	0.05	0.09	0.08	0.04	0.03	0.02	0.02	0.02	0.04	0.01	0.01	0.02
CO2e	10000	1	148	117	159	357	347	175	197	126	121	80	210	144	175	289

Table 5-17: Alternative 16 Estimated Daily Emissions

Pollutants	Regional Sigfinicant Rates (lbs/day)	Local Significant Rates (lbs/day)	2018 Estimated Emissions (lbs/day)	2019 Estimated Emissions (lbs/day)	2020 Estimated Emissions (lbs/day)	2021 Estimated Emissions (lbs/day)	2022 Estimated Emissions (lbs/day)	2023 Estimated Emissions (lbs/day)	2024 Estimated Emissions (lbs/day)	2025 Estimated Emissions (lbs/day)	2026 Estimated Emissions (lbs/day)	2027 Estimated Emissions (lbs/day)	2028 Estimated Emissions (lbs/day)	2029 Estimated Emissions (lbs/day)	2030 Estimated Emissions (lbs/day)	2031 Estimated Emissions (lbs/day)	2032 Estimated Emissions (lbs/day)
VOC	75	n/a	0.01	3.83	8.21	3.59	5.00	5.05	3.25	2.98	2.53	4.36	3.67	2.91	1.70	2.07	4.22
NOX	100	46	0.04	38.52	83.67	36.56	47.71	48.36	30.24	25.50	19.95	38.54	32.95	25.72	7.81	8.86	17.39
CO	550	231	0.17	25.37	59.37	29.02	41.55	45.42	28.35	27.16	26.24	39.56	35.77	26.40	14.73	18.47	31.22
SO2	150	n/a	<0.005	0.04	0.09	0.07	0.10	0.11	0.05	0.07	0.06	0.08	0.06	0.05	0.04	0.05	0.10
PM10	150	4	0.04	2.13	4.61	1.76	2.31	2.51	1.60	1.27	1.05	2.08	1.87	1.38	0.35	0.46	0.97
PM2.5	55	3	0.01	1.82	3.99	1.44	1.88	2.15	1.35	1.01	0.82	1.72	1.54	1.15	0.25	0.36	0.74
CO2e	n/a	n/a	40	3970	9043	6545	9775	10471	4824	6837	5752	7224	6132	5167	3897	4706	9631

Table 5-18: Alt 16 SPL GHG

Annual CO2e Emissions Sources	SCAQMD GHG Rates (MT/yr)	Annual Estimated Emissions (MT/year)
Construction	n/a	88
Maintenance	n/a	48
Visitations	n/a	2079
Total CO2e	10,000	2215

Table 5-19: Alternative 20 Estimated Annual Emissions

Pollutants	General Conformity Rates (tons/yr)	2018 Estimated Emissions (tons/year)	2019 Estimated Emissions (tons/year)	2020 Estimated Emissions (tons/year)	2021 Estimated Emissions (tons/year)	2022 Estimated Emissions (tons/year)	2023 Estimated Emissions (tons/year)	2024 Estimated Emissions (tons/year)	2025 Estimated Emissions (tons/year)	2026 Estimated Emissions (tons/year)	2027 Estimated Emissions (tons/year)	2028 Estimated Emissions (tons/year)	2029 Estimated Emissions (tons/year)	2030 Estimated Emissions (tons/year)	2031 Estimated Emissions (tons/year)	2032 Estimated Emissions (tons/year)
Ozone (VOC)	10	<0.005	0.13	0.01	0.01	0.22	0.21	0.24	0.10	0.06	0.06	0.08	0.13	0.07	0.08	0.14
Ozone (NOX)	10	<0.005	1.38	1.17	1.14	2.14	1.92	2.16	0.83	0.50	0.51	0.71	1.14	0.27	0.32	0.56
NO2	100	<0.005	1.38	1.17	1.14	2.14	1.92	2.16	0.83	0.50	0.51	0.71	1.14	0.27	0.32	0.56
CO	100	<0.005	0.85	0.80	0.84	1.77	1.82	2.12	0.92	0.66	0.64	0.82	1.21	0.64	0.54	0.87
PM10	100	<0.005	0.07	0.07	0.06	0.11	0.10	0.12	0.04	0.03	0.03	0.04	0.06	0.02	0.02	0.03
PM2.5	100	<0.005	0.06	0.06	0.05	0.09	0.08	0.09	0.03	0.02	0.02	0.03	0.05	0.01	0.01	0.02
CO2e	10000	1	148	117	159	357	347	412	197	126	121	153	254	144	175	289

Table 5-20: Alternative 20 Estimated Daily Emissions

Pollutants	Regional Sigfinicant Rates (lbs/day)	Local Significant Rates (lbs/day)	2018 Estimated Emissions (lbs/day)	2019 Estimated Emissions (lbs/day)	2020 Estimated Emissions (lbs/day)	2021 Estimated Emissions (lbs/day)	2022 Estimated Emissions (lbs/day)	2023 Estimated Emissions (lbs/day)	2024 Estimated Emissions (lbs/day)	2025 Estimated Emissions (lbs/day)	2026 Estimated Emissions (lbs/day)	2027 Estimated Emissions (lbs/day)	2028 Estimated Emissions (lbs/day)	2029 Estimated Emissions (lbs/day)	2030 Estimated Emissions (lbs/day)	2031 Estimated Emissions (lbs/day)	2032 Estimated Emissions (lbs/day)
VOC	75	n/a	0.01	3.83	8.21	3.59	5.00	5.05	6.77	2.98	2.53	4.36	1.99	3.80	1.70	2.07	4.22
NOX	100	46	0.04	38.52	83.67	36.56	47.71	48.36	59.25	25.50	19.95	38.54	18.02	32.50	7.81	8.86	17.39
CO	550	231	0.17	25.37	59.37	29.02	41.55	45.42	62.11	27.16	26.24	39.56	18.91	34.54	14.73	18.47	31.22
SO2	150	n/a	<0.005	0.04	0.09	0.07	0.10	0.11	0.14	0.07	0.06	0.08	0.04	0.08	0.04	0.05	0.10
PM10	150	4	0.04	2.13	4.61	1.76	2.31	2.51	3.19	1.27	1.05	2.08	1.00	1.78	0.35	0.46	0.97
PM2.5	55	3	0.01	1.82	3.99	1.44	1.88	2.15	2.53	1.01	0.82	1.72	0.80	1.41	0.25	0.36	0.74
CO2e	n/a	n/a	40	3970	9043	6545	9775	10471	13602	6837	5752	7224	3941	7928	3897	4706	9631

Table 5-21:Alt 20 GHG

Annual CO2e Emissions Sources	SCAQMD GHG Rates (MT/yr)	Annual Estimated Emissions (MT/year)
Construction	n/a	100
Maintenance	n/a	48
Visitations	n/a	2079
Total CO2e	10,000	2227

MAINTENANCE ANNUAL

Pollutants	General Conformity Rates (tons/yr)	Estimated Emissions (tons/year)
ROG	10	0.03
NOX	10	0.40
CO	100	0.28
PM10	100	0.02
PM2.5	100	0.02
CO2e	10000	48

MAINTENANCE DAILY

Pollutants	Regional Sigfinicant Rates (lbs/day)	Local Significant Rates (lbs/day)	Estimated Emissions (lbs/day)
VOC	55	n/a	2.4
NOX	55	46	26.6
CO	550	231	18.9
SO2	150	n/a	0.03
PM10	150	4	1.35
PM2.5	55	3	1.19
CO2e	n/a	n/a	3563

DAILY VISITATION

Pollutants	Emissions factors	average miles per car	number of cars per day	pounds per day	Metric tons per year	CO2e Daily (lbs/day)	CO2e Annual
CO	**0.00328779**	20	572	37.61232	6.141837		
NOx	**0.00027141**	20	572	3.104927	0.507014		
ROG	**0.00042052**	20	572	4.810804	0.785572		
SOx	**0.00001076**	20	572	0.123075	0.020097		
PM10	**0.00009687**	20	572	1.108248	0.180969		
PM2.5	**0.00006415**	20	572	0.733871	0.119836		
CO2	**1.11105829**	20	572	12710.51	2075.54		
CH4	**0.00003518**	20	572	0.402427	0.065714		
CO2e						12,720	2079

metric tons per year = lbs/day * 360 days * 0.00045359237 metric tons/lb

Annual CO2e calculated with EPA CO2e calculator at http://www.epa.gov/cleanenergy/energy-resources/calculator.html#results gasses used are CO2 (2075 metric tons) and CH4 (0.065 metric tons)

emissions factors from SCAQMD on-road factors for passenger vehicles; all model years from 1982-2026

Daily CO2e = (12710+0.402) = 12720 lbs per EPA CO2e calculator

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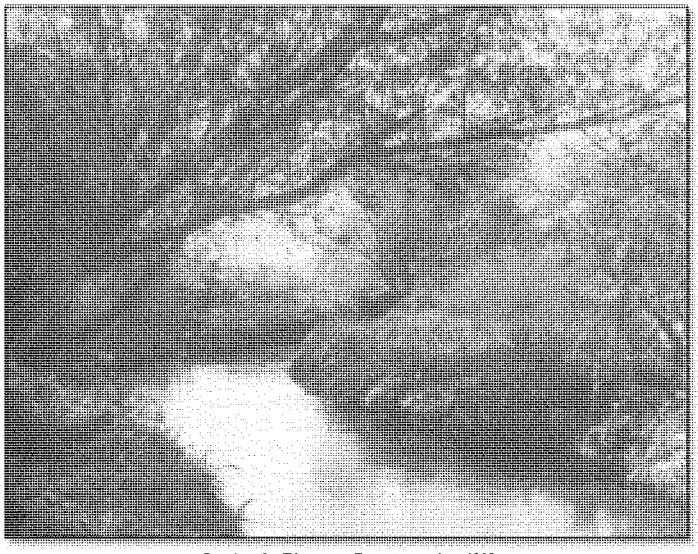
Los Angeles River Ecosystem Restoration Feasibility Study

Final
Habitat Evaluation (CHAP) Appendix G

September 2015



Los Angeles River near Downtown, circa 1900
from Blake Gumprecht's "The Los Angeles River"

CHAP Habitat Evaluation Appendix
Los Angeles River Ecosystem Restoration Study

U.S. Army Corp of Engineers
Los Angeles District

and

Northwest Habitat Institute

September 2015

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B. Master List Key Ecological Functions (KEFs)
C. Potential Species List for the Study Area
D. Relationship Matrix Descriptions & HU Calculation Overview
E. Verification Transect Report
F. Alternative Measures Matrix
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1.0 INTRODUCTION

This Appendix provides a habitat assessment analysis of alternatives proposed for the Los Angeles (LA) River Ecosystem Restoration (ER) Feasibility Study (the "Study"), Los Angeles, California. The Study examines restoration opportunities within an 11-mile segment of the LA River, referred to as the ARBOR (Alternative with Restoration Benefits and Opportunities for Revitalization) reach (hereafter referred to as Study area) (Figure 1-1). The Study alternatives evaluate restoration of the area to a condition characteristic of the historic, natural riparian river channel, as limited by the surrounding highly urbanized City of LA and the channel's purpose for flood risk management. Development of restoration alternatives was based on the following study objectives:

- Restore Valley Foothill Riparian Strand and Freshwater Marsh Habitat.
- Increase Habitat Connectivity.

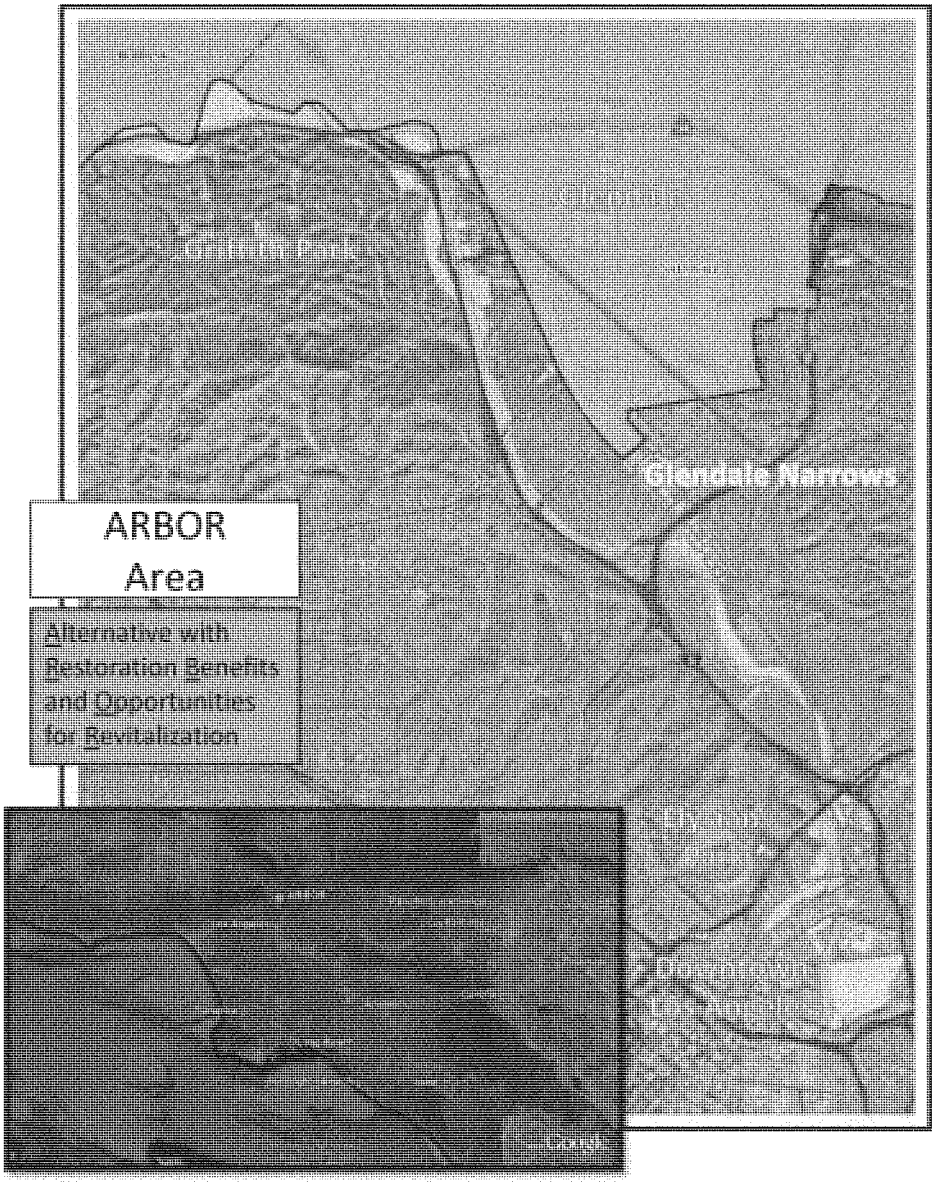
2.0 STUDY BACKGROUND

The U.S. Army Corps of Engineers' (Corps') involvement with the LA River began in the 1930s after devastating floods destroyed homes, businesses, and infrastructure in the early 20th Century. The City of Los Angeles and Los Angeles County initiated the flood control program that channelized the river after these floods. Congress authorized the Corps to undertake, with the County as partner, a modified version of the County's comprehensive plan. The Corps then joined the efforts, which led to the further channelization of the River in the 1930s and 1940s and the current concrete configuration. This configuration drastically altered the remaining riparian and freshwater marsh habitats as well as ecosystem functions in the once natural River system. The flood risk management project also allowed for increased urbanization and development in the floodplain, further reducing the marsh and riparian habitats that had naturally occurred on the river and its tributaries. The Corps' involvement on the LA River continues today in sharing operation and maintenance responsibilities with the LA County Flood Control District. The Corps has operation and maintenance responsibility for the portion of the river within the Study Area.

The U.S. Congress directed the Corps to undertake the LA River Ecosystem Restoration Study in 2006. The Study initially focused on the first 32 miles of river, and was subsequently narrowed to focus on the 11.5-mile Study area (aka ARBOR reach), which exhibits the greatest potential for ecosystem restoration. This reach includes the "soft-bottomed" Glendale Narrows that connects Griffith Park to Downtown LA and that currently supports degraded riparian habitat. The soft-bottomed reaches currently support a natural bed with concrete banks due to a high groundwater table that did not allow the bed to be constructed with concrete.

In 2007, the City of LA adopted the long-range LA River Revitalization Master Plan that calls for the creation of a 64-mile network of trails, parks, and recreation along both sides of the first 32 miles of the LA River, from the San Fernando Valley to the City of LA's border with the City of Vernon, an area home to more than one million people. The entire Study area is within the Master Plan's focus area.

Figure 1-1. ARBOR Study Area



The Feasibility Scoping Meeting milestone[1] for the LA River ER Study occurred in November 2007. The Study is currently in the Plan Formulation and Evaluation Phase with the City of LA as the non-Federal local sponsor. Planning workshops were held in December 2009, and the Corps used the information from these workshops to develop 19 preliminary alternatives defined by combinations of more than 200 measures. Elements from these preliminary 19 alternatives were later recombined and eventually reduced to four final alternatives for detailed consideration based on preliminary design and cost-benefit analyses. A final recommended plan will be chosen from this group of four alternatives.

3.0 SITE DESCRIPTION

The 11-mile Study area encompasses the soft bottom Glendale Narrows as well as portions of the concrete channel from Griffith Park to northern downtown LA. The Study area includes the LA River channel and select adjacent areas, beginning upstream at Pollywog Park, across from the Forest Lawn Cemetery. Further downstream, Verdugo Wash enters the LA River from the east, and the River then flows south through the Glendale Narrows. Just downstream of the Glendale Narrows, the Arroyo Seco enters the River from the east, and the River continues to flow south into downtown. The project area ends in downtown at First Street.

Large (i.e. in acreage) River-adjacent areas considered in the Study area include Pollywog Park, Burbank-Western Channel confluence, Bette Davis Park, Ferarro Fields, Verdugo Wash confluence, Griffith Park Golf Course (a.k.a. Harding Municipal Golf Course), Los Feliz Golf Course, Bowtie Parcel, Taylor Yard (a.k.a. G-2 Parcel), Arroyo Seco confluence, Cornfields (a.k.a. Los Angeles State Historic Park), and Piggyback Yard (Figure 3-1). The Study area encompasses approximately 842 acres.

The Study area is split into eight geomorphic reaches (Figure 3-2) generally defined by Study landmarks as follows:

1) Pollywog Park to Bette Davis Park (concrete bottom)
2) Bette Davis Park to Ferraro Fields (soft bottom)
3) Ferraro Fields to upstream Glendale Narrows (concrete bottom)
4) Upstream Glendale Narrows to Los Feliz Boulevard (soft bottom)
5) Los Feliz Boulevard to Bowtie Parcel (soft bottom)
6) Bowtie Parcel to downstream Glendale Narrows/Arroyo Seco (soft bottom)
7) Downstream Glendale Narrows/Arroyo Seco to Main Street (concrete bottom)
8) Main Street to First Street (concrete bottom)
   *Note that all reaches have concrete banks

1 Feasibility Scoping Meeting (FSM) = The purpose of the FSM is to bring the Corps vertical management team, the non-Federal sponsor, and resource agencies together to agree on the problems and solutions to be investigated by a Study, and the scope of analyses required. An FSM will address the problems, opportunities, and needs; refine study constraints; identify the key alternatives; and further define the scope, depth, and methods of analyses required.

Figure 3-1. Key River Adjacent Areas

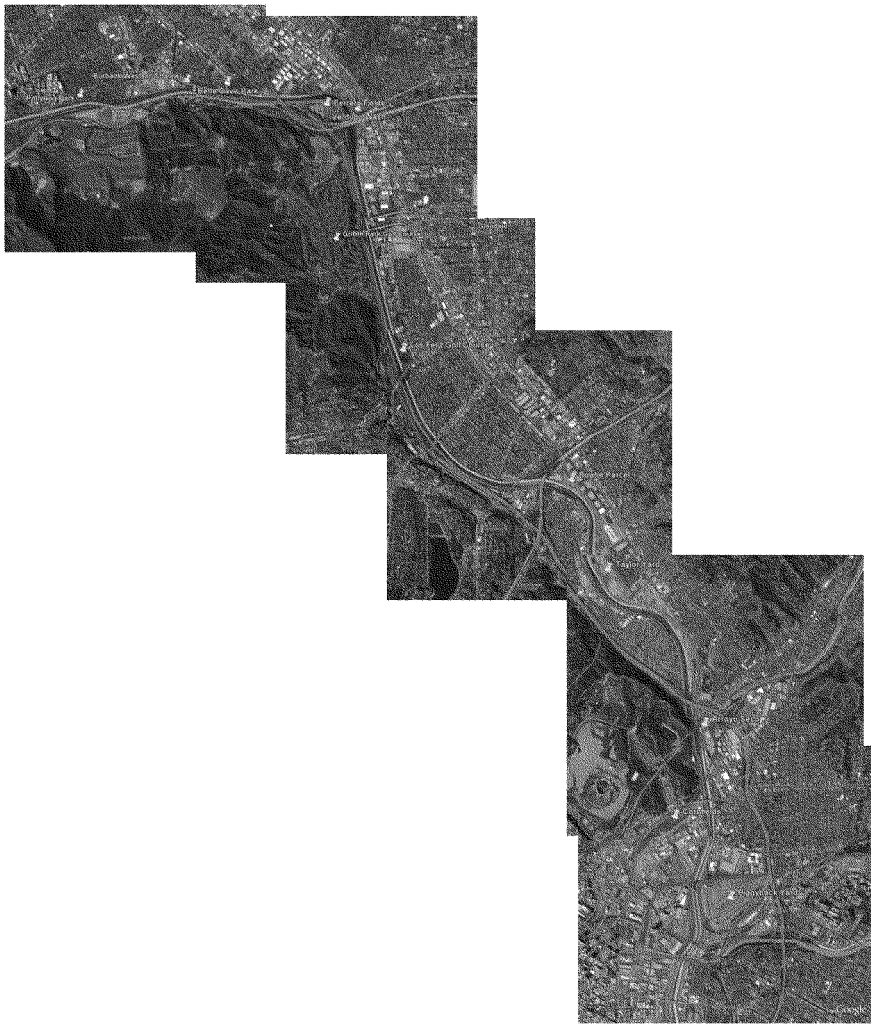
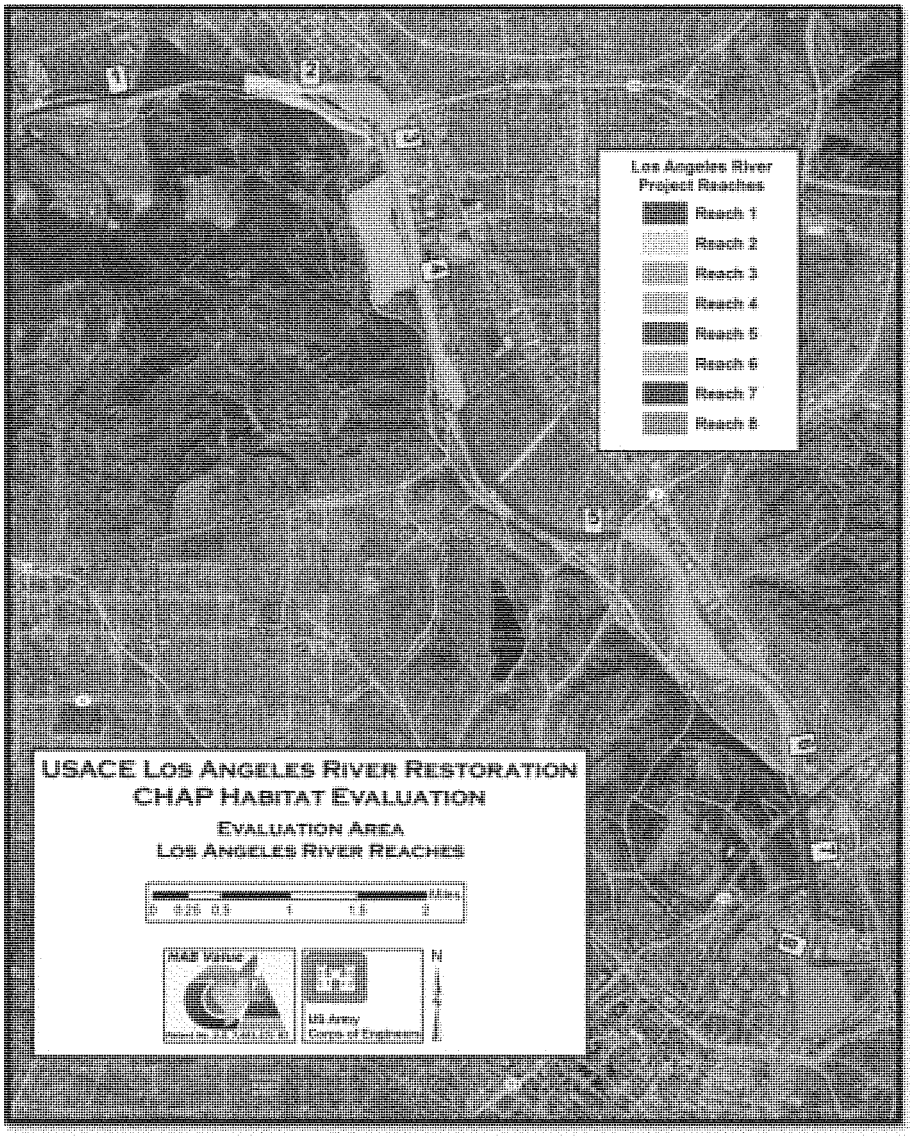


Figure 3-2. Geomorphic Reaches



The reaches of the River with a concrete bottom have three configurations in the Study area, including box and trapezoidal, or a combination of the two. The "soft" bottom areas have predominantly rock and cobble substrate that support riparian and wetland vegetation within trapezoidal concrete slopes.

4.0 STUDY AND METHODOLOGY ASSUMPTIONS AND CONSTRAINTS

Due to its highly urbanized setting and the hydrologic alterations that the River has undergone prior to and since its channelization, there are several constraints that were considered in defining alternatives and assessing how these alternatives can achieve the Study objectives.

Historic hydrologic conditions that are extremely important to riverine, riparian, and marsh ecosystems have been irreversibly altered along most of the LA River. Complete restoration of historic conditions is not feasible; therefore, to the greatest extent possible, the Study aims to restore riparian and wetland vegetation communities and habitats that were known to occur historically.

Residential, commercial, and industrial land uses border the River, thereby limiting the area adjacent to the River available for restoration. This is an important determinant in the potential acreage of each community type in the habitat analysis. More importantly, it influences the spatial and structural diversity that can be attained, as well as the quality of riparian habitat in terms of characteristics such as availability of water to River adjacent restoration areas and the relationship between interior versus edge space. Presently, the Study area (i.e., width of the restoration corridor) has been predominantly defined by existing easements and rights of way, existing structures, availability of adjacent lands for acquisition, local topography, and the historic floodplain. Furthermore, several of the River-adjacent areas that would provide substantial lands for restoration, if acquired, require cleanup of hazardous and toxic wastes from previous uses, such as rail yards.

Overall, water availability in the project area during the non-flood season, is predominated by upstream releases from the Tillman Water Reclamation Plant, as well as local surface runoff. Ongoing water conservation efforts include holding more water at upstream reservoirs with the intent of percolating in spreading basins. The City also has plans to remove dry weather flows from the River as part of its Integrated Regional Plan, specifically the Department of Water and Power's Recycled Water Master Plan. Lack of a more significant, reliable water source for the Study area poses constraints on the ability to sustain important functions of stream, riparian, and wetland habitats that currently exist, as well as proposed habitats in the alternative plans. However, the City is committed to maintaining flows necessary for the restoration plan to be implemented as a result of this study.

Several other ecosystem restoration studies and projects are on-going on LA River tributaries, including the Headworks, Sun Valley, and Arroyo Seco Ecosystem Restoration Continuing Authority Program Studies, and the Tujunga Wash project was recently completed. These Studies and projects will positively affect the LA River riverine system by restoring upstream habitat and functions, and by increasing ecosystem value. However, the implementation of these projects will also require a portion of the scarce water resources to support the restoration efforts.

The California High Speed Train (HST) project is also a factor in the extent to which the riparian ecosystem can be restored and the success of the restoration project in achieving its goals. Certain proposed alignment alternatives near the Study area may impact the restoration project. While HST project implementation is considered long-term and not precisely defined at this point, the alignments that abut and cross the Study area would have a negative impact on the value of wildlife habitat. Other development, transportation, and infrastructure projects occurring within or adjacent to the Study area would generally have a negative effect on restoration.

Ultimately the LA River in its current state is a flood risk management structure. The purpose of flood risk management must be maintained and there can be no increase in flood risk, thereby limiting the amount vegetation that can be sustained in the channel. Acquisition of river adjacent areas that would allow for widening of the River would allow for more vegetation in the channel; however these opportunities are limited.

Despite these constraints and limitations, the ARBOR reach retains the potential for substantial improvements to habitat quality in highly degraded areas, providing or enhancing wildlife movement corridors, and increasing nesting opportunities for native resident and migratory species.

5.0 HABITAT EVALUATION: COMBINED HABITAT ASSESSMENT PROTOCOL (CHAP)

5.1 CORPS RESTORATION POLICY

Under Corps authority, restoration opportunities that are associated with wetlands, riparian and other floodplain and aquatic systems are most appropriate for Corps involvement. The objective of Corps ecosystem restoration projects is to restore degraded ecosystem structure, function, and dynamic processes to a less degraded, more natural condition. Even partial restoration may provide significant and valuable improvements to degraded ecological resources (USACE 2000).

Restored ecosystems should mimic, as closely as possible, conditions that would occur in the area in the absence of human changes to the landscape and hydrology. Indicators of successful restoration would include the presence of a large variety of native plants and wildlife, the ability of the area to sustain larger numbers of key indicator species[2] or more biologically desirable species, and the ability of the restored area to continue to function and produce the desired habitat benefits with a minimum of continuing human intervention (USACE 2000).

Additional guidance for ecosystem restoration in the Civil Works Program assures that civil work investments in ecosystem restoration have the intended beneficial effects and would be conducted in the most cost effective manner (USACE 2000).

Corps guidance requires that the ecosystem related benefits of proposed alternatives be subjected

2 An indicator species is an organism whose presence, absence or abundance reflects a specific environmental condition. Indicator species can signal a change in the biological condition of a particular ecosystem, and thus may be used as a proxy to diagnose the health of an ecosystem.

to detailed economic analysis, allowing an explicit comparison of the costs and benefits associated with the alternatives. Consequently, it is necessary that the environmental benefits of the alternatives be based on some quantifiable unit of value. Since restoration value is difficult to monetize, instead of calculating benefits in monetary terms, the Corps ecosystem restoration projects calculate the value and benefits of restored habitat using established habitat assessment methodologies. Comparing the alternatives in this manner facilitates the determination of the most cost-effective restoration alternative that meets restoration goals (USACE 2000).

5.2 HABITAT ASSESSMENTS

Evaluating habitat quality is the approach most often taken to compare ecosystem restoration alternatives because habitat is thought of as a surrogate for ecosystems; it is the setting where plants and animals live, interact, and reproduce. Habitat is frequently viewed in conjunction with species information to gain insight to various uses, structures, and functions existing within a landscape or site.

Few methods for habitat assessment exist; however, most are focused only on aquatic habitats, wetland habitats, or habitat for a single species. One such habitat assessment methodology used by the Corps is the U.S. Fish and Wildlife Service's (USFWS) single species model known as the Habitat Evaluation Procedure/Habitat Suitability Index Models (HEP/HSI) (1980). HEP evaluates single species, a species guild, or a species assemblage using models comprised of measureable habitat variables and associated mathematical aggregations to estimate habitat suitability/quality (NHI 2007). The preliminary output of the HEP model is a habitat suitability index (HSI), which ranges from 0 (poor habitat quality) to 1.0 (optimum habitat quality). Habitat value is finally calculated in terms of Habitat Units (HUs) by multiplying the HSI by site acreage.

HUs are then used to rate and compare the value of one ecosystem restoration alternative to another. While HUs are a simple and useful form for presenting habitat quality as a numerical value, HEP assumes a linear relationship between habitat suitability and species response. In other words, HEP assumes that as HSI increases the wildlife population should also increase. This implies that the model has the ability to predict population response without errors (NHI 2007).

Furthermore, the single species method assumes that an entire community is represented by that species, which may result in a narrow representation of habitat quality (NHI 2007). The single species method does not account for substantial benefits that are afforded by the ecosystem as a whole, which includes multiple species and multiple habitats. Furthermore, it does not account for all functions or habitat components potentially present at a site.

Throughout the U.S. there is a shift towards assessing restoration and other conservation activities at the ecosystem level (Perkins 2002). Determining habitat structure and functional integrity of an area for all species potentially using it is more supportive of an ecosystem management approach. A habitat assessment methodology that measures functionality, which is critical to the success of many restoration projects, should incorporate multiple components such as vegetation, structure, surrounding landscape, and habitat size and shape (Breaux et al. 2005, Store and Jokimaki 2003).

5.3 CHAP BACKGROUND

Recently, an ecosystem-based habitat evaluation framework known as HAB (or the Habitat Accounting and Appraisal methodology) was developed by the Northwest Habitat Institute (NHI). This approach involves a triad assessment of species, habitat, and functions (O'Neil et al. 2005), and includes an inventory of habitat components and their relationship to ecological functions performed by species. The Combined Habitat Assessment Protocols (CHAP) method, which incorporates the HAB methodology, generates HUs based on an assessment of multiple species, habitat features, and functions by habitat type.

In the HAB approach, fish and wildlife with the potential to occur at a given site are identified. Potential species are determined using range maps in conjunction with information on vegetation types and habitat types, structural conditions, and habitat elements, also known as Key Environmental Correlates (KECs). KECs represent habitat elements (physical and biological) that are known to most influence a species distribution, abundance, fitness, and viability. KECs include habitat elements such as down wood, snags, litter layer, shrub layer, flowers, burrows, boulders, or riffles and pools. For the Master list of CHAP KECs, see Appendix A.

Habitat is defined as "the place, including physical and biotic conditions, where a plant or animal usually occurs" (Johnson and O'Neil 2001). Habitat types are often characterized by a dominant plant form or physical characteristic. Structural conditions of the habitat are also considered.

Function refers to the principal way organisms influence the environment, also known as Key Ecological Functions (KEF) (NHI 2007). KEFs refer to the principal set of ecological roles performed by each species in its ecosystem (NHI 2007). More specifically, KEFs refer to the main ways organisms use, influence, and alter their biotic and abiotic environments. KEFs include functions that organisms perform in the environment, such as a grazer, sap feeder, carrion feeder, seed disperser, nest parasite, primary cavity excavator, or impounds water by creating dams. For the Master list of CHAP KEFs see Appendix B.

While other methods consider habitat components, the HAB approach considers over 350 different KECs and over 100 KEFs as seen in Appendices A and B. KECs and KEFs are key components in determining the wildlife habitat unit values.

The HAB approach can be combined with elements of HEP to address habitat value at evaluation sites, with HUs as the output. Such a combined approach is referred to as CHAP (Combined Habitat Assessment Protocol) (NHI 2007).

The CHAP evaluation described herein utilizes the ecosystem-based approach to quantitatively characterize the ecological value of wildlife habitat associated with the restoration alternatives proposed for the LA River ER Study. Habitats for the following groups of animals were evaluated as part of the CHAP analysis and would be benefited by implementation of the alternatives:

- Resident and Migratory Birds, including raptors
- Reptiles
- Amphibians

- Mammals
- Fish

5.4 CORPS PLANNING PROCESS

In order to solve water resources and ecosystem restoration issues, the Corps Planning process identifies problems and opportunities, inventories and forecasts conditions, and formulates, evaluates, and compares alternative plans in order to select the best, most cost effective project alternative for implementation and construction.

In identifying problems and opportunities, project objectives and constraints are also developed that guide the formulation of alternatives. When inventorying and forecasting, the historic, existing, and future conditions are examined to establish a baseline for alternative comparison. Alternative formulation develops a suite of management measures[3] that are combined together in various ways to create a set of project alternative plans. The alternative plans are evaluated by forecasting conditions "with project" implementation and comparing them to the forecasted "without project" condition. The plans are then compared to one another based on how they meet project objectives, and on cost effectiveness and cost-benefit analyses, policy compliance, and acceptability by the public and stakeholders. The best plan, based on these factors, becomes the recommended plan for implementation.

The habitat assessment serves to quantify restoration benefits that inform the cost effectiveness and cost-benefit analyses and that contribute to the comparison of alternative plans.

6.0 CHAP ANALYSIS

The HAB approach, which is largely spatially based, uses Geographic Information Systems (GIS) to delineate habitat polygons[4] and map habitat types (cross-walked with associated vegetation types) within the Study area. These habitat type classifications are based on the California Wildlife Habitat Relationships (CWHR) habitat classification scheme, derived from the CDFG publication titled "A Guide to Wildlife Habitats of California" (Mayer and Laudenslayer 1988). For each habitat polygon, wildlife species associated with these CWHR habitat types are linked to key environmental correlates (KECs) (i.e. habitat elements) and key ecological functions (KEFs)(i.e. functions performed by species), which are derived from NHI's Interactive Habitat and Biodiversity Information System (IBIS) database[5] (Johnson and O'Neil, 2001).

The detailed steps of compiling KECs and KEFs are outlined in Section 6.1.1.

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3 A management measure is a feature or activity that can be implemented at a specific geographic site to address one or more planning objectives. It may be a "structural" feature that requires construction or assembly on-site, or it may be a "non-structural" action that requires no construction (USACE 1996).

4 In GIS, a polygon is a map feature that bounds an area at a given scale, such as a county on a world map or a district on a city map. In habitat mapping, the polygon bounds a specific habitat type.

5 The datasets for KECs and KEFs have been developed through a multiple expert panel process. IBIS is an extensively peer reviewed system that contains current ecological information on more than 1,000 fish and wildlife species, organized in searchable databases.

The subsequent analysis of these habitats, species, and functions results in a quantitative value for existing and forecasted with and without project habitats in the Study area.

6.1 BASELINE: EXISTING CONDITIONS

6.1.1 Baseline: Existing Conditions Methods

A fine level scale approach was used to calculate habitat value for the LA River ER study. The baseline CHAP approach, incorporating the HAB methodology, involves: 1) preliminary mapping, 2) field inventory, 3) species list, 4) data compilation and analysis, 5) conversion to HUs, and 6) Annualizing HUs.

1. Preliminary Mapping
   Using GIS and geo-referenced aerial imagery, the LA River ER study site was mapped by delineating potential habitat types or structural conditions within the site. Habitat types were identified using visual differences in land formations, vegetation, and structural condition, as detected and interpreted in the imagery. Preliminarily, the National Agriculture Imagery Program (NAIP) imagery was used, and later high-resolution imagery supplied by the Corps was used.

2. Field Inventory
   The field inventory included an ocular survey that verified the polygon delineations. Habitat type, structural conditions, and key environmental correlates within each polygon were identified and recorded. Invasive plant species and the presence of stressors within each polygon were also recorded.

   Stratified random verification transects were then employed to measure in detail the site's vegetation characteristics. These transects substantiate site variables including percent cover and species of trees, shrubs, herbaceous and invasive vegetation and serve as a double sampling technique to confirm the ocular field inventory.

3. Species List
   The CWHR was used to produce a site-specific species list by considering ecological and geographical connections between species and the habitat types within the Study area. Factors used to generate the species list are potential species linked to each of the habitat types and potential species linked to the Study area based on species range maps and known existing conditions.

   References from local experts including the Griffith Park Draft Wildlife Management Plan (Cooper and Mathewson 2008), The Biota of the Los Angeles River (Garrett 1993), and The State of the River – the Fish Study (FoLAR 2008), were also employed to develop an initial species list.

   The species list was reviewed and refined by a habitat evaluation team (See Section 8.0) comprised of Corps and City of LA staff and local resource agency experts including the U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Game (CDFG), Regional Water Quality Control Board (RWQCB), and a

local fish expert from the University of California Cooperative Extension, Los Angeles County. The team decided that seasonal migrants and infrequent visitors would be included on the species list, as creating an arbitrary limit for including a species as "occurring" would not account for all species that are known to use the project area. Additional review and input was requested from local experts including Dan Cooper (Cooper Ecological Monitoring, Inc.) and Drew Stokes (San Diego Natural Museum of History) to verify the presence or absence of certain species of interest. The resulting species list is included in Appendix C.

4. Data Compilation and Analysis
   Data from the mapping and field inventory was used to generate two relationship matrices including 1) a potential species by function (KEFs) matrix and 2) a habitat (KECs) by function (KEFs) matrix (for definitions of KEC and KEF See Section 5.3; for further details on the matrices see Appendix D).

   To create these matrices, the species list was sorted by its association with the CWHR habitat types and the list of taxa was linked to the associated habitat elements (KECs) and functions (KEFs).

   The first matrix determines the mean functional redundancy index (MFRI), which is based on the number of species performing functions in a habitat type (KEFs). More specifically, it is the number of species that are associated with the habitat type and performing each function divided by the number of potential functions associated with the habitat type. The result of the first matrix is the number of potential functions characterized by species specific to that polygon.

   The second matrix is based on the results of the field inventory of the Study area and the list of habitat elements (KECs) observed. The result of the second matrix is the number of functions characterized by habitat elements (KECs) specific to that polygon.

   Per-acre values were then computed for each polygon by adding the species-function matrix (MFRI) value and the habitat-function matrix value (for further details on calculations see Appendix D). In sum, for each polygon MFRI + KEC matrix = Per Acre Value.

   The per-acre value represents the intrinsic worth of an area to fish and wildlife, determined by accounting for species, habitats, and functions. Additional factors that may negatively impact this habitat value are accounted for as described in Section 6.1.2.

5. Conversion to HUs
   To determine HUs for site conditions, in order to compare Study alternatives and inform alternative cost-benefit analyses, each polygon's per-acre value was multiplied by its acreage. These values were then summed across all polygons to calculate the

total HUs for a particular condition or alternative scenario. In sum, for each polygon Per Acre Value x Acres = HUs.

Unlike HEP, where the preliminary output (HSI) ranges from 0 to 1 (as described in Section 5.2), CHAP's per-acre values are not limited to this range. In this way, where the HUs in HEP are dependent on acreage (HSI x acreage = HU; IE more acreage = more HUs), the HUs generated by CHAP are not dependent on acreage and reflect the intrinsic value of a particular habitat type based on species, functions, and habitat.

Results of the baseline CHAP analysis are provided in the form of GIS maps and Microsoft excel spreadsheets. GIS maps generated depict the habitat values (HUs) of each of the 172 polygons. Supporting maps illustrate: a) study area boundaries; b) polygon numbering; c) percentage of non-native plant species by polygon (See Section 6.1.2); d) wildlife habitat types by polygon (See Section 6.1.3); e) structural conditions by polygon (See Section 6.1.3); f) per-acre habitat value (See Section 6.1.3); and g) HUs (See Section 6.1.3).

Spreadsheets were developed that contain the calculations of the species-function and habitat-function matrices, along with calculations of Study area habitat values. Due to the large volume of data, maps, and spreadsheets, the complete set of files is available upon request from the Corps, Los Angeles District. Sample figures are provided in Figures 6.1.1-1, 6.1.2-1, and 6.1.3-1 to 6.1.3-8. Summary tables are included in Tables 6.1.3-1 and 6.1.3-3, and discussed in the following Sections 6.1.2 and 6.1.3.

6.1.2 Per-Acre Adjustment Value for Habitat Stressors

Since the LA River ER project area is located within a highly urbanized setting, there are several ecosystem drivers and stressors that affect the Study area and how it is currently managed. There are four noteworthy influences including: 1) invasive plant species, 2) potential use of the area for encampments by people who are homeless, 3) horseback riding in the river, and 4) excessive refuse/trash in the river.

Prior to conversion to HUs, the per-acre baseline value of each polygon was adjusted based on the presence of these stressors, in order to capture the value lost due to these factors within the Study area. The HAB method allows for these modifications when the habitat evaluation team deems them to be appropriate.

Invasive Plant Species

Each polygon was assigned an invasive plant value for each of three structural layers (grass/herbaceous, shrub, and tree) based on the presence and abundance of invasive species in that layer, as documented in the field inventory. Because invasive species generally negatively influence ecosystem function, the per-acre values were then discounted for the presence of invasives, to begin to arrive at a corrected per-acre value for each polygon. The value of discount applied based on presence of invasive species is described in Table 6.1.2-1. The deduction factor was multiplied by the per-acre value to reach the adjusted value. In sum, per-acre value x deduction factor = adjusted per-acre value.

The percent abundance of invasive species by polygon can also be spatially displayed in a map to show their influence on the habitat value. Sample maps are included in Figure 6.1.2-1.

Table 6.1.2-1. Invasive plant species deduction factors[6]

Invasive species cover	*X*
0-10%	1.0
11-35%	0.9
36-65%	0.7
66-90%	0.5
>90%	0.3

Homeless, Horseback Riding, Excessive Refuse

During the habitat evaluation team meetings, the subject of homeless encampments, horseback riding, and excessive refuse/trash and their influence on wildlife habitat was raised. The team members were reluctant to assign an arbitrary value of influence to weight the polygons based on these stressors, so to address these concerns a literature review was conducted. Activities noted as potential effects to wildlife habitat from these stressors include trampling, camping, sewage, erosion, and covering. KECs that are influenced by these activities are found in Table 6.1.2-2. Since the CHAP identifies KECs as absent or present within each polygon, the stressor influenced KECs are adjusted by changing their status from present to absent. For example, the presence of homeless encampments would result in camping/trampling, which would damage vegetation. KECs such as flowers, forbs, shrubs, and saplings would, therefore, be identified as absent for those polygons. In applying this to the Study Area, these local stressors influenced the site's overall habitat value approximately 7%.

6.1.3 Baseline: Existing Conditions Results

Habitat Types and Vegetation Communities

The 172 polygons in the LA River ER Study area were determined by delineating the California Wildlife Habitat types that occur within the Study area. The mapping performed by NHI within the Study area in 2011 documented several habitat types, each of which are an aggregation of several vegetation communities. Habitat types as described by the CWHR System included Coastal Scrub, Eucalyptus, Open Water/Riverine, Pasture, Perennial Grassland, Valley Foothill Riparian, Tree Farm, and Urban (High Density, Golf Course, and Low Density). Structural conditions included: grass-forb, shrub, and tree layers along with constrained river channel and urban with various levels of impervious surfaces.

6 Deduction factors for invasive plant species were developed by NHI in a team environment during the Oregon Bridge Replacement Program, where agencies wanted to receive credit for controlling invasive species at a site. The team was comprised of representatives from: U.S. Army Corps of Engineers, Bureau of Land Management, NOAA Fisheries Service, Environmental Protection Agency, U.S. Forest Service, U.S. Fish and Wildlife Service, Federal Highway Administration, Oregon Department of Transportation, Oregon Department of Environmental Quality, Oregon Department of Fish and Wildlife, Oregon Department of State Lands, and the State Historic Preservation Office.

