

105th Congress, 1st Session - - - - - House Document 105-171

LOUISIANA HURRICANE PROTECTION PROJECT

COMMUNICATION

FROM

THE ACTING ASSISTANT SECRETARY (CIVIL
WORKS), THE DEPARTMENT OF THE ARMY

TRANSMITTING

THE REPORT ON A HURRICANE AND STORM DAMAGE REDUCTION
PROJECT FOR THE LAKE CATAOUATCHE AREA ON THE WEST
BANK OF THE MISSISSIPPI RIVER IN THE VICINITY OF NEW OR-
LEANS, LOUISIANA, PURSUANT TO PUB. L. 104-303, SEC.
101(b)(11)



NOVEMBER 13, 1997.—Referred to the Committee on Transportation and
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WASHINGTON : 1998

CONTENTS

	Page
Letter of Transmittal	vii
Comments of the Office of Management and Budget	ix
Comments of the State of Louisiana	x
Comments of the Department of the Interior	xii
Response to the Department of the Interior	xv
Comments of the Department of Commerce	xvi
Comments of the Department of Health and Human Services	xviii
Comments of the Environmental Protection Agency	xix
Report of the Chief of Engineers, Department of the Army	1
Recommendation of the Division Engineer	10
Report of the District Engineer:	
Syllabus	12
Introduction	15
Study Authority	15
Study Purpose and Scope	15
Report and Study Process	16
Prior Studies and Reports	16
West Bank Hurricane Protection	17
Other Studies and Reports	18
Problem Identification	22
Introduction	22
The National Objective	22
Existing Conditions	22
Location	22
Physical Setting	23
Physiography	23
Geology	23
Subsidence	24
Soils	24
Cimatology/Hydrology	25
Existing Protection and Drainage	29
Development and Economy	31
Business/Industrial Activity and Regional Growth	31
Employment	32
Income	34
Population	35
Property Values and Housing	36
Economic Outlook	37
Environmental and Natural Resources	37
Biological	37
Aquatic Resources	38
Water Quality	38
Cultural Resources	39
Recreation	39
Conditions If No Federal Action Is Taken	40
Socioeconomic Resources	40
Environmental Resources	42
Biological	42
Aquatic Resources	44
Sea Level Rise and Subsidence	45
Water Quality	45
Cultural Resources	45
Recreation	45
Plan Formulation	46

IV

	Page
Report of the District Engineer—Continued	
Plan Formulation—Continued	
Problems, Needs and Opportunities	46
Problems and Needs Related to Hurricane Protection	46
Problems Related to Hurricane Evacuation	49
Opportunities for Natural Resource Protection	52
Improvements Desired	53
Planning Constraints	54
Planning Objectives	54
Management Measures	54
Formulation Principles	55
Plan Formulation Rationale	56
Plans Considered	58
Plan 1A	58
Plan 1B	59
Plan 1C	60
Plan 2A	61
Plan 2B	62
Plan Assessment and Evaluation	63
Plan 1A	64
Plan 1B	65
Plan 1C	69
Plan 2A	72
Plan 2B	73
Summary of Plan Assessment	75
Comparison of Plans	75
Economic Considerations	82
Social Consideration	83
Engineering Considerations	85
Environmental Considerations	88
Hazardous, Toxicological and Radioactive Waste (HTRW) Consid- erations	89
Public Interest Considerations	90
Conclusions	91
Risk-Based Analysis	91
National Economic Development (NED) Plan	95
Determination of the Recommended Plan	97
Rationale for Deviating from NED Protection	97
Recommended Plan	101
Plan Description	101
Plan Accomplishments	103
Summary of Economic Analysis	104
Engineering Design	107
Levees	107
Floodwalls	109
Pumping Stations	109
Relocations	110
Real Estate Considerations	110
Operation and Maintenance Considerations	111
Social, Environmental, HTRW and Public Interest Effects	112
Social Effects	112
Environmental Effects	112
HTRW Effects	113
Public Interest Effects	113
Relationship to Westwego to Harvey Canal	114
Plan Implementation	116
Introduction	116
Cost Apportionment	116
Division of Responsibilities	117
Federal Responsibilities	117
Non-Federal Responsibilities	117
Summary of Coordination	119
Local Cooperation	121
Views of Local Sponsor	121
Preliminary Financing Negotiations	121
Assessment of Financial Capability	121
Environmental Impact Statement	124

	Page
Report of the District Engineer—Continued	
Conclusion	182
Recommendations of the District Engineer	184
Plates 1 through 6.....	187–192

APPENDICES ACCOMPANYING THE REPORT OF THE DISTRICT ENGINEER

Appendix A—Engineering Investigations (only sections 2, 3, 4 & 5 printed)	193
Appendix B—Economics (only sections 9 & 10 printed)	206
Appendix C—Environmental Supporting Documentation (not printed).	
Appendix D—Fish and Wildlife Coordination Act Report (not printed).	
Appendix E—Real Estate Supplement (not printed).	
Appendix F—Public Views and Responses (not printed).	