Figure 6.1.1-1. Sample Maps – Baseline Existing Conditions – Polygon Identification Numbers

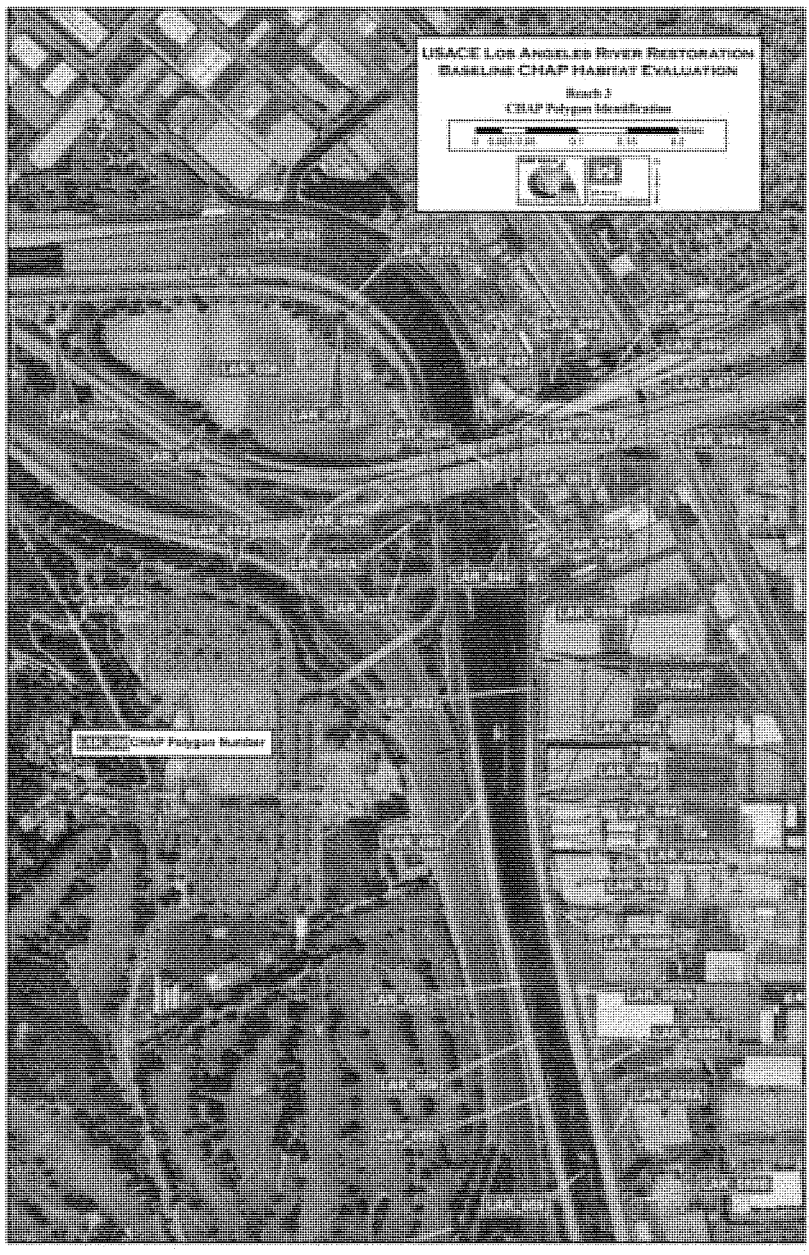


Figure 6.1.1-1. Sample Maps – Baseline Existing Conditions – Polygon Identification Numbers

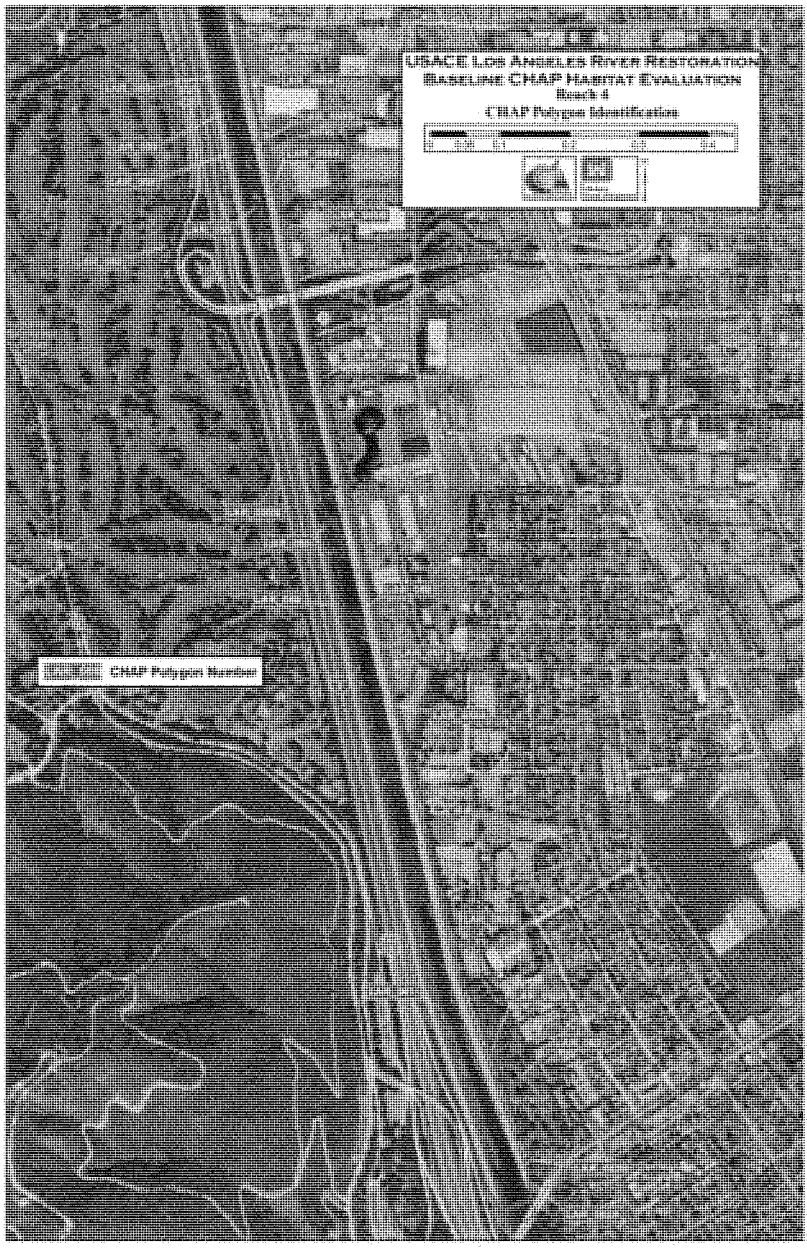


Figure 6.1.1-1. Sample Maps – Baseline Existing Conditions – Polygon Identification Numbers

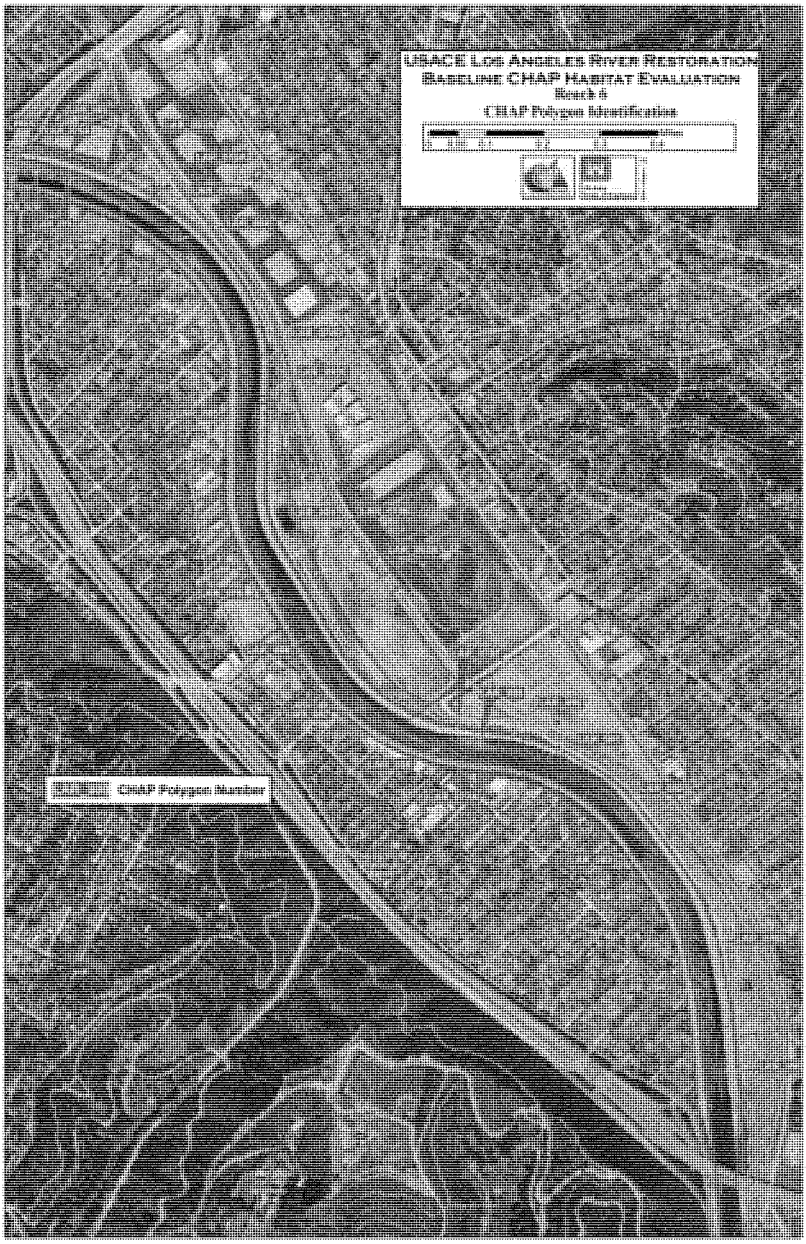


Figure 6.1.1-1. Sample Maps – Baseline Existing Conditions – Polygon Identification Numbers

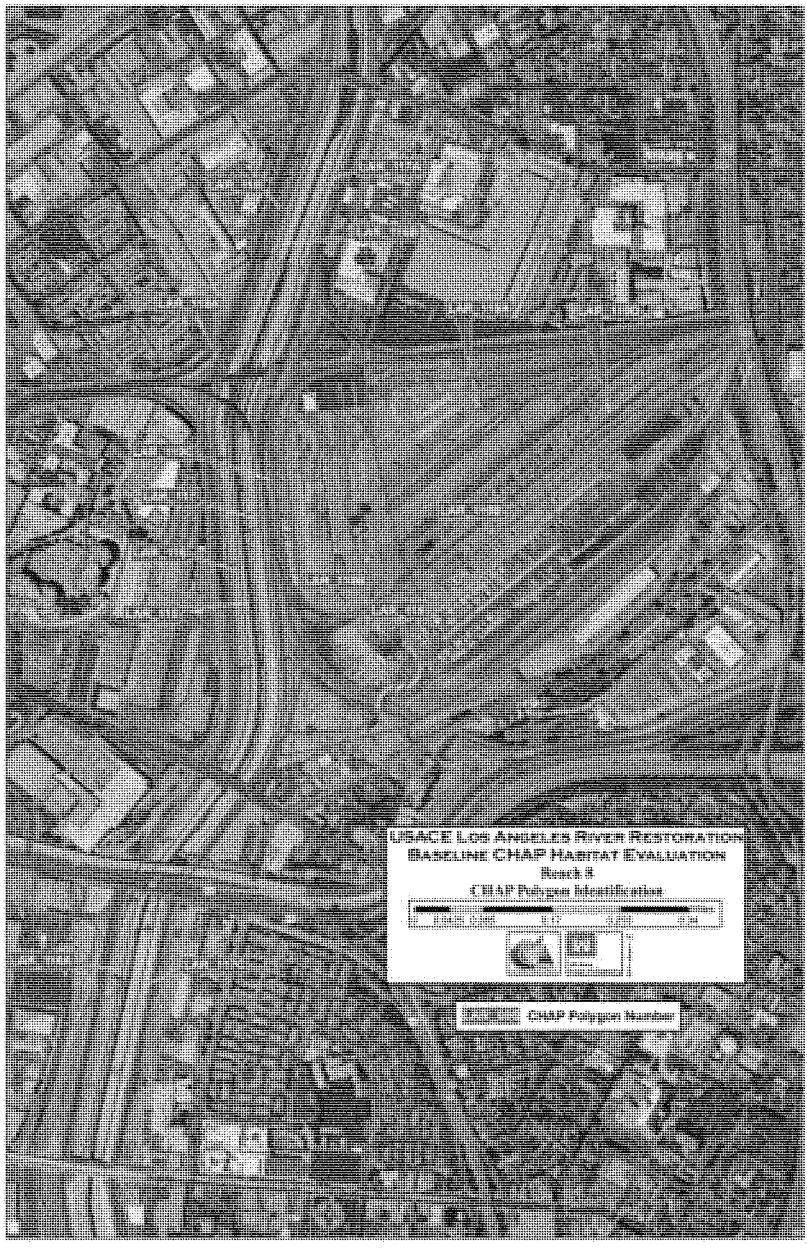


Figure 6.1.2-1. Sample Maps – Baseline Existing Conditions – Percentage of Non-native Plant Species – Herbaceous Species

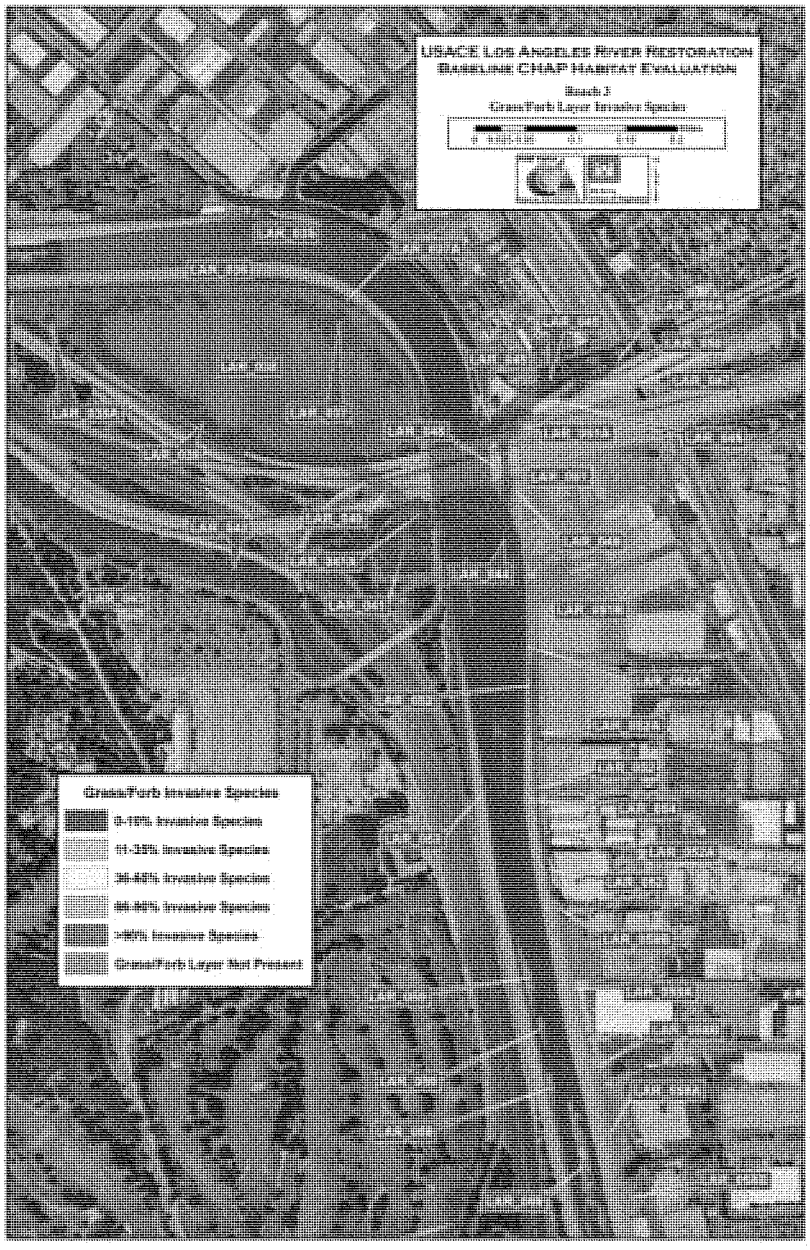


Figure 6.1.2-1. Sample Maps – Baseline Existing Conditions – Percentage of Non-native Plant Species – Herbaceous Species

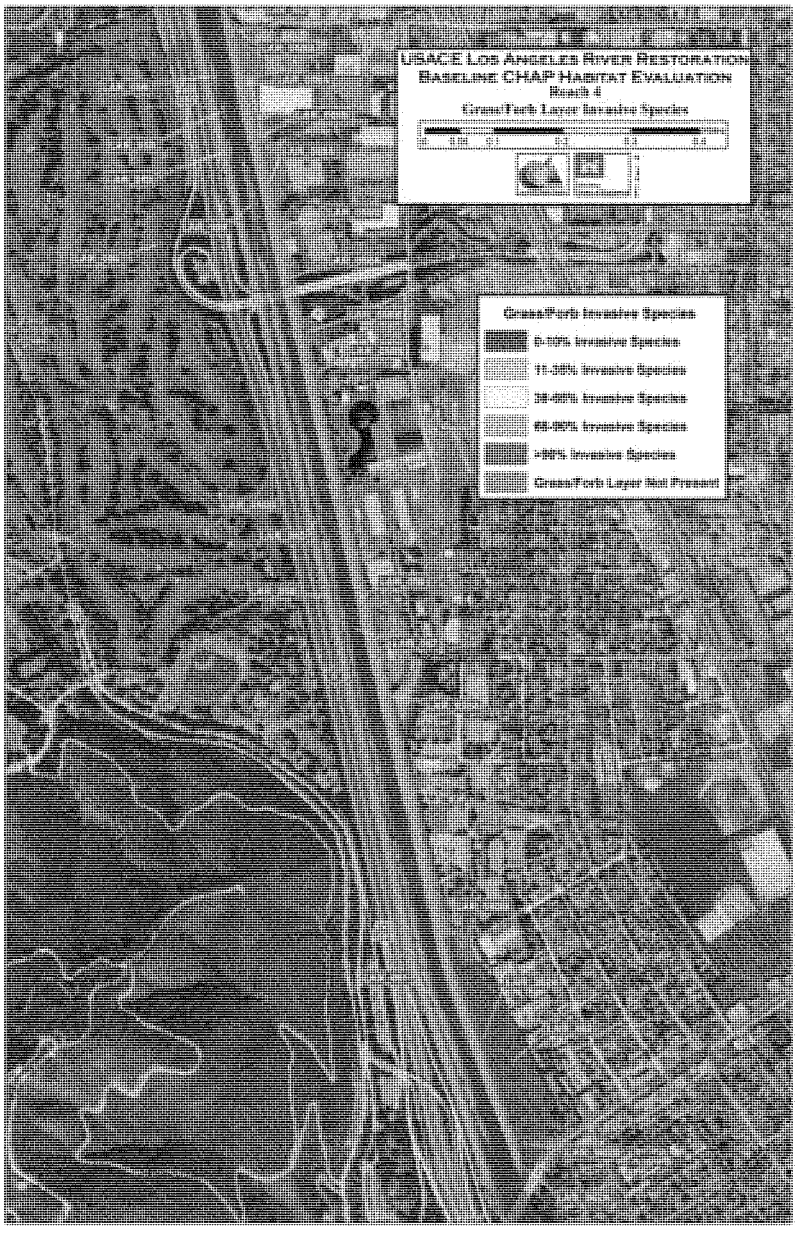


Figure 6.1.2-1. Sample Maps – Baseline Existing Conditions – Percentage of Non-native Plant Species – Herbaceous Species

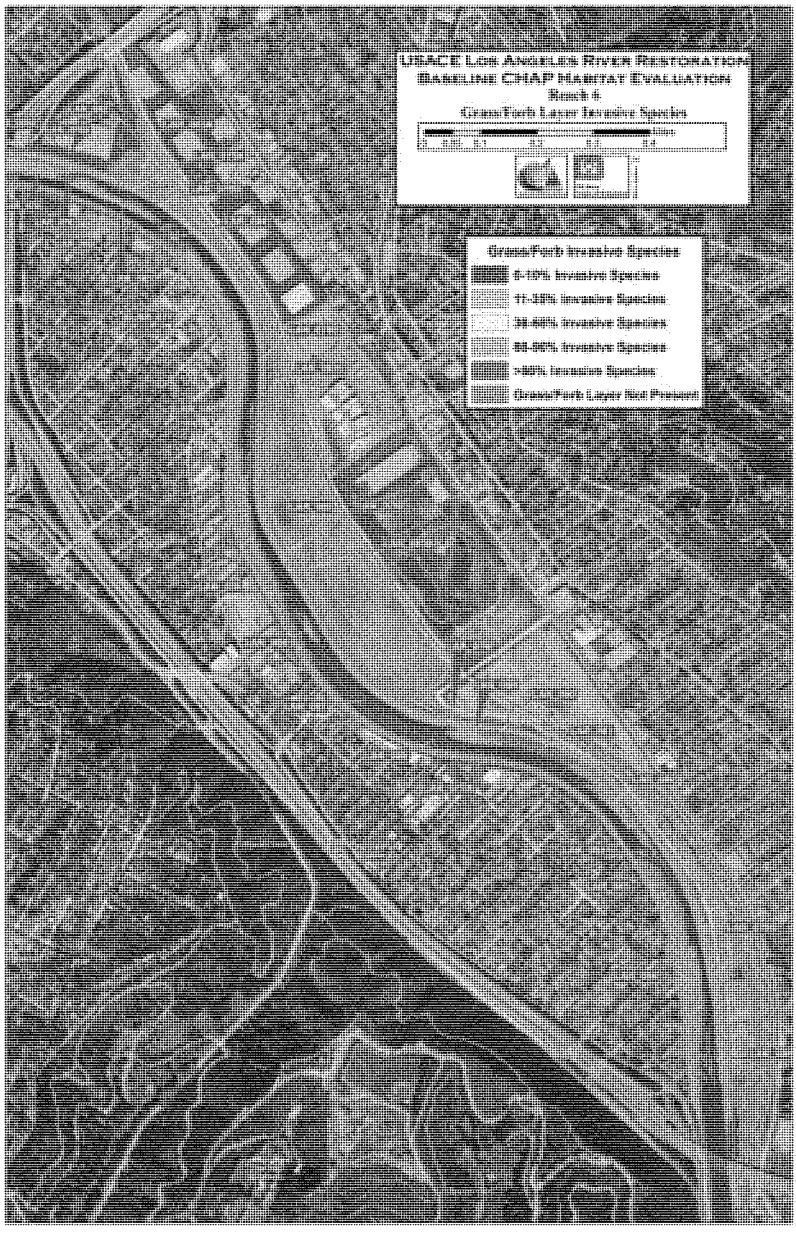


Figure 6.1.2-1. Sample Maps – Baseline Existing Conditions – Percentage of Non-native Plant Species – Herbaceous Species

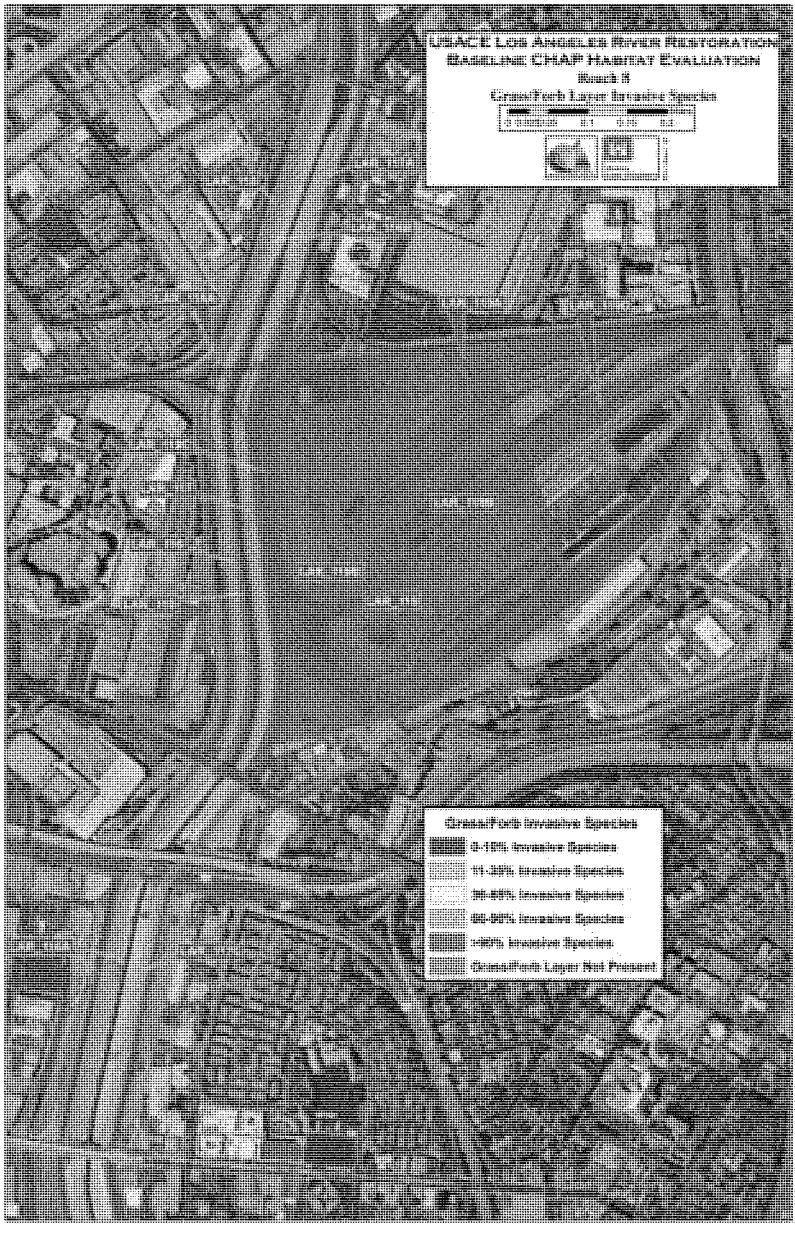


Table 6.1.2-2. KECs influenced by Stressors (homeless encampments, horseback riding, excessive refuse/trash)

Human Impact	KEC Code	KEC	Action
Homeless Encampments	1.2.1	herbaceous layer	camping/tramping
Homeless Encampments	1.2.5	flowers	camping/tramping
Homeless Encampments	1.2.8	forbs	camping/tramping
Homeless Encampments	1.2.6.1.1	shrubs small	camping/tramping
Homeless Encampments	1.2.6.1.2	shrubs medium	camping/tramping
Homeless Encampments	1.2.6.1.3	shrubs large	camping/tramping
Homeless Encampments	1.1.14.3.1	live tree seedling	camping/tramping
Homeless Encampments	1.1.14.3.2	live tree sapling	camping/tramping
Homeless Encampments	1.1.14.3.3	live tree small	camping/tramping
Homeless Encampments	1.1.14.3.4	live tree medium	camping/tramping
Homeless Encampments	1.1.14.3.5	live tree large	camping/tramping
Homeless Encampments	1.1.14.2.3	snag, small	camping/tramping
Homeless Encampments	4.1.12	aquatic nutrient enrichment	sewage
Human Impact	KEC Code	KEC	Action
Horse riding	1.1.3	duff	trampling
Horse riding	1.2.1	herbaceous layer	trampling
Horse riding	1.1.1.4.1	shrubs, small	trampling
Horse riding	1.1.1.4.2	shrubs, medium	trampling
Horse riding	1.1.5	moss	trampling
Horse riding	4.7.4	marshes	trampling/erosion
Horse riding	1.1.14.3.1	live tree, small	trampling/erosion
Horse riding	1.2.8	forbs	trampling/erosion
Horse riding	1.2.10	grasses	trampling/erosion
Horse riding	4.1.3	dissolved solids, aquatic	defecation/erosion
Horse riding	4.1.7	water tubidity	trampling/erosion
Horse riding	4.2.3.3	shorelines	trampling/erosion
Horse riding	4.1.12	aquatic nutrient enrichment	defecation/erosion
Horse riding	4.2.4.5	aquatic bentic structure	trampling/erosion
Horse riding	5.9	water clarity	trampling/erosion
Human Impact	KEC Code	KEC	Action
Refuse/Trash	1.2.1	herbaceous layer	covering
Refuse/Trash	1.2.8	forbs	covering
Refuse/Trash	1.1.1.2	down wood in riparian	covering
Refuse/Trash	1.1.4.1.1	small tree	covering
Refuse/Trash	1.1.4.1.2	medium tree	covering
Refuse/Trash	1.1.4.1.3	large tree	covering
Refuse/Trash	1.1.14.3.1	tree seedling	covering
Refuse/Trash	1.1.14.3.2	tree sapling	covering
Refuse/Trash	1.1.14.2.3	small snag	covering
Refuse/Trash	1.1.14.2.4	medium snag	covering
Refuse/Trash	1.1.14.2.5	large snag	covering
Refuse/Trash	4.2.4.5	aquatic bentic structure	covering
Human Impact	KEC Code	KEC	Action
Refuse/Trash	4.7.4	marshes	covering
Refuse/Trash	4.7.5	wet meadows	covering
Refuse/Trash	1.2.1	herbaceous layer	covering
Refuse/Trash	1.2.8	forbs	covering
Refuse/Trash	4.1.11	metals in water	depending on type
Refuse/Trash	8.19.3	pollution in water	depending on type
Refuse/Trash	5.9	water clarity	covering/depending on type

Vegetation communities associated with each habitat type are described below, as applicable, as documented in both "A Manual of California Vegetation" (2nd Edition) (Sawyer and Keeler-Wolf 2009) and "Preliminary Descriptions of the Terrestrial Communities of California" (Holland 1986).

1. **Coastal Scrub**

   Vegetation Communities

   Holland 1986
   - Riversidean Sage Scrub 32700

   Sawyer and Keeler-Wolf 2009
   - *Artemisia californica* Shrubland Alliance (California sagebrush scrub)

   Dominant species include California sagebrush (*Artemisia californica*) and California buckwheat (*Eriogonum fasciculatum*). This community is typically found on xeric sites such as steep slopes or well drained soils. Co-dominant species include brittlebush (*Encelia farinosa*), deerweed (*Lotus scoparius*), chaparral mallow (*Malacothamnus fasciculatus*), and white and black sage (*Salvia apiana* and *S. mellifera*).

2. **Eucalyptus**

   Vegetation Communities

   Sawyer and Keeler-Wolf 2009
   - *Eucalyptus* (*globules*, *camaldulensis*) Alliance (Eucalyptus groves) (semi-natural woodland stands)

   Several species of eucalyptus including blue gum, red gum, and silver gum are established in dense, pure stands and are typically adjacent to urban areas and non-native grasses.

3. **Open Water - Riverine**

   Vegetation Communities

   Holland 1986
   - Freshwater Marsh 52400

   Sawyer and Keeler-Wolf 2009
   - *Arundo donax* Semi-Natural Herbaceous Stands (Giant reed breaks)
   - *Typha* (*angustifolia*, *domingensis*, *latifolia*) Herbaceous Alliance (Cattail marshes)
   - *Schoenoplectus californicus* Herbaceous Alliance

Dominant species include cattails (*Typha* sp.), sedges, and rushes, as well as non-native invasive arundo (*Arundo donax*), in areas permanently saturated or flooded by freshwater.

Intermittent or continually running water distinguishes river and stream communities. Streams originate at an elevated source, such as a spring or lake, and flow velocity generally declines at progressively lower altitudes (Mayer and Laudenslayer 1988). These areas are considered to have a minimum of vegetation components, except along the edges, which may be mapped (in this case) as types such as freshwater marsh.

In the higher velocity stretches of natural streams, riffle/pool complexes are dominant and vegetation includes water moss and filamentous algae that are attached to rocks. In slower moving waters, with increasing temperatures, decreasing velocities and accumulating bottom sediment, emergent freshwater marsh vegetation, such as rushes, sedges, and cattails, establishes along river banks (Mayer and Laudenslayer 1988).

4. Pasture

Vegetation Communities

Holland 1986
- Non-native grassland 42200

Sawyer and Keeler-Wolf 2009
- *Conium maculatum – Foeniculum vulgare* Semi-Natural Herbaceous Stands (Poison hemlock or fennel patches)

Dominant species include non-natives such as fennel (*Foeniculum vulgare*), bromes (*Bromus sp.*), wild oat (*Avena sp.*), red-stem filaree (*Erodium cicutarium*), fescues (*Vulpia sp.*), and mustard (*Brassica sp.*). Scattered trees may also be present.

5. Perennial Grassland (Invasive)

Vegetation Communities

Holland 1986
- Non-native grassland 42200

Sawyer and Keeler-Wolf 2009
- *Conium maculatum – Foeniculum vulgare* Semi-Natural Herbaceous Stands (Poison hemlock or fennel patches)

Invasive Perennial Grassland is similar in composition to Pasture, where relic perennial grassland occurs in habitats now dominated by annual grasses and forbs (Mayer and Laudenslayer 1988).

6. Valley Foothill Riparian

Vegetation Communities

Holland 1986

- Southern Cottonwood-Willow Riparian Forest 61330
- Southern Willow Scrub 63320

Sawyer and Keeler-Wolf 2009

- *Salix gooddingii* Woodland Alliance (black willow thickets)
- *Salix laevigata* Woodland Alliance (red willow thickets)
- *Populous fremontii* Forest Alliance (Fremont cottonwood forest)

Dominant species include cottonwood (*Populus fremontii*), western sycamore (*Platanus racemosa*), and willows (*Salix* sp.). Forest understory may consist of shrubby willows and mule fat (*Baccharis salicifolia*) with herbaceous species including sedges, rushes, and mugwort (*Artemisia douglasiana*). Scrub habitat has less vertical structure, with shorter willows dominant.

7. Tree Farm

Ornamental or non-native hardwood species dominate this community, although other non-native conifers, shrubs, and grasses may be present. These communties are usually in developed areas, including urban and residential landscapes, parks, recreational areas, highways, and cemeteries, etc. and may include potted landscaping trees (USFS 2009).

8. Urban

This category includes landscapes dominated by urban structures, residential units, industrial areas, highways, parks, and other such structures (USFS 2009). Park areas may include alternately categorized vegetation such as non-native or ornamental. Urban areas are categorized as:

- High density
- Low density
- Golf course

The acreage of each habitat type by reach is shown in Table 6.1.3-1. To demonstrate the habitat mapping results, sample maps depicting habitat type and structural conditions are included in Figures 6.1.3-1 and 6.1.3-2.

Table 6.1.3-1. Acreage of Habitat Type by Reach

	Habitat Type (acres)										
Reach	Coastal Scrub	Eucalyptus	Open Water (Channel)	Pasture	Perennial Grassland	Riparian	Tree Farm	Urban	Urban (Golf Course)	Urban (Low Density)	TOTAL
1			22.80	11.75	2.19	2.97		108.12		7.98	155.81
2		12.37	9.02			4.01		12.78		9.82	48.00
3			30.84			7.07		38.62		24.61	101.14
4			29.00			7.94		35.90	20.33		93.16
5			28.02			8.97		30.72			67.71
6			32.42			28.90		103.01			164.33
7	0.29		23.14			2.55	6.30	21.48		5.15	58.90
8			6.97					146.35			153.32
TOTAL	0.29	12.37	182.21	11.75	2.19	62.42	6.30	496.97	20.33	47.55	842.37

Figure 6.1.3-1. Sample Maps – Baseline Existing Conditions – Wildlife Habitat Types

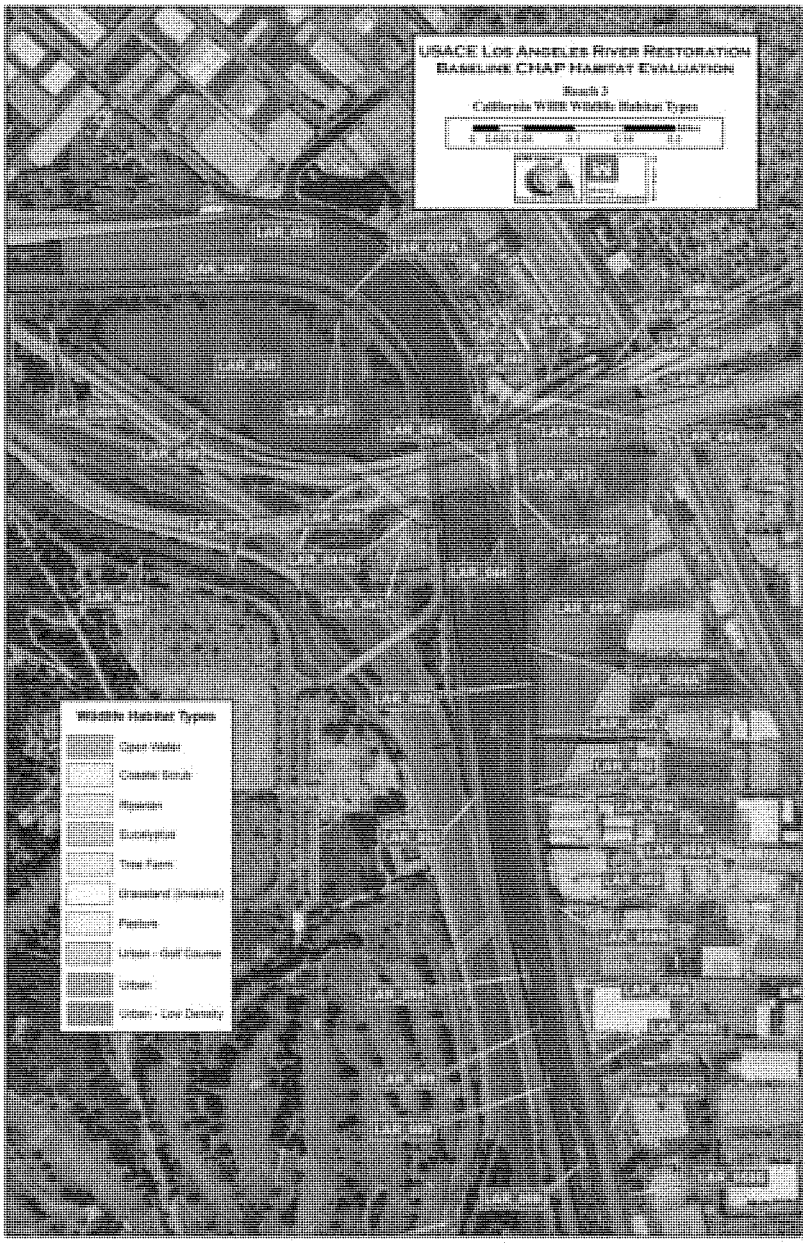


Figure 6.1.3-1. Sample Maps – Baseline Existing Conditions – Wildlife Habitat Types

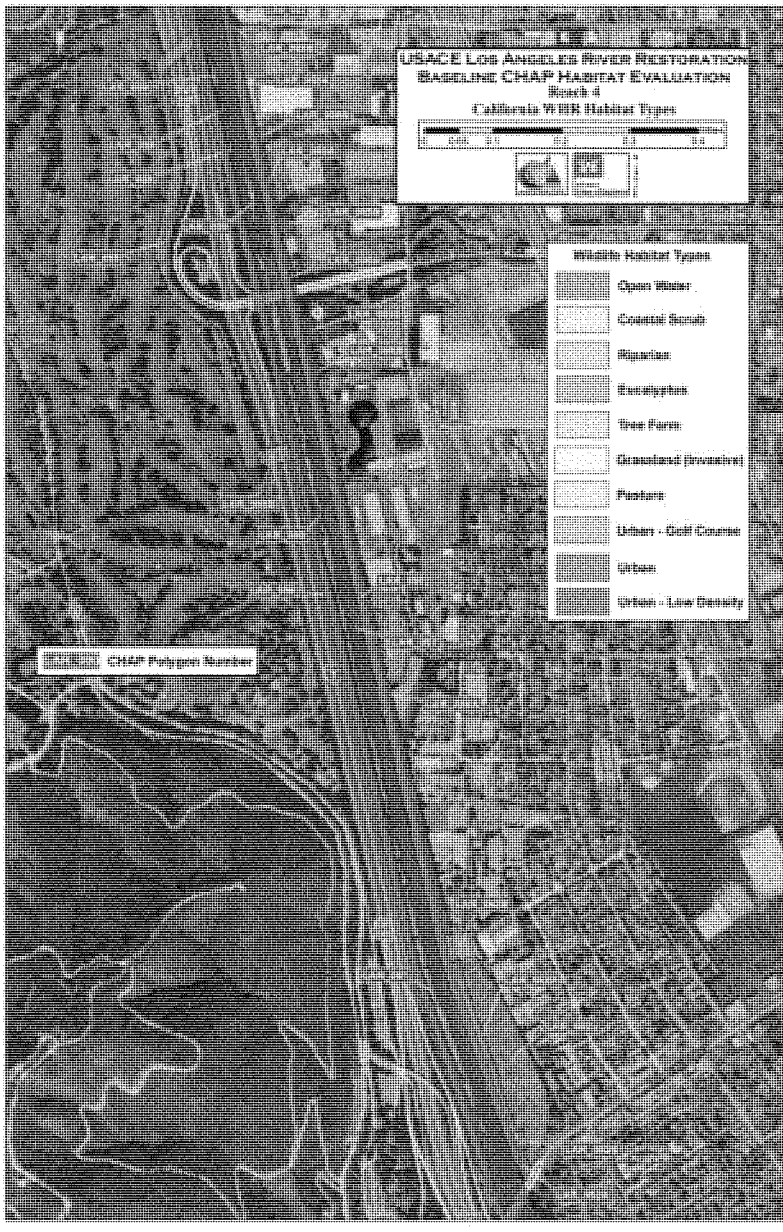


Figure 6.1.3-1. Sample Maps – Baseline Existing Conditions – Wildlife Habitat Types

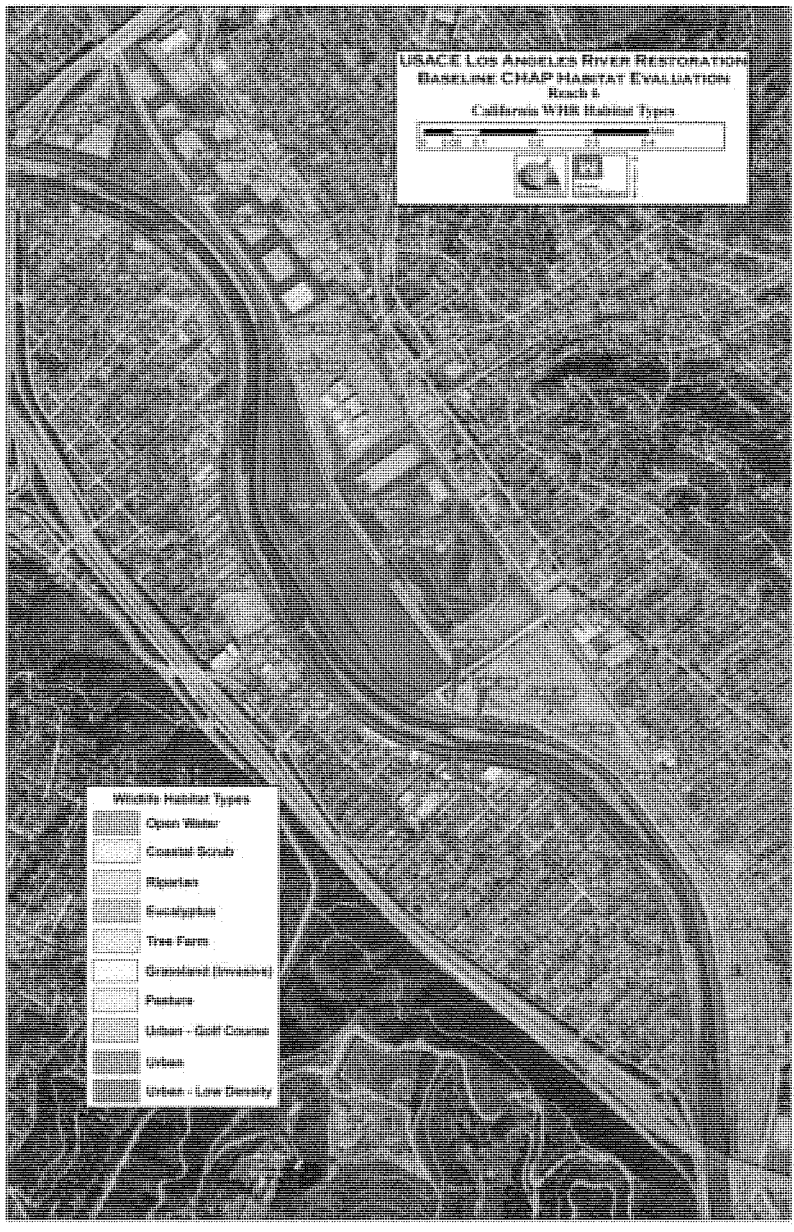


Figure 6.1.3-1. Sample Maps – Baseline Existing Conditions – Wildlife Habitat Types

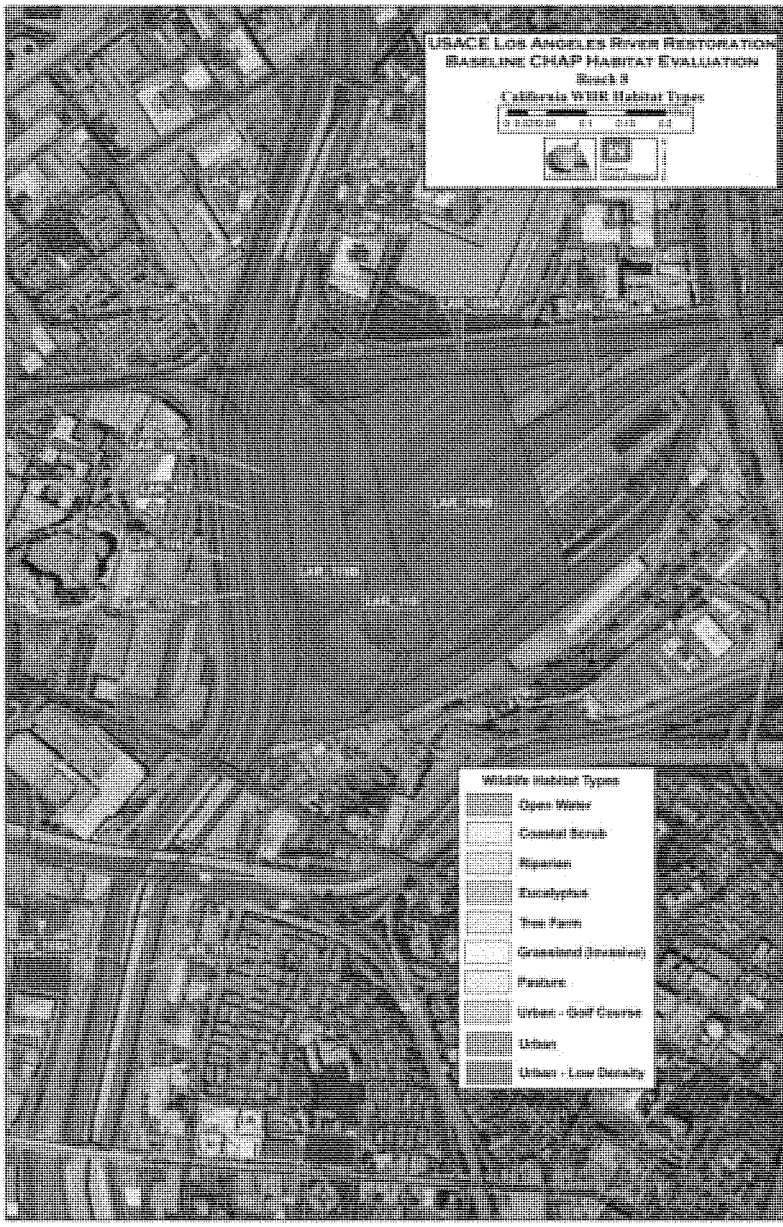


Figure 6.1.3-2. Sample Maps – Baseline Existing Conditions – Structural Conditions

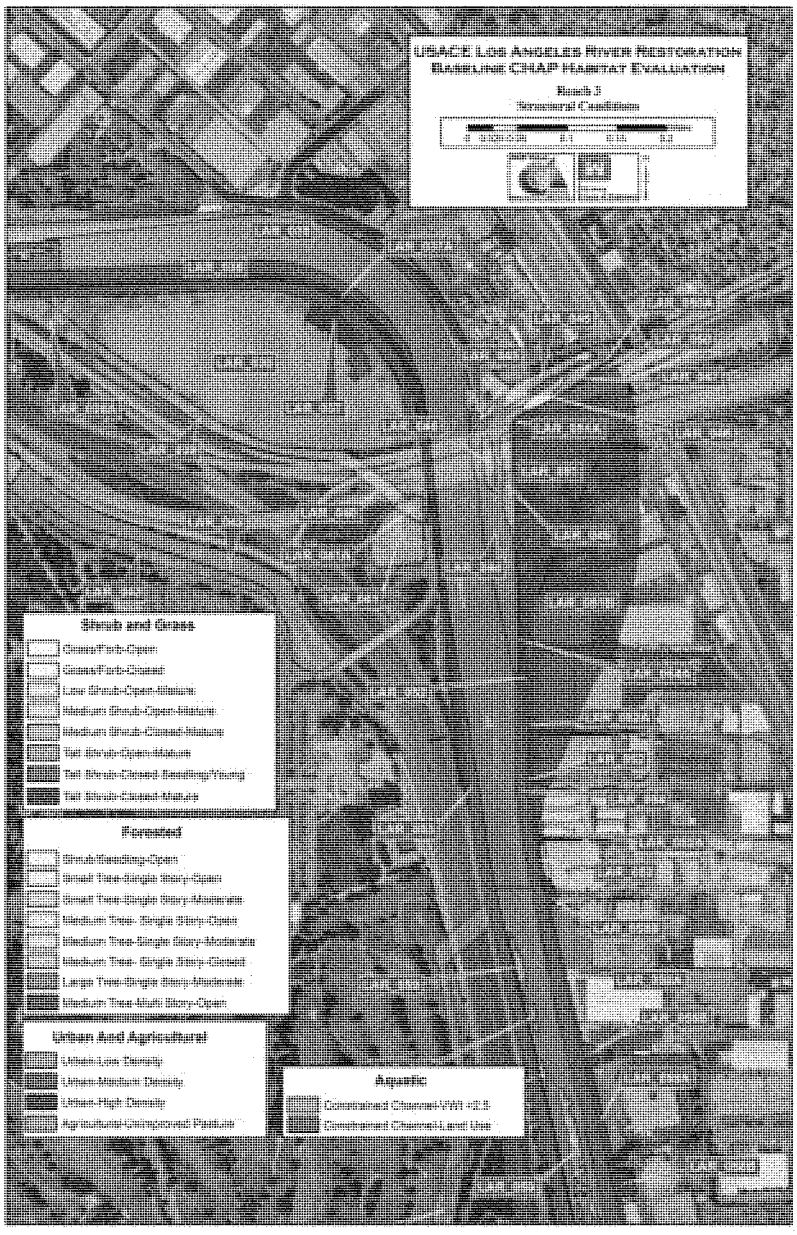


Figure 6.1.3-2. Sample Maps – Baseline Existing Conditions – Structural Conditions

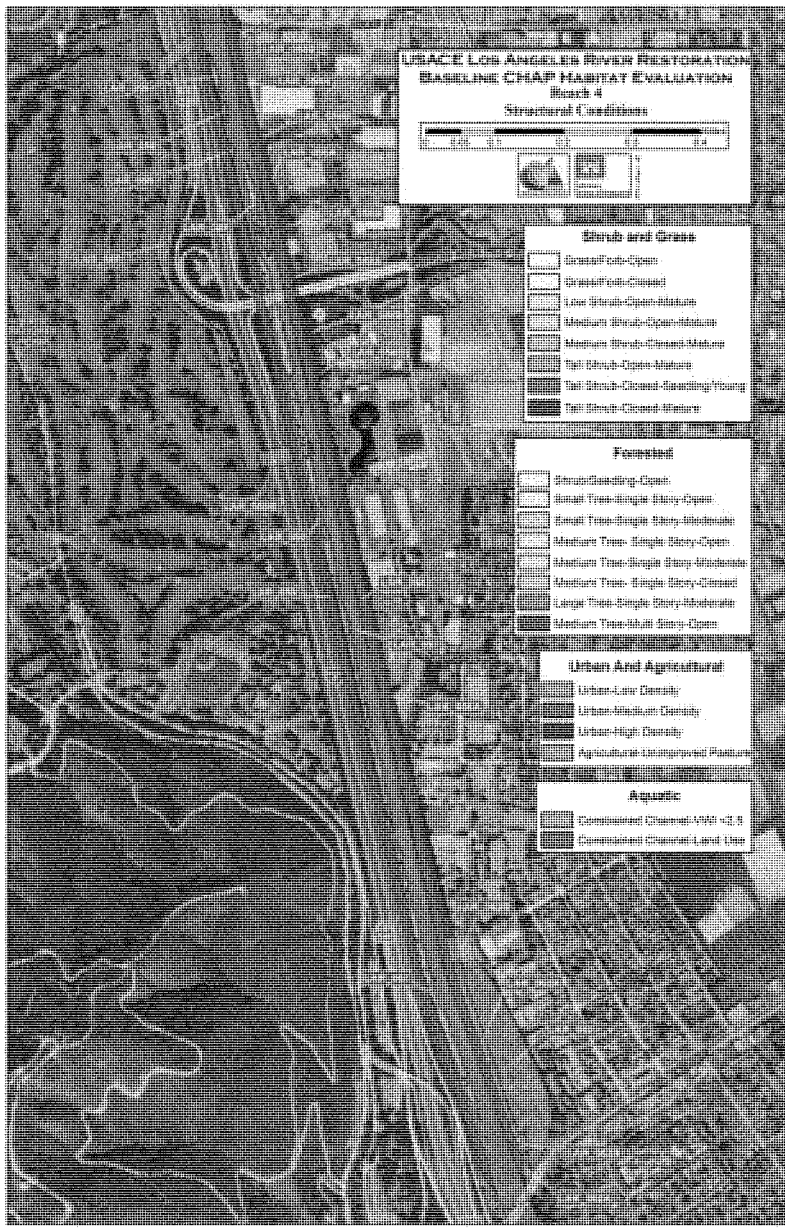


Figure 6.1.3-2. Sample Maps – Baseline Existing Conditions – Structural Conditions

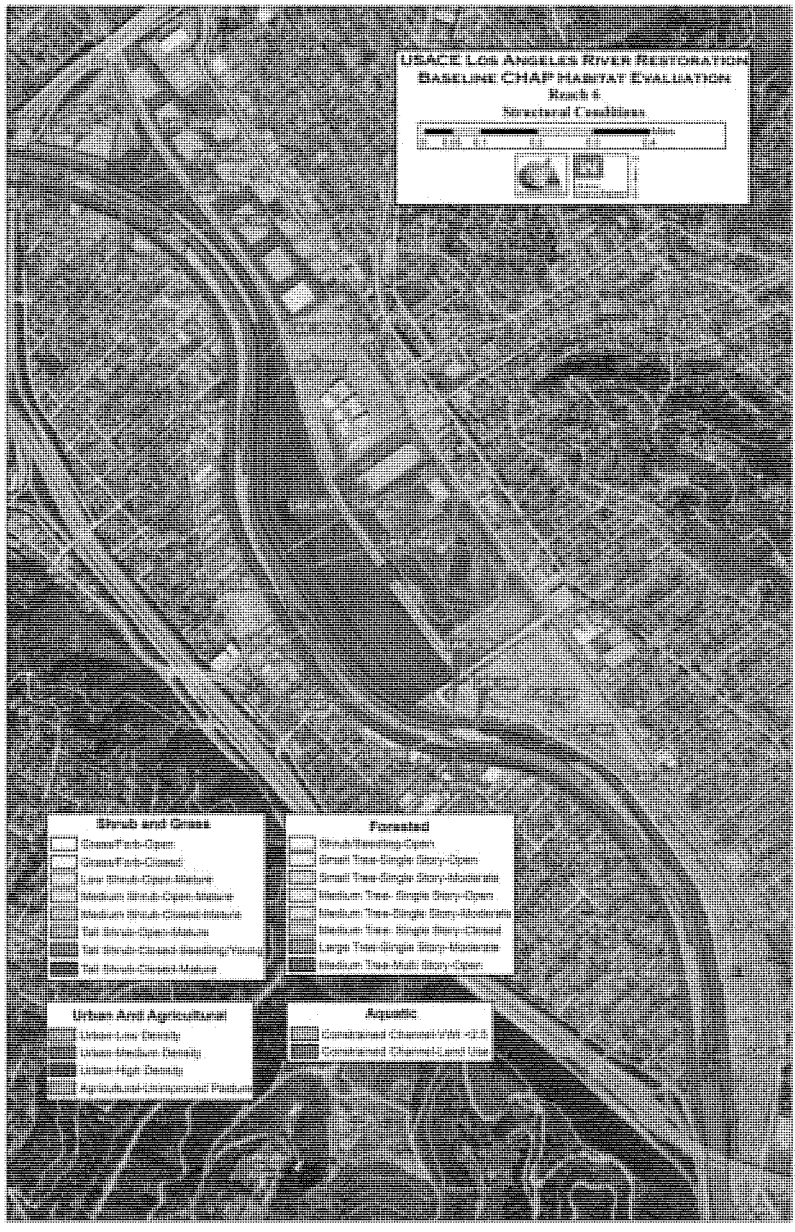
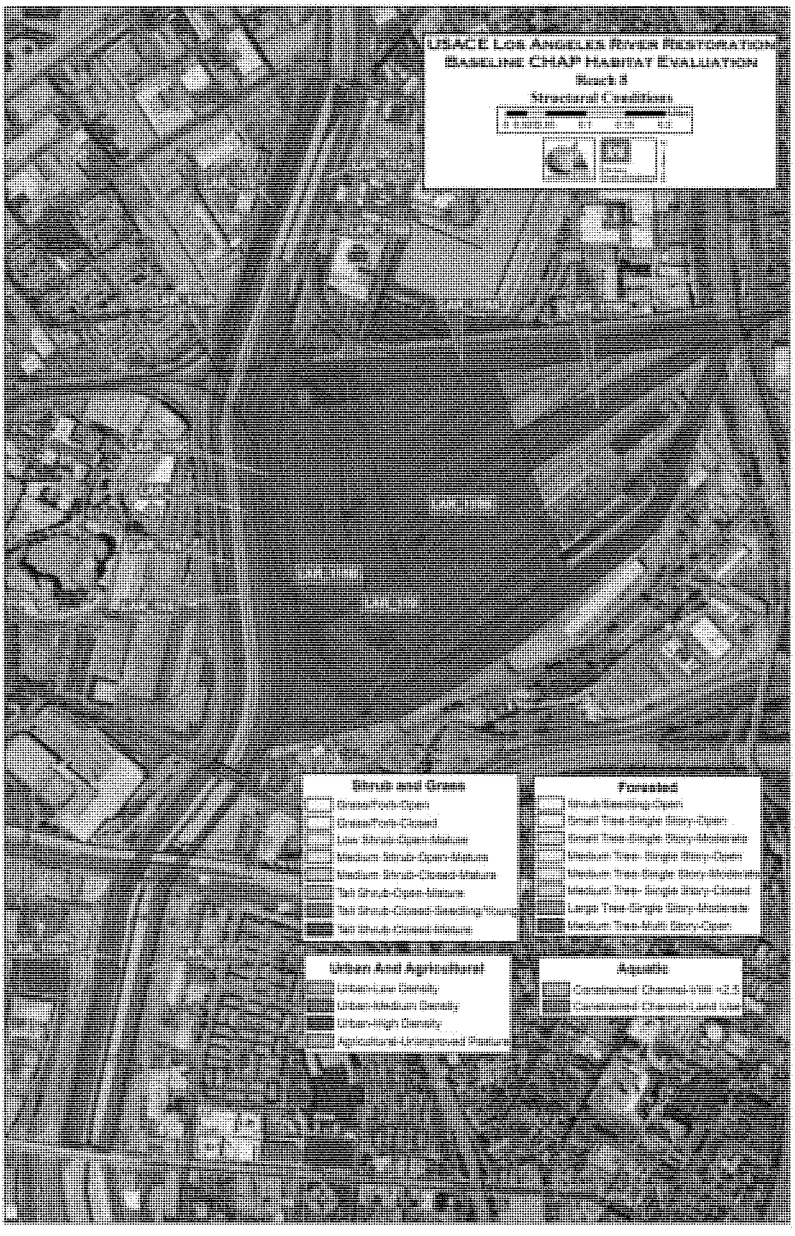


Figure 6.1.3-2. Sample Maps – Baseline Existing Conditions – Structural Conditions



Habitat Findings
Vegetation transects were employed to verify the results of the habitat inventory that occurred at the LA River ER Study site. Results of these verification transects are included in the LA River CHAP Verification Transect Report (Ashley 2010) (Appendix E). Figure 6.1.3-3 shows the location of the verification transects. Table 6.1.3-2 outlines a list of plant species encountered either along or near the verification line transects.

Habitat Units
The habitat assessment shows ten habitat types currently existing within the Study area, totaling approximately 842 acres. The acreage of each of the habitat types and their proportion of the total study area are depicted in Table 6.1.3-3. The baseline existing condition assessment calculated that these acres have a total value of 6,119 HUs. Graphs depicting acreage by habitat type and per-acre habitat value by habitat type follow in Figures 6.1.3-4 and 6.1.3-5. Sample figures depicting per-acre value and HUs are included in Figures 6.1.3-6 and 6.1.3-7.

Mapping of habitat types for baseline existing conditions shows that approximately 67% of the Study area (564.85 acres) is urban (including low density and golf course), providing an average 4.64 HUs per acre. Existing riparian habitat accounts for only 7% of the Study area (62.42 acres), however it provides 16.84 HUs per acre. These riparian areas occupy 9 times fewer acres than the urban areas, yet provide almost four times more HUs per acre than the urban areas. The open water areas also provide substantial HUs per acre, totaling 22% of the Study area (182.21 acres) and providing 11.89 HUs per acre. Other habitat types account for less than 4% of the Study area.

These conditions show that riparian and riverine restoration has the potential to provide substantial restored habitat function and value in the highly urban setting of Los Angeles, and that maximizing acreage of these habitats would benefit ecosystem functioning and species diversity in the area.

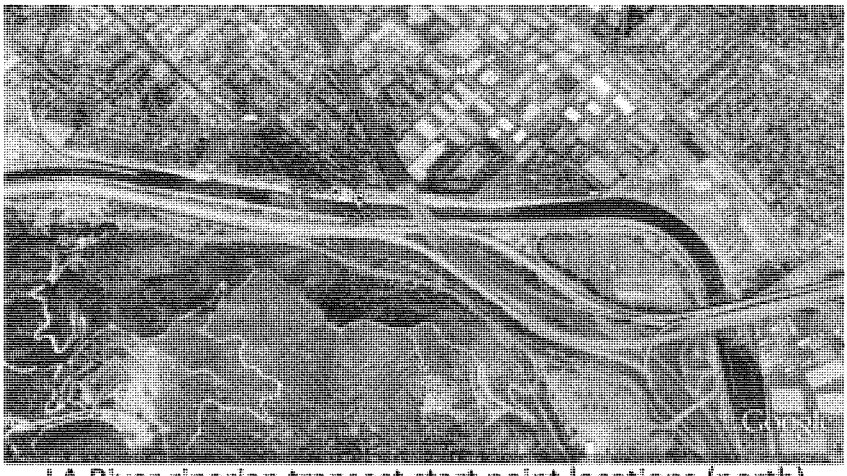
6.2 BASELINE: FIFTY YEAR FUTURE WITHOUT PROJECT

The future without project analysis forecasts the conditions in the Study area 50 years into the future assuming that no project is implemented (i.e. No Action alternative). The 50-year future without project analysis assesses two future time periods, 25 years and 50 years.

To undertake this assessment, several projections were made to assess habitats over the 50-year time period. These projections are based on past and current trends in habitat condition in the area. Specifically, reasonable predictions include: 1) an increase in presence of invasive plant species throughout the LA River ER Study area, 2) a large flood event (i.e. 500-year event) is likely to occur, and 3) fires threatening the project area will be suppressed.

The habitat evaluation team discussed a reduction in the number of fish and wildlife taxa present within the project area over time. However, in this case, it was the consensus of the habitat evaluation team that the current highly urban landscape conditions would prevail over time. Despite intense development pressure along certain areas of the river corridor, large swaths of existing open space (especially at Griffith Park) were expected to be conserved, consistent with long-established land use policies. Furthermore, it was assumed that native species are already

Figure 6.1.3-3. Verification Transect Locations (Ashley 2010)



LA River riparian transect start point locations (north)

LA River riparian transect start point locations (south)

Table 6.1.3-2. List of Plant Species Encountered on or Near Verification Transects

Common Name	Scientific Name	Native	Transect #			
			Los Angeles River			
Arroyo	Salix lasiolepis	Yes	19 -1	20 -1	24-1	31-1
Sage	Salvia columbariae	Yes	19 -1			
Castor Bean	Ricinus communis	No			24-1	
Eucalyptus	Eucalyptus sp.	No				31-1
Mexican Fan Palm	Washingtonia robusta	No			24-1	31-1
Mulefat	Baccharis salicifolia	Yes		20 -1	24-1	31-1
Red	Salix laevigata	Yes	19 -1		24-1	31-1
Shamel Ash	Fraxinus uhdei	No	19 -1	20-1	24-1	
Sycamore	Platanus racemosa	No		20 -1		
White Mulberry	Morus alba	No	19 -1	20 -1		

Common Name	Scientific Name	Native
Alkali bulrush	Schoenoplectus maritimus	Yes
Ash	Fraxinus velutina	Yes
Arundo	Arundo donax	No
Black mustard	Brassica nigra	No
bulrush	Schoenoplectus californicus	Yes
Sedge	Carex spp.	Yes
Cheatgrass	Bromus tectorum	No
Chickweed	Cerastium sp.	No
Dock	Rumex salicifolius	Yes
Datura	Datura wrightii	Yes
Fennel	Foeniculum vulgare	No
Foxtail chess brome	Bromus madritensis	No
Lemonade berry	Rhus integrifolia	Yes
Mustard	Brassica sp.	No
Narrow leaved Cat tail	Typha angustifolia	Yes
Pepper tree	Schinus molle	No
Plantain	Plantago major	No
Poa spp.	Poa spp.	**
Prickly lettuce	Lactuca serriola	No
Rattail Fescue	Vulpia myuros	No
Redstem filaree	Erodium cicutarium	No
Ripgut brome	Bromus diandrus	No
Slender oats	Avena barbata	No
Tabacco Tree	Nicotiana glauca	No
Bull Thistle	Cirsium vulgare	No
Fescue	Vulpia sp.	**
White sage	Salvia apiana	Yes
Wild cucumber	Marah macrocarpus	Yes
Wild radish	Raphanus raphanistrum	No
Yellow sweet clover	Melilotus officinalis	No

Table 6.1.3-3. Proportion of Acreage and Habitat Value by Wildlife Habitat Type

	Coastal Scrub	Eucalyptus	Open Water (Channel)	Pasture	Perennial Grassland	Riparian	Tree Farm	Urban	Urban (Golf Course)	Urban (Low Density)	TOTAL
Acres	0.29	12.37	182.21	11.75	2.19	62.42	6.30	496.97	20.33	47.55	842.37
Proportion of Acreage	0.00	0.01	0.22	0.01	0.00	0.07	0.01	0.59	0.02	0.06	1
Habitat Units (HUs)	2.38	129.51	2166.22	54.95	14.77	1051.38	42.18	2361.82	104.74	191.49	6119.44
Proportion of Habitat Value	0.00	0.02	0.35	0.01	0.00	0.17	0.01	0.39	0.02	0.03	1
Habitat Units (HUs) per Acre	8.29	10.47	11.89	4.68	6.74	16.84	6.69	4.75	5.15	4.03	

Figure 6.1.3-4. Baseline Existing Conditions – Acres by Habitat Type

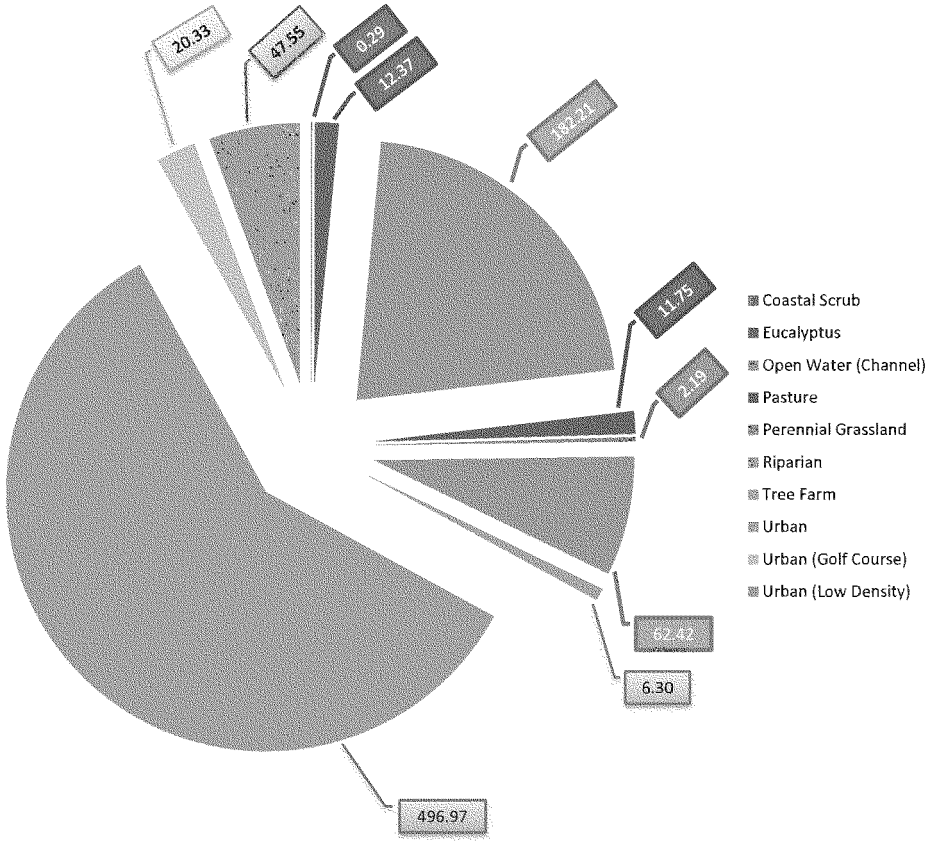


Figure 6.1.3-5. Baseline Existing Conditions – Per Acre Habitat Value by Habitat Type

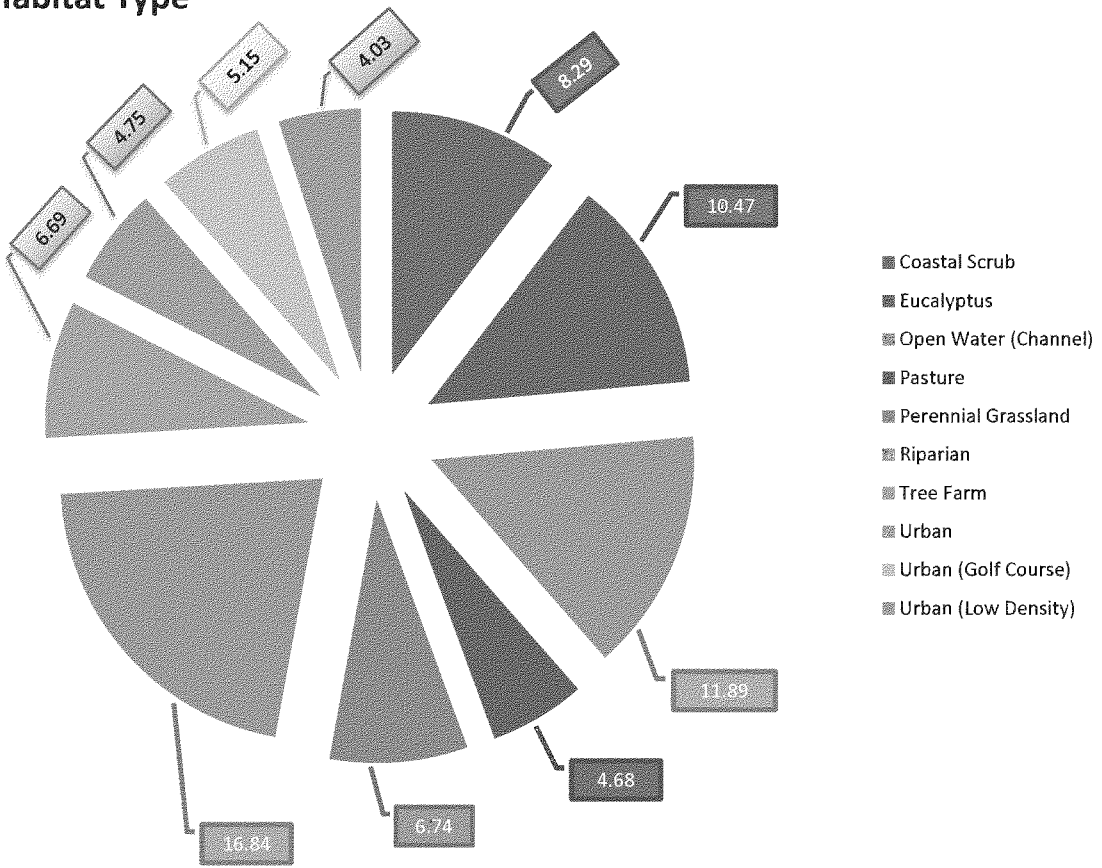


Figure 6.1.3-6. Sample Maps – Baseline Existing Conditions – Per-Acre Value

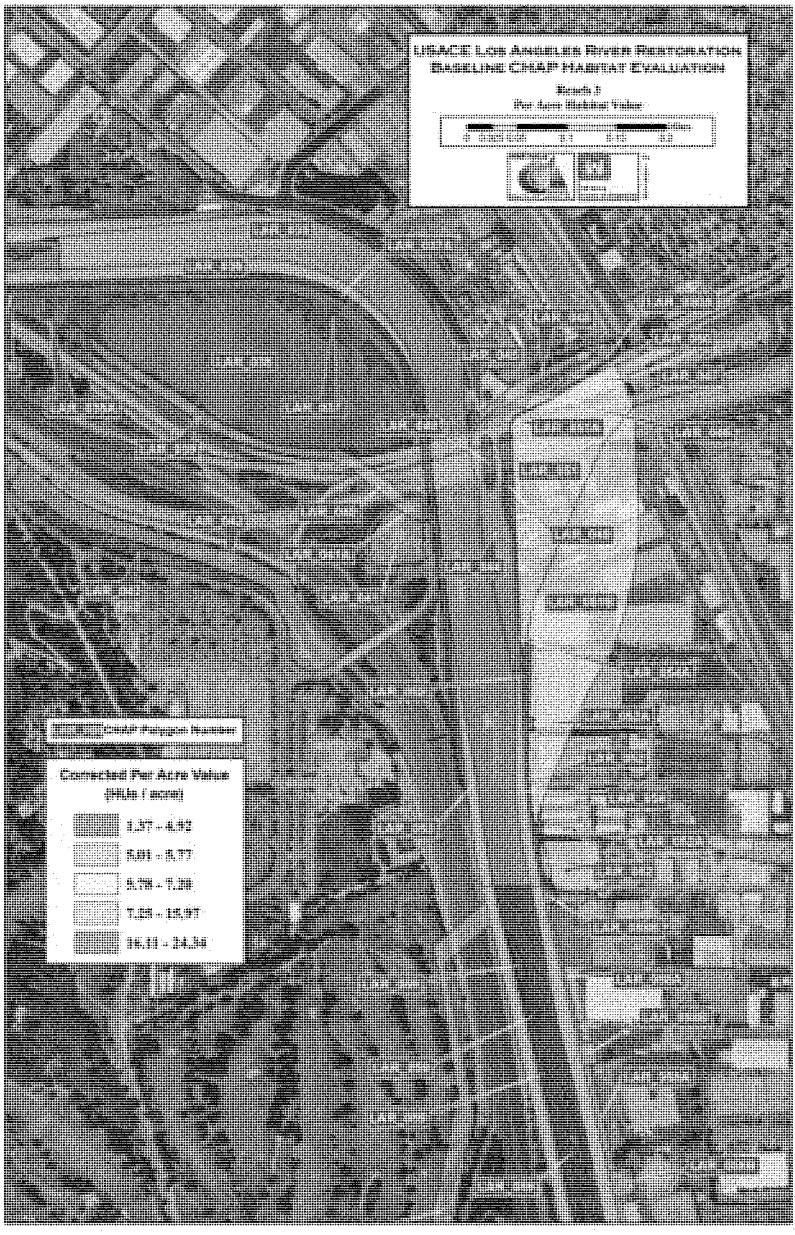


Figure 6.1.3-6. Sample Maps – Baseline Existing Conditions – Per-Acre Value

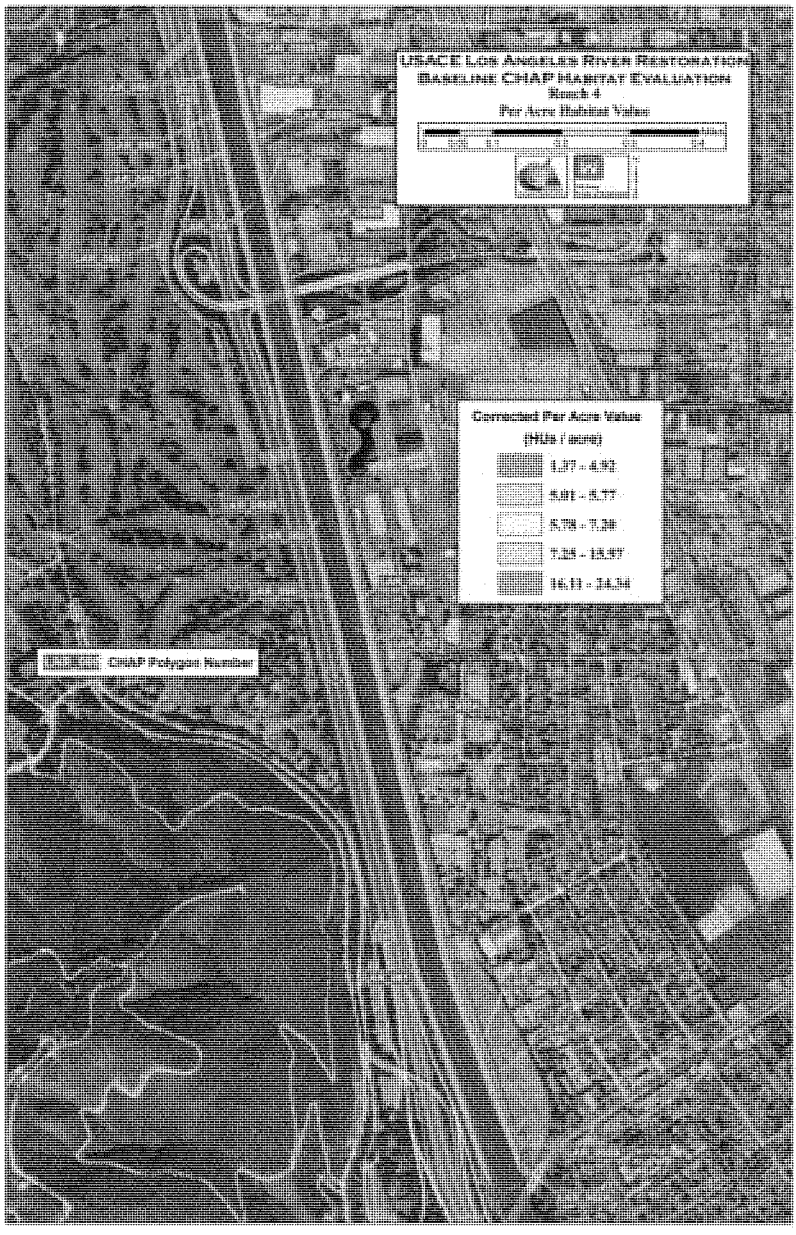


Figure 6.1.3-6. Sample Maps – Baseline Existing Conditions – Per-Acre Value

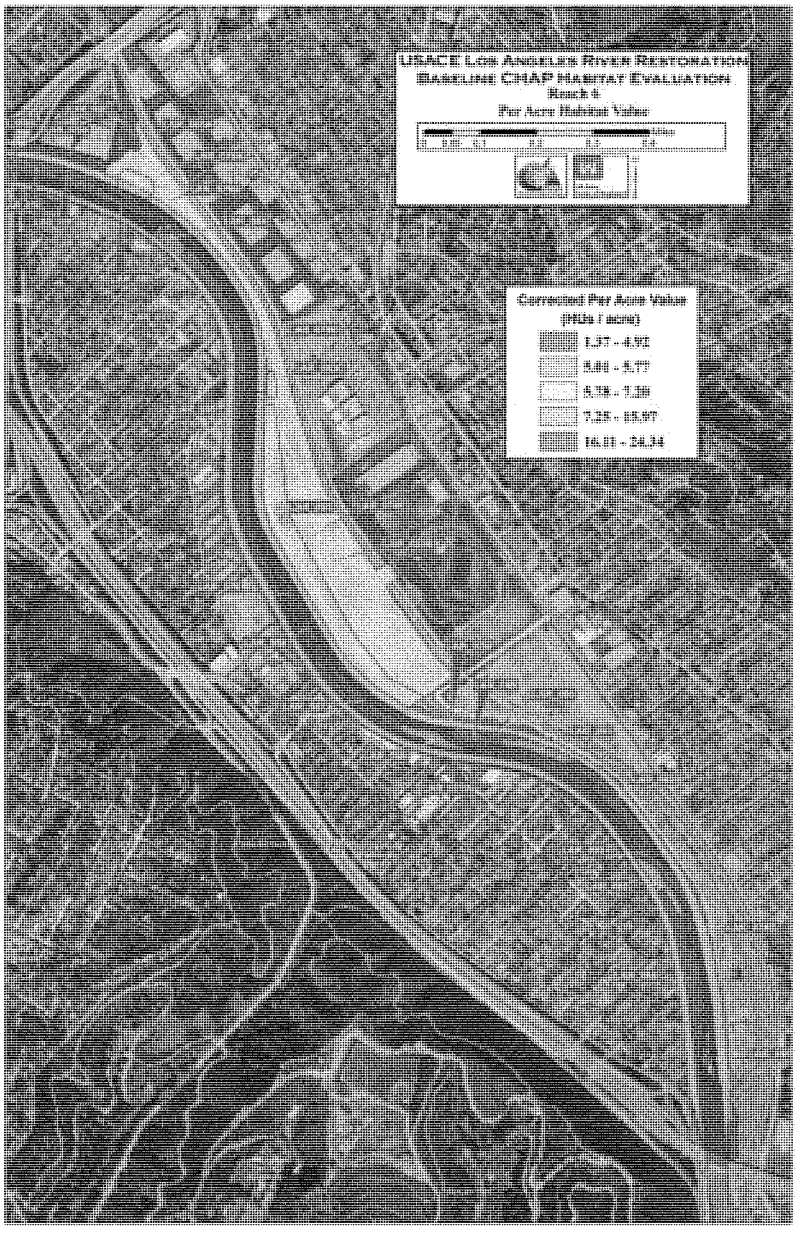


Figure 6.1.3-6. Sample Maps – Baseline Existing Conditions – Per-Acre Value

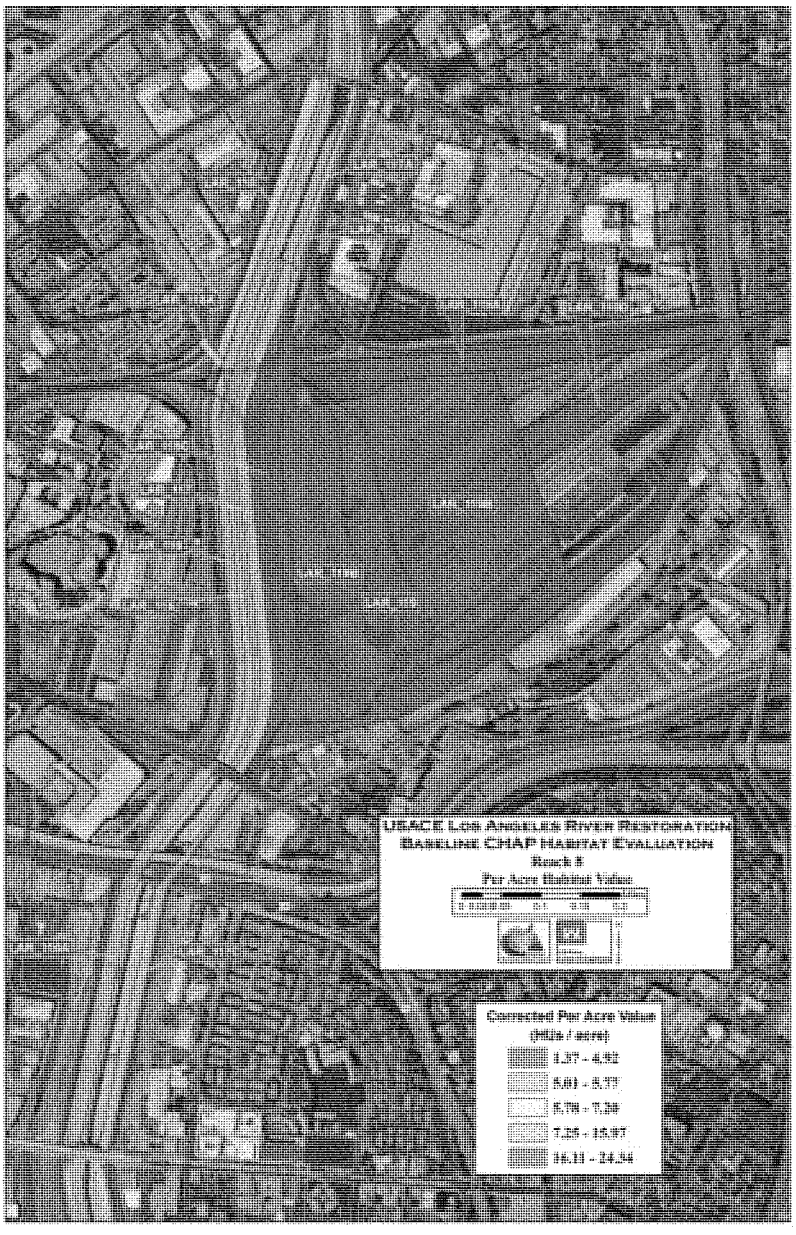


Figure 6.1.3-7. Sample Maps – Baseline Existing Conditions – Baseline HUs by Polygon Number

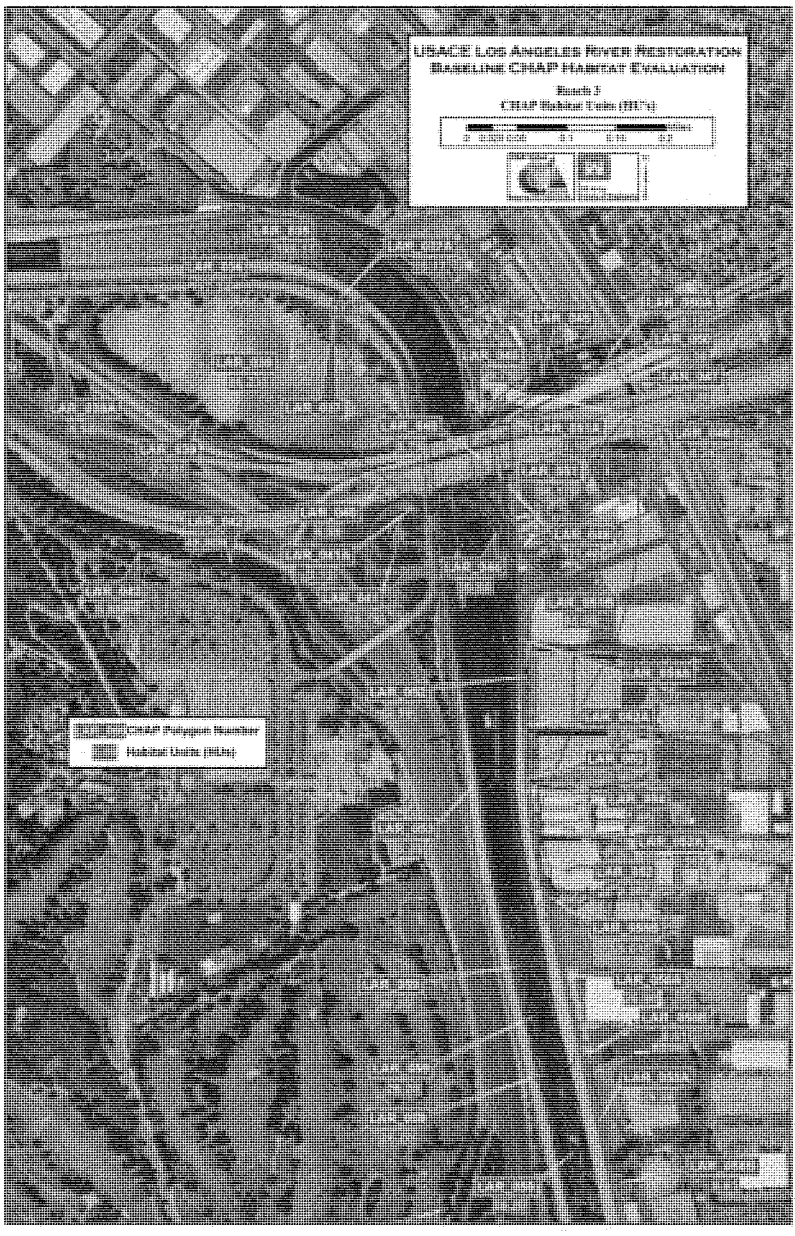


Figure 6.1.3-7. Sample Maps – Baseline Existing Conditions – Baseline HUs by Polygon Number

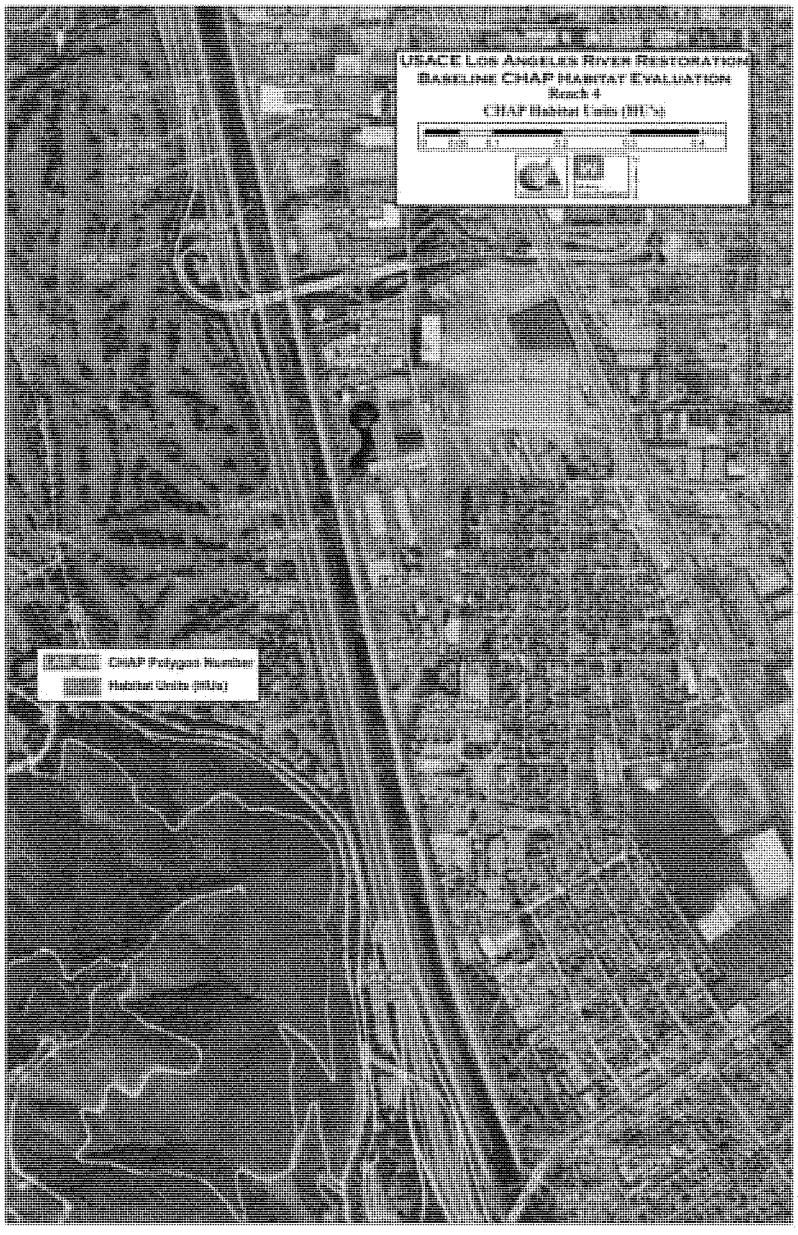
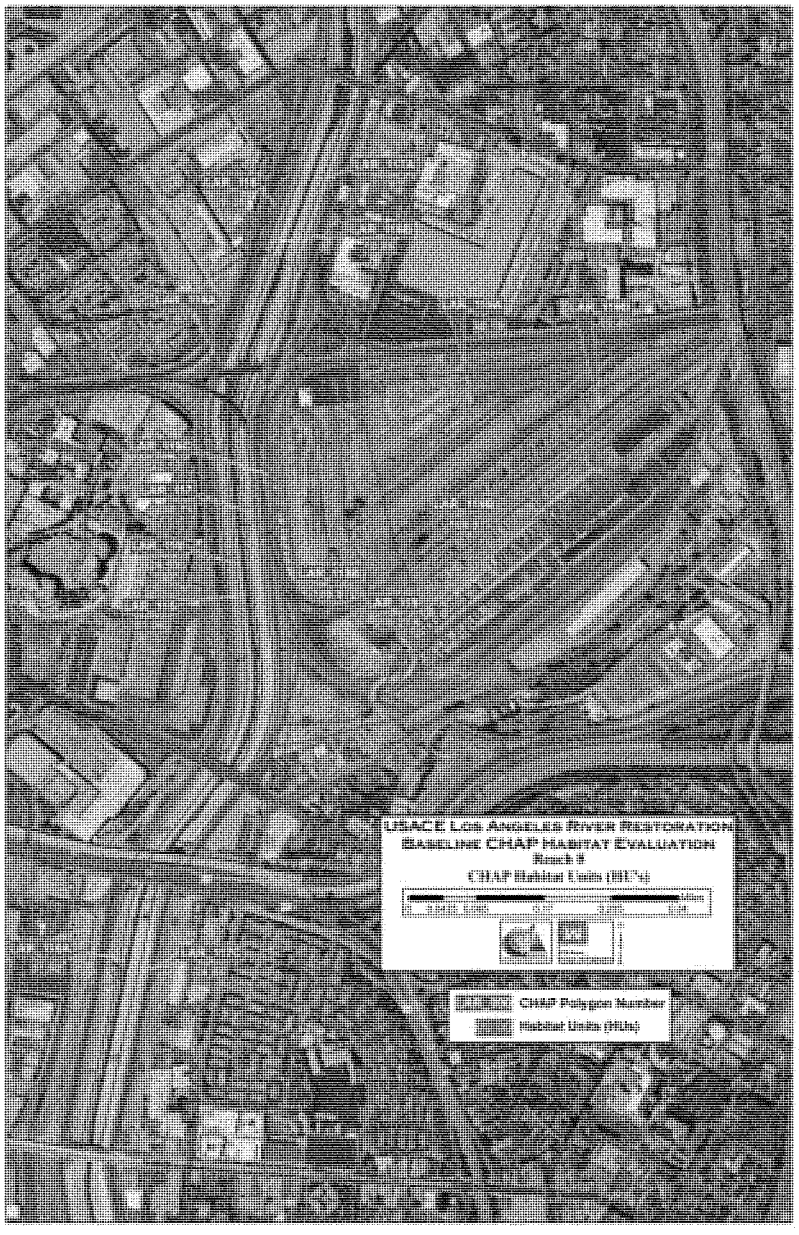


Figure 6.1.3-7. Sample Maps – Baseline Existing Conditions – Baseline HUs by Polygon Number

Figure 6.1.3-7. Sample Maps – Baseline Existing Conditions – Baseline HUs by Polygon Number



severely depressed, to nearly the maximum extent, given the impacts from urbanization. Therefore, it is assumed that the fish and wildlife species currently identified in the Study area, even under continued pressure from such stressors as invasive species, homeless encampments, horseback riding, and other urban uses, would likely prevail in the future. Thus, there were no adjustments made to the species list over the 50-year period.

Similarly, only minor adjustments to structural conditions were expected to occur from a simulated flood event. Due to the heavily urbanized environment surrounding the river and the engineered structure of the channel, conversion of wildlife habitat type and use by additional wildlife species would be unlikely. The riparian vegetation in the channel through the Glendale Narrows area has the potential to wash out during high flows, but would quickly recover, and has persisted through recent storm events.

6.2.1 Baseline: Future Without Project Methods

To determine a change in habitat values over time from the existing conditions, projections are needed to estimate changes to the species, habitat, and/or function parameters in the future. Applying these changes over several time periods requires some forecasting and theorizing to estimate the amount of alteration that might be expected during each time period. To display the future without project conditions and visualize these changes in value over time, changes to the habitat are applied to the fine scale habitat mapping, while changes to the species and functions, if any, are applied to their respective data sets.

The 25- and 50-year future without project analyses were built upon the baseline existing conditions analysis that illustrates the California wildlife habitat types within the Study area by GIS polygon (Figure 6.1.3-1). By modifying the species-habitat-function input information, which is based on the future projections for the area, a comparative time series evaluation over the 50-year period was generated.

Adjusting Species, Habitat or Functions

The habitat evaluation team met to generate projections for the 50-year future without project conditions. The rationale used by the habitat evaluation team, including logic and decision points, is included as follows.

1. Potential non-viable wildlife populations – The habitat evaluation team discussed the possibility of reducing or modifying the species list, however the team concluded that the current taxa, which are adapted to the highly urban environment surrounding the River, would most likely persist. It was assumed at the time of discussion that despite development pressure on the River, large open space areas, such as Griffith Park, were expected to be conserved due to high demand by the residents and established land use policies.

2. Invasive species would expand in area and abundance – Invasive plant species occurrence for baseline existing conditions was originally collected for three structural levels (the grass/forb layer, the shrub layer, and the tree layer) in each polygon. A discount factor

was applied based on the percentage of invasive species cover present, as shown in Table 6.1.2-1.

To determine the influence of invasive species for the future without project conditions, the habitat evaluation team forecasted that the presence and abundance of the invasive species would increase over time without implementation of a restoration project. Although occasional non-native and trash removal efforts are conducted by the Corps (and others) in certain reaches of the river, these efforts are not frequent or consistent, and are dependent on limited and unpredictable funding. They are also not conducted watershed-wide, so areas cleared of non-natives one year may be subject to re-infestation in later years. Therefore, it was estimated that the percentage of invasive species for each polygon at the baseline condition would advance to the next highest percentage level for the first 25 years, and to the subsequent level beyond that for the last 25 years. For example, if the baseline existing condition of a polygon exhibits 36-65% invasive cover in the grass/forb layer, then the condition at Year 25 would be assessed at 66-90% invasive cover, and the condition at Year 50 would be assessed at >90% invasive cover.

3. Flooding – A simulated 500-year flood event would likely have little influence on how the current wildlife population interacts with the landscape. It is possible that the riparian vegetation in the River within the soft-bottomed portions of the channel could be partially or even completely washed out by a 500-year event; however, historic photos indicate that current structural conditions are likely to persist in the soft-bottomed sections of the project area if no action is taken for the next 50 years. Riparian vegetation rapidly re-establishes after flood events, and this would be expected in the LA River channel. The project area outside the channel is extremely urbanized and any semi-natural areas would likely return to invasive shrub and grass conditions post-flood.

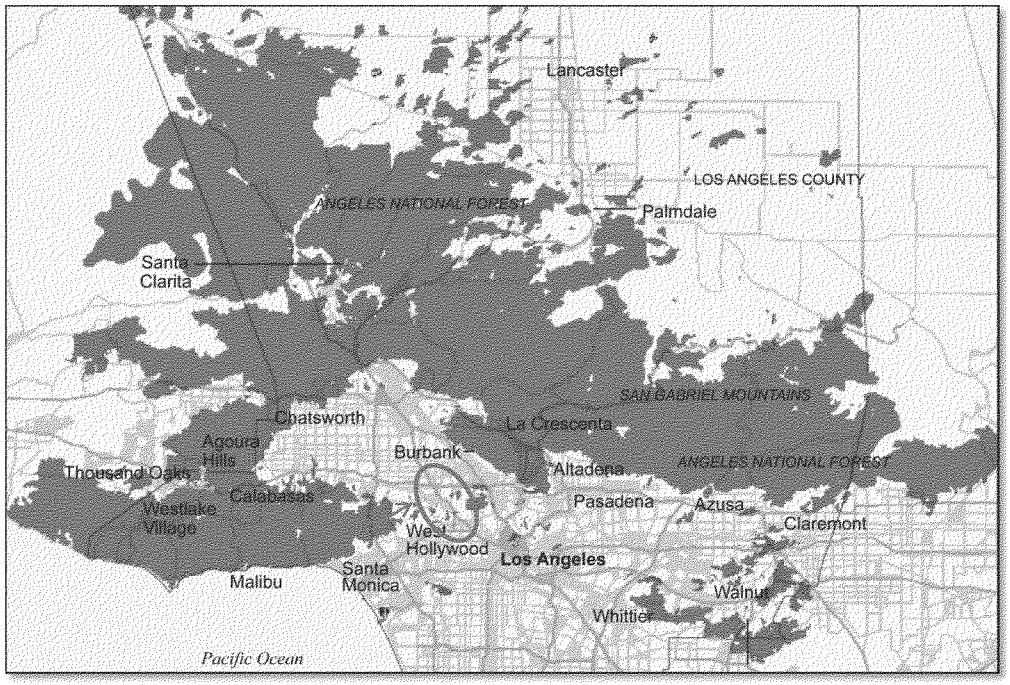
   While a 500-year storm event may wash larger amounts of urban trash and detritus into the river, in its current state the River already contains substantial levels of trash in the Study area. The impacts of trash in the River were, therefore, expected to persist in the event of major flooding without project implementation. Overall, it was not expected that the number of species present or how those species interact with the landscape (habitat function) would be altered by flooding in the absence of a restoration project. Figure 6.2.1-1 depicts the overflow area for a 500-year flood event.

4. Fire – Griffith Park may be threatened by wildfire, however extreme effort is placed on suppressing the spread of wildfire near the Study area due to the threat to human life and property (infrastructure). The 2007 Griffith Park fire burned 817 acres, and a similar fire in 1961 burned 814 acres. Neither fire impacted the habitat within the Study area. There may be a greater concern over time for a potential increase in wildfire due to increased drought conditions associated with climate change. Maturing vegetation types and senescence would increase fuel loading and the potential for wildfire to spread to the Study area.

   Therefore, the likelihood for at least one occurrence of a wildfire within the 50-year period has been projected based on the County's past fire history (Figure 6.2.1-2).

Figure 6.2.1-1. 500-year Flood Event – Overflow Area

Figure 6.2.1-2. LA County Fire History



Fire History from the Los Angeles County Fire Department illustrating the fires that have occurred from 1870s to 2005 [as reported in LA Times 08-05-2007].

Depending on the severity of a fire in the Study area, burned trees that do not suffer mortality may re-sprout from remnant vegetation and weedy species would likely return as ground cover. Over time some riparian vegetation in the Study area may re-establish from upstream seed sources, however weedy species would be expected to colonize quickly in the absence of established native vegetation. Without maintenance of non-native weeds, these species would be expected to further degrade existing riparian areas over time.

Some wildlife may benefit immediately after a fire, such as insectivorous birds that feed from post-fire insect outbreaks and cavity nesting birds and perching birds that find shelter and snags in the standing dead and damaged trees. Species that prefer structural diversity are generally expected to be negatively affected by a large stand-replacing fire in the Study area. A severe fire may change the water chemistry, leading to mortality of fish and other aquatic organisms. Loss of vegetation and the associated increase in sedimentation would also affect water quality for these species.

The Santa Ana winds, which can fan a wildfire into a major fire storm, were not considered a contributor to fire as the winds do not blow uniformly across Southern California and some areas, including the Study area, are relatively sheltered from the winds (Figure 6.2.1-3).

5. Planned Development – Currently, several development projects are anticipated to occur near the Study area. At the Headworks site, LA County Department of Water and Power is actively installing water tanks at the west end of the site. The Headworks site currently consists of a pile of fill dirt and hole for the future water tanks; therefore, KECs were altered for the area under the future without project condition to account for grass and shrub components that would be planted if no other action is taken at the site.