LETTER OF TRANSMITTAL



DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
CIVIL WORKS
108 ARMY PENTAGON
WASHINGTON, D.C. 20310-0108
10 NOV 1991

REPLY TO
ATTENTION OF

Honorable Newt Gingrich
Speaker of the House
of Representatives
Washington, D.C. 20515

Dear Mr. Speaker:

Section 101(b)(11) of the Water Resources Development Act (WRDA) of 1996 authorized a hurricane and storm damage reduction project for the Lake Cataouatche area on the west bank of the Mississippi River in the vicinity of New Orleans, Louisiana. The Secretary of the Army supports the authorization and plans to implement the project through the normal budgetary process.

The authorized project is described in the enclosed report of the Chief of Engineers, dated December 23, 1996, which includes other pertinent reports and comments. The study leading to this report was conducted under the authority of the Westwego to Harvey Canal project.

The views of the State of Louisiana, the Departments of the Interior, Commerce, Health and Human Services, and the Environmental Protection Agency are set forth in the enclosed report.

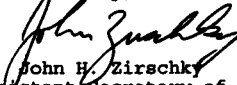
The authorized project provides for increased levels of hurricane protection to the Lake Cataouatche area by enlarging about 12 miles of existing non-Federal levees and floodwalls. The line of protection would extend from the west side of the Westwego to Harvey Canal project, which is currently under construction, toward the west along the alignment of the existing protection, crossing U.S. Highway 90 near the St. Charles Parish line, continuing northward across South Kenner Road, and ending at the Southern Pacific Railroad embankment. Construction of the project would negate the need for the westside closure of the Westwego to Harvey Canal project, resulting in cost savings to that project. Adverse impacts to fish and wildlife resources would be mitigated by the acquisition and development of about 39 acres of wetlands adjacent to Bayou Segnette State Park.

The authorized project is a deviation from the national economic development (NED) plan. The NED plan would provided a 200-year level of protection, while the authorized project will provide a 500-year level of protection. This higher level of protection, called the Standard Project Hurricane (SPH) level of protection, is the same level of protection afforded by the Westwego to Harvey Canal project. Provision of the additional level of hurricane protection is warranted.

Based on October 1996 price levels, the estimated total cost of the authorized project is about \$16,310,000. The cost required to address future project modifications due to land subsidence and sea level rise is included in this cost as deferred construction. The total Federal cost is estimated at about \$10,600,000, while the total non-Federal cost is estimated at about \$5,710,000. In accordance with Section 202(c) of WRDA 96, the non-Federal sponsor will develop, implement and enforce a flood plain management plan for the project area.

The Office of Management and Budget advises that there is no objection to the submission of this report to the Congress. A copy of its letter is enclosed in the report.

Sincerely,



John H. Zirschky
Acting Assistant Secretary of the Army
(Civil Works)

Enclosure

**COMMENTS OF THE OFFICE OF MANAGEMENT AND
BUDGET**



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

OCT 31 1997

The Honorable John H. Zirschky
Acting Assistant Secretary of the
Army for Civil Works
Pentagon -- Room 2E570
Washington, D.C. 203100103

Dear Dr. Zirschky:

As required by Executive Order 12322, the Office of Management and Budget has completed its review of former Assistant Secretary Lancaster's recommendation for the Post Authorization Change Report for the Westwego to Harvey Canal, Louisiana, Hurricane Protection Project in the Lake Cataouatche.

The Office of Management and Budget does not object to submission of this report to Congress.

Sincerely,

A handwritten signature in black ink, appearing to read "Kathleen Peroff", is written over the typed name.