   The California High Speed Train project is currently developing alternative alignments near the Study area. While the final alignment has not been determined, the alignment alternatives that abut and cross the Study area (if chosen) would have an impact on the value of wildlife habitat in the Study area under the future-without project scenario.

   In the absence of an ecosystem restoration project on the River, urbanization will continue near the Study area, particularly in Downtown LA. Other development, transportation and infrastructure projects occurring within or adjacent to the Study area would generally have a negative effect on habitat value.

6. Earthquakes – Earthquakes and tremors occur frequently in the Southern California area. Figure 6.2.1-4 depicts the seismic activity that occurred in and around the Los Angeles area from 1800 thru 2000. In the event of an earthquake, the primary impact would be to infrastructure along the corridor. It is expected that the design and engineering of the channel, including pipelines and tanks, would withstand predictive earthquakes for the area. If this infrastructure failed, flooding may occur, although surface water would eventually flow back in the Los Angeles River.

Figure 6.2.1-3. Santa Ana Winds

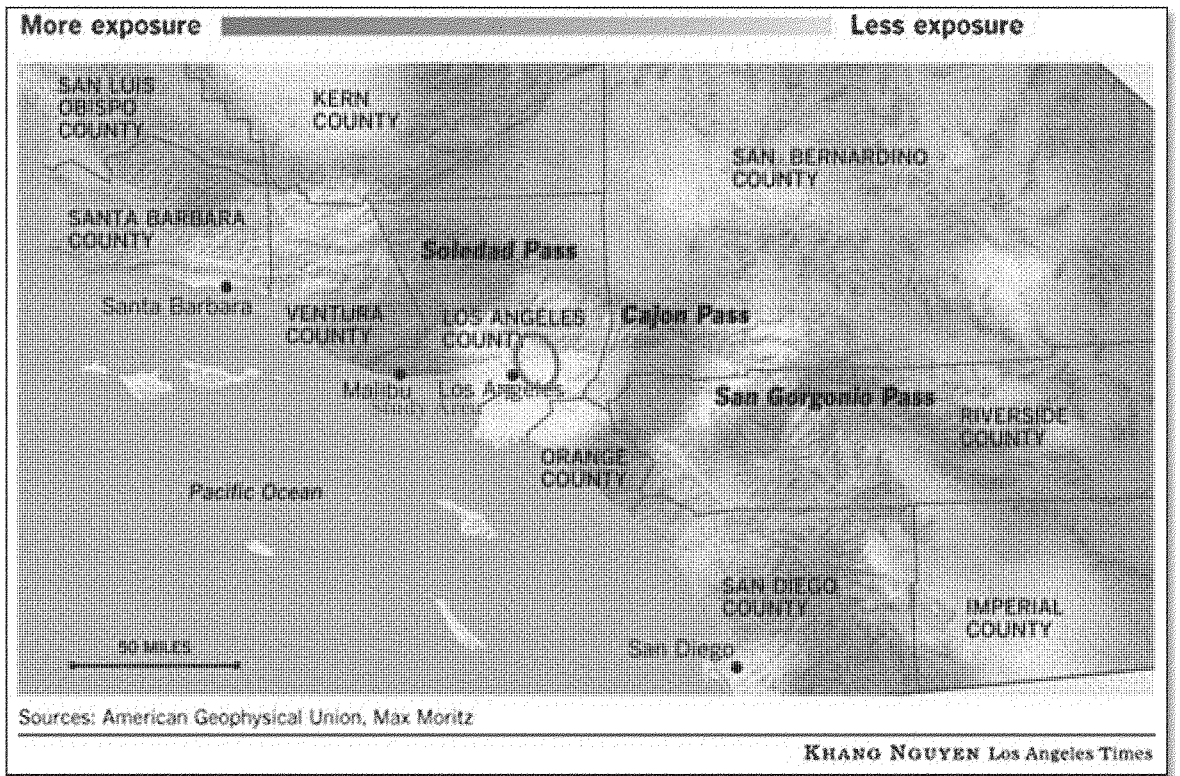
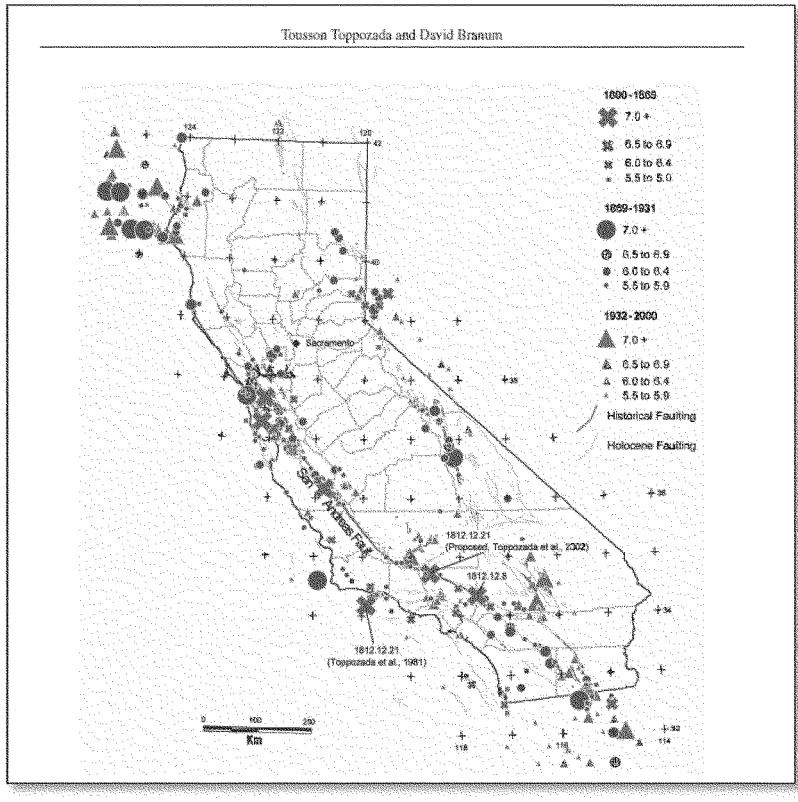


Figure 6.2.1-4: Earthquakes in Southern California



Magnitude greater or equal to 5.5 California earthquakes, 1800-2000 (modified from Toppozada and Branum, 2002).

7. Proximity to Other Natural Areas – The Study area is in close proximity to other natural areas, most notably Griffith Park, which is the eastern terminus of the Santa Monica Mountains (Figure 6.2.1-5). It was expected that these substantial nearby open space areas and habitat connections would persist in the future.

6.2.2 Baseline: Future Without Project Results

After adjusting the percent of cover of invasive species and adjusting the KECs of each polygon based on planned development, flood and fire events, and climate change, habitat values were generated for the 25 and 50-year time periods.

As expected, habitat value is projected to substantially decline within the Study area assuming no restoration activity is implemented over the next 50 years. Open water areas and urban areas mostly comprised of impervious surfaces (including the concrete channel banks) showed no change from the current habitat value. The remainder of the Study area is projected to decline steadily in habitat value, with an overall decline of 7% after 25 years and 14% after 50 years (Figure 6.2.2-1). In the absence of restoration in the Study area, the existing riparian areas that currently provide the most habitat value per acre will continue to degrade. Ecosystem functions in the Study area will also continue to diminish.

The future without project CHAP calculations are included in Microsoft excel spreadsheets and displayed in a GIS geodatabase. Due to the large volume of these spreadsheets and data, the complete set of files is available upon request from the Corps, Los Angeles District.

6.2.3 Annualizing HUs

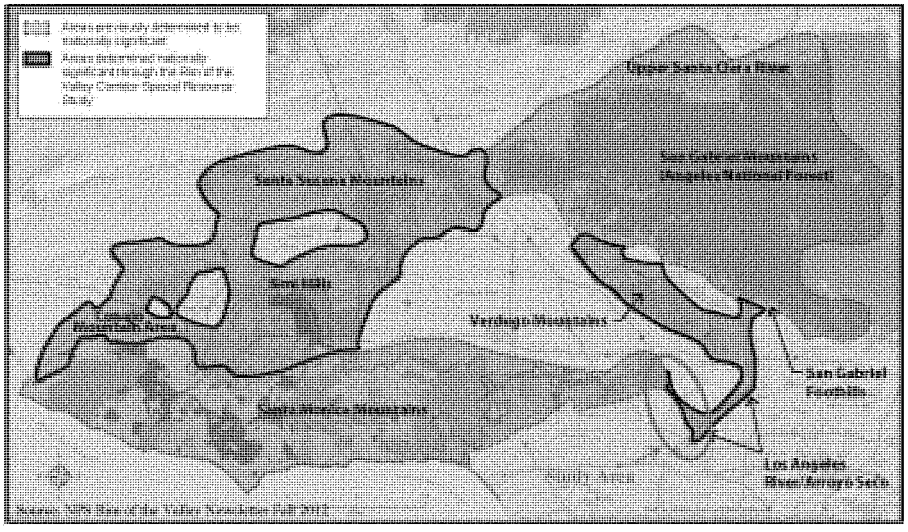
Since the amount and value of habitat found within the Study area is likely to vary over time, to account for time dependent variation habitat units were forecasted over the 50 year period of analysis. These 50 annualized values were then averaged to produce an average annual habitat unit value.

Annualized habitat unit values were generated by forecasting the amount and value of habitat expected to exist within the study area at discrete points of time during the period of analysis (i.e. the number of habitat units expected to exist in the 1st, 25th and 50th year of the period of analysis). The habitat values expected to exist in years between the forecast points were created by interpolating (linearly) between these forecast values. The resulting 50 habitat unit values (one for each year in the period of analysis) were then averaged to produce a single average annual habitat unit value. This annualized habitat value was compared to annualized costs in the economic cost effectiveness and incremental cost analyses (CE/ICA)(See Appendix B of the Main Feasibility Report).

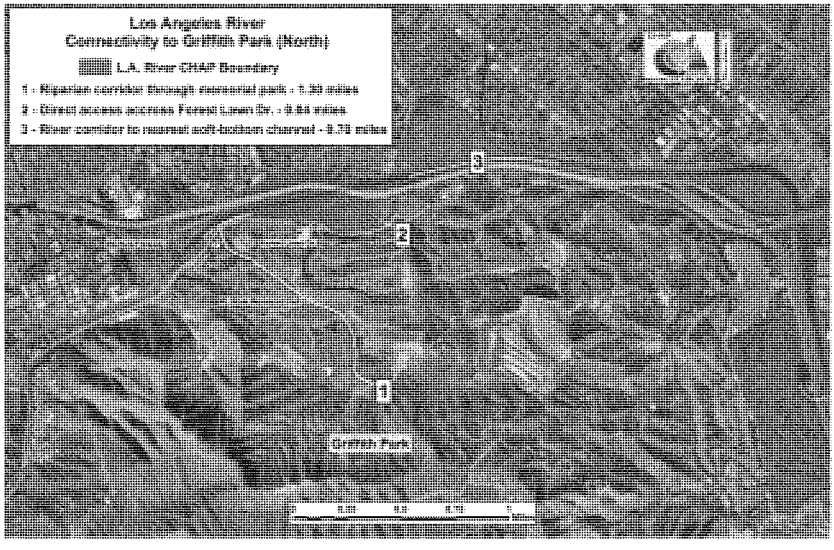
6.3 ALTERNATIVES ANALYSIS

Through the Corps' Plan Formulation process, 19 preliminary ecosystem restoration alternatives were developed based on input from local stakeholders and resource agency groups provided at workshops throughout the planning process.

Figure 6.2.1-5. Proximity to other Natural Areas

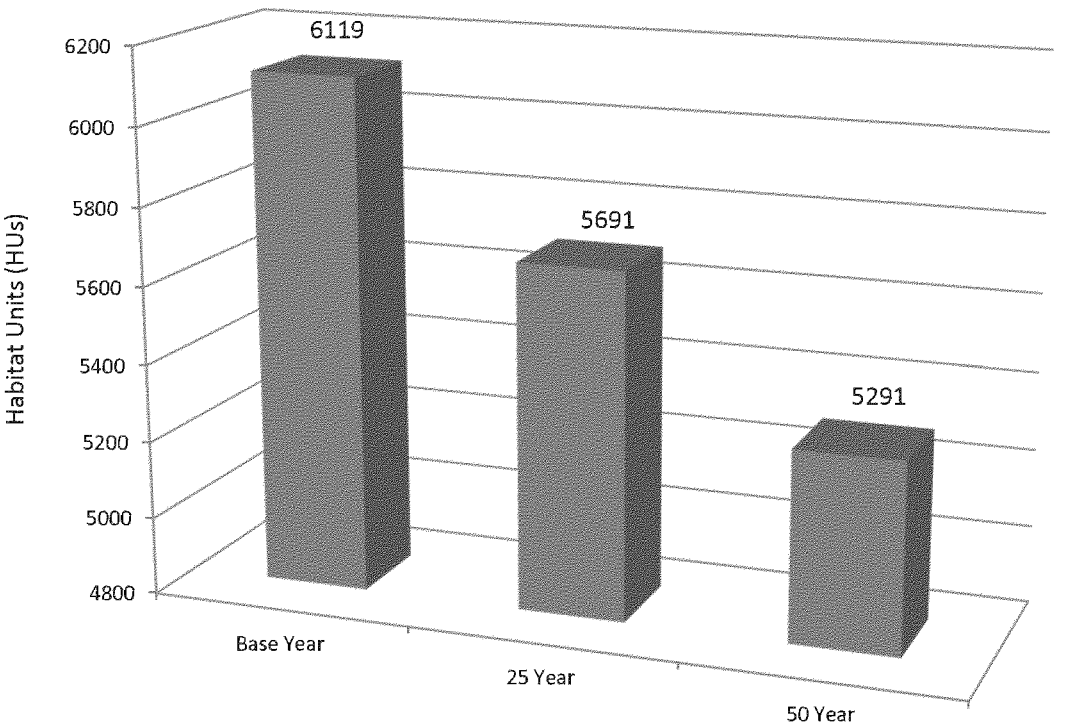


Regional Connectivity to Local Mountain Ranges and Nationally Significant Areas



Opportunities for Connections to Griffith Park

Figure 6.2.2-1. Without Project HUs



HUs were calculated for each restoration alternative by evaluating specific habitat creation, improvement, and management actions within the Study area, where preliminary design specifications and future with project assumptions were clearly, spatially defined. Informed predictions of habitat value for each of the 19 preliminary restoration alternatives were made by altering the inputs to the CHAP to match the anticipated outcomes of the different restoration alternatives. Habitat value results were then tabulated for each alternative by reach.

6.3.1 Alternatives Methods

To calculate habitat value for each alternative, the species by function matrix values are adjusted when the species list changes or there is a conversion of habitat type. The habitat by function values are adjusted when KECs (i.e. habitat elements) are added or removed. Restoration activities can increase the values of either or both matrices within the CHAP accounting system.

By converting dense, urban uses to functioning riparian, open water, and marsh habitats, which are all aquatic ecosystems, the number of potential species linked to those habitats greatly increases in that area. The number of species performing functions and the number of functions provided by the habitat type also increases for that area. These adjustments in species, habitat, and functions lead to increased species by function matrix value for a given polygon. Adding KECs, such as by planting vegetation and creating a more natural geomorphic character, or enhancing structures for wildlife use and connectivity, increases the habitat by function matrix values for a given polygon.

To calculate initial and future with project habitat values, representing the benefit of each alternative's proposed restoration activities, each of the total 172 CHAP polygons must be analyzed in terms of habitat type, structural conditions, and KECs expected to be present after restoration. For the purposes of the Study, habitat values were forecasted at initial HUs, after 25 years with project, and after 50 years with project. This provides a direct comparison to the baseline future without project conditions, at 25 and 50 years into the future.

The baseline CHAP polygons were delineated based on differences in habitat type or structural condition. During the alternatives analysis, some of the polygons established during baseline had to be split because different restoration actions were proposed in multiple areas within a given baseline polygon. In these cases the original CHAP baseline polygon number was retained, and any additional polygons resulting from split were labeled with a letter (e.g. polygon LAR_007 was split to LAR_007, LAR_007A and LAR_007B). Maintaining this continuity allowed for simplified spatial tracking.

After the polygons were split where necessary, and the new polygon acreages were calculated, each restoration measure was evaluated as to the habitat type it would create, and the structural condition and KECs expected to be present. The Corps' alternative matrix, describing alternative measures for each alternative per reach (Appendix F), was used to identify the sub-measures that occurred in each river reach for each alternative. Application of these sub-measures in certain areas dictated where habitat conversions would occur within the Study area for each alternative. Evaluations were also based on the proposed preliminary design cross sections (Appendix G),

habitat assumptions made by the design team related to management measures[7] (Table 6.3.1-1), discussions with the CHAP habitat evaluation team, as well as projections of what current features would persist in a given polygon. To further assist in evaluating which sub-measures were to be implemented in each polygon, the design team's alternative GIS mapping (Tetra Tech 2012) was used as a spatial reference (Figure 6.3.1-1 and 6.3.1-2).

The following descriptions document the adjustments made to CHAP inputs (i.e. habitat type, KECs, percent invasives) to reflect the forecasted changes that would occur in each polygon with implementation of sub-measures from the restoration alternatives. Trash removal and invasives removal for the life of the project was included as a measure in any reach where restoration activities are proposed. For the complete list of measures, sub-measures, and their detailed descriptions, refer to Section 4.4 of the Main Feasibility Report. The master list of KECs and their numerical codes are included in Appendix A.

These descriptions are generalized for each sub-measure, and do not include polygon specific KECs such as roads, fences, bridges, buildings, and other anthropogenic features that were evaluated additionally for a given polygon.

For example, in polygons where the following sub-measures are implemented,

- Restore riparian and marsh by day lighting streams
- Creation of attenuation basin with wetlands

the following KECs were altered:

- Convert habitat type to Freshwater Emergent Wetland
- Restore all invasive species levels to 0-10%
- Remove trash and pollution KECs if applicable: 8.19.1 Chemical, 8.19.2 Sewage, 8.19.3 Water, 8.9 Refuse
- Add KECs: 4.1.2 Water Depth, 4.6.3.2 Emergent Vegetation, 4.7.1 Wetlands, 4.7.2.2 Non-Forest, 4.7.3 Size <2 ha, 4.7.4 Marsh Characteristics, 4.9 Seasonal Flooding, 8.16 Culverts, 8.24 Water Diversion

In other words, in polygons where a particular alternative designates that streams currently in storm drains be day lighted and the outlets/confluences be naturalized with created wetlands , it is expected that freshwater marsh would be restored and that invasives management would be implemented. Therefore, those KECs (habitat elements) should be accounted for in that polygon for the future with project condition. Trash management would also be implemented, which would remove certain existing habitat elements including chemical, sewage, and water pollution, and refuse. The restoration of wetlands would add KECs associated with that habitat such as emergent vegetation, seasonal flooding, and water diversions.

7 For the complete list of measures, sub-measures, and their detailed descriptions, refer to Section 4.4 of the Main Feasibility Report.

Table 6.3.1-1: Habitat Design Assumptions Related to Management Measures

Sub-Measure	Assumption
Restore riparian and marsh by day lighting streams	Average 1 acre wetland per site (confluence).
Create geomorphology* and plant for freshwater marsh in adjacent side channel/in main LA River Channel. Create geomorphology for open water adjacent to the channel/in main LA River Channel.	Assume same percentage of wetland/riparian/open water as in existing soft bottom reaches.
Rebuild geomorphology for historic wash	Riparian.
Creation of attenuation basin with wetlands	Wetland.
Divert tributary & river flow into side channels	25% riparian/75% wetland.
Restructure/vegetate LA River concrete channel walls	This is applied to most of the channel banks but it is assumed that the banks will not be fully covered by vegetation. Assume 50% herbaceous riparian/50% concrete.
Habitat corridors/Riparian planting on over banks of the main channel or tributaries	50% riparian/50% shrub.
Terrace concrete banks/Planting built into modified channel walls	50% riparian/50% concrete**
Establish/improve open water habitat on concrete bottom areas within the main channel of the LA River	This measure is only in Reach 3. Assume 25% wetland (toe of the banks). Remaining stays as existing conditions.
Lower channel banks	One polygon adjacent to Verdugo Wash. Assume riparian.
Widen channel banks	Riparian.
Major tributary channels/widen channel	One polygon at Verdugo Wash. Assume same wetland/riparian percentage as existing conditions.
Terraces with earthen banks	Riparian.
In Soft Bottom Reaches 2, 4, 5, 6: Assume that the existing configuration of habitat in the channel bottom not modified. Assume trash cleanup and invasives management will be conducted for the life of the project in reaches where measures are implemented. Assume only occasional non-native/trash removal without the project.	

*Within this appendix, references to restoration, creation, or improvement of "hydrology" and "geomorphology" are intended to refer to restoration, creation, or improvement of a more natural hydrologic regime and a more natural geomorphic character.

**Habitat composed of 50% riparian and 50% concrete would provide half of the benefits attained by the fully restored riparian habitat. While it does not provide as much benefit as the comprehensive riparian restoration, this habitat is an important component for wildlife movement and connectivity within the project area for small animals (mammals, birds, reptiles) in more restricted reaches, providing opportunities for foraging and cover.

While concrete surfaces are not natural or a restored habitat, they do provide value to certain species, even if minimal value, in such a highly urbanized environment. Shorebirds benefit in areas of perennial flow where algae accumulates on the surface of the concrete. This provides them roosting and foraging habitat. This also serves as a linear open space corridor that wildlife can traverse without contending with traffic or other human intrusion. While persistence of concrete is not a restoration measure, it will continue to be a usable element for wildlife that will exist within the study area.

The main purpose of the habitat evaluation is to ensure that with-project values are significantly better than without project for the overall study area. Concrete is an existing condition, and while the value may be low it is not zero in this particular case. If concrete surfaces are assigned zero value then the overall value of the entire study area (for both existing and future conditions) would be undervalued. With the project, there will be less concrete and less non-native vegetation.

For the complete list of measures, sub-measures, and their detailed descriptions, refer to Section 4.4 of the Main Feasibility Report.

Figure 6.3.1-1. Sample Alternative Mapping – Alternative 1 – Reach 3

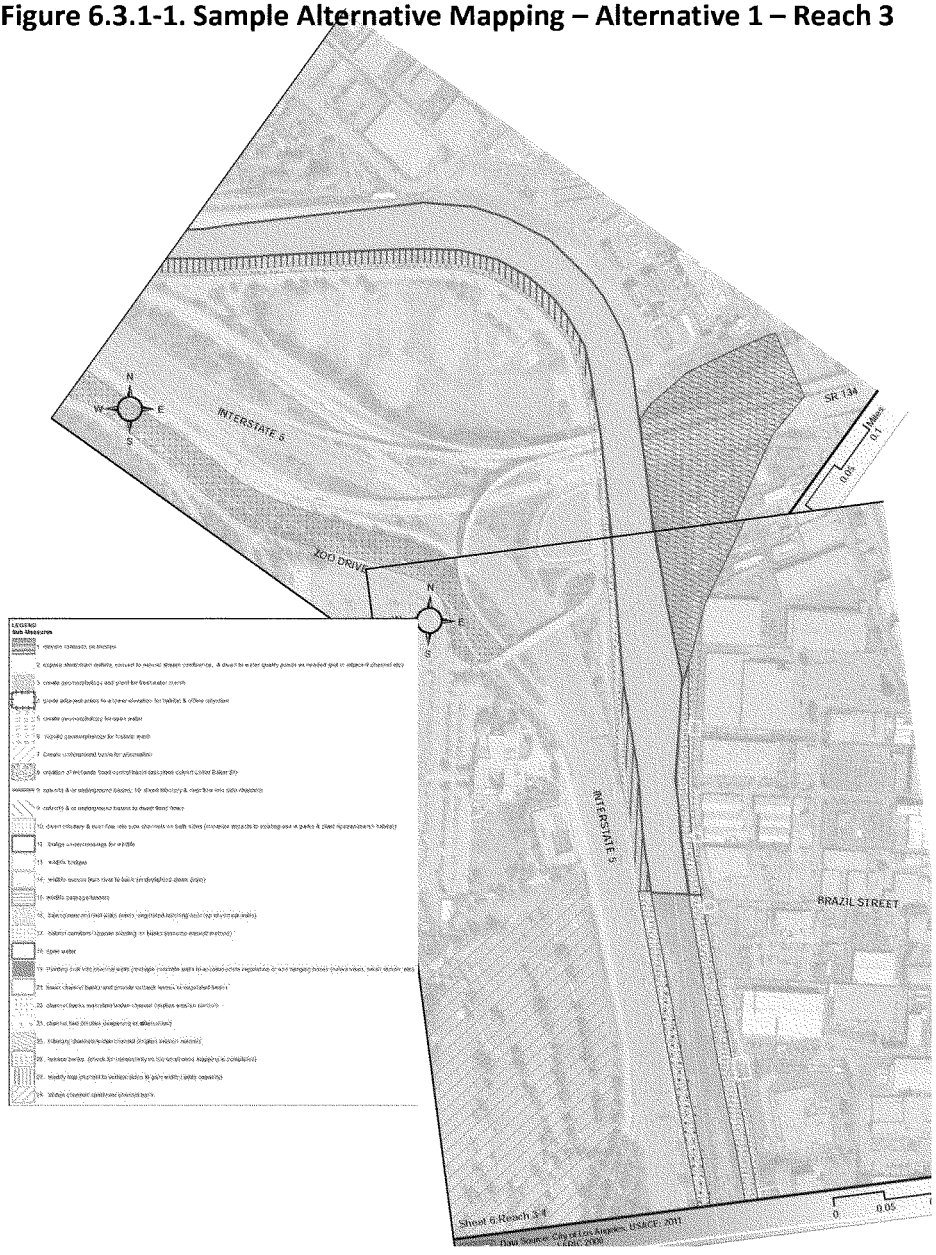
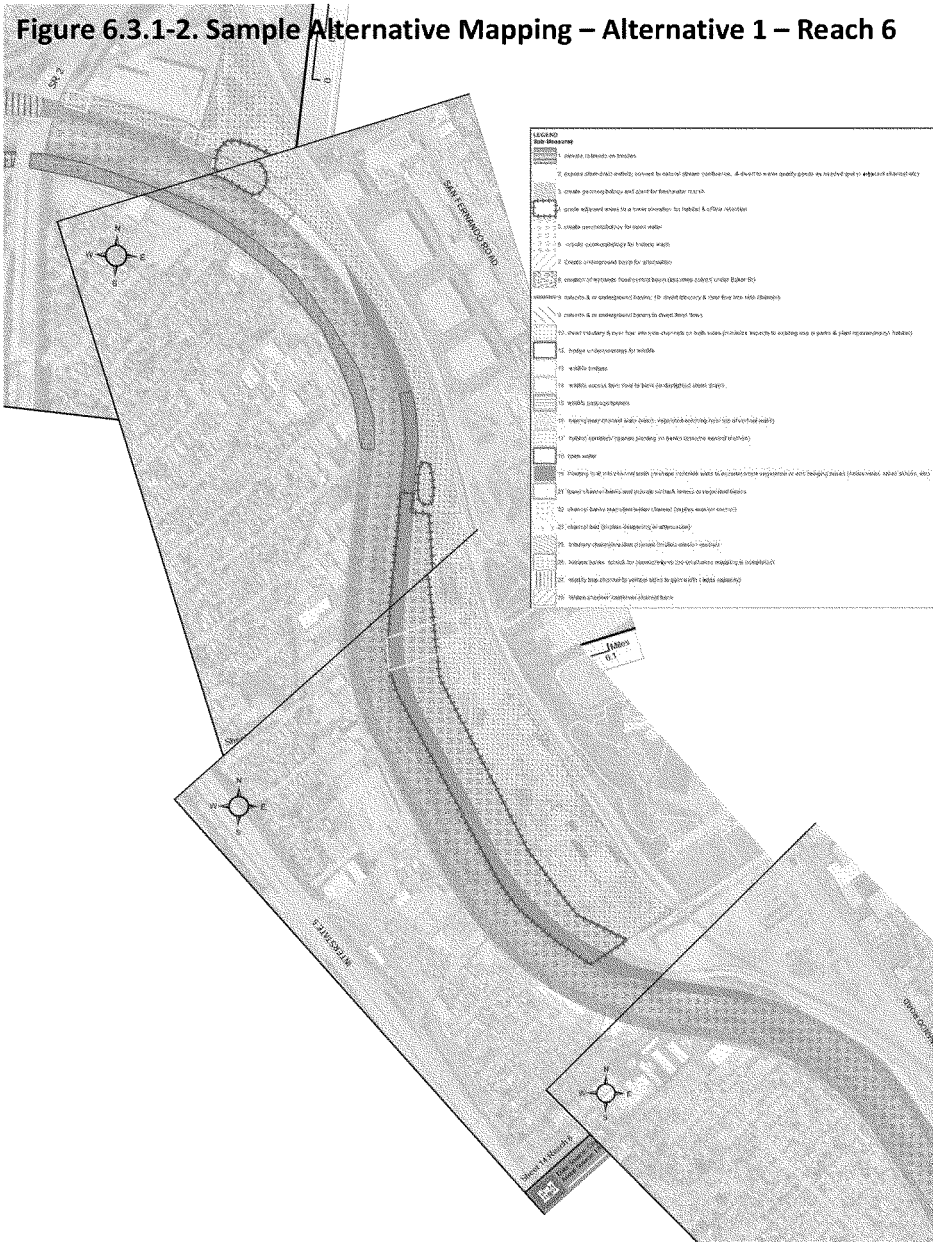


Figure 6.3.1-2. Sample Alternative Mapping – Alternative 1 – Reach 6



Similarly, the other sub-measures (below) would add or remove KECs to applicable polygons under the alternative future with project condition, based on the activities expected to occur for a particular alternative. The adjustments for each sub-measure are outlined as follows:

Create geomorphology and plant for freshwater marsh in adjacent side channel/in main LA River Channel
Create geomorphology for open water adjacent to the channel/in main LA River Channel

- Convert habitat type to Freshwater Emergent Wetland
- Restore all invasive species levels to 0-10%
- Remove trash and pollution KECs if applicable: 8.19.1 Chemical, 8.19.2 Sewage, 8.19.3 Water, 8.9 Refuse
- Add KECs: 4.1.2 Water Depth, 4.7.1 Riverine Wetland Characteristics, 4.6.3.2 Emergent Vegetation, 4.7.2.2 Non-Forest, 4.7.4 Marsh, 4.9 Seasonal Flooding, 8.16 Culverts, 8.24 Water Diversion Structures

Rebuild geomorphology for historic wash
Habitat corridors/Riparian planting on over banks of the main channel or tributaries
Widen channel banks
Terraces with earthen banks

- Convert habitat type to Valley Foothill Riparian
- Restore all invasive species levels to 0-10%
- Remove trash and pollution KECs if applicable: 8.19.1 Chemical, 8.19.2 Sewage, 8.19.3 Water, 8.9 Refuse
- Add KECs: 1.1.14.3.1 Seedling, 1.1.14.3.2 Sapling/Pole, 1.1.5 Moss, 1.1.6 Flowers, 1.1.7 Lichens, 1.1.8 Forbs, 1.1.13 Herbaceous Layer, 1.2.6.1.1 Small Shrub, 1.2.6.1.2 Medium Shrub, 3.2.3 Soil Moisture, 3.2.4 Soil Organic Matter

Divert tributary and river flow into side channels

- Convert habitat type to Freshwater Emergent Wetland
- Restore all invasive species levels to 0-10%
- Remove trash and pollution KECs if applicable: 8.19.1 Chemical, 8.19.2 Sewage, 8.19.3 Water, 8.9 Refuse
- Add KECs: 1.1.14.3.1 Seedling, 1.1.14.3.2 Sapling/Pole, 1.1.5 Moss, 1.1.6 Flowers, 1.1.7 Lichens, 1.1.8 Forbs, 1.1.13 Herbaceous Layer, 1.2.6.1.1 Small Shrub, 1.2.6.1.2 Medium Shrub, 3.2.3 Soil Moisture, 3.2.4 Soil Organic Matter, 8.24 Water Diversion, 4.7.1 Riverine Wetlands, 8.29 Regulated Hydrologic Regime

Restructure/vegetate LA River concrete channel walls
Terrace concrete banks/Planting built into modified channel walls

- Convert habitat type to Valley Foothill Riparian
- Restore all invasive species levels to 0-10%

- Remove trash and pollution KECs if applicable: 8.19.1 Chemical, 8.19.2 Sewage, 8.19.3 Water, 8.9 Refuse
- Add KECs: 1.1.5 Moss, 1.1.6 Flowers, 1.1.7 Lichens, 1.1.8 Forbs, 1.1.13 Herbaceous Layer, 1.2.6.1.1 Small Shrub, 1.2.6.1.2 Medium Shrub, 3.2.3 Soil Moisture, 3.2.4 Soil Organic Matter
- Apply restoration benefits to half of area (other half to remain concrete/baseline)

Establish/improve open water habitat on concrete bottom areas within the main channel of the LA River

- Convert habitat type to Open Water
- Remove trash and pollution KECs if applicable: 8.19.1 Chemical, 8.19.2 Sewage, 8.19.3 Water, 8.9 Refuse
- Add KECs: 4.1.2 Water Depth, 4.1.6 Water Velocity, 4.2.3.1 Open Water, 4.2.12 Banks

By adjusting the CHAP inputs based on the proposed restoration sub-measures, adjusting the individually unique inputs to each polygon, and calculating the CHAP matrices, per-acre HU values were generated for each polygon in each restoration alternative. KECs representing maturation of forecasted habitats (i.e. additional tree and shrub size classes, formation of downed wood and snags) were added to each polygon to predict the anticipated increased benefits of the restoration alternative at 25 and 50 years into the future. The per-acre value was then multiplied by the polygon acreage to obtain the total HUs for each polygon in each alternative.

The future with project CHAP calculations of habitat value are included in Microsoft excel spreadsheets and displayed in a GIS geodatabase. The design team's alternative mapping is also included in GIS. Due to the large volume of these spreadsheets and GIS data, the complete set of files is available upon request from the Corps, Los Angeles District. Sample figures depicting the alternative mapping and with project HUs are included in Figures 6.3.1-1 to 6.3.1-3. Summary tables are included in Table 6.3.2-1 and Appendix H, as discussed in the following Section 6.3.2.

6.3.2 Alternatives Results

By comparing the total with-project habitat value for each alternative to the baseline and without-project value, it is possible to isolate the benefits of the ecosystem restoration alternatives to fish and wildlife habitat. Table 6.3.2-1 outlines the gross and net benefits in HUs for the base year[8], 25 years with project, and 50 years with project for each of the 19 preliminary alternatives. Gross benefits are the total benefits afforded by the alternative. Net benefits are the difference in benefits between the with- and without-project value; in other words the with project value minus the without project value. Here, the net benefits describe the increase in benefits afforded by the alternative over the without-project condition. Results are also presented in terms of Gross and Net Benefits by reach for each alternative in tables in Appendix H. Figure 6.3.2-1 depicts the gross benefits for each of the 19 alternatives at the base year, 25 years with project, and 50 years with project. Note that the names associated with each

8 Base year: the year when the proposed project is expected to be operational (USACE 2000)

Figure 6.3.1-3. Sample Alternative Mapping – Alternative 1 Gross HUs

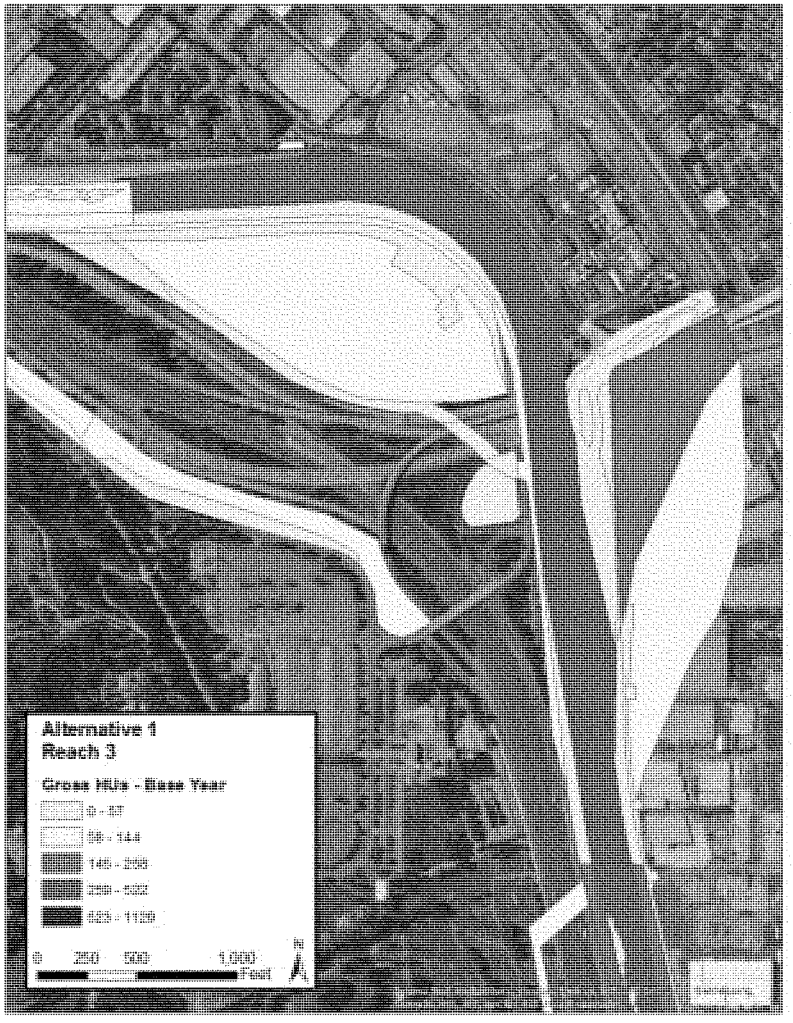


Figure 6.3.1-3. Sample Alternative Mapping – Alternative 1 Gross HUs

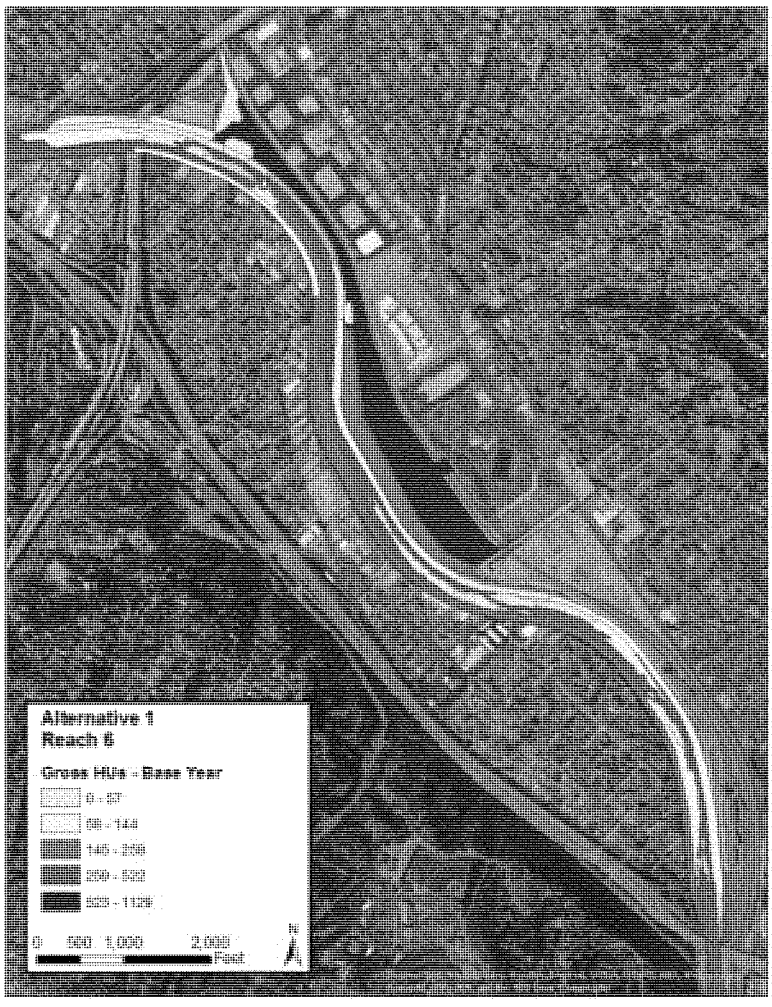


Figure 6.3.1-3. Sample Alternative Mapping – Alternative 1 Gross HUs

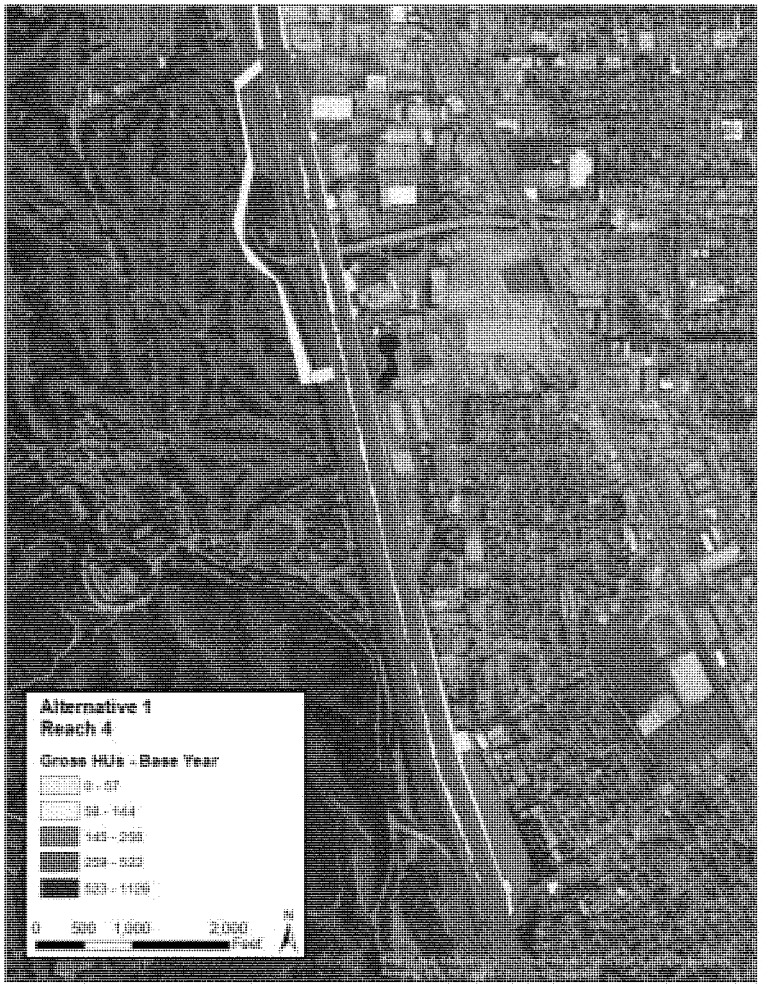


Figure 6.3.1-3. Sample Alternative Mapping – Alternative 1 Gross HUs

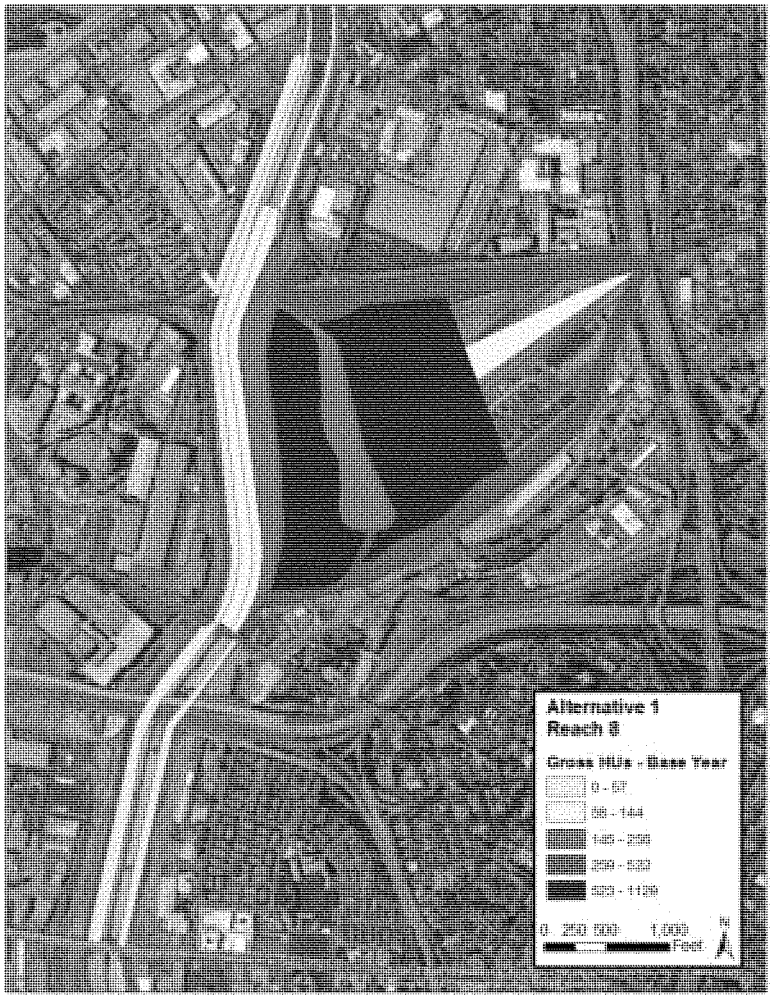


Table 6.3.2-1. Gross and Net Benefits for With Project Alternatives

	Without Project			
		Base Year	25 Year	50 Year
	Acres	Habitat Units (HUs)	Habitat Units (HUs)	Habitat Units (HUs)
Baseline	842.37	6,119.38	5,690.71	5,291.32

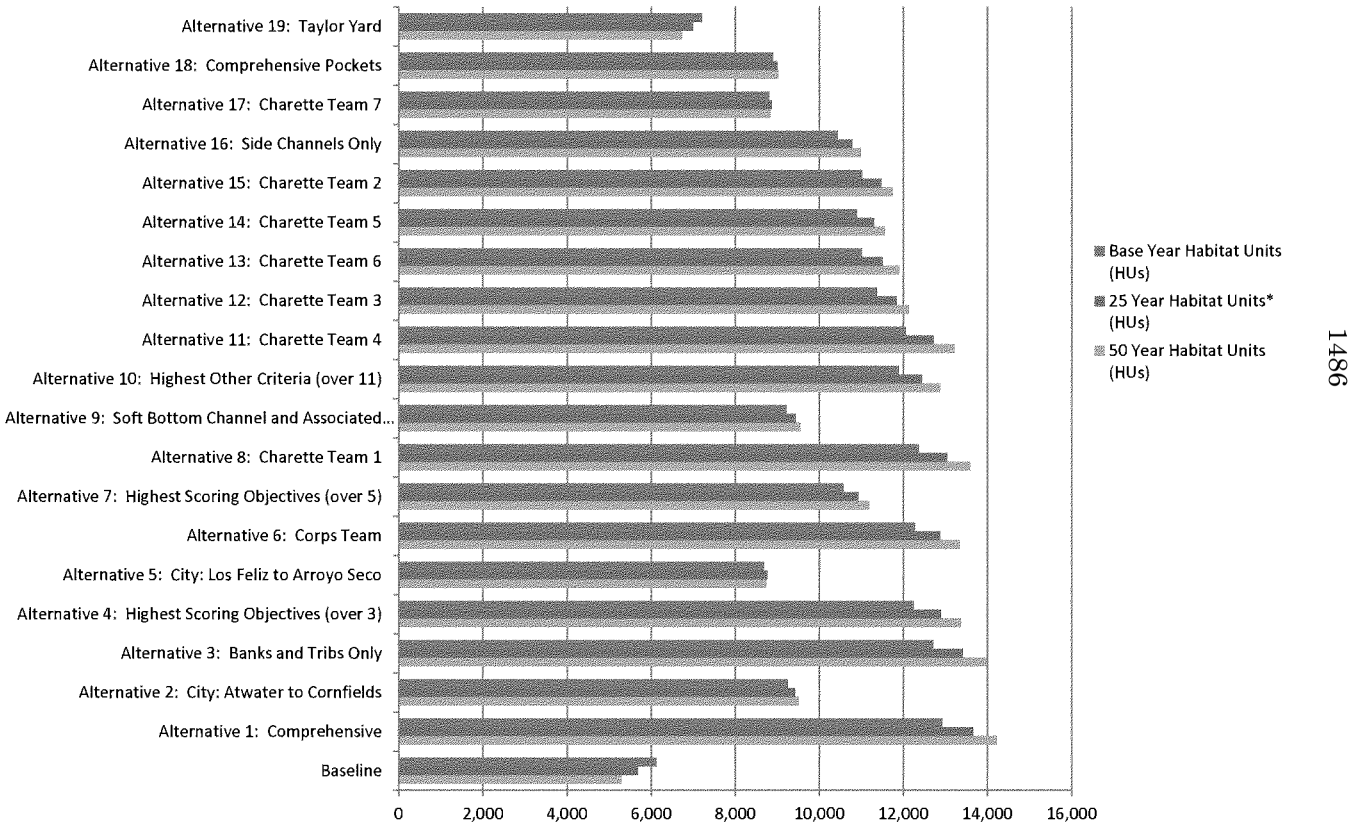
	With Project – Gross*				With Project – Net*		
		Base Year	25 Year	50 Year	Base Year	25 Year	50 Year
	Acres**	Habitat Units (HUs)***	Habitat Units (HUs)***	Habitat Units (HUs)***	Habitat Units (HUs)***	Habitat Units (HUs)***	Habitat Units (HUs)***
Alternative 1: Comprehensive	621.26	12,920.89	13,657.14	14,216.86	6,801.51	7,966.43	8,925.55
Alternative 2: City: Atwater to Cornfields	350.39	9,250.21	9,423.75	9,510.22	3,130.83	3,733.04	4,218.90
Alternative 3: Banks and Tribs Only	592.39	12,711.76	13,411.89	13,973.13	6,592.38	7,721.18	8,681.81
Alternative 4: Highest Scoring Objectives (over 3)	531.18	12,241.40	12,891.42	13,369.81	6,122.02	7,200.71	8,078.49
Alternative 5: City: Los Feliz to Arroyo Seco	285.75	8,674.95	8,766.52	8,743.87	2,555.57	3,075.81	3,452.55
Alternative 6: Corps Team	548.22	12,268.67	12,872.59	13,338.28	6,149.29	7,181.88	8,046.97
Alternative 7: Highest Scoring Objectives (over 5)	417.69	10,577.63	10,928.89	11,187.12	4,458.25	5,238.18	5,895.80
Alternative 8: Charette Team 1	596.19	12,365.07	13,042.78	13,591.57	6,245.69	7,352.07	8,300.25
Alternative 9: Soft Bottom Channel and Associated Banks	299.94	9,216.04	9,434.10	9,550.47	3,096.66	3,743.39	4,259.15
Alternative 10: Highest Other Criteria (over 11)	520.75	11,884.26	12,441.81	12,872.80	5,764.88	6,751.10	7,581.48
Alternative 11: Charette Team 4	529.43	12,050.11	12,716.92	13,210.78	5,930.73	7,026.21	7,919.46
Alternative 12: Charette Team 3	465.47	11,374.23	11,833.42	12,128.88	5,254.85	6,142.71	6,837.56
Alternative 13: Charette Team 6	520.22	11,009.62	11,504.09	11,896.13	4,890.24	5,813.38	6,604.81
Alternative 14: Charette Team 5	404.66	10,897.76	11,302.94	11,555.62	4,778.38	5,612.23	6,264.30
Alternative 15: Charette Team 2	407.04	11,022.81	11,470.26	11,742.84	4,903.43	5,779.55	6,451.52
Alternative 16: Side Channels Only	339.45	10,441.76	10,779.91	10,983.74	4,322.38	5,089.19	5,692.42
Alternative 17: Charette Team 7	236.88	8,799.73	8,865.86	8,837.49	2,680.35	3,175.15	3,546.17
Alternative 18: Comprehensive Pockets	285.38	8,895.97	9,005.18	9,023.68	2,776.59	3,314.47	3,732.36
Alternative 19: Taylor Yard	101.76	7,208.52	6,995.24	6,734.65	1,089.14	1,304.53	1,443.34

*Gross Benefits = Total Benefits afforded by an alternative; Net Benefits = With Project Value – Without Project Value

** acreage values represent acres experiencing a change in habitat value, and are not necessarily consistent with total project acreage

*** total Habitat Units (HUs) for entire 842 acre Study area

Figure 6.3.2-1. Gross Benefits (HUs) for With Project Alternatives at Base Year, 25 Years With Project, and 50 Years With Project and the Baseline Condition



of the 19 alternatives in Table 6.3.2-1 were used by the project team to more simply distinguish between alternatives. Generally, for each alternative, there is an increase in habitat value over the without project conditions.

Alternatives 5 and 17 show a decrease in gross benefit from the 25 years future with project to 50 years future with project condition. Alternative 19 shows a decrease in gross benefits from the base year to 25 years future with project to 50 years future with project. This decrease in gross benefits over time is due to the degradation of other reaches in the Study area where no restoration activity would occur. For example, in Alternative 19, restoration activity would only occur in Reach 6. The remaining 7 of the 8 reaches in the project area would have no restoration activity implemented; therefore, over time the degradation of those remaining 7 reaches would depress the HUs for the entire Study area. While gross benefits decrease over time from the base year in those cases, net benefits remain positive for all alternatives. This means that all 19 alternatives have increased benefits over the without project condition.

Figure 6.3.2-2 further depicts the net benefits as HUs per reach per alternative at the base year, 25 years with project, and 50 years with project.

As expected, the Comprehensive Alternative 1, which includes all measures implemented in all reaches, provides the greatest increase in habitat value from without project conditions (i.e. net benefit), with a 111% increase in HUs at the base year over without project conditions and a 169% increase in HUs at year 50 over without project conditions. However, even the most minimal alternative 19, which includes measures in only one reach (Reach 6/Taylor Yard), still provides an 18% increase in HUs at the base year over the without project conditions and a 27% increase in HUs after 50 years over the without project conditions. The range of increase in net benefits among all 19 alternatives can be seen in Table 6.3.2-2.

6.3.3 Economic Analysis

The results of the CHAP analysis were annualized, as described in Section 6.2.3, to inform the Corps' economic analyses, which includes a Cost Effectiveness Analysis and an Incremental Cost Analysis (CE/ICA). These analyses are used to determine which alternative plans are the most cost effective, or produce a given amount of habitat value at the lowest possible cost, and which alternative plans are the best buys, or produce the most additional habitat value for the lowest additional cost.

In performing the CE/ICA analysis, the alternatives are broken down by reach, and alternative reaches are recombined to produce the most cost effective, best buy plans. In other words, different measures are implemented in each of the 8 reaches for each of the 19 alternative plans, resulting in a total of 8 x 19 (152) alternative reaches. These 152 alternative reaches are recombined, based on the CHAP benefits (HUs) and the restoration costs, into new cost effective/best buy alternative plans, such that (for example) the measures from Reach 1 in Alternative 11 are combined with the measures from Reach 2 in Alternative 16, and the measures from Reach 3 in Alternative 1, and so on.

The original 19 alternatives are not cost effective in themselves in that the best (i.e. most cost effective) ideas for each reach could not be expected to be produced in a single alternative plan

Figure 6.3.2-2. Net Benefits (HUs) for With Project Alternatives at Base Year, 25 Years With Project, and 50 Years With Project - Showing Increase in HUs over Without Project Conditions

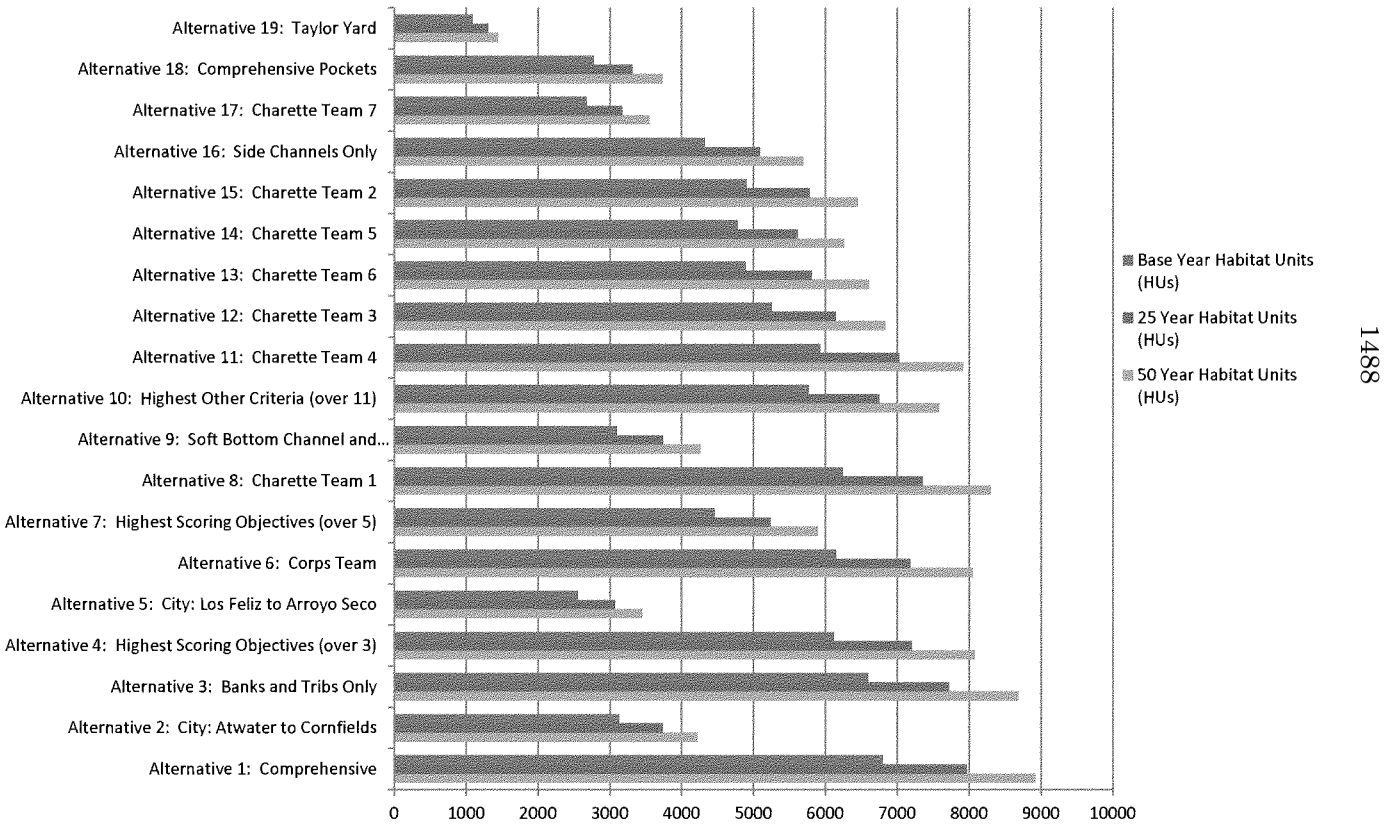


Table 6.3.2-2. Percent Increase in HUs for With Project Alternatives

	Without Project			
		Base Year	25 Year	50 Year
	Acres	Habitat Units (HUs)	Habitat Units (HUs)	Habitat Units (HUs)
Baseline	842.37	6,119.38	5,690.71	5,291.32

	With Project – Net*						
		Base Year		25 Year		50 Year	
	Acres**	Habitat Units (HUs)	% increase in HUs***	Habitat Units (HUs)	% increase in HUs***	Habitat Units (HUs)	% increase in HUs***
Alternative 1: Comprehensive	621.26	6,801.51	111%	7,966.43	140%	8,925.55	169%
Alternative 2: City: Atwater to Cornfields	350.39	3,130.83	51%	3,733.04	66%	4,218.90	80%
Alternative 3: Banks and Tribs Only	592.39	6,592.38	108%	7,721.18	136%	8,681.81	164%
Alternative 4: Highest Scoring Objectives (over 3)	531.18	6,122.02	100%	7,200.71	127%	8,078.49	153%
Alternative 5: City: Los Feliz to Arroyo Seco	285.75	2,555.57	42%	3,075.81	54%	3,452.55	65%
Alternative 6: Corps Team	548.22	6,149.29	100%	7,181.88	126%	8,046.97	152%
Alternative 7: Highest Scoring Objectives (over 5)	417.69	4,458.25	73%	5,238.18	92%	5,895.80	111%
Alternative 8: Charette Team 1	596.19	6,245.69	102%	7,352.07	129%	8,300.25	157%
Alternative 9: Soft Bottom Channel and Associated Banks	299.94	3,096.66	51%	3,743.39	66%	4,259.15	80%
Alternative 10: Highest Other Criteria (over 11)	520.75	5,764.88	94%	6,751.10	119%	7,581.48	143%
Alternative 11: Charette Team 4	529.43	5,930.73	97%	7,026.21	123%	7,919.46	150%
Alternative 12: Charette Team 3	465.47	5,254.85	86%	6,142.71	108%	6,837.56	129%
Alternative 13: Charette Team 6	520.22	4,890.24	80%	5,813.38	102%	6,604.81	125%
Alternative 14: Charette Team 5	404.66	4,778.38	78%	5,612.23	99%	6,264.30	118%
Alternative 15: Charette Team 2	407.04	4,903.43	80%	5,779.55	102%	6,451.52	122%
Alternative 16: Side Channels Only	339.45	4,322.38	71%	5,089.19	89%	5,692.42	108%
Alternative 17: Charette Team 7	236.88	2,680.35	44%	3,175.15	56%	3,546.17	67%
Alternative 18: Comprehensive Pockets	285.38	2,776.59	45%	3,314.47	58%	3,732.36	71%
Alternative 19: Taylor Yard	101.76	1,089.14	18%	1,304.53	23%	1,443.34	27%

*Net Benefits = With Project Value – Without Project Value

** acreage values represent acres experiencing a change in habitat value, and are not necessarily consistent with total project acreage

*** % increase in HUs over the without project condition

during formulation. The determination of cost effectiveness is only made with detailed economic analysis. With the recombinations, therefore, the most cost effective ideas from each of the original 19 alternatives are combined into various new cost effective alternative plans. The final array of 4 of these new plans was chosen to be carried forward for further analysis in the Feasibility Study. The final array of 4 alternatives is described in detail in Section 4.14 of the Main Feasibility Report.

For additional detail on the CE/ICA analysis and the recombined cost effective alternative plans, see the Economic Appendix B in the Main Feasibility Report. For additional detail on the choice of alternative plans for the Final Array, see Section 4 of the Main Feasibility Report.

7.0 OTHER BENEFITS NOT CAPTURED IN CHAP

7.1 CONNECTIVITY

The CHAP analysis accounts for benefits provided by restored ecosystem functions, habitats, and species. There are, however, other types of benefits afforded by the restoration alternatives, including restoration of a more natural hydrologic regime, that influence and support restoration of biological systems. Restoration of movement corridors for wildlife is another benefit of restoration. Both hydrologic and wildlife connectivity has been lost since urbanization of the Study area and the channelization of the LA River in the early 20th century.

These benefits were considered in addition to the CHAP benefits to evaluate and compare the final array of alternatives, as described in Section 6.6 of the Main Feasibility Report.

7.1.1 Hydrologic and Hydraulic Connectivity - Reconnection of River to Floodplain

Hydrologic connections may be made naturally, by widening the river channel, removing artificial barriers, and allowing the river to naturally meander and reshape the adjacent floodplain area. Natural connections also support natural ecological processes such as exchange of sediment, nutrients, and energy between the river and floodplain. Connections may also be made artificially to support habitat, using river water to feed overbank sites via pipes, culverts, or pumps. Artificial connections are valuable to establish habitat, but are less capable of supporting other ecosystem processes and exchanges.

Maintaining ecological and evolutionary processes includes natural disturbance regimes, hydrologic processes, nutrient recycling and biotic interactions (EPA 1999). This benefit can only be achieved with reconnection of the river to its floodplain. This will protect the integrity of the ecosystem and increase sustainability. Biogeochemical interactions between the river and terrestrial sources are not as vital to riparian systems as overbank flow from floodplain connections (Hein 2003).

Floodplain connectivity also benefits restoration of fish habitat. Floodplain habitats provide critical spawning and rearing habitats for many large-river fishes. The standard that floodplains are essential habitats is often a key reason for restoring altered rivers to natural flow regimes (Burgess 2012).

Removal of concrete and widening restores ecosystem processes such as natural disturbance, a

more natural hydrologic regime, nutrient cycling, biotic interactions, population dynamics, and evolution, which determine the species composition, habitat structure, and ecological health of an ecosystem (EPA 1999). Channel widening would allow the river to connect to the overbank, which restores a dynamic floodplain and supports diverse riparian and in stream habitat for plants and wildlife.

7.1.2 Wildlife Connectivity

River channels in arid and semi-arid regions provide important wildlife movement corridors because they support continuous chains of vegetation that wildlife can use for cover and food (which may not be supported in drier upland habitats). These river corridors naturally guide wildlife movement, both daily and generationally, which is essential to species survival (Levick et al. 2008).

The remaining fragments of habitat in the urban landscape (or habitat "nodes") benefit the integrity of the larger ecosystem by supporting metapopulations (assemblages of local populations connected by migration) (Hanski & Gilpin 1991). By increasing patches and reducing the distances between them, colonization among populations improves (Hanski & Thomas 1994). Metapopulations depend on seed dispersal and wildlife movements to persist, and such dispersal is in turn dependent on the connectivity of the landscape (Schippers et al 1996).

Nodes may be larger or smaller. Large habitat nodes support colonization of wildlife in the smaller nodes, while smaller nodes act as peripheral refuge habitat (Rudd et al. 2002). Large nodes tend to have high biodiversity and provide important breeding and seeding habitat for interior species, as well as edge species and transients. Smaller nodes are partly or entirely dependent on individuals immigrating from the larger nodes as they have a higher rate of extinction and therefore need to be repopulated constantly (Hansson 1991; van Apeldoorn et al. 1992). Smaller nodes (those under 250 acres) may not be able to support large numbers of species on their own but are able to provide important peripheral habitat to species in the larger nodes (Hansson 1991).

Generally, nodes have a greater overall interaction when they are larger and closer together (Linehan et al 1995). Well connected systems prevent inbreeding depression and disease, and have a lower extinction rate as populations can more easily colonize if they are highly connected (Noss 1983; Schippers et al 1996). Without connections between habitat areas, isolation and loss of genetic diversity is imminent (Hobbs & Saunders 1990).

In order to benefit the biological integrity of a landscape, corridors should be restored to allow for dispersal between habitat areas. More corridors equal more routes to suitable habitat, creating more opportunities for dispersal. A complex network of nodes and corridors is therefore critical to restoration in an urban environment, as suitable habitat often remains unused if isolated (Hanski & Thomas 1994).

Restoring connectivity for wildlife and movement between patches of habitat provides several benefits including reconnecting genetically isolated populations of species and preventing inbreeding depression, providing necessary interactions between predators and prey to control

population size and providing a healthy ecosystem balance, and connecting individual wildlife to required resources that may not be present within one isolated area.

7.2 ECONOMIC

Other benefits include installation of recreational features and regional economic development (RED) benefits. RED benefits may include increases in employment and regional income/gross regional product (GRP) resulting from the project. Benefits may also include other social effects that have value that were not explicitly valued in monetary terms, such as increases in "community cohesion" or carbon offsets from the installation of carbon sequestering vegetation.

These benefits are accounted for in the narrative of the Main Feasibility Report in Section 6.6.

8.0 CHAP HABITAT EVALUATION TEAM

8.1 PARTICIPANTS

The CHAP Habitat Evaluation Team consisted of the following representatives from the USACE environmental and plan formulation branches, City of Los Angeles Bureau of Engineering (BOE), Northwest Habitat Institute (NHI), U.S. Fish and Wildlife Service (USFWS), Regional Water Quality Control Board (RWQCB), California Department of Fish and Game (CDFG), and U.C. Cooperative Extension. The CHAP analysis team members based their evaluation on expertise in local ecology, plants and wildlife, study objectives, and field visits to the project site. The team members are listed below:

- Erin Jones, Biologist, U.S. Army Corps of Engineers, Planning Division
- Kathleen Bergmann, Study Manager, U.S. Army Corps of Engineers, Planning Division
- Larry Hsu, City of Los Angeles, formerly Bureau of Engineering
- Tom O'Neil, Northwest Habitat Institute
- Andy Hackethorn, Northwest Habitat Institute
- Scott Estergard, Tetra Tech
- Peter Beck, U.S. Fish and Wildlife Service
- Shirley Birosik, Regional Water Quality Control Board, Los Angeles Region
- Scott Harris, California Department of Fish and Game
- Sabrina Drill, U.C. Cooperative Extension, Los Angeles County

8.2 MEETINGS

Habitat evaluation team meetings were held at the Corps' Los Angeles District Office to discuss baseline existing conditions, baseline future without project conditions, and future with project conditions. Meetings were held on January 7, 2010; April 21, 2010; and November 3, 2011.

9.0 CONCLUSION

The CHAP analysis is a habitat assessment tool that evaluates habitats, functions, and species to quantify habitat value. For the LA River ER Feasibility Study, CHAP was used to quantify the value, or benefits, of various restoration alternatives in terms of Habitat Units (HUs) in order to

compare alternative plans. Habitat value was calculated for baseline conditions including the future without project conditions at 25 and 50 years into the future. Habitat value was also calculated for the 19 restoration alternatives developed during the plan formulation process.

The benefits of each restoration alternative were used with project costs to inform the economic cost effectiveness and incremental cost analysis. This analysis recombined the 8 reaches among the 19 alternatives, resulting in an array of new cost effective alternative plans. The final array of 4 of these new plans was chosen to be carried forward for further analysis in the Feasibility Study.

Additional benefits not captured in CHAP were used to evaluate and compare the final array of alternatives. These benefits include hydrologic connectivity to support biotic and abiotic functions, and nodal connectivity to support wildlife movement and dispersal. An assessment of these benefits is applied outside of the CHAP analysis as part of the environmental impact analysis.

10.0 REFERENCES

Ashley, P. 2010. *LA River CHAP Verification Transect Report.* April 11, 15 pp.

Becker, S. and Sweet, A. *Crosswalk Between WHR and California Vegetation Classifications.* Available as PDF at http://www.dfg.ca.gov/biogeodata/cwhr/wildlife_habitats.asp

Breaux, A., S. Cochrane, J. Evens, M. Martindale, B. Pavlik, L. Suer, and D. Benner. 2005. *Wetland ecological and compliance assessments in the San Francisco Bay Region, California, USA.* Journal of Environmental Management, 74:217-237.

Burgess, O.T, W.E. Pine III, S.J. Walsh. 2012. *Importance of Floodplain Connectivity to Fish Populations in the Apalachicola River, Florida.* Article first published online: 9 MAR 2012, DOI: 10.1002/rra.2567, John Wiley & Sons, Ltd.

City of Los Angeles, Department of Public Works, Bureau of Engineering. 2007. *Los Angeles River Revitalization Master Plan.*

Cooper, D. and P. Mathewson. 2008. *Griffith Park Wildlife Management Plan –Draft. For City of Los Angeles.* Cooper Ecological Monitoring, Inc. Los Angeles, CA pp.88

Dwire, Kathleen A., and J. Boone Kauffman, 2003. *Fire and riparian ecosystems in landscapes of the western USA.* In: Young, Michael K.; Gresswell, Robert E.; Luce, Charles H., guest eds. Selected papers from an international symposium on effects of wildland fire on aquatic ecosystems in the western USA; 2002 April 22-24; Boise, ID. In: Forest Ecology and Management. Special Issue: The effects of wildland fire on aquatic ecosystems in the western USA. New York: Elsevier Science B. V; 178(1-2): 61-74. [44923]

Friends of the Los Angeles River. 2008. *State of the River – The Fish Study.* Los Angeles, CA. pp. 38.

Garrett, K. 1993. *The biota of the Los Angeles River ~ an overview of the historical and present plant and animal life of the Los Angeles River drainage.* Natural History Museum of Los Angeles County Foundation. For California Dept. of Fish and Game, contract no. FG 0541. March. pp. 352.

Gumprecht, B. 2001. *The Los Angeles River: Its Life, Death, and Possible Rebirth.* Johns Hopkins University Press. 369 pp.

Hanski, I., and M. Gilpin. 1991. *Metapopulation dynamics: brief history and conceptual domain.* Biological Journal of the Linnean Society 42: 3–16.

Hanski, I., and C. D. Thomas. 1994. *Metapopulation dynamics and conservation: a spatially explicit model applied to butterflies.* Biological Conservation 68: 167–180.

Hansson, L. 1991. *Dispersal and connectivity in metapopulations.* Biological Journal of the Linnean Society 42: 89–103.

Hein, T., Baranyi, C., Herndl, G. J., Wanek, W., & Schiemer, F. 2003. *Allochthonous and autochthonous particulate organic matter in floodplains of the River Danube: the importance of hydrological connectivity.* Freshwater Biology, 48(2), 220-232.

Hobbs, R. J., and D. A. Saunders. 1990. *Nature conservation: the role of corridors.* Ambio 19: 94–95.

Holland, R.F. 1986. *Preliminary Descriptions of the Terrestrial Natural Communities of California.* California Department of Fish and Game. October.

Johnson, D. H., and T.A. O'Neil, (managing directors). 2001. *Wildlife-Habitat Relationships in Oregon and Washington.* Oregon State University Press, Corvallis, OR. pp. 736

Levick, L., J. Fonseca, D. Goodrich, M. Hernandez, D. Semmens, J. Stromberg, R. Leidy, M. Scianni, D. P. Guertin, M. Tluczek, and W. Kepner. 2008. *The Ecological and Hydrological Significance of Ephemeral and Intermittent Streams in the Arid and Semi-arid American Southwest.* U.S. Environmental Protection Agency and USDA/ARS Southwest Watershed Research Center, EPA/600/R-08/134, ARS/233046, 116 pp.

Linehan, J., M. Gross, and J. Finn. 1995. *Greenway planning: developing a landscape ecological network approach.* Landscape and Urban Planning 33: 179–193

Mayer, K.E. and Laudenslayer, W.F. 1988. *A Guide to Wildlife Habitats of California.* State of California, Resources Agency, Department of Fish and Game. Sacramento, CA. 166 pp.

Northwest Habitat Institute (NHI). 2007. *HAB Primer: An Introduction to the Habitat Appraisal and barter (HAB) Method for Fish & Wildlife Habitat Assessment.* March 21.

Noss, R. F. 1983. *A regional landscape approach to maintain diversity.* BioScience 33: 700–706.

O'Neil, T., 2005. *A multi-value habitat evaluation procedure for fish and wildlife.* Northwestern Naturalist, 86(2): 111.

O'Neil, T., B.G. Marcot, and P. Paquet. 2005. *The habitat-species-function triad: a planning framework for ecoprovinces and subbasins.* Northwestern Naturalist, 86(2): 111.

Perkins, J.P. 2002. *Like a cool drink of water.* Conservation Biology, 16(3):852-853. June.

Rudd, H., J. Vala, and V. Schaefer. 2002. *Importance of Backyard Habitat in a Comprehensive Biodiversity Conservation Strategy: A Connectivity Analysis of Urban Green Spaces.* Restoration Ecology, 10(2): 368-375.

Sawyer, J.O., Keeler-Wolf, T., Evens, J.M. 2009. *A Manual of California Vegetation, 2nd Edition*. California Native Plant Society Press. Sacramento, California.

Schippers, P., J. Verboom, J. P. Knaapen, and R. C. van Apeldoorn. 1996. *Dispersal and habitat connectivity in complex heterogeneous landscapes: an analysis with a GIS-based random walk model*. Ecography 19: 97–106.

Store, R., and J. Jokimäki. 2003. *A GIS-based multi-scale approach to habitat suitability modeling*. Ecological Modelling, 169:1-15.

Toppozada, T.R. and D. Branum. 2002. *California $M \geq 5.5$ earthquakes, history and areas damaged*. in International Handbook of Earthquake and Engineering Seismology, edited by W.H. LEE, H. KANAMORI and P. JENNINGS (International Association of Seismology and Physics of the Earth's Interior). February 1, 2012

U.S. Army Corps of Engineers (USACE). 1996. *Planning Manual*. Water Resources Support Center, Institute for Water Resources. IWR Report 96-R-21. Charles E. Yoe, Ph.D. and Kenneth D. Orth. November.

USACE. 1999. *Pamphlet No. 1165-2-502 30 September 1999, Water Resources Policies and Authorities Ecosystem Restoration Supporting Policy Information.*

USACE. 2000. *Planning Guidance Notebook Engineering Regulation (ER) 1105-2-100*. April 22.

USACE. 2007. *Draft Integrated Future Without Project Conditions and Baseline Environmental Conditions Report, Los Angeles River - ER Feasibility Study*. November, pp.154.

U.S. Environmental Protection Agency (EPA). 1999. Considering Ecological Processes in Environmental Impact Assessments. Office of Federal Activities. July.

U.S. Forest Service (USFS). 2009. *Vegetation Descriptions: South Coast and Montane Ecological Province, CALVEG Zone 7*. March 30. Available at: http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsbdev3_045405.pdf

van Apeldoorn, R. C., W. T. Oostenbrink, A. van Winden, and F. F. van der Zee. 1992. *Effects of habitat fragmentation on the bank vole, Clethrionomys glareolus, in an agricultural landscape*. Oikos 65: 265–274.

CHAP Appendix
Appendix A
Master List Key Environmental Correlates (KECs)

KEC #	KEC Name	KEC Definition
1.1.1	down wood	Includes downed logs, branches, and rootwads, in a forested context.
1.1.1.1	decay class	System by which down wood is classified based on its deterioration.
1.1.1.1.1	hard [class 1,2]	Little wood decay evident; bark and branches present; log resting on branches, not fully in contact with ground; includes classes 1 and 2 as described in Thomas (1979).
1.1.1.1.2	moderate [class 3]	Moderate decay present; some branches and bark missing or loose; most of log in contact with ground; includes class 3 as describedin Thomas (1979).
1.1.1.1.3	soft [class 4, 5]	Well decayed logs; bark and branches missing; fully in contact with ground; includes classes 4 and 5 as described in Thomas (1979).
1.1.1.2	down wood in riparian areas	Includes down wood in the terrestrial portion of riparion zones in forest habitats. Does not refer to in-stream woody debris.
1.1.1.3	down wood in upland areas	Includes downed wood in upland areas of forest habitats.
1.1.1.4	size of down wood	Count all down wood >/= 6 feet long.
1.1.1.4.1	small	</= 5 inches large end diameter
1.1.1.4.2	medium	>5 to <20 inches large end diameter
1.1.1.4.3	large	>/= 20 inches large end diameter
1.1.2	litter	The upper layer of loose, oreganic (primarily vegetative) debris on the forest floor. Decomposition may have begun, but components still recognizable.
1.1.3	duff	The matted layer of organic debris beneath the litter layer. Decomposition more advanced than in litter layer; intergrades with uppermost humus layer of soil.
1.1.4	shrub layer	Refers to the shrub strata within forest stands.
1.1.4.1	shrub size	Refers to shrub height. Select all categories present within the map unit.
1.1.4.1.1	small shrubs	< 20 inches
1.1.4.1.2	medium shrubs	20 inches - 6.5 feet
1.1.4.1.3	large shrubs	6.6 feet - 16.5 feet
1.1.4.2	percent shrub canopy cover	Percent of ground covered by vertical projection of shrub crown diamter.
1.1.4.3	shrub canopy layers	Within a shrub community, differences in shrub height and growth-form produce multi-layered shrub canopies in the forest understory.
1.1.5	moss	Large group of nonvascular green plants without flowers but with small leafy stems growing in clumps.
1.1.6	flowers	A modified plant branch for the production of seeds and bearing leaves specialized into floral organs.
1.1.7	lichens	Any of a various complex of lower plants made up of an alga and a fungus growing as a unit on a solid surface.
1.1.8	forbs	Borad-leaved herbaceous plants. Does not include: grasses, sedges or rushes.
1.1.9	cactus	Any of a large group of drought-resistant plants with fleshy, ususally jointed stems and leaves replaced by scales or prickles.
1.1.10	fungi	Mushrooms, molds, yeasts, rusts, etc.
1.1.11	roots, tubers, underground plant parts	Any underground part of a plant that functions in nutrient absorbtion, aeration, storage, reproduction and/or anchorage.
1.1.12	ferns	Any of a group of flowerless, seedless vascular green plants.
1.1.13	herbaceous layer	Understory non-woody vegetation layer beneath shrub layer (forest context). May include forbs, grasses, and ferns.
1.1.14	trees	Includes both coniferous and hardwood species.
1.1.14.1	snags	Standing dead trees.
1.1.14.1.1	decay class	System by which snags are classified based on their deterioration.
1.1.14.1.1.1	hard [class 1, 2]	Little wood decay evident; bark, branches, top, present; recently dead; includes class 1 as described in Brown
1.1.14.1.1.2	moderate [class 3]	Moderately decayed wood; some branches and bark missing and/or loose; top broken; includes classes 2 and 3 as describe din Brown (1985).
1.1.14.1.1.3	soft [class 4, 5]	Well-decayed wood; bark and branches generally absent; top broken; includes classes 4 and 5 as described in Brown (1985).
1.1.14.2	snag size (dbh)	Measured in diameter at breast height (dbh), the standard measurement for standing trees taken at 4.5 feet above the ground.
1.1.14.2.1	seedling	< 1 inch
1.1.14.2.2	sapling/pole	1 - 9 inches
1.1.14.2.3	small tree	10 - 14 inches
1.1.14.2.4	medium tree	15 - 19 inches
1.1.14.2.5	large tree	20 - 29 inches
1.1.14.2.6	giant tree	>= 30 inches
1.1.14.3	tree size (dbh)	Measured in diameter at breast height (dbh), the standard measurement for standing trees taken at 4.5 feet above the ground.
1.1.14.3.1	seedling	< 1 inch
1.1.14.3.2	sapling/pole	1 - 9 inches
1.1.14.3.3	small tree	10 - 14 inches
1.1.14.3.4	medium tree	15 - 19 inches
1.1.14.3.5	large tree	20 - 29 inches
1.1.14.3.6	giant tree	>= 30 inches
1.1.14.4	mistletoe brooms/witches brooms	Dense masses of deformed branches caused by any type of broom-forming parasite (fungal or plant).
1.1.14.5	dead parts of live tree	Portions of live trees with rot; can include broken tops; branches with decay; tree base with rot.
1.1.14.6	hollow living trees (chimney trees)	Tree bole with large hollow chambers.
1.1.14.7	tree cavities	Smaller chamber in a tree; can be in bole, limbs, or forks of live or dead trees. May be excavated or result from decay or damage.
1.1.14.8	bark	Includes crevices/fissures, loose or exfoliating bark.
1.1.14.9	live remnant/legacy trees	A live mature or old-growth tree remaining from the previous stand. Context is remnant trees in recently harvested or burned stands up through young forested stands. See dead parts of live trees, hollow living trees, tree cavities, an bark to see which species benefit from remnant trees with these attributes.
1.1.14.10	large live tree branches	Large branches often growing horizontally out from the tree bole.
1.1.14.11	tree canopy layer	Referes to the strata occupied by tree crowns.
1.1.14.11.1	sub-canopy	The space below the predominant tree crowns.
1.1.14.11.2	above canopy	The space above the predominant tree crowns.
1.1.14.11.3	tree bole	The tree trunk.
1.1.14.11.4	canopy	The more or less continuous cover of branches and foliage formed collectively by the crowns of adjacent trees and other woodly growth.
1.1.15	fruits/seeds/nuts	Plant reproductive bodies that are used by animals.
1.1.16	edges	The place where plant communities meet or where successive stages or vegetative conditions within plant communitites come together; an edge between 2 different habitat types; only record this one time (i.e. don't record for both of the habitat types).

1.2	Shrubland/Grassland Vegetative Elements or Substrates	Biotic components found within a shrubland or grassland context. Positive influences only.
1.2.1	herbaceous layer	Zone of understory non-woody vegetation beneath shrub layer (non-forest context). May include forbs, grasses.
1.2.2	fruits/seeds/nuts	Plant reproductive bodies that are used by animals.
1.2.3	moss	Large group of nonvascular green plants without flowers but with small leafy stems growing in clumps; record moss found in trees, shrubs, etc.; do NOT record moss found on soil surface (this is recorded in KEC 1.2.11).
1.2.4	cactus	Any of a large group of drought-resistant plants with fleshy, usually jointed stems and leaves replaced by scales or prickles.
1.2.5	flowers	A modified plant branch for the production of seeds and bearing leaves specialized into floral organs.
1.2.6	shrubs	Plant with persistent woody stems and less than 16 feet tall; usually produces several basal shoots as opposed to a single bole.
1.2.6.1	shrub size	Refers to height.
1.2.6.1.1	small	< 20 inches
1.2.6.1.2	medium	20 inches - 6.5 feet
1.2.6.1.3	large	6.6 feet - 16.5 feet
1.2.6.2	percent shrub canopy cover	Percent of ground covered by vertical projection of shrub crown diameter.
1.2.6.2.1	<5%	
1.2.6.2.2	21-35%	
1.2.6.2.3	36-50%	
1.2.6.2.4	>50%	
1.2.6.3	shrub canopy layer	Within a shrub community, differences in shrub height and growth form produce multi-layered shrub canopies.
1.2.6.3.1	sub-canopy	The space below the predominant shrub crowns.
1.2.6.3.2	above canopy	The space above the predominant shrub crowns.
1.2.7	fungi	Mushrooms, molds, yeasts, rusts, etc.
1.2.8	forbs	Broad-leaved herbaceous plants. Does not include: grasses, sedges or rushes.
1.2.9	bulbs/tubers	Any underground part of a plant that functions in nutrient absorbtion, aeration, storage, reproduction and/or
1.2.10	grasses	Members of the Poaceae (Graminae) family.
1.2.11	cryptogamic crusts	Non-vascular plants that grow on the soil surface. Primarily lichens, mosses and algae. Often found in arid or semi-arid regions. May form soil surface "pinnacles".
1.2.12	trees (located in a shrubland/grassland context)	Small groups of trees or isolated individuals.
1.2.12.1	snags	Standing dead trees.
1.2.12.1.1	decay class	System by which snags are classified based on their deterioration.
1.2.12.1.1.1	hard	Little wood decay evident; bark, branches, top, present; recently dead; includes class 1 as described in Brown
1.2.12.1.1.2	moderate	Moderately decayed wood; some branches and bark missing and/or loose; top broken; includes classes 2 and 3 as describe din Brown (1985).
1.2.12.1.1.3	soft	Well-decayed wood; bark and branches generally absent; top broken; includes classes 4 and 5 as described in Brown (1985).
1.2.12.2	snag size (dbh)	Measured in diameter at breast height (dbh), the standard measurement for standing trees taken at 4.5 feet above the ground.
1.2.12.2.1	seedling	< 1 inch
1.2.12.2.2	sapling/pole	1 - 9 inches
1.2.12.2.3	small tree	10 - 14 inches
1.2.12.2.4	medium tree	15 - 19 inches
1.2.12.2.5	large tree	20 - 29 inches
1.2.12.2.6	giant tree	>= 30 inches
1.2.12.3	tree size (dbh)	Measured in diameter at breast height (dbh), the standard measurement for standing trees taken at 4.5 feet above the ground.
1.2.12.3.1	seedling	< 1 inch
1.2.12.3.2	sapling/pole	1 - 9 inches
1.2.12.3.3	small tree	10 - 14 inches
1.2.12.3.4	medium tree	15 - 19 inches
1.2.12.3.5	large tree	20 - 29 inches
1.2.12.3.6	giant tree	>= 30 inches
1.2.13	edges	The place where plant communities meet or where successive stages or vegetative conditions within plant communitites come together.
2.0	Influences by Other Organisms	Selected interspecies relationships within the biotic community. Both positive and negative influences.
2.1	exotic species	When checked, these KECs refer to the relationship between an exotic species and the species queried by the user. This relationship may be positive or negative, and the user should refer to the comments section for further information. Exotic species are defined as any non-native plant or animal, including cats, dogs, and cattle.
2.1.1	exotic plants	This field refers to the relationship between an exotic plant species and the animal species queried by the user. This relationship may be positive or negative, and the user should refer to the comments section for further information. If no specific species of interest is known, only check if exotic plant presence is obvious and list the
2.1.2	exotic animals	This field refers to the relationship between an exotic animal species and the animal species queried by the user. This relationship may be positive or negative, and the user should refer to the comments section for further information. If applicable, the user will also find clarification of how the species queried is affected by the exotic species in HE subcategories 2.1.2.1 - 2.1.2.3. If no specific species of interest is known, only check if exotic animal presence is obvious and list the species.
2.1.2.1	predation	The species queried is preyed upon by or preys upon an exotic species. If no specific species of interest is known, only check if exotic animal predation is obvious and list the species.
2.1.2.2	direct displacement	The species queried is physically displaced by an exotic species, either by competition or actual disturbance. If no specific species of interest is known, only check if direct displacement by an exotic animal is obvious and list the species.
2.1.2.3	habitat structure change	The species queried is affected by habitat structural changes caused by an exotic species, for example, cattle grazing. If no specific species of interest is known, only check if habitat structure changes by exotic animals are obvious and list the species.
2.1.2.4	other	Any other effects of an exotic species on a native species (not used by panelists).
2.2	insect population irruptions	The queried species directly benefits from insect population eruptions (i.e., benefits from the insects themselves, not the resulting tree mortality or loss of foliage).
2.2.1	mountain pine beetle	The queried species directly benefits from Mountain Pine Beetle eruptions.
2.2.2	spruce budworm	The queried species directly benefits from Spruce Budworm eruptions.
2.2.3	douglas-fir tussock moth	The queried species directly benefits from Douglas-fir Tussock Moth eruptions (not used by panelists).
2.2.4	other	

2.3	beaver/muskrat activity (dams, lodges, ponds)	The results of beaver activity including dams, lodges, and ponds, that are beneficial to other species.
2.4	burrows (aquatic or terrestrial)	Aquatic or terrestrial cavities produced by burrowing animals that are beneficial to other species.
2.5	pathogens	Fish pathogens
3.0	Non-Vegetative, Abiotic Habitat Elements	Non-living components found within any ecosystem. Primarily positive influences with a few exceptions as indicated.
3.1	rocks	Solid mineral deposits.
3.1.1	gravel	Particle size from 0.1-3.0-inches diameter; gravel bars associated with streams and rivers are a separate category.
3.1.2	talus	Accumulations of rocks at the base of cliffs or steep slopes; rock/boulder sizes varied and determine what species can inhabit the spaces between them.
3.1.3	talus-like habitats	Refers to areas that contain many rocks and boulders but are not associated with cliffs or steep slopes.
3.2	soils	Various soil characteristics.
3.2.1	soil depth	Enter the distance from the top layer of the soil to the bedrock or hardpan below, measured in feet. Note, only complete this field if you are actually sampling soil depth.
3.2.2	soil temperature	Enter the measure of soil temperature or range of temperatures that are key to the queried species, measured in degrees F. Note, only complete this field if you are actually sampling soil temperature.
3.2.3	soil moisture	Enter the amount of water contained within the soil as a percentage. Note, only complete this field if you are actually sampling soil moisture.
3.2.4	soil organic matter	The accumulation of decomposing plant and animal materials found within the soil.
3.2.5	soil texture	Refers to size distribution and amount of mineral particles (sand, silt, and clay) in the soil; examples are sandy clay, sandy loam, silty clay etc.
3.2.6	no correlation	
3.3	rock substrates	Various rock formations.
3.3.1	avalanche chute	An area where periodic snow or rockslides prevent the establishment of forest conditions; typically shrub and herb dominated (Sitka alder and/or vine maple).
3.3.2	cliffs	A high, steep formation, usually of rock. Coastal cliffs are a separate category under Marine Habitat Elements.
3.3.3	caves	An underground chamber open to the surface with varied opening diameters and depths; includes cliff-face caves, intact lava tubes, coastal caves, and mine shafts.
3.3.4	rocky outcrops and ridges	Areas of exposed rock.
3.3.5	rock crevices	Refers to the joint spaces in cliffs, and fissures and openings between slab rock; crevices among rocks and boulders in talus fields are a separate category (talus).
3.3.6	barren ground	Bare exposed soil with >40% of area not vegetated; includes mineral licks and bare agricultural fields; natural bare exposed rock is under the rocky outcrop category.
3.3.7	playa (alkaline, saline)	Shallow desert basins without natural drainage-ways where water accumulates and evaporates seasonally.
3.3.8	no correlation	
3.4	snow	Selected features of snow. Can be negative or positive.
3.4.1	snow depth	Any measure of the distance between the top layer of snow and the ground below.
3.4.2	glaciers, snow field	Areas of permanent snow and ice.
3.5	insect fall	The accumulation of dead insects in an aquatic environment. Note: complete this field only for aquatic map units.
3.6	litter fall	The accumulation of dead plant material in an aquatic water environment. Note: complete this field only for aquatic map units.
3.7	precipitation	Accumulation of rainfall and/or snowfall in an aquatic environment. Note: complete this field only for aquatic map
3.8	wind stress	Effects of wind on the turbidity and movement of hydrologic forces. Can influence fish through upwelling of nutrients and mortality of young in turbulent waters. Note: complete this field only for aquatic map units.
4.0	Freshwater Riparian & Aquatic Bodies Habitat Elements	Includes selected forms and characteristics of any body of freshwater.
4.1	Water Characteristics	Various freshwater attributes. Ranges of continuous attributes that are key to the queried species, if known, will be in the comments.
4.1.1	dissolved oxygen	The amount of oxygen passed into solution. Note, only complete this field if you are actually sampling for DO.
4.1.2	water depth	Enter the distance from the surface of the water to the bottom substrate.
4.1.3	dissolved solids	A measure of dissolved minerals in water. Note, only complete this field if you are actually sampling for dissolved
4.1.4	water pH	A measure of water acidity or alkalinity. Note, only complete this field if you are actually sampling for pH.
4.1.5	water temperature	Water temperature range that is key to the queried species, if known, is in the comments field. Note, only complete this field if you are actually sampling water temperature.
4.1.6	water velocity	The speed or momentum of water flow. Note, only complete this field if you are actually sampling water velocity.
4.1.7	water turbidity	Refers to the amount of roiled sediment within the water and the resulting clarity of the water. Note, only complete this field if you are actually sampling for turbidity.
4.1.8	free water (derived from any source)	Water derived from any source
4.1.9	salinity and alkalinity	The presence of salts.
4.1.10	icing in inland rivers and streams (scouring action)	Freezing of water columns and benthic substrate; especially important to fish and invertebrates in small and headwater stream and rivers that may freeze solid. Substrate scouring comes during spring runoff.
4.1.11	metals in water column	A measure of metals present in water.
4.1.12	nutrient enrichment	Enrichment of the water column with nutrients (i.e., decaying salmon carcasses)
4.2	Rivers & Streams	Various characteristics of streams and rivers.
4.2.1	oxbows	A pond or wetland created when a river bend is cut off from the main channel of the river.
4.2.2	order and class	Systems of stream classification.
4.2.2.1	intermittent	Streams/rivers, which contain non-tidal flowing water for only part of the year, water may remain in isolated pools.
4.2.2.2	upper perennial	Streams/rivers with a high gradient, fast water velocity, no tidal influence, some water flowing throughout the year, substrate consists of rock, cobbles, or gravel with occasional patches of sand, little floodplain development.
4.2.2.3	lower perennial	Streams/rivers with a low gradient, slow water velocity, no tidal influence, some water flowing throughout the year, substrate consists mainly of sand and mud, floodplain is well developed.
4.2.3	zone	System of water body classification based on the horizontal strata of the water column.
4.2.3.1	open water	Open water areas not closely associated with the shoreline or bottom.
4.2.3.2	submerged/benthic	Relating to the bottom of a body of water, includes the substrate and the overlaying body of water within one meter of the substrate.
4.2.3.3	shoreline	Continually exposed substrate that is subject to splash, waves, and/or periodic flooding. Includes gravel bars, islands, and immediate nearshore areas.
4.2.4	in-stream substrate	The bottom materials in a body of water.
4.2.4.1	boulders	Rocks (Boulders) > 256 mm (10") in diameter.
4.2.4.2	cobble/gravel	Rocks or pebbles, 4-256 mm in diameter (10"), substrata may consist of cobbles, gravel, shell, and sand with no one substratum type exceeding 70 percent cover.
4.2.4.3	sand/mud	Fine substrata < 4 mm in diameter, little gravel present, may be mixed with organics.
4.2.4.4	bedrock	Reflects bedrock as a substrate in aquatic environs (e.g., stream, river, lake).
4.2.4.5	aquatic bentic structure	Embeddedness, interstitial space

4.2.5	vegetation	Herbaceous plants
4.2.5.1	submergent vegetation	Rooted aquatic plants that do not emerge above the water surface.
4.2.5.2	emergent vegetation	Rooted aquatic plants that emerge above the water surface.
4.2.5.3	floating mats	Unrooted plants that form vegetative masses on the surface of the water.
4.2.6	coarse woody debris in streams and rivers	Any piece of woody material (debris piles, stumps, root wads, fallen trees) that intrudes into or lies within a river or stream.
4.2.6.1	rootwads	Lower stem and root fan of a dead tree.
4.2.6.2	large woody debris (tree stems)	"Large" is considered stems that are 10 cm (4 in) in diameter or larger, and 2 m (6 ft) in length or longer.
4.2.6.3	small woody debris (branches, twigs,etc.)	"Small" is considered stems that are less than 10 cm (4 in) in diameter.
4.2.7	pools	Portions of the stream with reduced current velocity, often with water deeper than surrounding areas.
4.2.7.1	secondary channel pools	formed by merging-flow scour from secondary channels
4.2.7.2	backwater pools	eddy or slack water along the channel margin separated from the main current by a gravel bar or small channel obstruction.
4.2.7.3	trench pools	long, usually deep slot in a stable substrate (often bedrock).
4.2.7.4	plunge pools	basin scoured by a vertical drop over a channel obstruction.
4.2.7.5	lateral scour pools	scoured basin near the channel margin caused by flow being directed to one side of the stream by a partial channel obstruction.
4.2.7.6	dammed pools	Dammed pools: pool impounded upstream from a complete or nearly complete channel blockage (including beaver ponds).
4.2.8	riffles	Shallow rapids where the water flows swiftly over completely or partially submerged obstructions to produce surface agitation, but where standing waves are absent.
4.2.8.1	low gradient riffles	shallow reach of gradient <4% with moderate current velocity and moderate turbulence.
4.2.8.2	rapids	shallow reach of gradient >4% with high current velocity and considerable turbulence.
4.2.8.3	cascades	series of small steps of alternating small waterfalls and small pools.
4.2.9	runs/glides	Areas of swiftly flowing water, without surface agitation or waves, which approximates uniform flow and in which the slope of the water surface is roughly parallel to the overall gradient of the stream reach.
4.2.10	overhanging vegetation	Herbaceous plants that cascade over stream and riverbanks and are < 1 meter above the water surface.
4.2.11	waterfalls	Steep decent of water within a stream or river.
4.2.12	banks	Rising ground that borders a body of water.
4.2.12.1	undercut banks	Stream or river banks that have been undercut by hydrologic forces resulting in the bank overhanging the water. This feature is critical to many fish species for cover from predation.
4.2.13	seeps or springs	A concentrated flow of ground water issuing from openings in the ground.
4.2.14	channel morphology	the general shape of a channel
4.2.14.1	Channel length	a measure of the length of a reach of stream channel
4.2.14.2	Channel width	a measure of the width of a reach of stream channel
4.2.15	flow	Rate of water flow, typically given in cubic feet per second (ft3/sec)
4.2.15.1	high flow	Change in interannual variability in high flows.
4.2.15.2	low flow	Change in interannual variability in low flows.
4.2.15.3	diel flow	Intra-daily variation in flow level (regulated rivers influenced by sotrm water runoff).
4.2.15.4	intra-annual flow	The average extent of intra-annual flow variation during a month (stream "flashiness").
4.3	ephemeral pools	Pools that contain water for only brief periods of time usually associated with periods of high precipitation.
4.4	sand bars	Exposed areas of sand or mud substrate.
4.5	gravel bars	Exposed areas of gravel substrate.
4.6	Lakes/Ponds/Reservoirs	Various characteristics of lakes, ponds, and reservoirs.
4.6.1	zone	System of water body classification based on the horizontal strata of the water column.
4.6.1.1	open water	Open water areas not closely associated with the shoreline or bottom substrates.
4.6.1.2	submerged/benthic	Relating to the bottom of a body of water, includes the substrate and the overlaying body of water within one meter of the substrate.
4.6.1.3	shoreline	Continually exposed substrate that is subject to splash, waves, and/or periodic flooding. Includes gravel bars, islands, and immediate nearshore areas.
4.6.2	in-water substrate	The bottom materials in a body of water.
4.6.2.1	boulders	Rocks (Boulders) > 256 mm (10 inches) in diameter.
4.6.2.2	cobble/gravel	Rocks or pebbles, 4-256 mm in diameter (10"), substrata may consist of cobbles, gravel, shell, and sand with no one substratum type exceeding 70 percent cover.
4.6.2.3	sand/mud	Fine substrata < 4 mm in diameter, little gravel present, may be mixed with organics.
4.6.3	vegetation	Herbaceous plants.
4.6.3.1	submergent vegetation	Rooted aquatic plants that do not emerge above the water surface.
4.6.3.2	emergent vegetation	Rooted aquatic plants that emerge above the water surface.
4.6.3.2.1	Sedges and rushes	Emergent vegetation characterized by a predominance of sedges and rushes.
4.6.3.3	floating mats	Unrooted plants that form vegetative masses on the surface of the water.
4.6.3.4	Riparian (including woody vegetation)	Emergent vegetation characterized by a predominance of woody vegetation.
4.6.4	size	Refers to whether or not the species is differentially associated with water bodies based on their size.
4.6.4.1	ponds	< 2 ha
4.6.4.2	lakes	>= 2 ha
4.7	Wetlands/Marshes/Wet Meadows/Bogs and Swamps	Various components and characteristics related to any of these systems.
4.7.1	riverine wetlands	Wetlands found in association with rivers.
4.7.2	context	When checked, indicates that the setting of the wetland, marsh, wet meadow, bog or swamp is key to the queried species.
4.7.2.1	forest	Wetlands within a forest.
4.7.2.2	non-forest	Wetlands that are not surrounded by forest.
4.7.3	size	When checked, indicates that the queried species is differentially associated with a wetland, marsh, wet meadow, bog or swamp based on the size of the water body.
4.7.4	marshes	Frequently or continually inundated wetlands characterized by emergent herbaceous vegetation (grasses, sedges, reeds) adapted to saturated soil conditions.
4.7.5	wet meadows	Grasslands with waterlogged soil near the surface but without standing water for most of the year.
4.8	islands	A piece of land made up of either rock and/or unconsolidated material that projects above and is completely surrounded by water.
4.9	seasonal flooding	Flooding that occurs periodically due to precipitation patterns.
4.10	Littoral zone	Area of shallow water where some fish migrate, find protection and find key food resources. Typically regarded as the shoreline (<5m depth) of lakes, reservoirs, and large rivers.
5.0	Marine Habitat Elements	Selected biotic and abiotic components and characteristics of marine systems.
5.1	zone	System of marine classification based on water depth, and relationship to substrate.