Kathleen Peroff
Deputy Associate Director
Energy and Science Division

X

COMMENTS OF THE STATE OF LOUISIANA



M. J. "MIKE" FOSTER, JR.
GOVERNOR

STATE OF LOUISIANA
DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT
P. O. Box 94245
Baton Rouge, Louisiana 70804-9245
December 18, 1996



FRANK M. DENTON
SECRETARY

Mr. Raleigh H. Leef
Acting Chief, Policy Division
ATTN: CECW-AR (SA)
7701 Telegraph Road
Alexandria, Virginia 22315-3861

Dear Mr. Leef:

This is in supplement to my December 17, 1996 letter indicating our full support for the proposed Westwego to Harvey Canal, Louisiana, Hurricane Protection Project (Lake Cataouatche Area).

We understand that the \$14,806,000 estimated project first cost does not include \$1,500,000 of deferred construction, of which \$525,000 would be non-Federal. As stated in the report, the deferred construction cost is required to address future changes in flood stages due to subsidence and sea level rise. These costs were not included in the breakdown of Federal and non-Federal costs due to the uncertainty associated with future sea level rise and subsidence. It is my understanding that the deferred construction would be performed when actual conditions warrant.

Sincerely,

A handwritten signature in dark ink, appearing to read "Denton", written over a horizontal line.

Frank M. Denton
Secretary

pc: Honorable Murphy J. Foster, Jr.
Governor



M. J. "MIKE" FOSTER, JR.
GOVERNOR

STATE OF LOUISIANA
DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT
P. O. Box 94245
Baton Rouge, Louisiana 70804-9245
December 17, 1996



FRANK M. DENTON
SECRETARY

Mr. Raleigh H. Leef
Acting Chief, Policy Division
ATTN: CECW-AR (SA)
7701 Telegraph Road
Alexandria, Virginia 22315-3861

Dear Mr. Leef:

This is in response to your recent request for comments on the proposed report of the Chief of Engineers and the report of the district engineer, including the final environmental impact statement, on Westwego to Harvey Canal, Louisiana (Lake Cataouatche Area).

We believe that protection from flooding and hurricanes is of great importance to the citizens of the State of Louisiana. The tentative plan for the Lake Cataouatche Area will provide Standard Project Hurricane protection to some 24,000 residents. The proposed improvements will provide protection equal to the hurricane protection system now being constructed on the west bank of Jefferson Parish eastward of this area (i.e. the Westwego to Harvey Canal project). Of particular note is a cost savings on the order of \$5.2 million by eliminating the need for the western closure of the Westwego to Harvey Canal project due to the combining of both projects. The Lake Cataouatche proposal has a very favorable benefit/cost ratio of 5.5 to 1.

On behalf of Governor Murphy J. Foster, Jr., the State of Louisiana is in full support of the proposed improvements to the Lake Cataouatche Area.

Sincerely,

A handwritten signature in dark ink, appearing to read "F. Denton".

Frank M. Denton
Secretary

pc: Honorable Murphy J. Foster, Jr.
Governor

COMMENTS OF THE DEPARTMENT OF THE INTERIOR



United States Department of the Interior

OFFICE OF THE SECRETARY
Washington, D.C. 20240

ER 96/711

DEC 19 1996

Mr. Raleigh H. Leef
Acting Chief, Policy Division
Directorate of Civil Works
Attn: CECW-AR (SA)
7701 Telegraph Road
Alexandria, Virginia 22315-3861

Dear Mr. Leef:

In response to your December 5, 1996, letter to Secretary Babbitt, The U.S. Department of the Interior has reviewed the proposed report of the Chief of Engineers, and the final Post Authorization Change Report, Environmental Impact Statement, and technical appendices, on the Westwego to Harvey Canal, Louisiana, Hurricane Protection Project (Lake Cataouatche Area). The following comments are provided for your consideration.

General Comments

As stated in your letter, the principal issue raised during our previous review of the draft reports involves the U.S. Army Corps of Engineers' (Corps) recommendation for mitigation of direct project impacts on fish and wildlife resources. The U.S. Fish and Wildlife Service (FWS) maintains that the Corps' mitigation proposal to acquire and manage 39 acres of forest land adjacent to Bayou Segnette State Park will not adequately compensate for project-related habitat losses (see specific comments below). We are, however, pleased with the Corps' expressed willingness to continue coordinating with FWS on this issue during future phases of the study.