5.1.1	supratidal	The zone that extends landward from the higher high water line up to either the top of a coastal cliff or the landward limit of marine process (i.e., storm surge limit).
5.1.2	intertidal	The zone between the higher high water line and the lower low water line.
5.1.3	nearshore subtidal	The zone that extends from the lower low water line seaward to the 20 meter isobath, typically within 1 kilometer of shore i.e.
5.1.4	shelf	The area between the 20 and 200-meter isobath, typically within 60 kilometers of shore.
5.1.5	oceanic	The zone that extends seaward from the 200-meter isobath.
5.2	substrates	The bottom materials in a body of water.
5.2.1	bedrock	The solid rock underlying surface materials.
5.2.2	boulders	Large, worn, rocks > 256 mm (10 inches) in diameter.
5.2.3	hardpan	Consolidated clays forming a substratum firm enough to support an epibenthos and too firm to support a normal infauna (clams, worms, etc.), but with an unstable surface which sloughs frequently.
5.2.4	cobble	Rocks or pebbles, 64-256 mm in diameter, may be a mix of cobbles, gravel, shells, and sand, with no one type exceeding 70 percent cover.
5.2.5	mixed-coarse	Substrata consisting of cobbles, gravel, shell, and sand with no one substratum type exceeding 70 percent cover.
5.2.6	gravel	Small rocks or pebbles, 4-64 mm in diameter.
5.2.7	sand	Fine substrata < 4 mm in diameter, little gravel present, may be mixed with organics.
5.2.8	mixed-fine	Mixture of sand and mud particles < 4 mm in diameter, little gravel present.
5.2.9	mud	Fine substrata < 0.06 mm in diameter, little gravel present, usually mixed with organics.
5.2.10	organic	Substrata composed primarily of organic matter such as wood chips, leaf litter, or other detritus.
5.2.11	clay	Substrata composed primarily of clayey materials.
5.2.12	shell	Substrata composed of mainly marine organism shells.
5.2.13	Artificial substrata (riprap)	Substrata consisting of artificial (man-made) material including riprap.
5.3	energy	Degree of exposure to oceanic swell, currents, and wind waves.
5.3.1	degree of exposure	Measure of how exposed a shoreline is to the hydrologic forces of a large body of water.
5.3.1.1	Protected	No sea swells, little or no current, and restricted wind fetch.
5.3.1.2	Semi protected	Shorelines protected from sea swell, but may receive waves generated by moderate wind fetch, and/or moderate to weak tidal currents.
5.3.1.3	Partially exposed	Oceanic swell attenuated by offshore reefs, islands, or headlands, but shoreline substantially exposed to wind waves, and/or strong to moderated tidal currents.
5.3.1.4	Exposed	Highly exposed to oceanic swell, wind waves, and/or very strong currents.
5.3.2	Sources of energy	Hydrodynamic forces in a marine environment.
5.3.2.1	Upwelling	A process in which cold, often nutrient-rich waters from the ocean depths rise to the surface.
5.3.2.2	Local jets and eddies	strong currents moving in different directions from the main current, often in a circular motion in eddies.
5.3.2.3	Outflow plume	pattern of circulation of one body of water flowing into another.
5.3.2.4	Fresh water inflow	area of flow where a freshwater source meets marine waters.
5.4	vegetation	Includes herbaceous plants and plants lacking vascular systems.
5.4.1	species dominated communities	Species dominated communities
5.4.1.1	mixed macro algae	Includes brown, green, and red algae.
5.4.1.1.1	algal blooms	Quickly growing concentrations of algae that may be harmful to the environment, plants, or animals.
5.4.1.1.2	toxic blooms	High concentrations of cyanobacteria that are highly toxic to plants and animals.
5.4.1.2	kelp	Subaquatic rooted vegetation found in the nearshore marine environment.
5.4.1.3	eelgrass	Subaquatic rooted vegetation found in an estuarine environment
5.4.1.4	pickleweed	A salt loving plant (Salicornia europeae) found in estuarine environments.
5.4.2	vegetation zone	Tidally influenced vegetation zones
5.4.2.1	Low sandy marshes	Occur on sandy substrate with a gradual slope, typically on the low-energy side of bay mouth sand spits or as fringing marshes on islands with coarse-textured sediments. They are flooded by nearly all high tides and drain diffusely (i.e., there are not tidal creeks) over the marsh surface. Near the tidal flat edge, the vegetation is scattered, but becomes continuous up the slope.
5.4.2.2	Low silty marshes	Develop on fine-textured sediments, silt, or mud substrates in low energy parts of esturaries and are relatively flat. These marshes develop in areas of rapid sedimentation and are flooded by nearly all high tides; have diffuse drainage patterns with some defined channels around clumps of plants.
5.4.2.3	Sedge marshes	Form on silt and have a nearly level surface. They are oftenfound on islands or delta edges with elevations somewhat above the first two marsh types. They are flooded by most high tides and drain via creeks in the higher sedge marshes and diffusely in the lower ones.
5.4.2.4	Immature high marshes	Relatively level with some bare depressions and are located on silty substrates. Organic matter accumulation is abundant here as it is in sedge wetlands. Immature high marshes occur above sedge and low sandy marshes, ususally at least 40 cm above the tidal flat; often the transition is an abrupt rise. Many of the high tides (especially the higher highs) cover the soil surface. A well-defined system of channels drain and flood these marshes.
5.4.2.5	Mature high marshes	They are level and have developed extensive peaty soils. A dendritic network of steep-sided stream channels circulates water to the soil surface on higher high tides. Shallow saline pools produce openings in the otherwise continuous sward of vegetation. Salinities fluctuate widely and depend on rainfall, tidal input, and evaporation.
5.4.2.6	Bulrush and sedge marshes	Low marshes in brackish parts of the estuary. The substrate is silt or sand, and inundation occurs with most high tides. Drainage is diffuse; vegetation is continuous and its composition is dependent on the salinity.
5.4.2.7	Intertidal gravel marshes	Rare forms; develop on sand and gravel bars near the mouths of relatively high-energy estuaries with large volumes of freshwater. Vegetation is discontinous and of a type which indicates low salinities. The salt from the tidal water is probably leached by rainwater and freshwater runoff through the coarse substrates.
5.4.2.8	Diked salt marshes	Manmade habitats that develop when the tides are excluded from immature and mature high marshes. Althouugh non-salt marsh plants may invade, the area retains some wetland characteristics due to seepage, high water tables, and perhaps residual salinity. Vegetation is continuous over the marsh surface and the old dendritic stream channels system has collapsed.
5.4.2.9	Riparian zone (freshwater influenced)	Reflects the terrestrial vegetation community immediately alongside marine, estuarine, lagoon, and inlet water environs. This area contributes nutrients, insects (i.e., "insect rains"), minerals, vegetation, soil, and woody stems directly to marine/estuarine systems.
5.4.2.9.1	coniferous	Riparian vegetation community dominated by coniferous forests.
5.4.2.9.2	deciduous	Riparian vegetation community dominated by deciduous forests.
5.4.2.9.3	mixed coniferous/deciduous	Riparian vegetation community dominated by a mixture of coniferous and deciduous forests.
5.4.2.9.4	sedges	Riparian vegetation community dominated by sedges.
5.4.2.9.5	forbs	Riparian vegetation community dominated by forbs.
5.5	water depth	Refers to the vertical layering of the water column.
5.5.1	surface layer	The uppermost part of the water column.
5.5.1.1	fronts (e.g. tide rips, and confluence zones)	A current of water disturbed by an opposing current, especially in tidal water or by passage over an irregular bottom.
5.5.1.2	surface microlayer (neuston)	The thin uppermost layer of the water's surface.

5.5.2	euphotic	Upper layer of a water body that receives sufficient sunlight for the photosynthesis of plants.
5.5.3	disphotic	Area below the euphotic zone where photosynthesis ceases.
5.5.4	demersal/benthic	Submerged lands including vegetated and unvegetated areas.
5.6	water temperature	Measure of ocean water temperature.
5.7	salinity zone	The presence and concentration of salts; salinity range that is key to the species, if it is known, will be in the comments field. Positive or negative influences.
5.7.1	tidal fresh	Tidal freshwater
5.7.2	mixing	Area with recurrent mixing of freshwater and seawater; brackish waters.
5.7.3	seawter	Highly saline water from marine waters.
5.8	forms	Morphological elements within marine areas.
5.8.1	beach	An accumulation of unconsolidated material (sand, gravel, angular fragments) formed by waves and wave-induced currents in the intertidal and subtidal zones.
5.8.2	off-shore islands/rocks/sea stacks/off-shore cliffs	A piece of land made up of either rock and/or unconsolidated material that projects above and is completely surrounded by water at higher high water for large (spring) tide. Includes off-shore marine cliffs.
5.8.3	marine cliffs (mainland)	A sloping face steeper than 20 degrees usually formed by erosional processes and composed of either bedrock and/or unconsolidated materials.
5.8.4	delta	Accumulations of sand, silt, and gravel deposited at the mouth of a stream where it discharges into the sea.
5.8.5	dune	In a marine context; a mound or ridge formed by the transportation and deposition of wind-blown material (sand and occasionally silt).
5.8.6	lagoon	Shallow depression within the shore zone continuously occupied by salt or brackish water lying roughly parallel to the shoreline and separated from the open sea by a barrier.
5.8.7	salt marsh	A coastal wetland area which is periodically inundated by tidal brackish or salt water and which supports significant (15% cover) non-woody vascular vegetation (e.g., grasses, rushes, sedges) for at least part of the year.
5.8.8	reef	A rock outcrop, detached from the shore, with maximum elevations below the high-water line.
5.8.9	tidal flat	A level or gently sloping (less than 5 degrees) constructional surface exposed at low tide, usually consisting primarily of sand or mud with or without detritus, and resulting from tidal processes.
5.8.10	tide pools	Pools of water left behind after tides recede.
5.8.11	high tide current channels	Channels formed by the moment of water at high tides.
5.8.12	complex dendritic channel morphology	Dendritic channel complexity reflects the extensive dissection of the inter-tidal environment; the many naturally-deepened aquatic channels offer important structures providing food and refuge environs (even short-term) for estuarine and marine fishes
5.8.13	spit berms	Berms of sand that are formed on spits due to wave action.
5.8.14	underwater channels	Channels formed by the movement of water, such as at a river or stream mouth on a larger body of water, that are permanently underwater.
5.9	water clarity	As influenced by sediment load.
6.0	No Data	
7.0	Fire as a Habitat Element	Fire can influence species in a positive or negative way.
8.0	Anthropogenic Disturbances and Elements	Anthropogenic - Related Habitat Elements: This section contains selected examples of human-related Habitat Elements that may be a key part of the environment for many species. These HE's may have either a negative or positive influence on the queried species.
8.1	campgrounds/picnic areas	Sites developed and maintained for camping and picnicking.
8.2	roads	Roads that are either paved or unpaved.
8.2.1	paved	Roads that are paved with asphalt or concrete.
8.2.2	un-paved	Roads or trails that are not paved (i.e., gravel or dirt roads).
8.3	buildings	Permanent structures.
8.4	bridges	Permanent structures typically over water or ravines.
8.5	diseases transmitted by domestic animals	Some domestic animal diseases may be a source of mortality or reduced vigor for wild species.
8.6	harvest/persecution (of animals)	Includes illegal harvest/poaching, incidental take (resulting from fishing net by-catch, or by hay mowing, for example), and targeted removal for pest control.
8.7	fences/corrals	Wood, barbed wire, or electric fences.
8.8	supplemental food	Food deliberately provided for wildlife (e.g. bird feeders, ungulate feeding programs, etc.) as well as spilled or waste grain along railroads and cattle feedlots.
8.9	refuse (includes landfills)	Any source of human-derived garbage (includes landfills).
8.10	supplemental boxes, structures and platforms	Includes birdhouses, bat boxes, raptor and waterfowl nesting platforms.
8.11	guzzlers and waterholes	Water sources typically built for domestic animal use.
8.12	toxic chemical use	Proper use of regulated chemicals; documented effects only.
8.12.1	herbicides/fungicides	Chemicals used to kill vegetation and fungi.
8.12.2	insecticides	Chemicals used to kill insects.
8.12.3	pesticides	Chemicals used to kill vertebrate species.
8.12.4	fertilizers	Chemicals used to enhance vegetative growth.
8.12.5	fire fighting chemicals	Chemicals used to suppress fire.
8.13	hedgerows/windbreaks	Woody and/or shrubby vegetation either planted or that develops naturally along fence lines and field borders.
8.14	sewage treatment plant	Settling ponds associated with sewage treatment plants.
8.15	repellents	Various methods purposely used against wildlife species that damage crops or property (excluding pesticides and insecticides)..
8.15.1	chemical (taste or smell)	Chemical substances that repel wildlife.
8.15.2	noise or visual disturbance	Non-chemical methods to deter wildlife.
8.16	culverts	Drain crossings under roads or railroads.
8.17	irrigation ditches/canals	Ditches built to transport water to agricultural crops or to handle runoff.
8.18	powerlines/corridors	Utility lines, poles, and rights-of-way associated with transmission, telephone, and gas lines.
8.19	pollution	Human-caused environmental contamination.
8.19.1	chemical	Contamination caused by chemicals.
8.19.2	sewage	Contamination caused by human waste.
8.19.3	water	Aquatic contamination from any source.
8.20	piers	A structure built out over water.
8.21	mooring piles, dolphins, buoys	Floating objects anchored out in the water for nautical purposes.
8.22	bulkheads, seawalls, revetment	Retaining structures built to protect the shoreline from wave action.
8.23	jetties, groins, breakwaters	Structures built to influence the current or protect harbors.
8.24	water diversion structures	Structures built to funnel or direct water, including dams, dikes and levies.
8.25	log boom	A raft of logs lashed together either to transport the logs or as barriers to boat traffic near marinas or dams.
8.26	boats/ships	Watercraft, either motorized or non-motorized.
8.27	dredge spoil islands	Sediment deposited from dredging operations.

8.28	hatchery facilities and fish	Fish that are hatched in captivity and later released into the wild. For simplicity this refers to freshwater areas, though marine birds and mammals likely feed on hatchery-released fish too.
8.29	hydrologic regime - regulated (river)	Rivers that are altered and controlled by human activities.
8.30	obstructions (to fish passage)	Obstructions or blockages to fish passage (e.g., poorly situated culverts; fences; piers; warm thermal pulses).
8.31	weirs	A fence or wattle placed in a stream to catch or retain fish.
8.32	other	Any other anthropogenic-related habitat elements not described by KECs 8.1-8.31)

CHAP Appendix
Appendix B
Master List Key Ecological Functions (KEFs)

SHP-KEF	KEFDescription
~	added by fish review
1	Trophic relationships
1.1	heterotrophic consumer
1.1.1	primary consumer (herbivore) (also see below under Herbivory)
1.1.1.1	foliovore (leaf-eater)
1.1.1.2	spermivore (seed-eater)
1.1.1.3	browser (leaf, stem eater)
1.1.1.4	grazer (grass, forb eater)
1.1.1.5	frugivore (fruit-eater)
1.1.1.6	sap feeder
1.1.1.7	root feeders
1.1.1.8	nectivore (nectar feeder)
1.1.1.9	fungivore (fungus feeder)
1.1.1.10	flower/bud/catkin feeder
1.1.1.11	aquatic herbivore
1.1.1.12	feeds in water on decomposing benthic substrate
1.1.1.13	bark/cambium/bole feeder
1.1.1.14	periphyton eater (including algae) ~
1.1.1.15	phytoplankton eater (including algae) ~
1.1.2	secondary consumer (primary predator or primary carnivore)
1.1.2.1	invertebrate eater
1.1.2.1.1	terrestrial invertebrates
1.1.2.1.2	aquatic macroinvertebrates
1.1.2.1.3	freshwater or marine zooplankton
1.1.2.2	vertebrate eater (consumer or predator of herbivorous vertebrates)
1.1.2.2.1	piscivorous (fish eater)
1.1.2.3	ovivorous (egg eater)
1.1.2.4	prey (fish) for secondary consumers ~
1.1.3	tertiary consumer (secondary predator or secondary carnivore)
1.1.4	carrion feeder
1.1.5	cannibalistic
1.1.6	coprophagous (feeds on fecal material)
1.1.7.1	aquatic (e.g. offal and bycatch of fishing boats)
1.1.7.2	terrestrial (e.g. landfills)
1.1.7	feeds on human garbage/refuse
1.2	prey relationships
1.2.1	prey for secondary or tertiary consumer (primary or secondary predator)
1.2.2	fish prey for secondary or tertiary consumer (primary or secondary predator)
2	aids in physical transfer of substances for nutrient cycling (C,N,P, etc.)
2.1	significant carrier of nutrients ~
2.1.1	within aquatic system ~
2.1.2	within terrestrial systems (including wetlands) ~
2.2	significant carrier of heavy metals ~
2.2.1	within aquatic systems ~
2.2.2	within terrestrial systems (including wetlands) ~
3	organismal relationships
3.1	controls or depresses insect population peaks
3.1.1	influences aquatic invertebrate population peaks ~
3.1.2	influences zooplankton population peaks ~
3.2	controls terrestrial vertebrate populations (through predation or displacement)
3.3	pollination vector
3.4	transportation of viable seeds, spores, plants or animals ^
3.4.1	disperses fungi

3.4.2	disperses lichens
3.4.3	disperses bryophtes, including mosses
3.4.4	disperses insects and other invertebrates
3.4.4.1	disperse aquatic invertebrates ~
3.4.5	disperses seeds/fruits (through ingestion or caching)
3.4.6	disperses vascular plants
3.5.1	creates feeding opportunities (other than direct prey relations)
3.5.1.1	creates sapwells in trees
3.5.2	creates roosting, denning, or nesting opportunities
3.5	creates feeding, roosting, denning, or nesting opportunities for other organisms
3.6.1	aerial structures
3.6.2	ground structures
3.6.3	aquatic structures
3.6	primary creation of structures (possibly used by other organisms)
3.7.1	aerial structures
3.7.2	ground structures
3.7.3	aquatic structures
3.7	user of structures created by other species
3.8.1	interspecies parasite
3.8.2	common interspecific host
3.8	nest parasite
3.9	primary cavity excavator (in aquatic and/or terrestrial systems)
3.10	secondary cavity user
3.11.1	creates large burrows (rabbit-sized or larger)
3.11.2	creates small burrows (less than rabbit-sized)
3.11	primary burrow excavator (fossorial or underground burrows)
3.12	uses burrows dug by other species (secondary burrow user)
3.13	creates runways (possibly used by other species)
3.14	uses runways created by other species)
3.15	pirates food from other species
3.16	interspecific hybridization
3.16.1	interspecific hybridization with native species
3.16.2	interspecific hybridization with exotic species
4	carrier, transmitter, or reservoir of vertebrate diseases
4.1	diseases that affect humans
4.2	diseases that affect domestic animals
4.3	diseases that affect other wildlife species
4.4	diseases that affect other fish species ~
5	soil relationships
5.1	physically affects (improves) soil structure, aeration (typically by digging)
5.2	physically affects (degrades) soil structure, aeration (typically by trampling)
5.3	physically affects aquatic soils and bed materials (typically by digging or spawning actions)
6	wood structure relationships (either living or dead wood)
6.1	physically fragments down wood
6.2	physically fragments standing wood
7	water relationships
7.1	impounds water by creating diversions or dams
7.2	creates ponds or wetlands through wallowing
8	vegetation structure and composition relationships
8.1	creates standing dead trees (snags)
8.2	herbivory on trees or shrubs that may alter vegetation structure and composition (browsers)
8.3	herbivory on grasses or forbs that may alter vegetation structure and composition (grazers)

CHAP Appendix
Appendix C
Study Area - Species - Potential List

Largemouth bass	*Micropterus salmoides*
Black bullhead	*Ictalorus (Ameiurus) melas*
Carp	*Cyprinus carpio*
Mosquitofish	*Gambusia affinis*
Green sunfish	*Lepomis cyanellus*
Tilapia	*Oreochromis spp.*
Western toad	*Bufo boreas*
California Treefrog	*Pseudacris regilla*
Bullfrog	*Rana catesbeiana*
Red-eared Slider	*Trachemys scripta elegans*
Southern Alligator Lizard	*Elgaria multicarinata*
Western Fence Lizard	*Sceloporus occidentalis*
Side-blotched lizard	*Uta stansburiana*
Two-Striped Garter Snake	*Thamnophis hammondii*
Pied-billed Grebe	*Podilymbus podiceps*
Eared Grebe	*Podiceps nigricollis*
Double-crested Cormorant	*Phalacrocorax auritus*
Great blue heron	*Ardea herodias*
Great Egret	*Ardea alba*
Snowy Egret	*Egretta thula*
Green Heron	*Butorides virescens*
Black-crowned Night-Heron	*Nycticorax nycticorax*
Turkey Vulture	*Cathartes aura*
Canada Goose	*Branta canadensis*
Gadwall	*Anas strepera*
American Wigeon	*Anas americana*
Mallard	*Anas platyrhynchos*
Blue-winged Teal	*Anas discors*
Cinnamon teal	*Anas cyanoptera*
Northern Shoveler	*Anas clypeata*
Northern Pintail	*Anas acuta*
Green-winged Teal	*Anas crecca*
Bufflehead	*Bucephala albeola*
Hooded Merganser	*Lophodytes cucullatus*
Ruddy Duck	*Oxyura jamaicensis*
Muscovy Duck	*Cairina moschata*
Osprey	*Pandion haliaetus*
White-tailed Kite	*Elanus leucurus*
Sharp-shinned Hawk	*Accipiter striatus*
Cooper's Hawk	*Accipiter cooperii*
Red-shouldered Hawk	*Buteo lineatus*
Red-tailed Hawk	*Buteo jamaicensis*
American Kestrel	*Falco sparverius*
Merlin	*Falco columbarius*
Peregrine Falcon	*Falco peregrinus*
Sora	*Porzana carolina*
Common Moorhen	*Gallinula chloropus*
American Coot	*Fulica americana*
Killdeer	*Charadrius vociferus*

Black-necked Stilt	*Himantopus mexicanus*
Greater Yellowlegs	*Tringa melanoleuca*
Lesser Yellowlegs	*Tringa flavipes*
Spotted Sandpiper	*Actitis macularia*
Western sandpiper	*Calidris mauri*
Least Sandpiper	*Calidris minutilla*
Wilson's Snipe	*Gallinago delicata*
Ring-billed Gull	*Larus delawarensis*
California Gull	*Larus californicus*
Western Gull	*Larus occidentalis*
Caspian Tern	*Sterna caspia*
Rock Pigeon	*Columba livia*
Mourning Dove	*Zenaida macroura*
Barn Owl	*Tyto alba*
Great Horned Owl	*Bubo virginianus*
Vaux's Swift	*Chaetura vauxi*
White-throated Swift	*Aeronautes saxatalis*
Black-chinned Hummingbird	*Archilochus alexandri*
Anna's Hummingbird	*Calypte anna*
Rufous Hummingbird	*Selasphorus rufus*
Allen's Hummingbird	*Selasphorus sasin*
Belted Kingfisher	*Ceryle alcyon*
Acorn Woodpecker	*Melanerpes formicivorus*
Red-breasted Sapsucker	*Sphyrapicus ruber*
Nuttall's Woodpecker	*Picoides nuttallii*
Downy Woodpecker	*Picoides pubescens*
Northern Flicker	*Colaptes auratus*
Western Wood-pewee	*Contopus sordidulus*
Willow Flycatcher	*Empidonax traillii*
Pacific-slope Flycatcher	*Empidonax difficilis*
Black Phoebe	*Sayornis nigricans*
Say's Phoebe	*Sayornis saya*
Ash-throated Flycatcher	*Myiarchus cinerascens*
Cassin's Kingbird	*Tyrannus vociferans*
Western Kingbird	*Tyrannus verticalis*
Loggerhead Shrike	*Lanius ludovicianus*
Bell's Vireo	*Vireo bellii*
Cassin's Vireo	*Vireo cassinii*
Hutton's Vireo	*Vireo huttoni*
Warbling Vireo	*Vireo gilvus*
Western Scrub Jay	*Aphelocoma californica*
American Crow	*Corvus brachyrhynchos*
Common Raven	*Corvus corax*
Tree Swallow	*Tachycineta bicolor*
Violet-green Swallow	*Tachycineta thalassina*
Northern rough winged swallow	*Stelgidopteryx serripennis*
Cliff Swallow	*Petrochelidon pyrrhonota*
Barn Swallow	*Hirundo rustica*
Oak Titmouse	*Baeolophus inornatus*
Bushtit	*Psaltriparus minimus*

Bewick's Wren	*Thryomanes bewickii*
House Wren	*Troglodytes aedon*
Ruby-crowned Kinglet	*Regulus calendula*
Blue-gray Gnatcatcher	*Polioptila caerulea*
Western Bluebird	*Sialia mexicana*
Swainson's Thrush	*Catharus ustulatus*
Hermit Thrush	*Catharus guttatus*
American Robin	*Turdus migratorius*
Wrentit	*Chamaea fasciata*
Northern mockingbird	*Mimus polyglottos*
California Thrasher	*Toxostoma redivivum*
European Starling	*Sturnus vulgaris*
American Pipit	*Anthus rubescens*
Cedar Waxwing	*Bombycilla cedrorum*
Phainopepla	*Phainopepla nitens*
Orange-crowned Warbler	*Vermivora celata*
Nashville Warbler	*Vermivora ruficapilla*
Yellow Warbler	*Dendroica petechia*
Yellow-rumped Warbler	*Dendroica coronata*
Black-throated Gray Warbler	*Dendroica nigrescens*
Townsend's Warbler	*Dendroica townsendi*
Hermit Warbler	*Dendroica occidentalis*
MacGillivray's Warbler	*Oporornis tolmiei*
Common Yellowthroat	*Geothlypis trichas*
Wilson's Warbler	*Wilsonia pusilla*
Yellow-breasted Chat	*Icteria virens*
Western Tanager	*Piranga ludoviciana*
Spotted Towhee	*Pipilo maculatus*
California Towhee	*Pipilo crissalis*
Chipping Sparrow	*Spizella passerina*
Lark Sparrow	*Chondestes grammacus*
Savannah Sparrow	*Passerculus sandwichensis*
Song sparrow	*Melospiza melodia*
Lincoln's Sparrow	*Melospiza lincolnii*
White-crowned Sparrow	*Zonotrichia leucophrys*
Golden-crowned Sparrow	*Zonotrichia atricapilla*
Dark-eyed Junco	*Junco hyemalis*
Black-headed Grosbeak	*Pheucticus melanocephalus*
Blue Grosbeak	*Guiraca caerulea*
Lazuli Bunting	*Passerina amoena*
Red-winged blackbird	*Agelaius phoeniceus*
Western Meadowlark	*Sturnella neglecta*
Brewer's Blackbird	*Euphagus cyanocephalus*
Great tailed Grackle	*Quiscalus mexicanus*
Brown-headed Cowbird	*Molothrus ater*
Hooded Oriole	*Icterus cucullatus*
Bullock's Oriole	*Icterus bullockii*
Purple Finch	*Carpodacus purpureus*
House Finch	*Carpodacus mexicanus*
Lesser Goldfinch	*Carduelis psaltria*

Lawrence's Goldfinch	*Carduelis lawrencei*
American Goldfinch	*Carduelis tristis*
House Sparrow	*Passer domesticus*
Virginia opossum	*Didelphis virginiana*
California Myotis	*Myotis californicus*
Yuma Myotis	*Myotis yumanensis*
Silver-haired Bat	*Lasionycteris noctivagans*
Western Pipistrelle	*Pipistrellus hesperus*
Big Brown Bat	*Eptesicus fuscus*
Western Red Bat	*Lasiurus blossevillii*
Hoary Bat	*Lasiurus cinereus*
Townsend's Big-eared Bat	*Corynorhinus townsendii*
Brazilian Free-tailed Bat	*Tadarida brasiliensis*
Desert Cottontail	*Sylvilagus audubonii*
California ground squirrel	*Spermophilus beecheyi*
Eastern Fox Squirrel	*Sciurus niger*
Little Pocket Mouse	*Perognathus longimembris*
Western Harvest Mouse	*Reithrodontomys megalotis*
Deer Mouse	*Peromyscus maniculatus*
Dusky-footed Wood Rat	*Neotoma fuscipes*
Black Rat	*Rattus rattus*
Norway Rat	*Rattus norvegicus*
House Mouse	*Mus musculus*
Coyote	*Canis latrans*
Raccoon	*Procyon lotor*
Striped skunk	*Mephitis mephitis*
Bobcat	*Lynx rufus*
Amazon sailfin catfish	*Pterygoplichthys pardalis*
African clawed frog	*Xenopus laevis*
Gopher snake	*Pituophis catenifer*
Southern Pacific Rattlesnake	*Crotalus helleri*
Ring-Necked Duck	Aythya collaris
Domestic Dog	Canis familiaris
Domestic Cat	Felis catus

CHAP Appendix
Appendix D
Relationship Matrix Descriptions
HU Calculation Overview

Relationship Matrix Descriptions

MATRIX 1: Potential Species by Function (KEF) Matrix

The potential species list generated by IBIS is aligned with Key Ecological Functions (KEFs) that could potentially be performed in the habitat type and structural condition represented by the polygon. For example, if the polygon represents a "shrub-steppe" habitat type, the KEFs thought to be performed in that habitat type by the potential species are included in the relationship matrix. This information is acquired from IBIS. The result of this matrix is the number of potential species performing key functions in that habitat type. Example follows:

Lowland Mixed Conifer Habitat Type (Potential)	Function 1 Transportation of Viable Seeds, Spores or Plants	Function 2 Breaks up Down Wood	Function 3 Primary Excavator	Function 4 Eats Terrestrial Invertebrates
American Beaver	1			
Pileated Woodpecker		1	1	1
Black Bear	1	1	1	1
Black-tailed Deer	1	1		
Steelhead Salmon	1			1

Relationship Matrix Descriptions

MATRIX 2: Habitat (Actual KEC) by Function (KEF) Matrix

In this matrix, the functions, or KEFs, are again related to Key Environmental Correlates (KECs), but this time the KECs are those actually present at the site (based on field data inventory). Because this is an actual account, those KEFs not correlated to an actual KEC are then removed. The result of this matrix is the number of KEFs characterized by KECs specific to that polygon. Example follows:

Lowland Mixed Conifer Habitat Type (Actual)	Function 1 Creates Snags	Function 2 Breaks up Down Wood	Function 3 Pollination Vector	Function 4 Primary Excavator	Function 5 Filtering Water	Function 6 Eats Terrestrial Insects
Down Wood		1				1
Snags	1			1		1
Tree Cavities	1	1		1		1
Hollow Living Trees		1				1
Flowers			1			
Emergent Vegetation					1	

Calculations

For Each Matrix

Divide: $\dfrac{\text{total number of 1s in matrix}}{\text{total number of non-zero functions*}}$

1 ***Total # of 1s = 12***

Total # non-zero fxns = 4

2 ***Total # of 1s = 13***

Total # non-zero fxns = 6

$$\frac{\text{Number of species performing functions}}{\text{Total number of potential functions}} = \frac{12}{4} = 3.0 + \frac{\text{Number of KECs at site}}{\text{Total number of functions characterized}} = \frac{13}{6} = 2.17$$

$$= \text{Per Acre Habitat Value } 5.17$$

*non-zero functions refer to function columns in the matrix that have at least one "1" in that column

CHAP Appendix
Appendix E
Verification Transect Report

Lone Pine Butte Consulting

LA River CHAP Verification Transect Report

Combined Habitat Assessment Protocols (CHAP)

Paul R Ashley
4/11/2010

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Introduction

Northwest Habitat Institute (NHI) staff evaluated habitat quality on and along selected portions of the Los Angeles River (LAR) within the city limits of Los Angeles, California in late March and early April 2010. NHI staff used Combined Habitat Assessment Protocols (CHAP) to assess habitat quality.

CHAP methodology includes delineating and displayed habitat types, structural conditions, and attributes as Geographic Information System (GIS) data, which is verified in the field with ocular observations and measured verification transects. Ocular observations and verification transect data is then used to modify initial habitat quality/attribute estimates.

Funding for the LAR habitat assessment project and assistance with data collection was provided by the US Army Corps of Engineers (USACOE). This report includes only the results of the verification transects.

Study Area

The study area is located on the south side of Burbank, California just east of Universal City and includes the Los Angeles River channel and adjacent uplands. The general project area is shown in Figure 1. CHAP verification transects were limited to "soft bottom" areas in the LA River channel and the "Head Works" area.

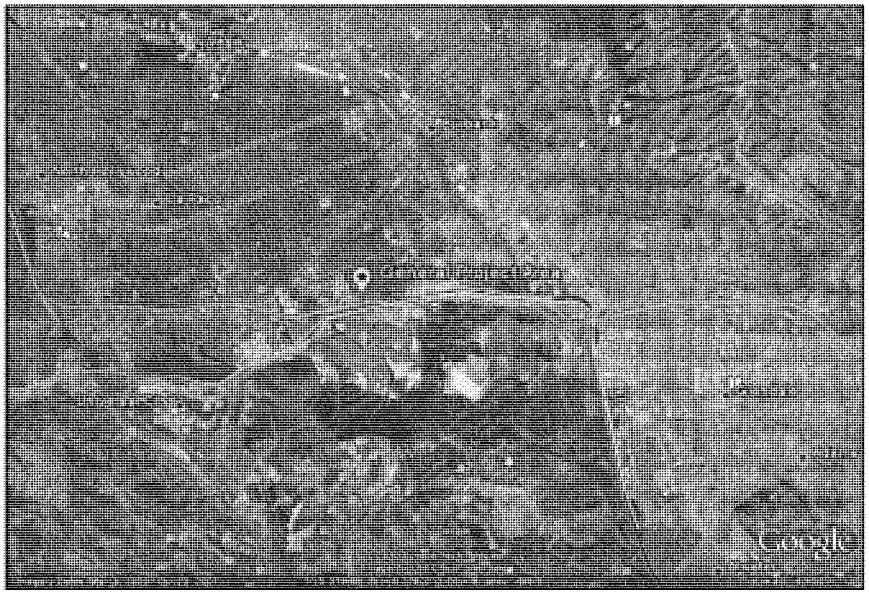


Figure 1 General location of LA River CHAP study

Verification Transect Locations

Habitat variable data was collected on 11 transects to verify and support GIS map layers and associated ocular habitat attribute estimates. Seven verification transects were established at the Head Works location (Figure 2) while four transects were disbursed in "soft bottom" areas of the LA River (Figure 3 and Figure 4). A transect overview map is shown in Figure 5.

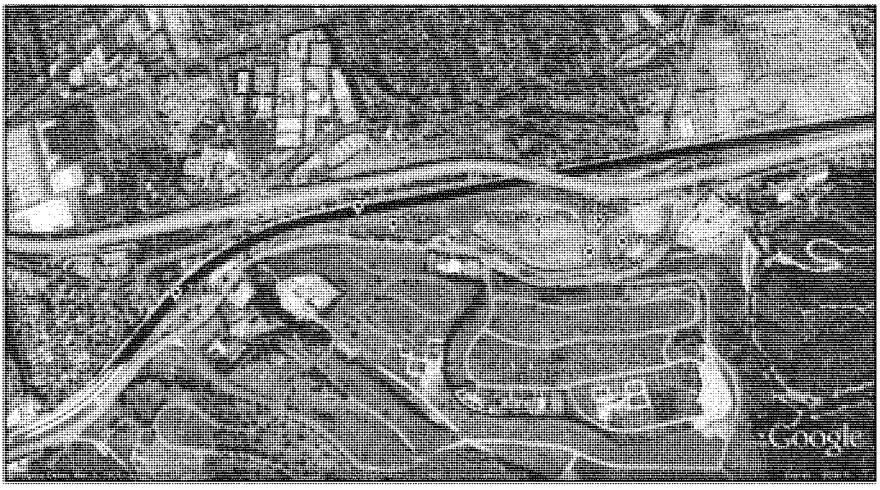


Figure 2 Head Works transect start point locations

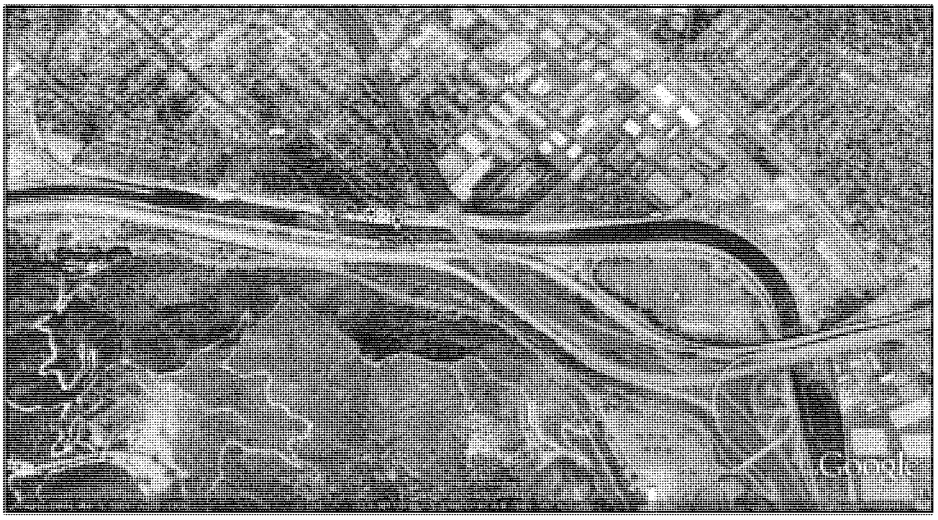


Figure 3 LA River riparian transect start point locations (north)

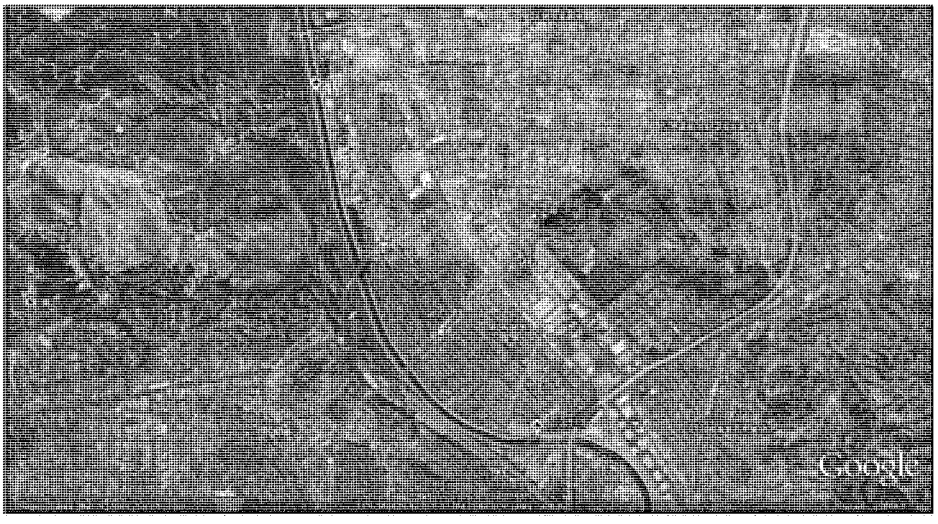


Figure 4 LA River riparian transect start point locations (south)

Figure 5 Verification transect start point overview map (all transect start locations)

Transect start points were established at random locations. Transect azimuths were selected from a random numbers table whenever possible (the narrow, linear nature of riparian habitats/transects precluded use of random azimuths). Once an azimuth was determined, a 300' measuring tape was used as the transect line from which habitat variable measurements were taken.

Transect start and end UTM coordinates were recorded on a Garmin 60CSx® global positioning system (GPS) and are displayed Table 1. The end point for transect 24-1 was unavailable due to limited GPS satellite coverage.

Transect length was 300 feet wherever possible. Transect 19-1, however, was only 250 feet in length because of the limited amount of riparian forest habitat available. Similarly, transect 63-1 extended only 150 feet.

Table 1 LA River project transect UTM coordinates, azimuths, and lengths

Site	Transect Number	Point	UTM Coordinates (NAD 83)		Magnetic Azimuth	Transect Length (FT)
			E	N		
LA River	19-1	Start	0380805	3780223	275	250
		End	0380735	3780227		
	20-1	Start	0380891	3780198	080	300
		End	0380976	3780196		
	24-1	Start	0382423	3777918	156	300
		End	Unknown	Unknown		
	31-1	Start	0384453	3774886	075	300
		End	0384540	3774889		
	63-1	Start	0377536	3779670	052	150
		End	0377575	3779686		
Head Works	14-1	Start	0378089	3779962	097	300
		End	0378174	3779949		
	14B-1	Start	0378654	3779919	230	300
		End	0378585	3779865		
	14D-1	Start	0378915	3779852	245	300
		End	0378904	3779941		
	14F-1	Start	0378811	3779819	245	300
		End	0378719	3779805		
	14G-1	Start	0378843	3779920	178	300
		End	0378812	3779844		
	15-1	Start	0378198	3779907	265	300
		End	0378110	3779918		

Methods

Verification transects (n = 11) were established in riparian forest, floodplain riparian shrub, grassland, and shrubland cover types located on LA River "soft bottom" sites and/or the Head Works area. Ashley (2010) describes the specific methods used to measure habitat attributes in Habitat Measurement Techniques.

Habitat attributes measured in this study included:

1. Tree and shrub species
2. Tree and shrub canopy cover
3. Tree and shrub height
4. Diameter breast height (DBH)
5. Snag density, size, and class (only one snag was detected)
6. Percent herbaceous plant cover
7. Herbaceous cover height
8. Percent grass cover
9. Percent cover forbs
10. Percent cover exotic/invasive herbaceous vegetation

Tree and shrub data was collected using the point intercept method. Tree canopy point cover was collected at five foot intervals while shrub point intercept data was collected at either five foot or two intervals foot intervals predicated on initial shrub cover estimates (two foot intervals are applied when estimated shrub cover is < 30%).

A rectangular 0.10m^2 quadrat was used to estimate total herbaceous cover, grass cover, forbs cover, and percent cover of invasive herbaceous species (percent cover = aerial cover). Quadrats were placed adjacent to the transect line at 25 foot intervals. Herbaceous vegetation height measurements were taken within the quadrats with a "pocket rod" and recorded in 10ths of feet (Ashley 2010).

Results

Verification transect results for the LA River and Head Works sites are summarized below. Percent cover estimates are rounded to the nearest whole number. Actual data sets, including species information, can be viewed at the data link locations included in the summary tables. Transect photographs are shown in Appendix A.

LA River

Three verification transects were established in the riparian forest cover type, one transect in shrub-scrub floodplain, and one transect in disturbed grassland. Snag, shrub, and tree data was collected on the riparian forest and shrub-scrub transects (only one snag was detected which had an 8.5 inch dbh). Only herbaceous habitat attribute data was recorded on Transect 63-1 (shrubs were not present).

Tree canopy cover ranged from 17% to 77%. The average minimum tree height was just over 17 feet while the maximum tree height was slightly more than 49 feet. Tree species detected included

eucalyptus (*Eucalyptus* globules), shamel ash (*Fraxinus* uhdei), white mulberry (*Morus alba*), sycamore (*Paltanus* sp.), and red willow (*Salix* laevigata).

Shrub cover ranged from 48% to 64% while mean shrub height varied little extending from approximately 3.5 feet to just over 4 feet. Shrub species (included trees < 16 feet in height) detected included castor bean (*Ricinus* spp.), Mexican fan palm (*Washingtonia robusta*), arroya willow (Salix lasiolepis), shamel ash, white mulberry, mule fat (*Baccharis salicifolia*), red willow, and California sagebrush (*Artemisia californica*).

Total herbaceous cover on transect 63-1 was 81%, which was comprised entirely of invasive plant species. Summarized LA River transect results and data spreadsheet links are provided in Table 2.

Table 2 Summarized LA River verification transect results and data links

Cover Type	Transect Number	Habitat Stratum	Percent Cover	Mean Height (Feet)	DBH Class Range (Inches)	Data Link
Riparian Forest	19-1	Trees	58%	49.20	<4 to >20	19
		Shrubs	64%	3.53	N/A	
Riparian Forest	20-1	Trees	72%	37.50	4 to 20	20
		Shrubs	50%	3.77	N/A	
Riparian Forest	24-1	Trees	77%	38.00	4 to >20	24
		Shrubs	53%	4.22	N/A	
Shrub-scrub Floodplain	31-1	Trees	17%	17.30	<4 to 20	31
		Shrubs	48%	4.00	N/A	

Cover Type	Transect Number	Habitat Stratum	Percent Herb. Cover	Mean Height	Percent Grass	Percent Forbs	Percent Exotics	Data Link
Disturbed Grassland	63-1	Herbaceous Stratum	81%	6"	71.50	23.50	80.50	63

Head Works

Four shrubland and two grassland verification transects were established at the Head Works site. Both shrub and herbaceous habitat attribute data was collected on most transects.

Percent shrub cover ranged from 11% to 92% while shrub height was between 5 feet and 6 feet on three transects and just over 10 feet on the fourth transect. Shrub species detected included Spanish broom (*Spartium* junceum), poison oak (*Toxicodendron diversilobum*), mule fat, Mexican elderberry (*Sambucus mexicana*), laurel sumac (*Malosma laurina*), coyote brush (*Baccharis pilularis*), deerweed (*Lotus scoparius*) (half shrub), and California sagebrush (Table 3).

Table 3 Head Works site shrub verification transect results

Cover Type	Transect Number	Habitat Stratum	Percent Cover	Mean Height (Feet)	Data Link
Shrubland	14B-1	Shrubs	11%	5.82	14B-1
Shrubland	14D-1	Shrubs	35%	5.04	14D-1
Riparian Shrub	14F-1	Shrubs	53%	5.75	14F-1
Shrubland	15-1	Shrubs	92%	10.22	15-1

Percent cover of herbaceous vegetation ranged from 67% to 88% with only a trace amount (<1%) comprised of native species while the average height ranged from four to 15 inches. Herbaceous transect results are summarized in Table 4.

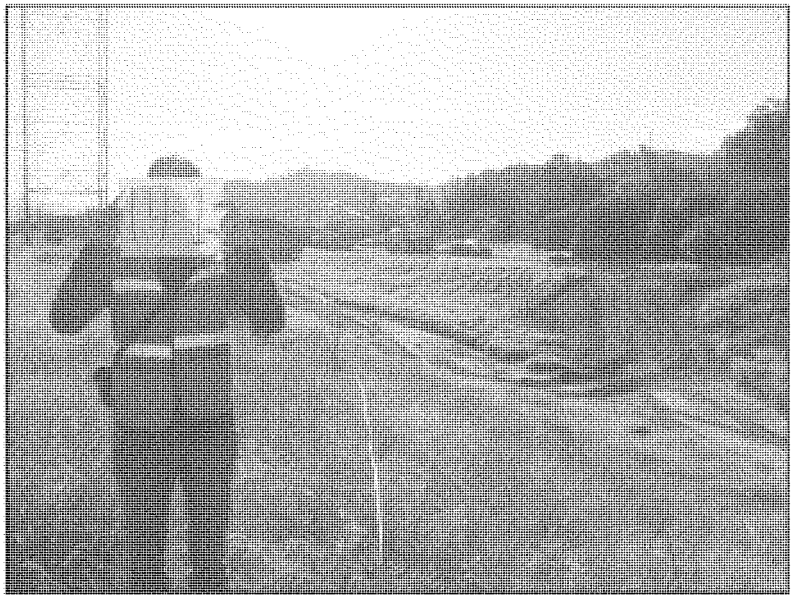
Table 4 Head Works site herbaceous stratum verification transect results

Cover Type	Transect Number	Habitat Stratum	Percent Herb. Cover	Mean Height	Percent Grass	Percent Forbs	Percent Exotics	Data Link
Shrubland	14B-1	Herbaceous	67%	4"	31%	50%	67%	14B-1
Grassland	14-1	Herbaceous	84%	13"	82%	5%	83%	14-1
Shrubland	14D-1	Herbaceous	88%	7"	79%	36%	88%	14D-1
Grassland	14G-1	Herbaceous	70%	15"	35%	60%	70%	14G-1

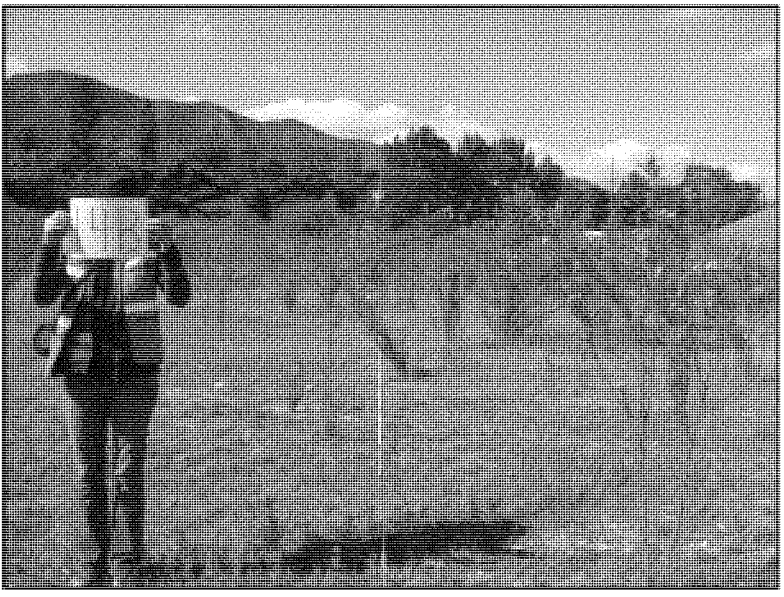
References

Ashley, P. R. 2010. Habitat Measurement Techniques. Regional HEP Team. Columbia Basin Fish and Wildlife Authority. Portland, OR.

Appendix A – Transect Photographs



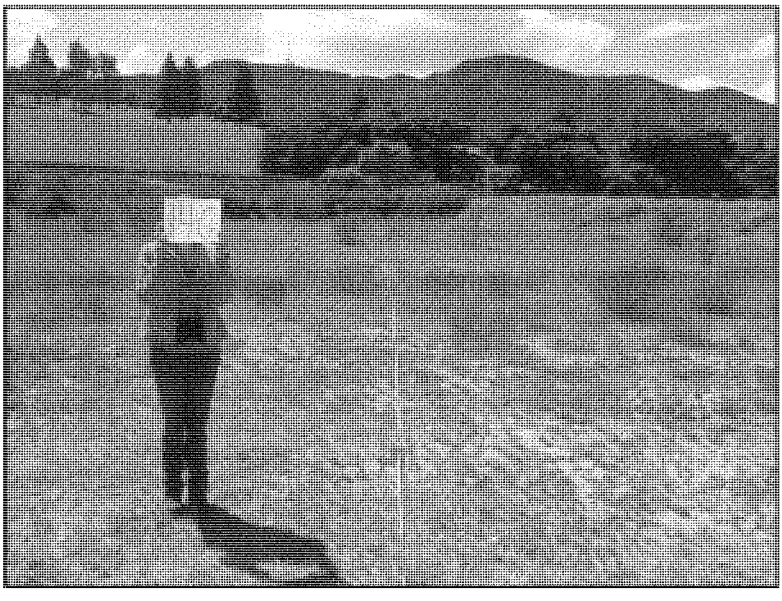
Transect 14-1



Transect 14B-1

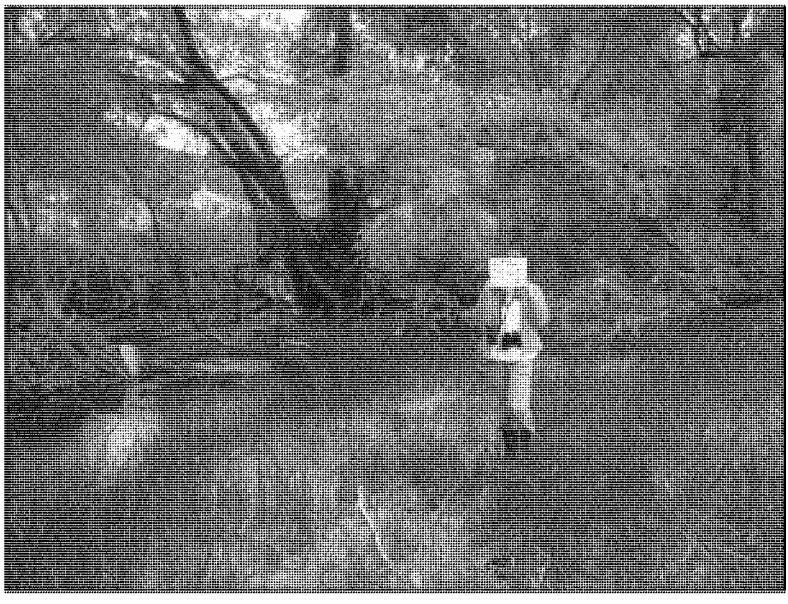
Transect 14D-1

Transect 14F-1

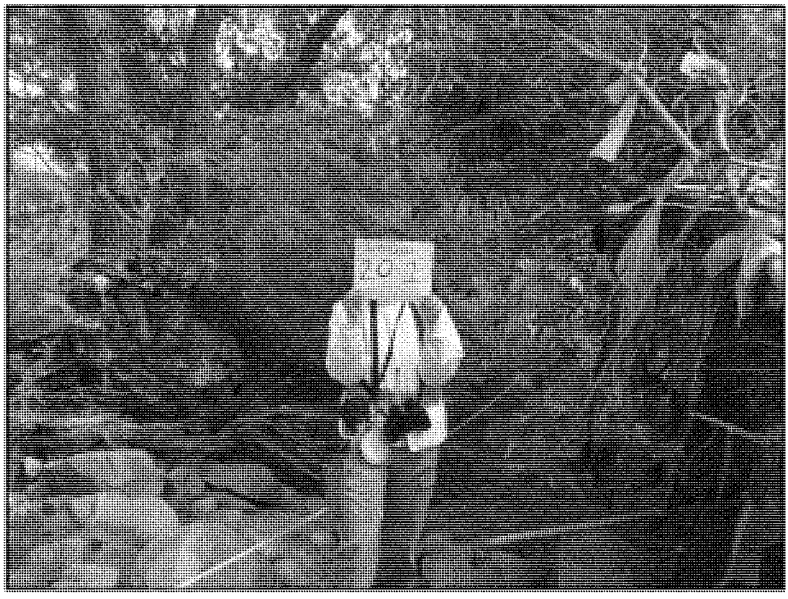


Transect 14G-1

Transect 15-1



Transect 19-1



Transect 20-1

Transect 24 -1

Transect 63-1

CHAP Appendix
Appendix F
Alternative Measures Matrix

Alternatives Submeasure Matrix by River Reach

Reach	Submeasure	Comprehensive	City: Atwater to Cortfields	Banks & Tribs Only	Highest Scoring Objectives (over 3)	City: Los Feliz to Arroyo Seco	Corps Team	highest objectives (over 5)	Charette Team 1	associated banks &Soft Bottom Channl	Highest Other Criteria (over 11)	Charette Team 4	Charette Team 3	Charette Team 6	Charette Team 5	Charette Team 2	Side Channels Only	Charette Team 7	nsive PocketsCompriehe	Taylor Yard
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. Pollywog Park/Headworks to Midpoint of Betty Davis Park	3/5. create geomorphology and plant for freshwater marsh, open water le pool/riffle system	X		X	X					X	X				X	X	X	X		
	2. expose stormdrain outlets, convert to natural stream confluence, & divert to water quality ponds as needed (put in adjacent channel etc)	X		X			X			X	X				X		X			
	10. divert tributary & river flow into side channels on both sides (minimize impacts to existing use in parks & plant riparan/marsh habitat)	X		X			X		X	X	X						X			
	7. Create underground basin for attenuation at equestrian center - continue current use	X		X			X			X					X		X	X		
	9. culverts & or underground basins to divert flood flows	X		X	X		X	X	X	X						X		X		
	16. bioengineer channel walls (vines, vegetated notching near top of vertical walls)	X							X					X						
	17. habitat corridors/ riparian planting on banks (assume easiest method)	X		X	X		X		X	X	X	X	X	X	X	X	X	X	X	
	23. channel bed (implies deepening or attenuation)	X			X		X		X	X	X		X		X					
	25. tributary channels/widen channel (implies erosion control)	X		X			X			X										
	26. terrace banks (check for connectivity vs too small once mapping is completed)	X		X			X		X	X	X		X	X	X			X		
	27. modify trap channel to vertical sides to gain width (adds capacity)	X			X			X						X						

Reach	Submeasure	Comprehensive 1	City: Atwater to Cornfields 2	Banks & Tribs Only 3	Highest Scoring Objectives (over 3) 4	City: Los Feliz to Arroyo Seco 5	Corps Team 6	highest objectives (over 5) 7	Charette Team 1 8	associated banks &Soft Bottom Channl 9	Highest Other Criteria (over 11) 10	Charette Team 4 11	Charette Team 3 12	Charette Team 6 13	Charette Team 5 14	Charette Team 2 15	Side Channels Only 16	Charette Team 7 17	Comprehensive Pockets 18	Taylor Yard 19
2. Midpoint Betty Davis Park to upstream end of Ferraro Fields	3/5. create geomorphology and plant for freshwater marsh, open water Ie pool/riffle system	X		X	X					X	X				X	X	X	X		
	2. expose stormdrain outlets; convert to natural stream confluence, & divert to water quality ponds as needed (put in adjacent channel etc)	X		X			X			X	X						X			
	10. divert tributary & river flow into side channels on both sides (minimize impacts to existing use in parks & plant ripairan/marsh habitat)	X		X			X		X	X	X						X			
	9. culverts & or underground basins to divert flood flows	X		X	X		X	X	X	X						X		X		
	16. bioengineer channel walls (vines, vegetated notching near top of vertical walls)	X							X					X						
	17. habitat corridors/ riparian planting on banks (assume easiest method)	X		X	X		X	X	X	X	X	X	X	X	X	X	X			
	23. channel bed (implies deepening or attenuation)				X			X												
	26. terrace banks (check for connectivity vs too small once mapping is completed)	X					X		X	X	X		X							
	27. modify trap channel to vertical sides to gain width (adds capacity)	X			X			X						X						

Reach	Submeasure	Comprehensive 1	City: AMwater to Cornfields 2	Banks & Trbs Only 3	Highest Scoring Objectives (over 3) 4	City: Los Feliz to Arroyo Seco 5	Corps Team 6	highest objectives (over 5) 7	Charette Team 1 8	associated banks &Soft Bottom Chanel 9	Highest Other Criteria (over 11) 10	Charette Team 4 11	Charette Team 3 12	Charette Team 6 13	Charette Team 5 14	Charette Team 2 15	Side Channels Only 16	Charette Team ? 17	Comprehensive Pockets 18	Taylor Yard 19
3. Ferraro Fields to Brazil St	3/5. create geomorphology and plant for freshwater marsh; open water le pool/riffle system	X		X	X					X	X			X	X		X		X	
	2. expose stormdrain outlets; convert to natural stream confluence; & divert to water quality ponds as needed (put in adjacent channel etc)	X	X	X			X		X	X							X	X		
	10. divert tributary & river flow into side channels on both sides (minimize impacts to existing use in parks & plant ripairan/marsh habitat) ro recreate channel braiding	X		X	X				X	X	X	X	X				X		X	
	9. culverts & or underground basins to divert flood flows	X	X	X	X		X	X	X	X				X		X		X		
	16. bioengineer channel walls (vines, vegetated notching near top of vertical walls)	X	X						X					X						
	17. habitat corridors/ riparian planting on banks (assume easiest method)	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X		X	
	18. open water	X								X								X		
	21/22 widenchannel, provide erosion control may lower channel banks and provide setback levees or vegetated berms			X						X		X		X					X	
	23. channel bed (implies deepening or attenuation)		X		X			X												
	25. tributary channels/widen channel (implies erosion control)	X					X		X	X		X	X	X	X	X				X
	26. terrace banks (check for connectivity vs too small once mapping is completed)	X		X			X			X		X		X						
	27. modify trap channel to vertical sides to gain width (adds capacity)	X	X		X			X												

Reach	Submeasure	Comprehensive 1	City: Atwater to Cornfields 2	Banks & Trib Only 3	Highest Scoring Objectives (over 3) 4	City: Los Feliz to Arroyo Seco 5	Corps Team 6	highest objectives (over 5) 7	Charette Team 1 8	associated banks &Soft Bottom Channl 9	Highest Other Criteria (over 11) 10	Charette Team 4 11	Charette Team 3 12	Charette Team 6 13	Charette Team 5 14	Charette Team 2 15	Side Channels Only 16	Charette Team 7 17	Comprehensive Pockets 18	Taylor Yard 19
4. Brazil to Los Feliz Blvd	3/5. create geomorphology and plant for freshwater marsh, open water le pool/riffle system	X	X	X	X			X	X		X						X	X		
	2. expose stormdrain outlets; convert to natural stream confluence, & divert to water quality ponds as needed (put in adjacent channel etc)	X	X	X	X	X	X	X	X	X	X		X			X	X	X		
	10. divert tributary & river flow into side channels on both sides (minimize impacts to existing use in parks & plant ripairan/marsh habitat)	X	X	X	X	X	X	X	X		X			X			X			
	7. Create underground basins for attenuation - continue current use	X		X					X				X	X			X			
	9. culverts & or underground basins to divert flood flows	X	X	X	X	X	X	X	X	X						X		X		
	12. bridge undercrossings for wildlife	X	X													X				
	15. wildlife passage/tunnels	X	X	X			X							X		X				
	16. bioengineer channel walls (vines, vegetated notching near top of vertical walls)	X	X			X			X					X						
	17. habitat corridors/ riparian planting on banks (assume easiest method)	X	X		X	X	X	X	X			X	X	X			X			
	21/22 widenchannel, provide erosion control may lower channel banks and provide setback levees or vegetated berms	X	X		X		X	X					X		X					
	26. terrace banks (check for connectivity vs too small once mapping is completed)	X	X	X	X		X	X	X	X	X	X		X	X					
	27. modify trap channel to vertical sides to gain width (adds capacity)	X	X		X	X		X						X						

Reach	Submeasure	1 Comprehensive	2 City: Atwater to Cornfields	3 Banks & Tribs Only	4 Highest Scoring Objectives (over 3)	5 City: Los Feliz to Arroyo Seco	6 Corps Team	7 highest objectives (over 5)	8 Charette Team 1	9 associated banks &Soft Bottom Channl	10 Highest Other Criteria (over 11)	11 Charette Team 4	12 Charette Team 3	13 Charette Team 6	14 Charette Team 5	15 Charette Team 2	16 Side Channels Only	17 Charette Team 7	18 Comprehensive Pockets	19 Taylor Yard
5. Los Feliz to Glendale Fwy (2)	3/5. create geomorphology and plant for freshwater marsh, open water Ie pool/riffle system	X	X	X		X			X		X	X		X						
	2. expose stormdrain outlets, convert to natural stream confluence, & divert to water quality ponds as needed (put in adjacent channel etc)	X	X			X	X			X							X			
	9. culverts & or underground basins to divert flood flows	X	X	X	X	X	X	X	X	X						X		X		
	14. wildlife access from river to bank (in daylighted storm drain)	X	X			X	X		X		X					X					
	16. bioengineer channel walls (vines, vegetated notching near top of vertical walls)	X	X			X			X					X							
	17. habitat corridors/ riparian planting on banks (assume easiest method)	X	X		X	X	X	X	X			X	X	X			X				
	23. channel bed (implies deepening or attenuation)		X		X	X		X													
	26. terrace banks (check for connectivity vs too small once mapping is completed)	X	X	X		X						X									
	27. modify trap channel to vertical sides to gain width (adds capacity)	X	X		X	X		X						X							

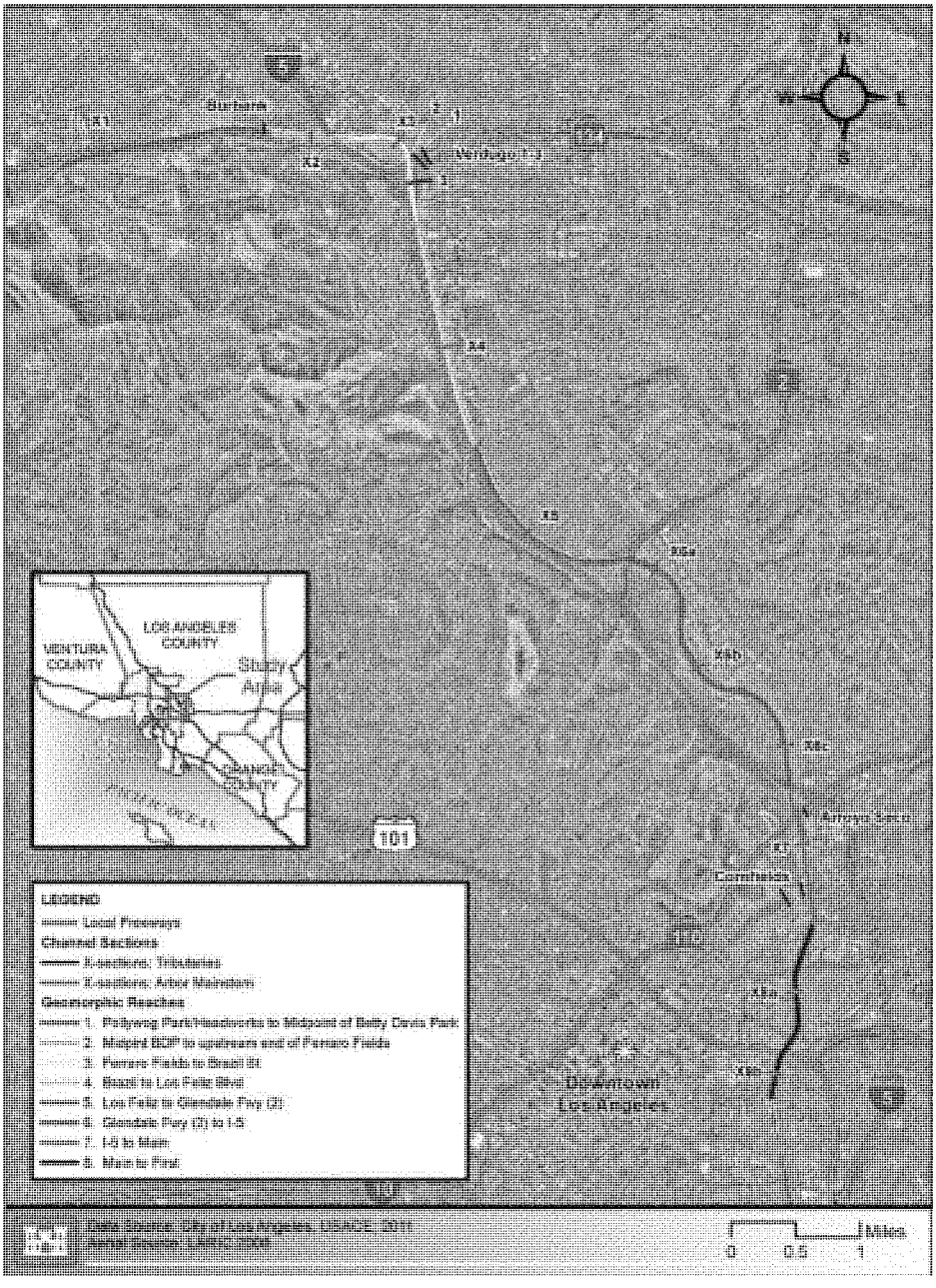
Reach	Submeasure	Comprehensive 1	City: Alhwater to Cornfields 2	Banks & Tribs Only 3	Highest Scoring Objectives (over 3) 4	City: Los Feliz to Arroyo Seco 5	Corps Team 6	highest objectives (over 5) 7	Charette Team 1 8	associated banks &Soft Bottom Chanel 9	Highest Other Criteria (over 11) 10	Charette Team 4 11	Charette Team 3 12	Charette Team 6 13	Charette Team 5 14	Charette Team 2 15	Side Channels Only 16	Charette Team 7 17	Comprehensive Pockets 18	Taylor Yard 19
6. Glendale Fwy (2) to I-5	3/5. create geomorphology and plant for freshwater marsh, open water Ie pool/riffle system	X	X	X	X	X	X			X	X		X	X	X	X	X	X	X	X
	2. expose stormdrain outlets; convert to natural stream confluence, & divert to water quality ponds as needed (put in adjacent channel etc)	X	X	X	X	X	X			X							X		X	X
	9. culverts & or underground basins to divert flood flows	X	X	X	X	X	X	X	X	X						X		X		
	16. bioengineer channel walls (vines, vegetated notching near top of vertical walls)	X	X			X			X					X						
	17. habitat corridors/ riparian planting on banks (assume easiest method)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X
	19. Planting built into channel walls (reshape concrete walls to accommodate vegetation or add hanging boxes (native vines, small shrubs, etc)		X	X		X					X	X		X						
	20. bring concrete down to channel level; reconfigure as soft bottom channel	X	X	X	X	X	X			X				X	X	X			X	X
	21/22 widenchannel, provide erosion control may lower channel banks and provide setback levees or vegetated berms	X	X	X	X	X	X	X		X		X	X	X	X	X		X	X	X
	26. terrace banks (check for connectivity vs too small once mapping is completed)	X	X	X		X	X		X	X	X	X	X	X		X		X	X	X
	27. modify trap channel to vertical sides to gain width (adds capacity)	X	X		X	X		X						X						

Reach	Submeasure	1 Comprhensive	2 City: Atwater to Cornfields	3 Banks & Trbs Only	4 Highest Scoring Objectives (over 3)	5 City: Los Feliz to Arroyo Seco	6 Corps Team	7 highest objectives (over 5)	8 Charette Team 1	9 associated banks &Soft Bottom Chanml	10 Highest Other Criteria (over 11)	11 Charette Team 4	12 Charette Team 3	13 Charette Team 6	14 Charette Team 5	15 Charette Team 2	16 Side Channels Only	17 Charette Team 7	18 Comprhensive Pockets	19 Taylor Yard
	2. expose existing storm drains & gravity flow through DWP to LAR with terracing into the river	X	X	X			X		X		X	X				X			X	
	3/5. create geomorphology and plant for freshwater marsh, open water le pool/riffle system	X	X	X	X	X	X		X		X	X		X		X	X	X	X	
	3. expose stormdrain outlets, convert to natural stream confluence, & divert to water quality ponds as needed (put in adjacent channel etc)	X	X			X	X			X							X			
	10. divert tributary & river flow into side channels on both sides (minimize impacts to existing use in parks & plant ripairan/marsh habitat)	X	X	X										X			X		X	
	8. creation of wetlands flood control basin (assumes culvert under Baker St)	X	X	X			X					X							X	
	9. culverts & or underground basins to divert flood flows	X	X	X	X	X	X	X	X	X						X		X		
	16. bioengineer channel walls (vines, vegetated notching near top of vertical walls)	X	X			X			X											
	17. habitat corridors/ riparian planting on banks (assume easiest method)	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X		X	
	19. Planting built into channel walls (reshape concrete walls to accommodate vegetation or add hanging boxes (native vines, small shrubs, etc)	X	X	X		X					X	X	X	X					X	
	26. terrace banks (check for connectivity vs too small once mapping is completed)	X	X	X		X	X		X		X	X		X						
	27. modify trap channel to vertical sides to gain width (adds capacity)	X	X		X	X		X						X						

Reach	Submeasure	Comprehensive 1	City: Atwater to Cornfields 2	Banks & Tribs Only 3	Highest Scoring Objectives (over 3) 4	City: Los Feliz to Arroyo Seco 5	Corps Team 6	highest objectives (over 5) 7	Charette Team 1 8	associated banks &Soft Bottom Channl 9	Highest Other Criteria (over 11) 10	Charette Team 4 11	Charette Team 3 12	Charette Team 6 13	Charette Team 5 14	Charette Team 2 15	Side Channels Only 16	Charette Team 7 17	Comprehensive Pockets 18	Taylor Yard 19
8. Main to First	1. elevate railroads on trestles (consider other locations when necessary - is this an "all alts" measure?)	X		X					X				X					X		
	3/5. create geomorphology and plant for freshwater marsh, open water le pool/riffle system	X		X	X		X		X		X				X		X			
	2. expose stormdrain outlets; convert to natural stream confluence, & divert to water quality ponds as needed (put in adjacent channel etc)	X					X			X							X			
	6. rebuild geomorphology for historic wash	X		X	X				X			X				X				
	10. divert tributary & river flow into side channels on both sides (minimize impacts to existing use in parks & plant ripairan/marsh habitat) to recreate channel braiding	X		X	X		X							X			X	X		
	9. culverts & or underground basins to divert flood flows	X		X	X		X	X	X	X						X		X		
	15. wildlife passage/tunnels	X		X			X					X				X				
	16. bioengineer channel walls (vines, vegetated notching near top of vertical walls)	X							X					X						
	17. habitat corridors/ riparian planting on banks (assume easiest method)	X		X	X		X	X	X		X	X	X	X	X	X	X			
	26. terrace banks (check for connectivity vs too small once mapping is completed)			X			X					X								
	27. modify trap channel to vertical sides to gain width (adds capacity)	X			X			X						X						

CHAP Appendix
Appendix G
Preliminary Design - Channel Cross Sections

Key to Cross Section Locations



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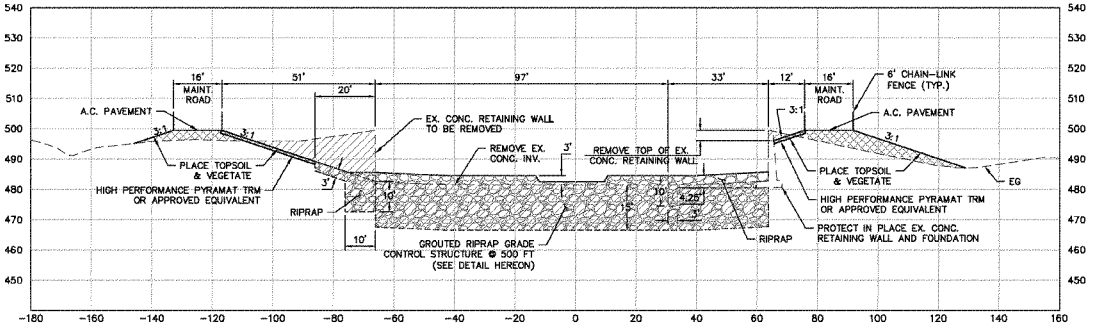
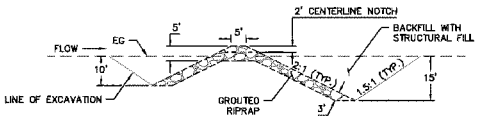
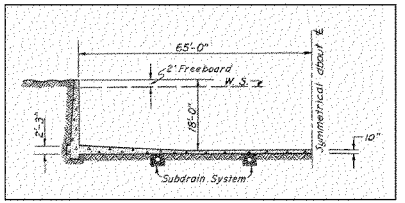




GRADE CONTROL STRUCTURE DETAIL
NTS



EXISTING TYPICAL SECTION
NTS

LEGEND

- EX. GROUND
- PROPOSED CHANNEL
- EXCAVATION
- COMPACTED FILL
- RIPRAP
- REINFORCED CONCRETE
- HIGH PERFORMANCE PYRAMAT TURF REINFORCEMENT MAT (TRM) OR APPROVED EQUIVALENT

0 15 30 60

REVISIONS				LOS ANGELES RIVER FEASIBILITY STUDY PRELIMINARY DESIGN	DATE 10/25/11
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				ARBOR REACH CROSS SECTION 1	SHT NO. 1 OF 19

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Irvine, CA 92614
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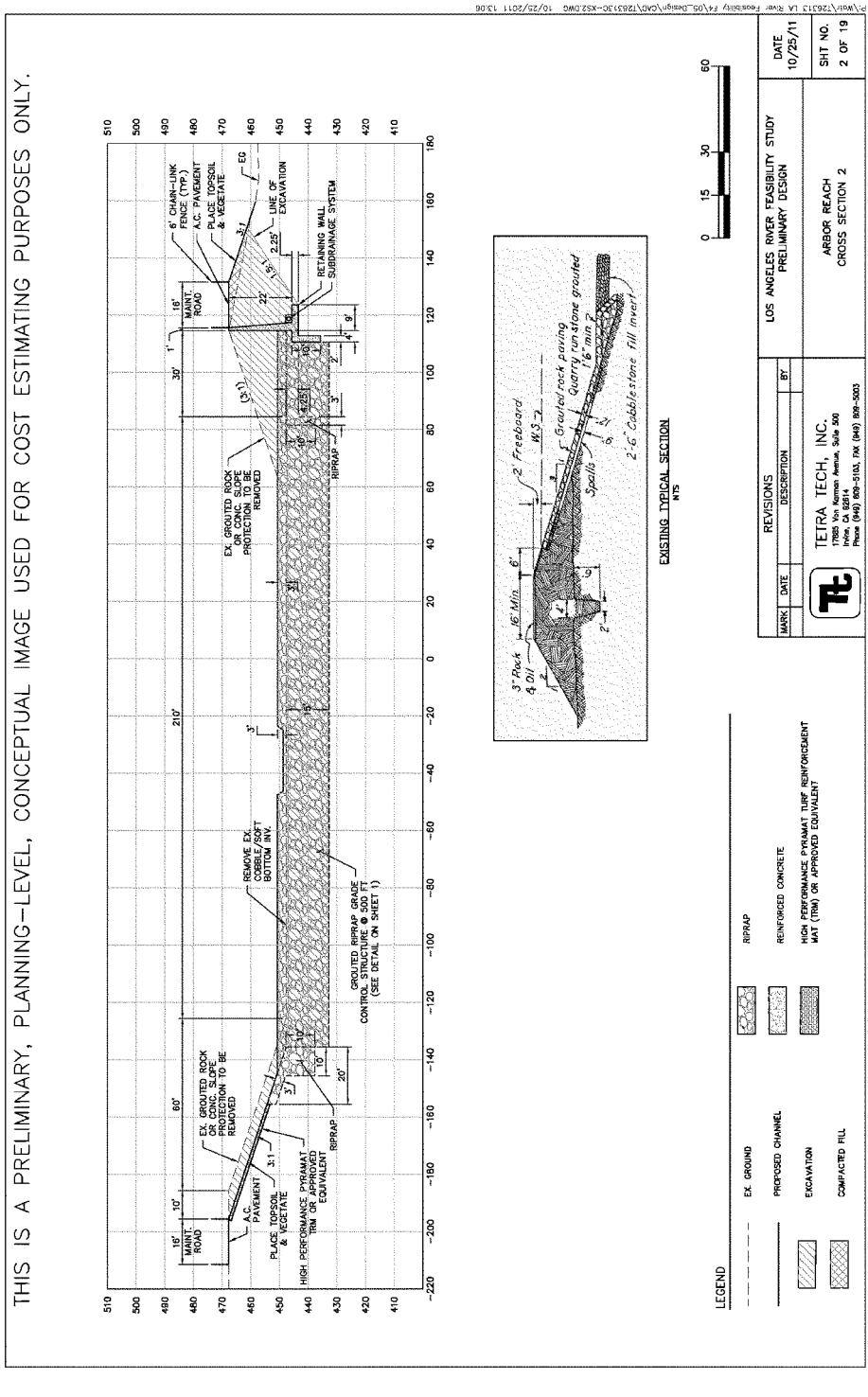
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EXCAVATION
COMPACTED FILL
RIPRAP
REINFORCED CONCRETE
HIGH PERFORMANCE PYRAMAT TURF REINFORCEMENT MAT (TRM) OR APPROVED EQUIVALENT
EXISTING TYPICAL SECTION
0 15 30 60
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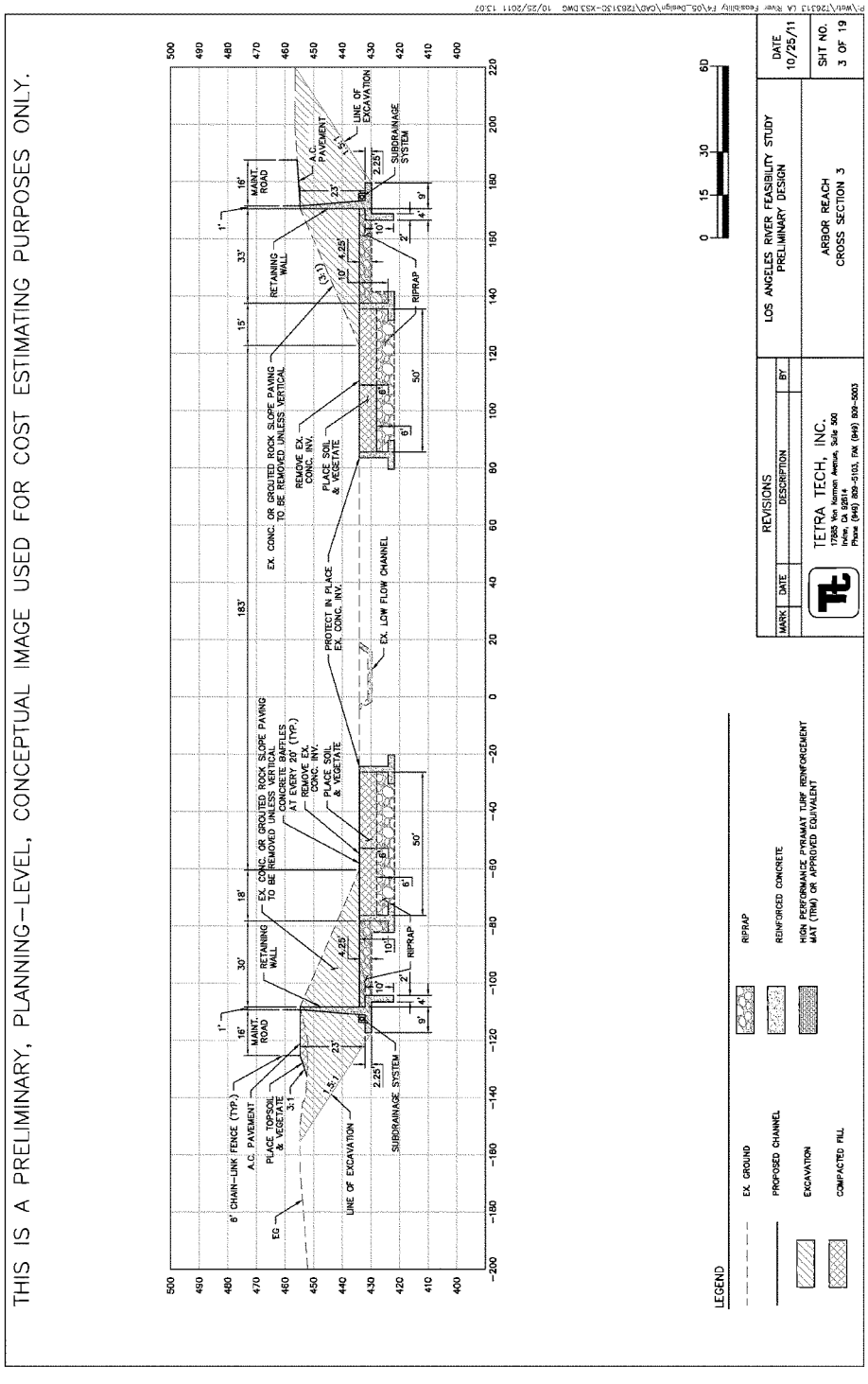
DATE 10/25/11
SHT NO. 2 OF 19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LEGEND
EX. GROUND
PROPOSED CHANNEL
EXCAVATION
COMPACTED FILL
RIPRAP
REINFORCED CONCRETE
HIGH PERFORMANCE PYRAMAT TURF REINFORCEMENT MAT (TRM) OR APPROVED EQUIVALENT
EG
6' CHAIN-LINK FENCE (TYP.)
A.C. PAVEMENT
PLACE TOPSOIL & VEGETATE
3:1
LINE OF EXCAVATION
SUBDRAINAGE SYSTEM
16' MAINT. ROAD
1'
30'
RETAINING WALL
18'
EX. CONC. OR GROUTED ROCK SLOPE PAVING TO BE REMOVED UNLESS VERTICAL
CONCRETE BAFFLES AT EVERY 20' (TYP.)
REMOVE EX. CONC. INV.
PLACE SOIL & VEGETATE
PROTECT IN PLACE EX. CONC. INV.
183'
EX. LOW FLOW CHANNEL
EX. CONC. OR GROUTED ROCK SLOPE PAVING TO BE REMOVED UNLESS VERTICAL
REMOVE EX. CONC. INV.
PLACE SOIL & VEGETATE
15'
33'
RETAINING WALL
(3:1)
19'
4.25'
23'
5:1
A.C. PAVEMENT
LINE OF EXCAVATION
SUBDRAINAGE SYSTEM
2.25'
10'
6'
50'
RIPRAP
2'
4'
9'
0
15
30
60
REVISIONS
MARK
DATE
DESCRIPTION
BY
TETRA TECH, INC.
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3 OF 19
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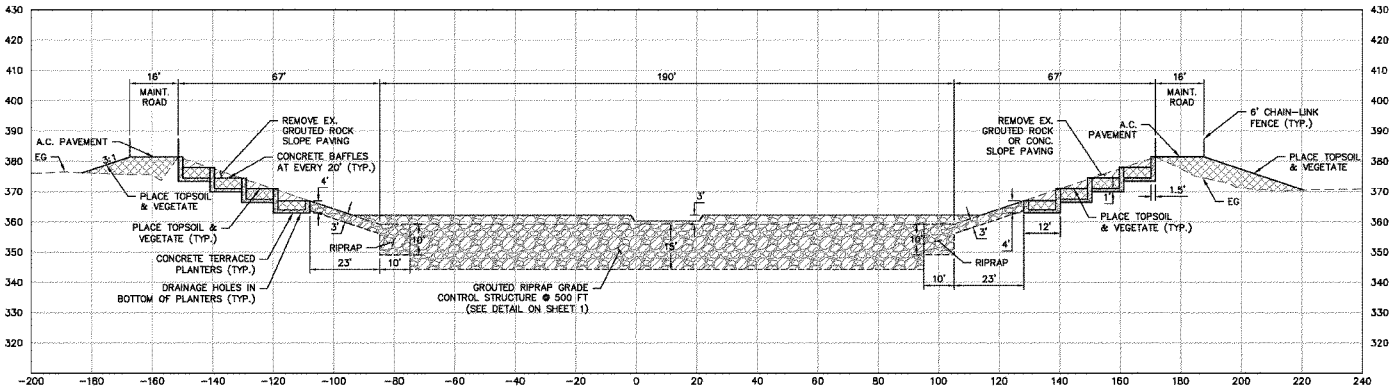

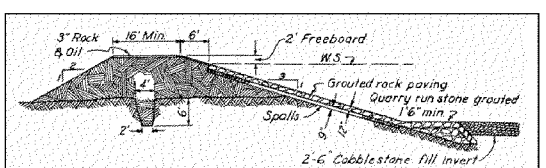

EXISTING TYPICAL SECTION
NTS

0 15 30 60

LEGEND

- EX. GROUND
- PROPOSED CHANNEL
- EXCAVATION
- COMPACTED FILL
- RIPRAP
- REINFORCED CONCRETE
- HIGH PERFORMANCE PYRAMAT TURF REINFORCEMENT MAT (TRM) OR APPROVED EQUIVALENT

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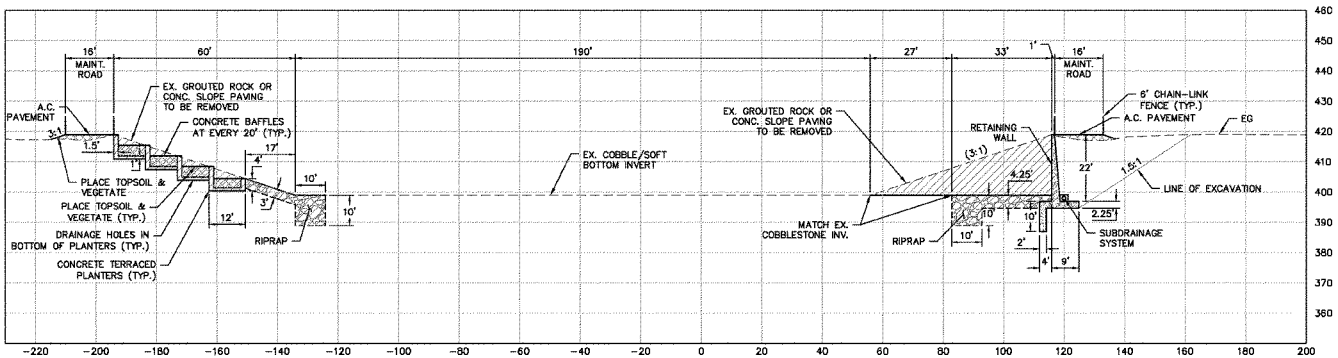

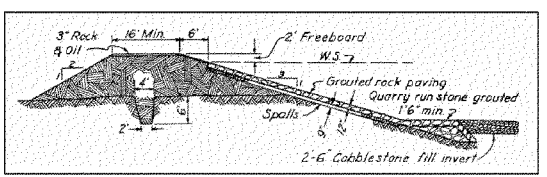

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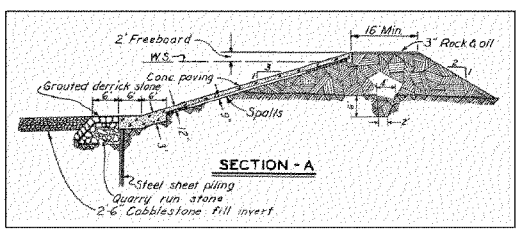

EXISTING TYPICAL SECTION
NTS

LEGEND

EX. GROUND	RIPRAP
PROPOSED CHANNEL	REINFORCED CONCRETE
EXCAVATION	HIGH PERFORMANCE PYRAMAT TURF REINFORCEMENT MAT (TRM) OR APPROVED EQUIVALENT
COMPACTED FILL	

0 15 30 60

REVISIONS			
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PRELIMINARY DESIGN

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CROSS SECTION 5

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SHT NO. 5 OF 19

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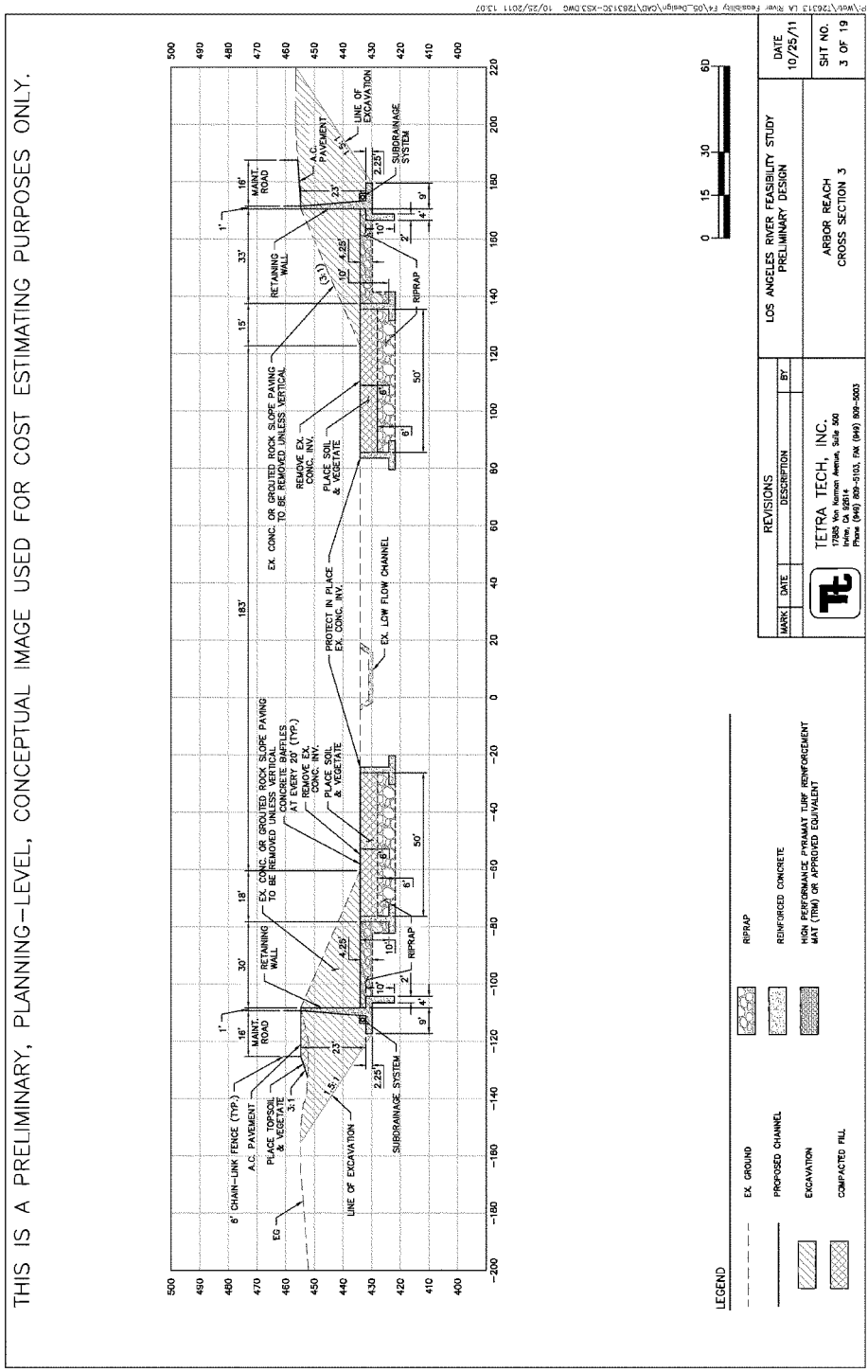
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LEGEND
EX. GROUND
PROPOSED CHANNEL
EXCAVATION
COMPACTED FILL
RIPRAP
REINFORCED CONCRETE
HIGH PERFORMANCE PYRAMAT TURF REINFORCEMENT MAT (TRM) OR APPROVED EQUIVALENT
REVISIONS
MARK DATE DESCRIPTION BY
TETRA TECH, INC.
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LOS ANGELES RIVER FEASIBILITY STUDY
PRELIMINARY DESIGN
ARBOR REACH
CROSS SECTION 3
DATE 10/25/11
SHT NO. 3 OF 19
0 15 30 60
6' CHAIN-LINK FENCE (TYP.)
A.C. PAVEMENT
PLACE TOPSOIL & VEGETATE
EG
LINE OF EXCAVATION
SUBDRAINAGE SYSTEM
MAINT. ROAD
RETAINING WALL
EX. CONC. OR GROUTED ROCK SLOPE PAVING TO BE REMOVED UNLESS VERTICAL
CONCRETE BAFFLES AT 40' CENTERS (TYP.)
REMOVE EX. CONC. INV.
PLACE SOIL & VEGETATE
PROTECT IN PLACE EX. CONC. INV.
EX. LOW FLOW CHANNEL
EX. CONC. OR GROUTED ROCK SLOPE PAVING TO BE REMOVED UNLESS VERTICAL
RETAINING WALL
MAINT. ROAD
A.C. PAVEMENT
LINE OF EXCAVATION
SUBDRAINAGE SYSTEM
RIPRAP
RIPRAP
183'
50'
50'

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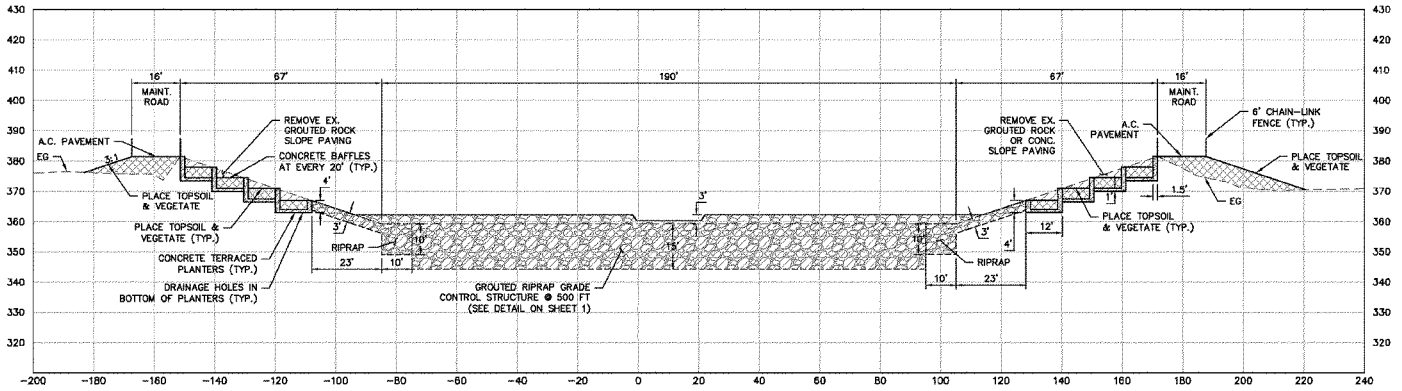

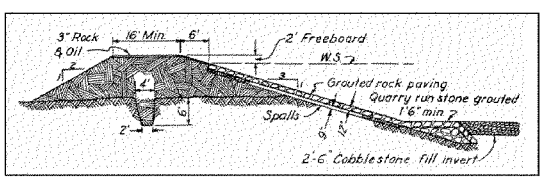

EXISTING TYPICAL SECTION
NTS

0 15 30 60

LEGEND

EX. GROUND	RIPRAP
PROPOSED CHANNEL	REINFORCED CONCRETE
EXCAVATION	HIGH PERFORMANCE PYRAMAT TURF REINFORCEMENT MAT (TRM) OR APPROVED EQUIVALENT
COMPACTED FILL	

REVISIONS				LOS ANGELES RIVER FEASIBILITY STUDY PRELIMINARY DESIGN	DATE 10/25/11
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				ARBOR REACH CROSS SECTION 4	SHT NO. 4 OF 19

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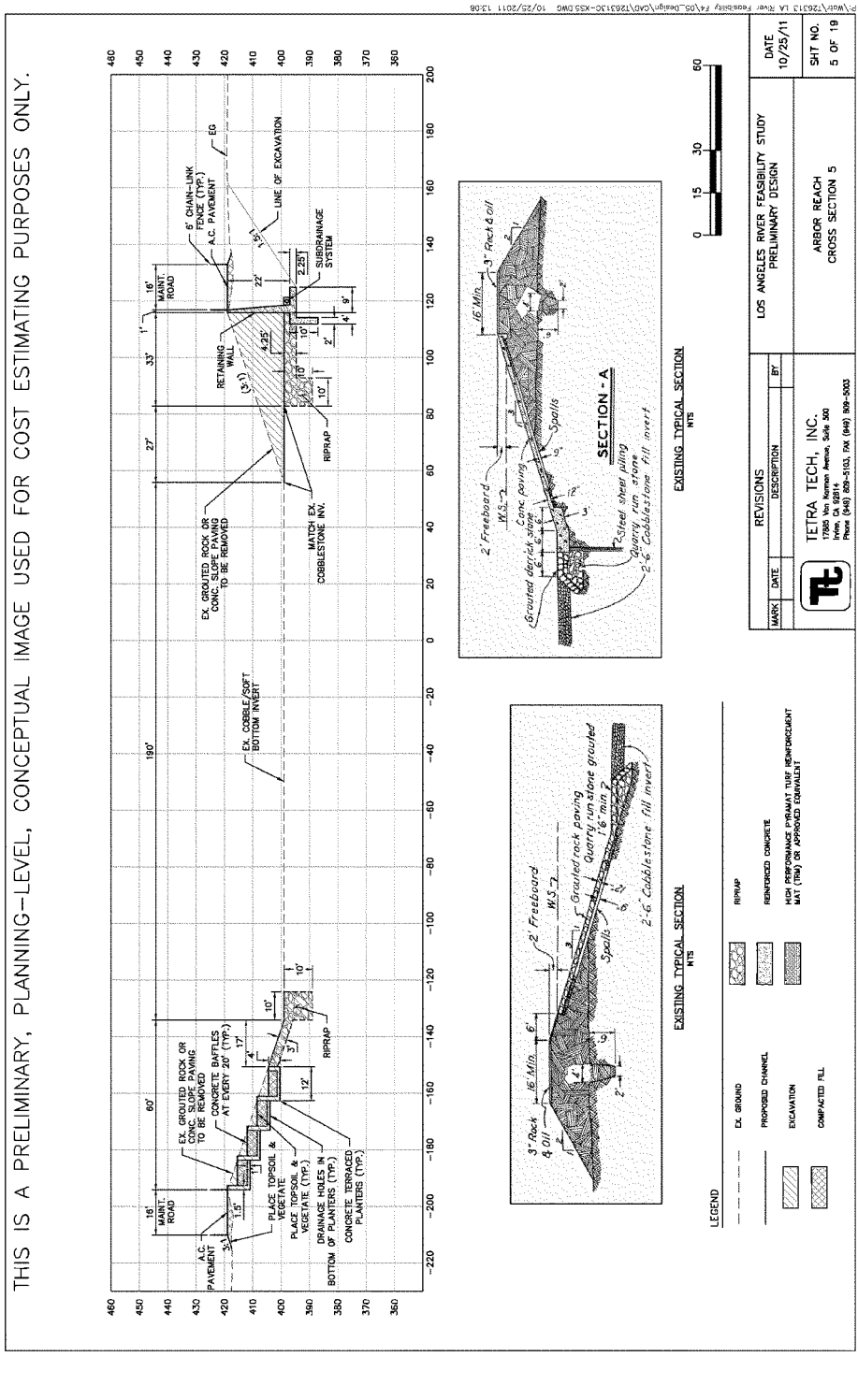
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MAINT. ROAD
A.C. PAVEMENT
EX. GROUTED ROCK OR CONC. SLOPE PAVING TO BE REMOVED
CONCRETE BAFFLES AT EVERY 20' (TYP.)
PLACE TOPSOIL & VEGETATE (TYP.)
DRAINAGE HOLES IN BOTTOM OF PLANTERS (TYP.)
CONCRETE TERRACED PLANTERS (TYP.)
RIPRAP
EX. COBBLE/SOFT BOTTOM INVERT
RETAINING WALL
6' CHAIN-LINK FENCE (TYP.)
EG
LINE OF EXCAVATION
SUBDRAINAGE SYSTEM
MATCH EX. COBBLESTONE INV.
EXISTING TYPICAL SECTION
NTS
3" Rock & oil
16" Min.
2' Freeboard
W.S.-2
Grouted rock paving
Quarry run stone grouted
16" min.
Spalls
2'-6" Cobblestone fill invert
SECTION - A
Steel sheet piling
Quarry run stone
Conc paving
Grouted derick stone
0 15 30 60
LEGEND
EX. GROUND
PROPOSED CHANNEL
EXCAVATION
COMPACTED FILL
RIPRAP
REINFORCED CONCRETE
HIGH PERFORMANCE DYNAMAT TURF REINFORCEMENT MAT (TRM) OR APPROVED EQUIVALENT
REVISIONS
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LOS ANGELES RIVER FEASIBILITY STUDY
PRELIMINARY DESIGN
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CROSS SECTION 5
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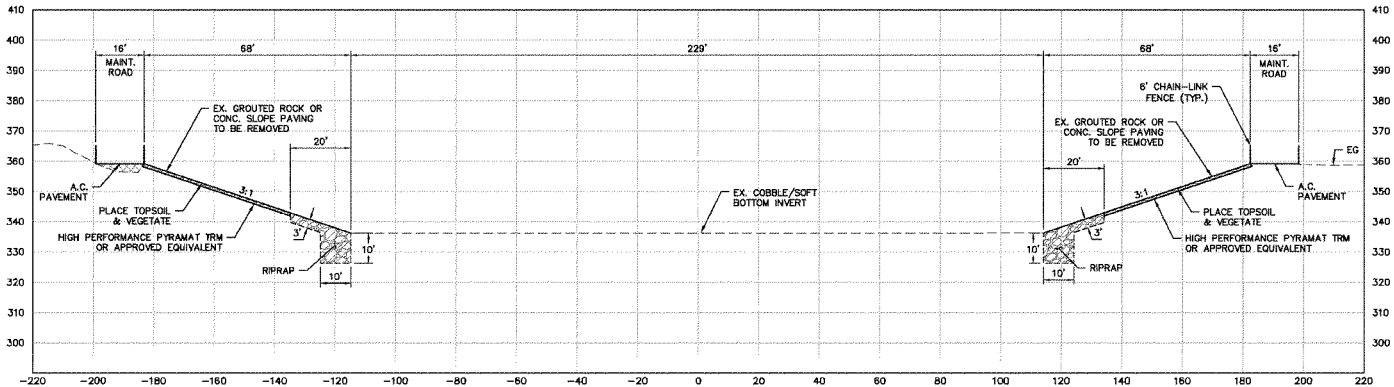

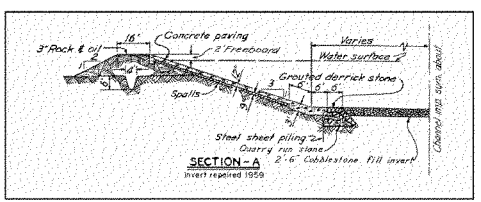

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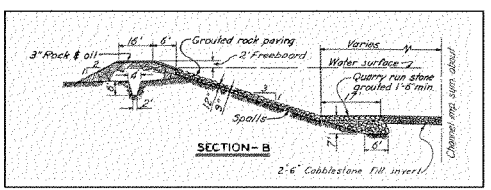

EXISTING TYPICAL SECTION
NTS

0 15 30 60

LEGEND

EX. GROUND		RIPRAP	
PROPOSED CHANNEL		REINFORCED CONCRETE	
EXCAVATION		HIGH PERFORMANCE PYRAMAT TURF REINFORCEMENT MAT (TRM) OR APPROVED EQUIVALENT	
COMPACTED FILL			

REVISIONS			
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LOS ANGELES RIVER FEASIBILITY STUDY
PRELIMINARY DESIGN

ARBOR REACH
CROSS SECTION 6a

DATE
10/25/11

SHT NO.
6 OF 19

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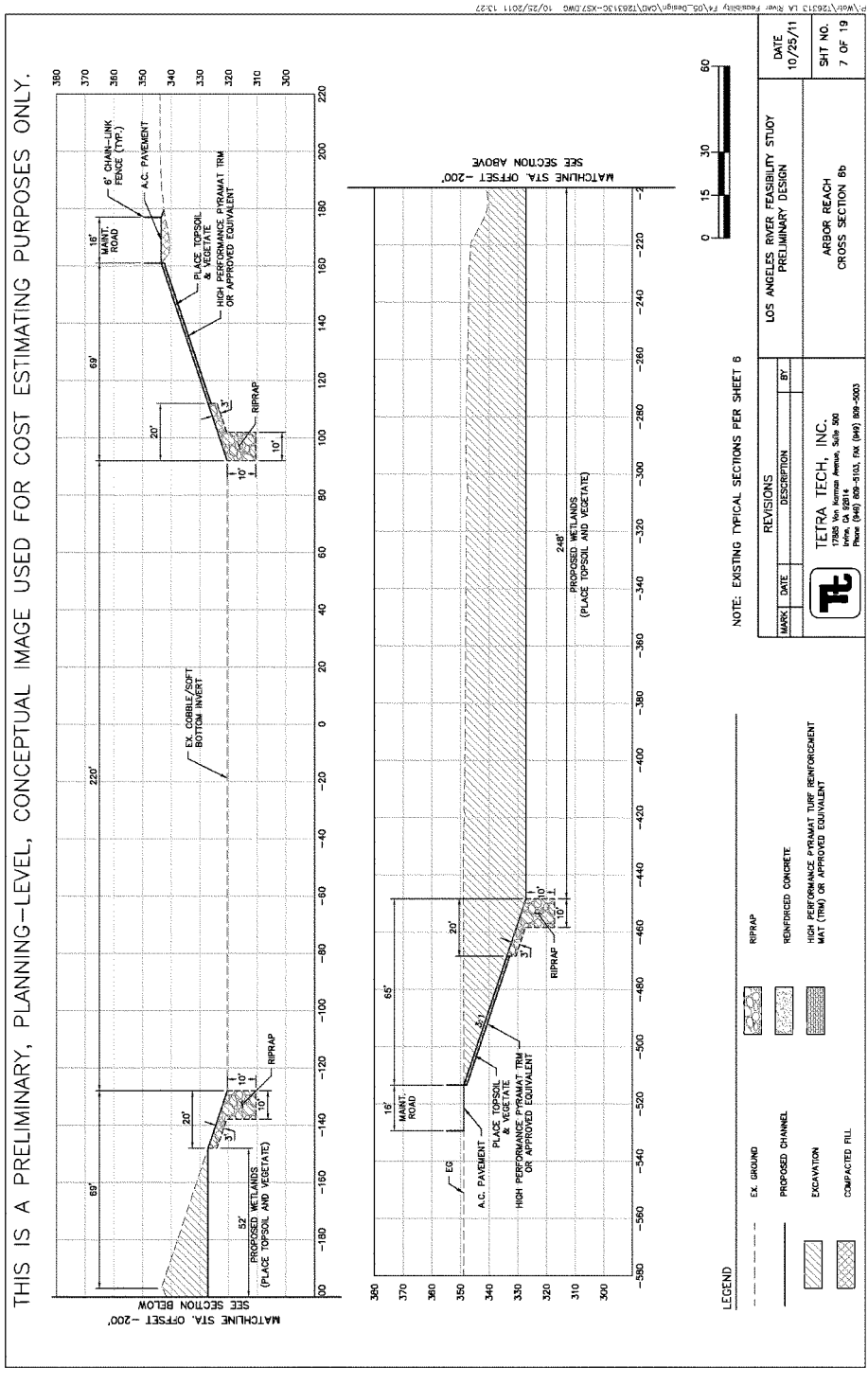
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MATCHLINE STA. OFFSET -200'
SEE SECTION BELOW
MATCHLINE STA. OFFSET -200'
SEE SECTION ABOVE
6' CHAIN-LINK FENCE (TYP.)
A.C. PAVEMENT
18' MAINT. ROAD
PLACE TOPSOIL & VEGETATE
HIGH PERFORMANCE PYRAMAT TRM OR APPROVED EQUIVALENT
RIPRAP
EX. COBBLE/SOFT BOTTOM INVERT
PROPOSED WETLANDS (PLACE TOPSOIL AND VEGETATE)
EG
LEGEND
EX. GROUND
PROPOSED CHANNEL
EXCAVATION
COMPACTED FILL
RIPRAP
REINFORCED CONCRETE
HIGH PERFORMANCE PYRAMAT TURF REINFORCEMENT MAT (TRM) OR APPROVED EQUIVALENT
NOTE: EXISTING TYPICAL SECTIONS PER SHEET 6
REVISIONS
MARK DATE DESCRIPTION BY
TETRA TECH, INC.
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Phone (949) 809-5100, FAX (949) 809-5003
LOS ANGELES RIVER FEASIBILITY STUDY
PRELIMINARY DESIGN
ARBOR REACH
CROSS SECTION 6b
DATE 10/25/11
SHT NO. 7 OF 19

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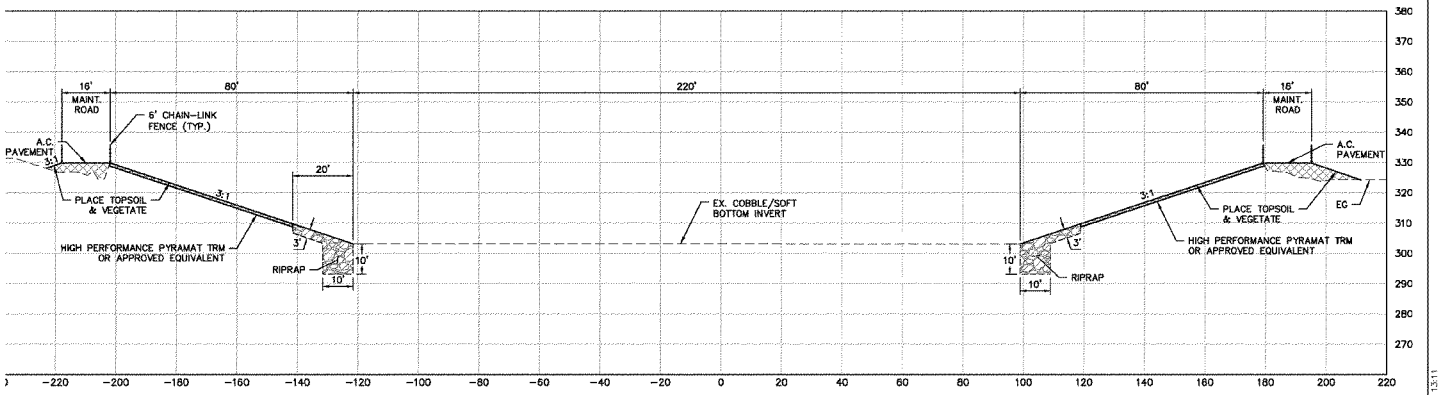

LEGEND

- EX. GROUND
- PROPOSED CHANNEL
- EXCAVATION
- COMPACTED FILL
- RIPRAP
- REINFORCED CONCRETE
- HIGH PERFORMANCE PYRAMAT TURF REINFORCEMENT MAT (TRM) OR APPROVED EQUIVALENT

0 15 30 60

NOTE: EXISTING TYPICAL SECTIONS PER SHEET 6

REVISIONS			
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Irvine, CA 92614
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LOS ANGELES RIVER FEASIBILITY STUDY
PRELIMINARY DESIGN

ARBOR REACH
CROSS SECTION 6c

DATE 10/25/11

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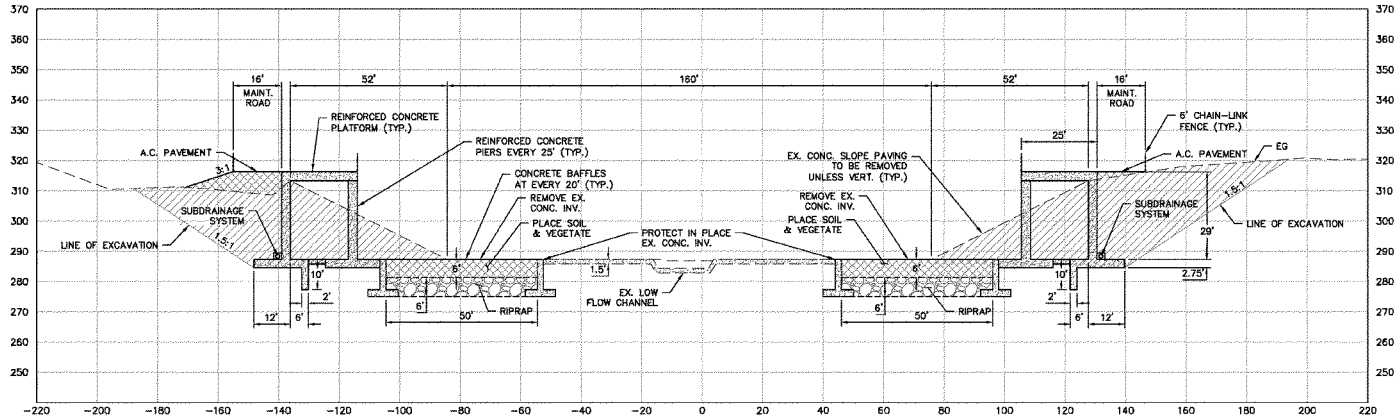

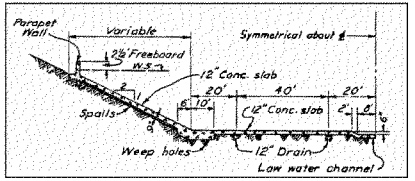

EXISTING TYPICAL SECTION
NTS

0 15 30 60

LEGEND

- EX. GROUND
- PROPOSED CHANNEL
- EXCAVATION
- COMPACTED FILL
- RIPRAP
- REINFORCED CONCRETE
- HIGH PERFORMANCE PYRAMAT TURF REINFORCEMENT MAT (TRM) OR APPROVED EQUIVALENT

REVISIONS			
MARK	DATE	DESCRIPTION	BY

TETRA TECH, INC.
17885 Von Karman Avenue, Suite 500
Irvine, CA 92614
Phone (949) 809-5103, FAX (949) 809-5003

LOS ANGELES RIVER FEASIBILITY STUDY
PRELIMINARY DESIGN

ARBOR REACH
CROSS SECTION 7

DATE 10/25/11

SHT NO. 9 OF 19

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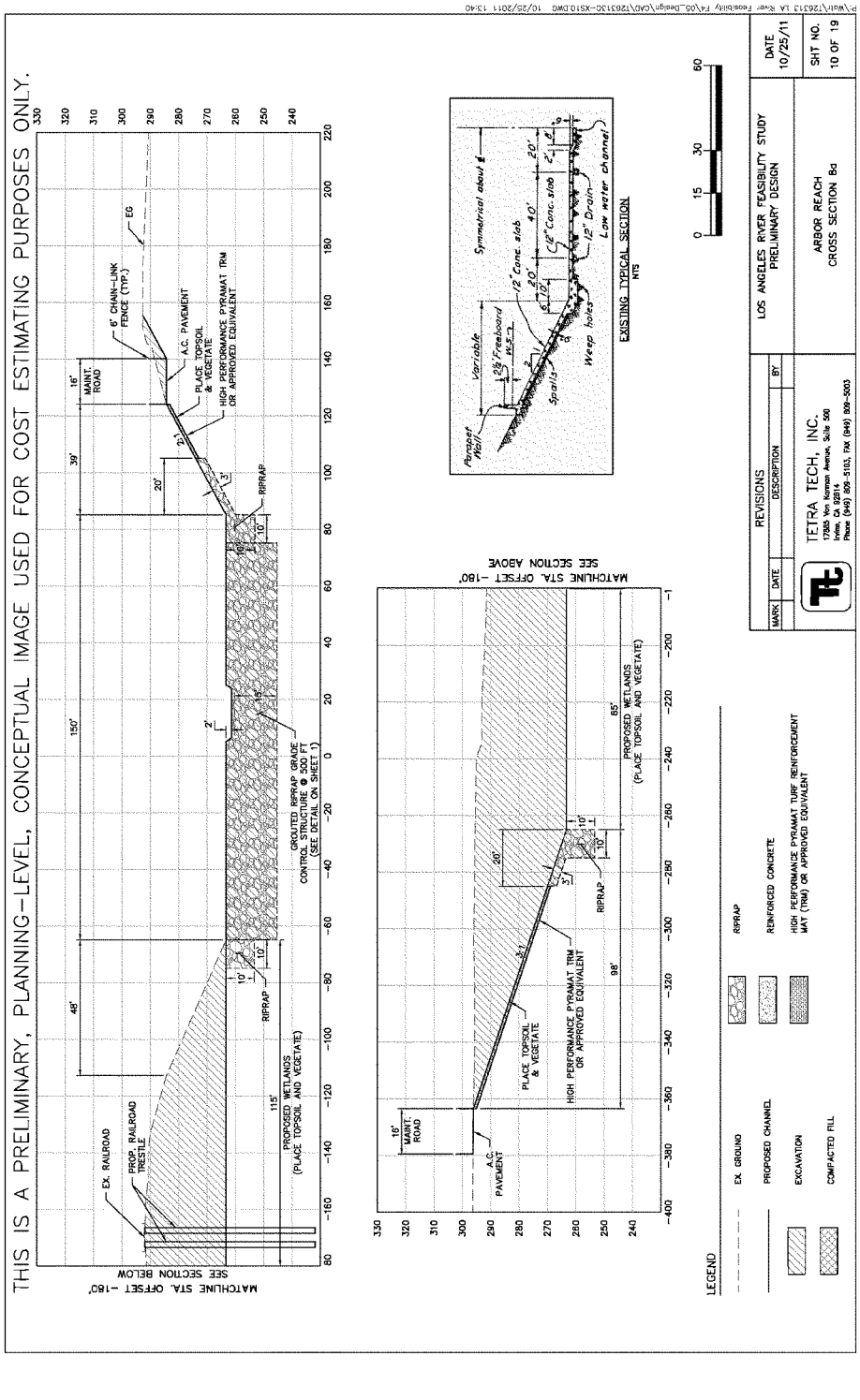
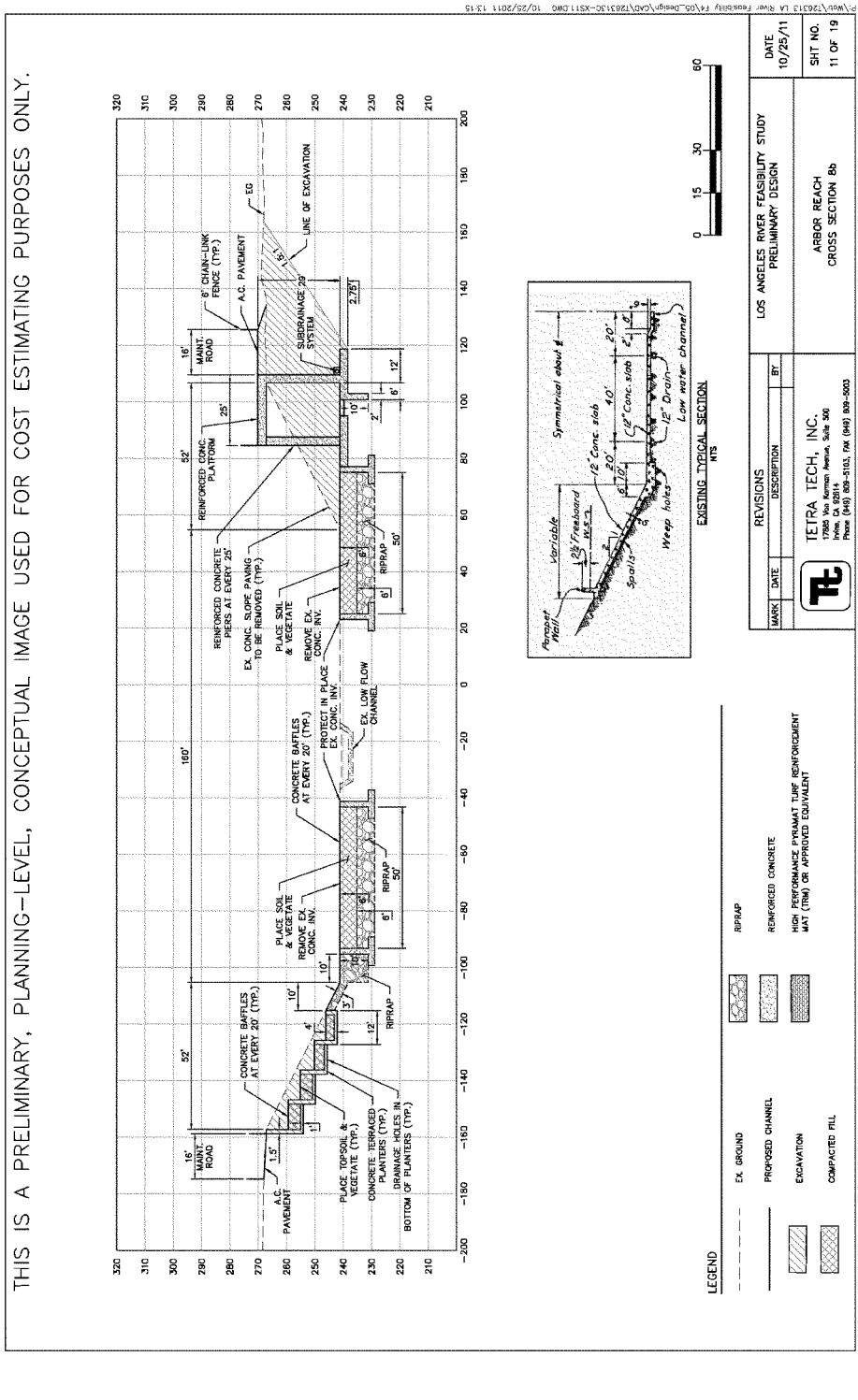

THIS IS A PRELIMINARY, PLANNING-LEVEL, CONCEPTUAL IMAGE USED FOR COST ESTIMATING PURPOSES ONLY.
MATCHLINE STA. OFFSET -180' SEE SECTION BELOW
EX. RAILROAD
PROP. RAILROAD TRESTLE
115'
PROPOSED WETLANDS (PLACE TOPSOIL AND VEGETATE)
RIPRAP
48'
150'
16' MAINT. ROAD
39'
6' CHAIN-LINK FENCE (TYP.)
EG
A.C. PAVEMENT
PLACE TOPSOIL & VEGETATE
HIGH PERFORMANCE PYRAMAT TRM OR APPROVED EQUIVALENT
20'
3:1
3'
2'
GROUTED RIPRAP GRADE CONTROL STRUCTURE @ 500 FT (SEE DETAIL ON SHEET 1)
MATCHLINE STA. OFFSET -180' SEE SECTION ABOVE
85'
98'
26'
EXISTING TYPICAL SECTION
NTS
Parapet Wall
Variable
2½' Freeboard
12" Conc. slab
Symmetrical about ℄
Spalls
Weep holes
12" Drain
Low water channel
0 15 30 60
LEGEND
EX. GROUND
PROPOSED CHANNEL
EXCAVATION
COMPACTED FILL
RIPRAP
REINFORCED CONCRETE
HIGH PERFORMANCE PYRAMAT TURF REINFORCEMENT MAT (TRM) OR APPROVED EQUIVALENT
REVISIONS
MARK DATE DESCRIPTION BY
TETRA TECH, INC.
17885 Von Karman Avenue, Suite 500
Irvine, CA 92614
Phone (949) 809-5103, FAX (949) 809-5093
LOS ANGELES RIVER FEASIBILITY STUDY
PRELIMINARY DESIGN
ARBOR REACH
CROSS SECTION 8a
DATE 10/25/11
SHT NO. 10 OF 19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LEGEND
EX. GROUND
PROPOSED CHANNEL
EXCAVATION
COMPACTED FILL
RIPRAP
REINFORCED CONCRETE
HIGH PERFORMANCE PYRAMAT TURF REINFORCEMENT MAT (TRM) OR APPROVED EQUIVALENT
A.C. PAVEMENT
PLACE TOPSOIL & VEGETATE (TYP.)
CONCRETE TERRACED PLANTERS (TYP.)
DRAINAGE HOLES IN BOTTOM OF PLANTERS (TYP.)
CONCRETE BAFFLES AT EVERY 20' (TYP.)
MAINT. ROAD
PLACE SOIL & VEGETATE
REMOVE EX. CONC. INV.
PROTECT IN PLACE EX. CONC. INV.
EX. LOW FLOW CHANNEL
REINFORCED CONCRETE PIERS AT EVERY 25'
EX. CONC. SLOPE PAVING TO BE REMOVED (TYP.)
REINFORCED CONC. PLATFORM
SUBDRAINAGE SYSTEM
8' CHAIN-LINK FENCE (TYP.)
EG
LINE OF EXCAVATION
EXISTING TYPICAL SECTION
NTS
Parapet Wall
Variable
2ft Freeboard
Symmetrical about ℄
12' Conc. slab
20'
40'
Spalls
Weep holes
12" Drain
Low water channel
0
15
30
60
REVISIONS
MARK
DATE
DESCRIPTION
BY
TETRA TECH, INC.
17885 Von Karman Avenue, Suite 300
Irvine, CA 92614
Phone (949) 809-5103, FAX (949) 809-5003
LOS ANGELES RIVER FEASIBILITY STUDY
PRELIMINARY DESIGN
ARBOR REACH
CROSS SECTION Bb
DATE
10/25/11
SHT NO.
11 OF 19

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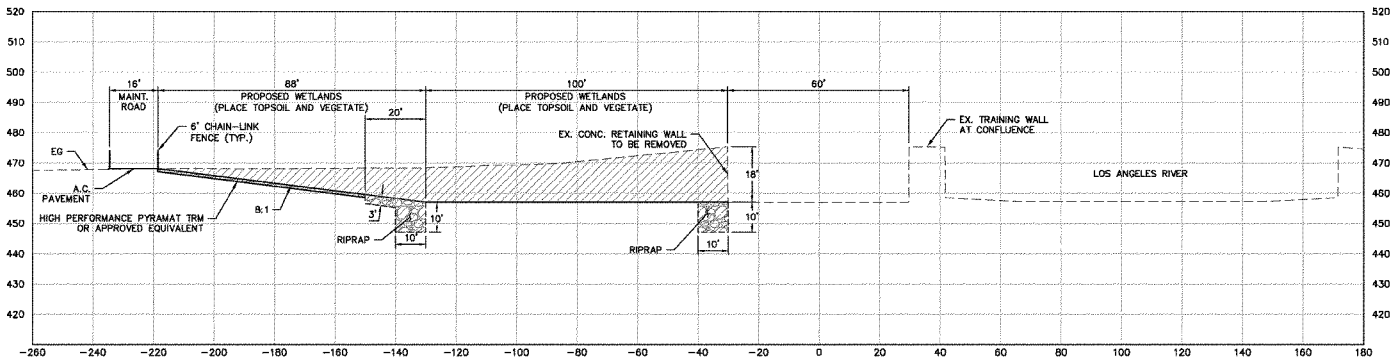

LEGEND

- EX. GROUND
- PROPOSED CHANNEL
- EXCAVATION
- COMPACTED FILL
- RIPRAP
- REINFORCED CONCRETE
- HIGH PERFORMANCE PYRAMAT TURF REINFORCEMENT MAT (TRM) OR APPROVED EQUIVALENT

0 15 30 60

REVISIONS			
MARK	DATE	DESCRIPTION	BY

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LOS ANGELES RIVER FEASIBILITY STUDY
PRELIMINARY DESIGN

BURBANK CHANNEL
CROSS SECTION

DATE 10/25/11

SHT NO. 12 OF 19

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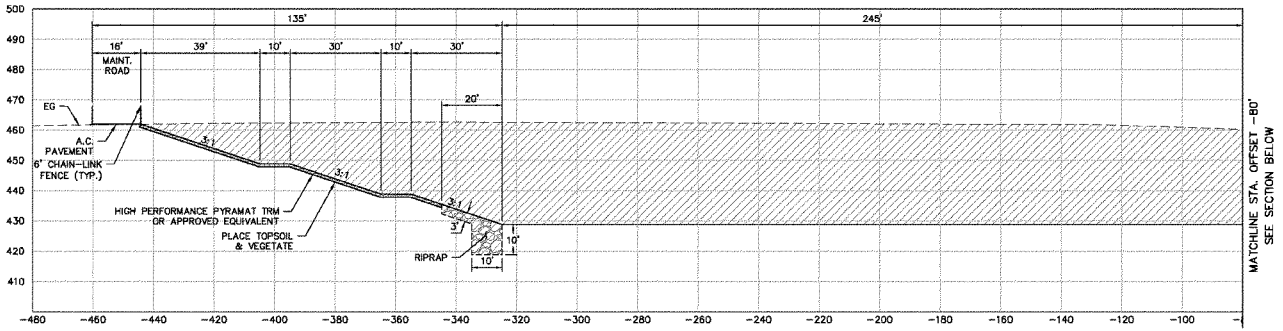

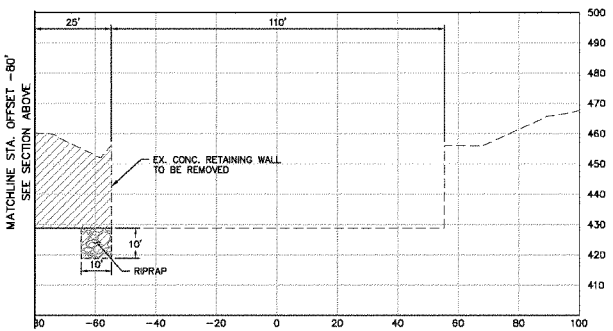

NOTE: FREEWAY PIER DEPTH/
AS-BUILT DRAWING INFORMATION BEING AQUIRED.

0 15 30 60

LEGEND

- EX. GROUND
- PROPOSED CHANNEL
- EXCAVATION
- COMPACTED FILL
- RIPRAP
- REINFORCED CONCRETE
- HIGH PERFORMANCE PYRAMAT TURF REINFORCEMENT MAT (TRM) OR APPROVED EQUIVALENT

REVISIONS			
MARK	DATE	DESCRIPTION	BY

TETRA TECH, INC.
17885 Von Karman Avenue, Suite 300
Irvine, CA 92614
Phone (949) 809-5103, FAX (949) 809-5003

LOS ANGELES RIVER FEASIBILITY STUDY
PRELIMINARY DESIGN

VERDUGO WASH
CROSS SECTION 1

DATE 10/25/11

SHT NO. 13 OF 19

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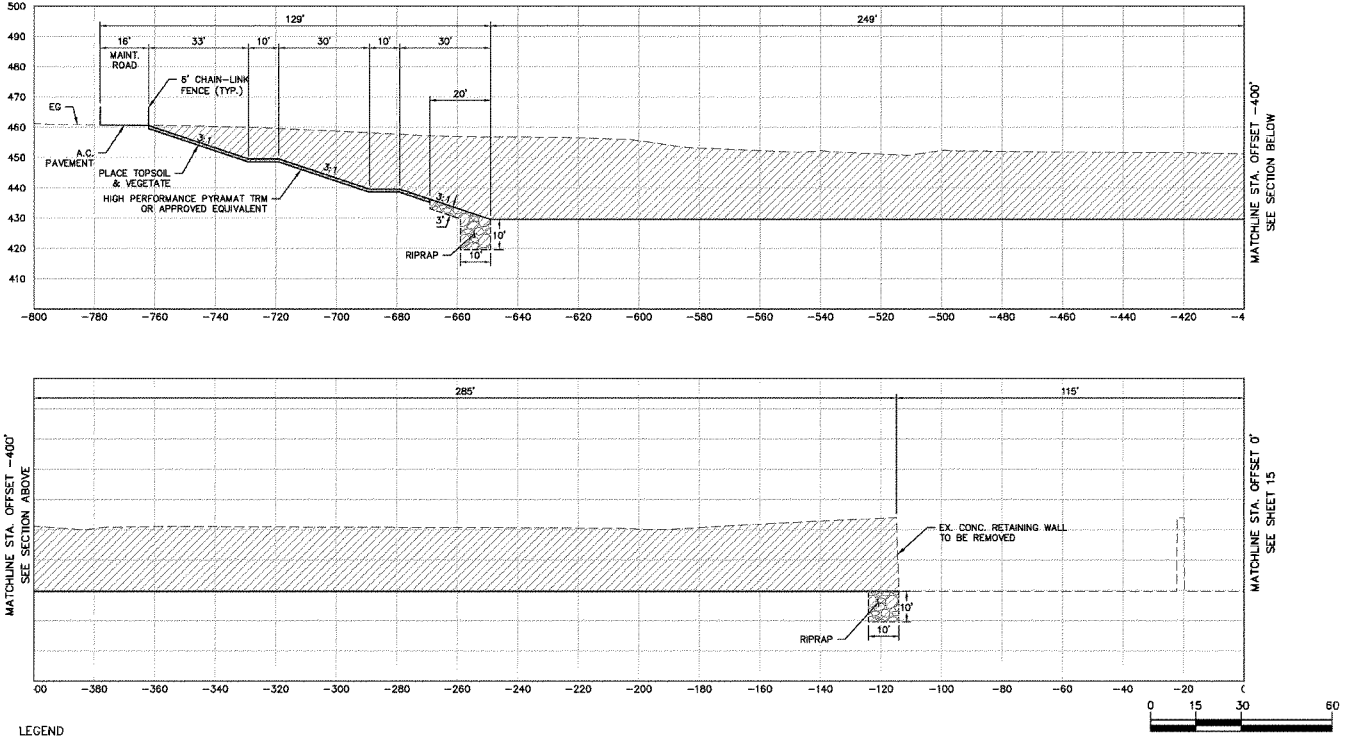

LEGEND

- EX. GROUND
- PROPOSED CHANNEL
- EXCAVATION
- COMPACTED FILL
- RIPRAP
- REINFORCED CONCRETE
- HIGH PERFORMANCE PYRAMAT TURF REINFORCEMENT MAT (TRM) OR APPROVED EQUIVALENT

REVISIONS				LOS ANGELES RIVER FEASIBILITY STUDY PRELIMINARY DESIGN	DATE 10/25/11
MARK	DATE	DESCRIPTION	BY		
				VERDUGO WASH CROSS SECTION 2	SHT NO. 14 OF 19

TETRA TECH, INC.
17885 Von Karman Avenue, Suite 500
Irvine, CA 92614
Phone (949) 809-5103, FAX (949) 809-5003

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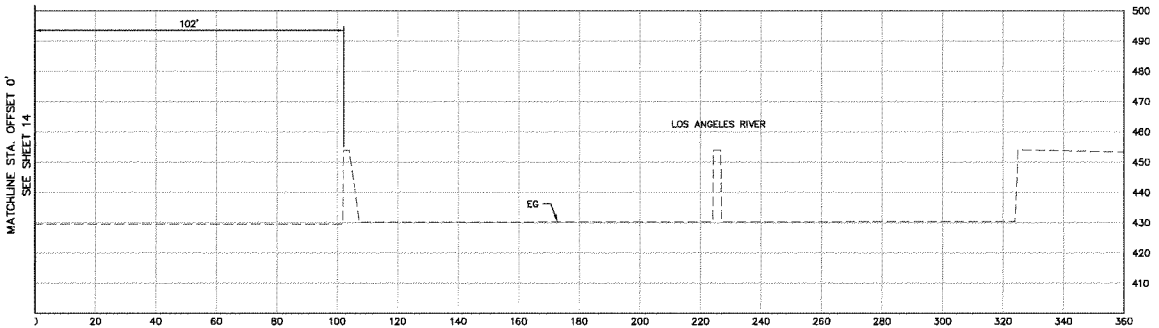

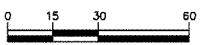

LEGEND

- EX. GROUND
- PROPOSED CHANNEL
- EXCAVATION
- COMPACTED FILL
- RIPRAP
- REINFORCED CONCRETE
- HIGH PERFORMANCE PYRAMAT TURF REINFORCEMENT MAT (TRM) OR APPROVED EQUIVALENT

REVISIONS			
MARK	DATE	DESCRIPTION	BY

TETRA TECH, INC.
17885 Von Karman Avenue, Suite 500
Irvine, CA 92614
Phone (949) 809-5103, FAX (949) 809-5003

LOS ANGELES RIVER FEASIBILITY STUDY
PRELIMINARY DESIGN

VERDUGO WASH
CROSS SECTION 2 CONT.

DATE
10/25/11

SHT NO.
15 OF 19

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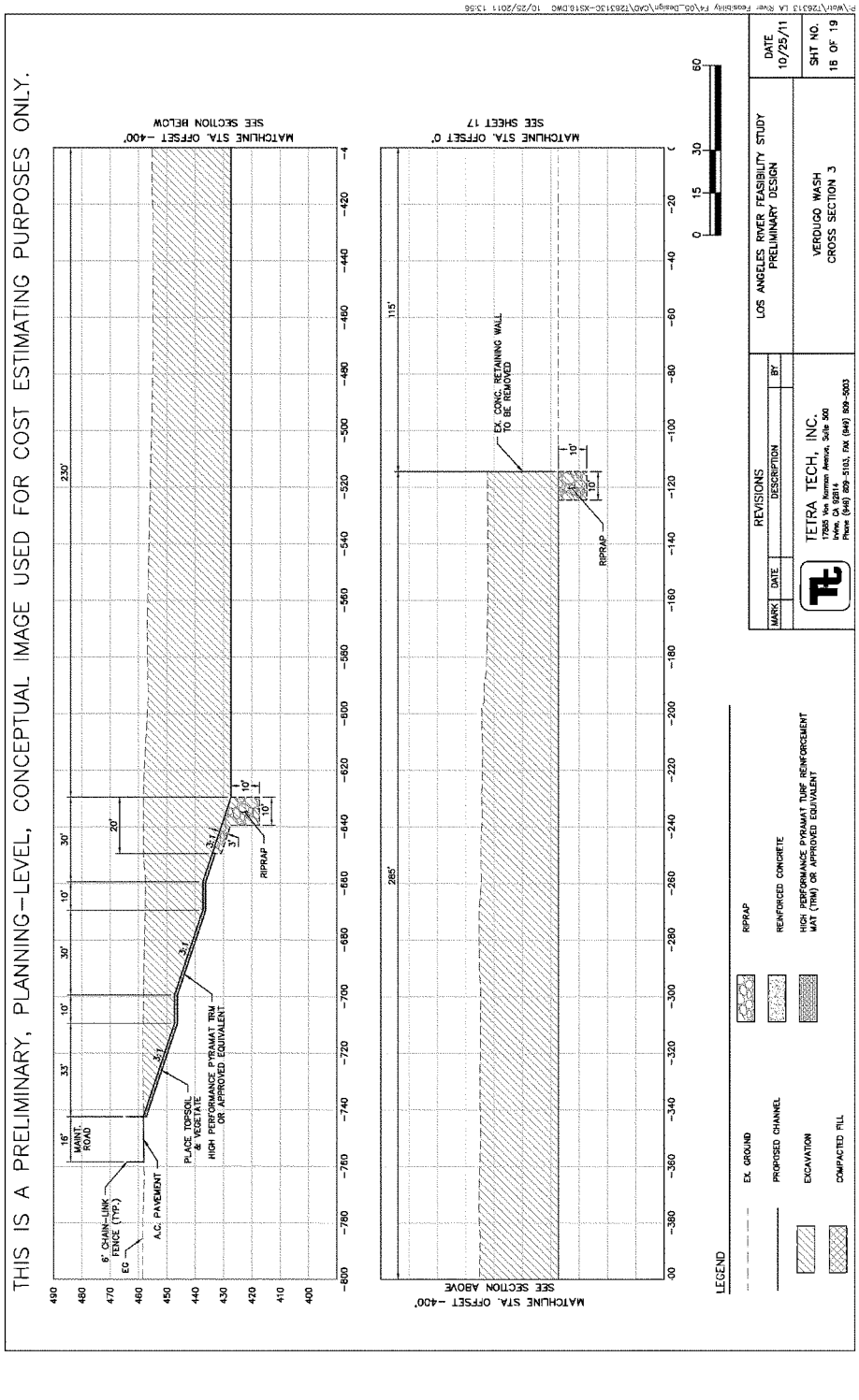
THIS IS A PRELIMINARY, PLANNING-LEVEL, CONCEPTUAL IMAGE USED FOR COST ESTIMATING PURPOSES ONLY.
MATCHLINE STA. OFFSET -400'
SEE SECTION BELOW
MATCHLINE STA. OFFSET 0'
SEE SHEET 17
MATCHLINE STA. OFFSET -400'
SEE SECTION ABOVE
16' MAINT. ROAD
33'
10'
30'
10'
30'
20'
230'
115'
285'
5' CHAIN-LINK FENCE (TYP.)
EG
A.C. PAVEMENT
PLACE TOPSOIL & VEGETATE
HIGH PERFORMANCE PYRAMAT TRM OR APPROVED EQUIVALENT
3:1
RIPRAP
10'
EX. CONC. RETAINING WALL TO BE REMOVED
LEGEND
EX. GROUND
PROPOSED CHANNEL
EXCAVATION
COMPACTED FILL
RIPRAP
REINFORCED CONCRETE
HIGH PERFORMANCE PYRAMAT TURF REINFORCEMENT MAT (TRM) OR APPROVED EQUIVALENT
REVISIONS
MARK
DATE
DESCRIPTION
BY
TETRA TECH, INC.
17885 Von Karman Avenue, Suite 500
Irvine, CA 92614
Phone (949) 809-5103, FAX (949) 809-5003
LOS ANGELES RIVER FEASIBILITY STUDY
PRELIMINARY DESIGN
VERDUGO WASH
CROSS SECTION 3
DATE
10/25/11
SHT NO.
16 OF 19

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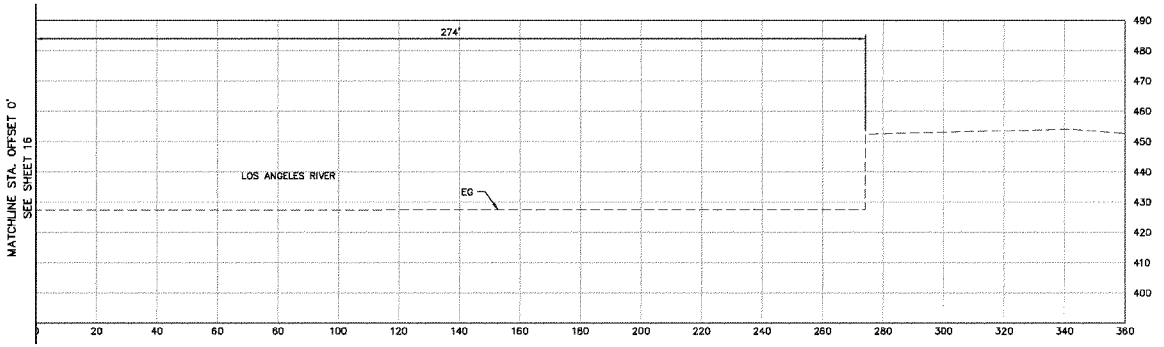

LEGEND

- EX. GROUND
- PROPOSED CHANNEL
- EXCAVATION
- COMPACTED FILL
- RIPRAP
- REINFORCED CONCRETE
- HIGH PERFORMANCE PYRAMAT TURF REINFORCEMENT MAT (TRM) OR APPROVED EQUIVALENT

REVISIONS			
MARK	DATE	DESCRIPTION	BY

TETRA TECH, INC.
17885 Von Karman Avenue, Suite 500
Irvine, CA 92614
Phone (949) 809-5103, FAX (949) 809-5003

LOS ANGELES RIVER FEASIBILITY STUDY
PRELIMINARY DESIGN

VERDUGO WASH
CROSS SECTION 3 CONTINUED

DATE 10/25/11

SHT NO. 17 OF 19

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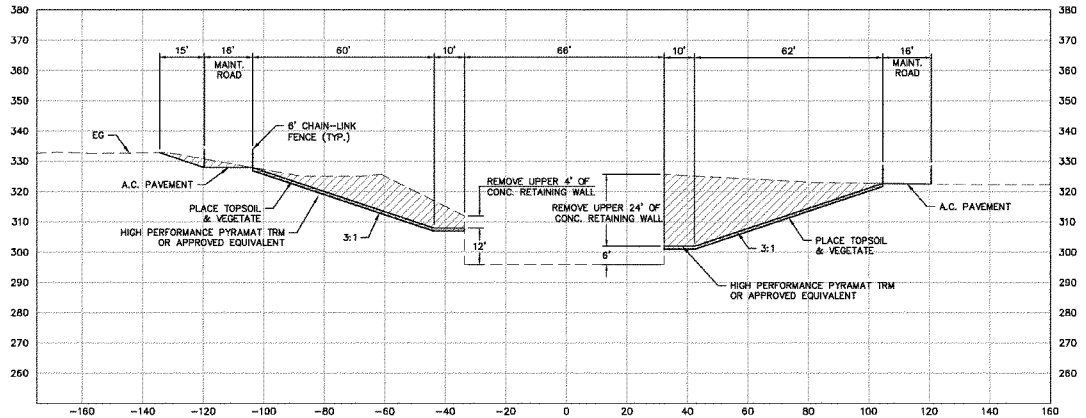

LEGEND

- EX. GROUND
- PROPOSED CHANNEL
- EXCAVATION
- COMPACTED FILL
- RIPRAP
- REINFORCED CONCRETE
- HIGH PERFORMANCE PYRAMAT TURF REINFORCEMENT MAT (TRM) OR APPROVED EQUIVALENT

0 15 30 60

REVISIONS			
MARK	DATE	DESCRIPTION	BY

TETRA TECH, INC.
17885 Von Karman Avenue, Suite 500
Irvine, CA 92614
Phone (949) 809-5103, FAX (949) 809-5003

LOS ANGELES RIVER FEASIBILITY STUDY
PRELIMINARY DESIGN

ARROYO SECO
CROSS SECTION

DATE 10/25/11

SHT NO. 18 OF 19

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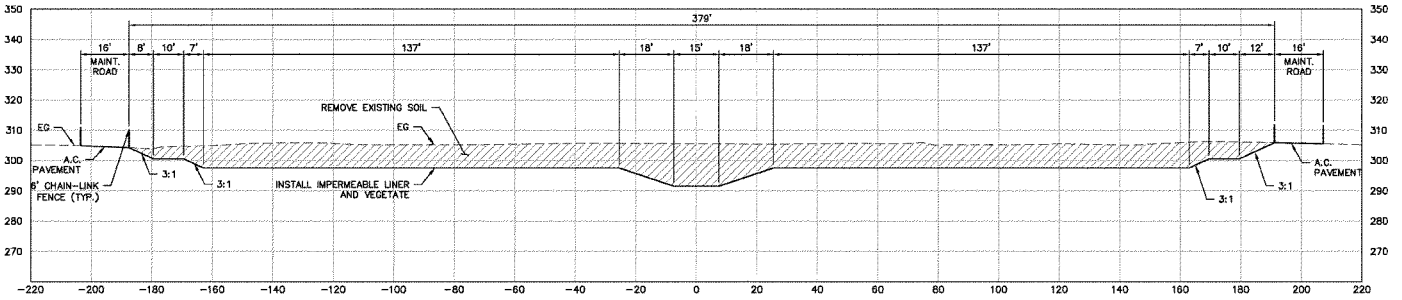

0 15 30 60

LEGEND

- EX. GROUND
- PROPOSED CHANNEL
- EXCAVATION
- COMPACTED FILL
- RIPRAP
- REINFORCED CONCRETE
- HIGH PERFORMANCE PYRAMAT TURF REINFORCEMENT MAT (TRM) OR APPROVED EQUIVALENT

REVISIONS			
MARK	DATE	DESCRIPTION	BY

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17885 Von Karman Avenue, Suite 500
Irvine, CA 92614
Phone (949) 809-5103, FAX (949) 809-5003

LOS ANGELES RIVER FEASIBILITY STUDY
PRELIMINARY DESIGN

CORN FIELD
CROSS SECTION

DATE 10/25/11

SHT NO. 19 OF 19

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FOR CONTINUATION OF HOUSE DOCUMENT 115-29

LOS ANGELES RIVER ECOSYSTEM RESTORATION INTEGRATED FEASIBILITY REPORT: FINAL FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT/ ENVIRONMENTAL IMPACT REPORT

SEE PART 2