We are concerned about: (1) the conditional project authorization mandated by Section 101(b) of Public Law 104-303, and (2) providing only a 13-day review period for this project. Such a shortened review period will likely reduce our ability to adequately address future and potentially more-damaging Corps projects (as required under the Fish and Wildlife Coordination Act), especially in those instances where the Corps and FWS mitigation recommendations are not in agreement. While we believe that meeting the new 30-day limit on review of Chief's reports mandated by Section 223 of Public Law 104-303 will be difficult, we will work with you to make it successful.

Specific Comments

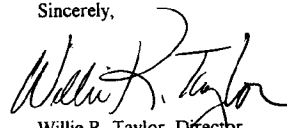
Proposed Chief's Report, Paragraph 4, EIS pages EIS-58 and 59, Technical Appendix C, Table C-4-4, page C-4-12, and Technical Appendix F, page F-11 - The FWS has recommended that 50 acres of land be acquired and managed to adequately compensate for direct project impacts. The Corps proposes, instead, to acquire and manage 39 acres, based on the arguable assumption that the habitat values in the impact area will remain constant for 100 years, under both with-project and without-project conditions. The Corps' rationale is that Chinese tallow trees are the dominant vegetation in that area, and that no nearby seed source for mast-producing trees is available. Chinese tallow is an exotic plant; because of its relatively recent introduction, very little published information exists about the nature and rate of succession in tallow-dominated areas within coastal Louisiana. Anecdotal evidence suggests that the plant is an earlier successional species. As a Chinese tallow stand passes maturity and becomes decadent, native shade-tolerant species may become established, particularly those light-seeded and soft mast species that are dispersed via wind, water, and/or animal transport. The FWS impact analysis conservatively recognizes that potential via a moderate escalation of habitat suitability values (from 0.19 to 0.39) under future without-project conditions in the impact area.

Rather than the impact area analyses, however, the differing mitigation acreage recommendations result primarily from the Corps' projected rate of habitat quality increase due to management of the proposed mitigation site. The Corps' assumption that the habitat quality index of the mitigation site will escalate from 0.11 to 0.73 during the first 19 years of management is not biologically supportable, nor is it realistic or consistent with previous mitigation analyses of bottomland hardwood habitats in the Lower Mississippi River Valley. The FWS's mitigation analysis, in contrast, assumes that habitat suitability would escalate from 0.03 to 0.52 during that same period as the result of management. We recommend that the Corps reassess their projected rate of habitat quality increase in the mitigation area under future with-management conditions using more realistic and biologically sound assumptions.

Summary Comments

The current difference in mitigation recommendations, though relatively minor (i.e., 11 acres), underscores the need to allow our field entities sufficient time to resolve such technical issues prior to submittal of proposed Chief of Engineers' reports. We are confident that the differences in this case can be resolved at the field level. We, therefore, recommend that your District staff contact the Field Supervisor of the FWS' Lafayette, Louisiana, field office with a view toward resolving the project mitigation acreage issue as soon as possible.

Sincerely,


Willie R. Taylor, Director
Office of Environmental Policy
and Compliance



United States Department of the Interior

OFFICE OF THE SECRETARY
Washington, D.C. 20240

ER 96/711

NOV 20 1996

Mr. Raleigh H. Leef
Acting Chief, Policy Division
Directorate of Civil Works
ATTN: CECW-AR (SA)
7701 Telegraph Road
Alexandria, VA 22315-3861

Dear Mr. Leef:

The U.S. Department of the Interior has reviewed the Chief of Engineers Proposed Report for the Westwego to Harvey Canal Hurricane Protection Project, Lake Cataouatche Area, Louisiana. The following comments are offered for your consideration.

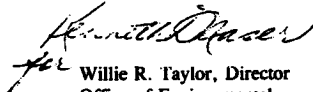
The Corps of Engineers (Corps) assessment of mitigation needs, as stated in paragraph 3 of the subject report, appears to fall slightly short of adequately compensating for direct project impacts. The Fish and Wildlife Service (FWS) and the Corps conducted separate mitigation analyses utilizing different methodologies to calculate mitigation needs. The FWS evaluated project-related impacts using a Habitat Assessment Model (HAM) for bottomland hardwoods designed by the Louisiana Department of Natural Resources, while the Corps utilized their Habitat Evaluation System (HES). Based on HES, the Corps calculates that only 39 acres of scrub/shrub habitat need be acquired and managed to compensate for 57 acres of direct impacts. Utilizing the HAM methodology, the FWS calculates that acquisition and management of 50 acres of scrub/shrub habitat are necessary to offset 47 acres of direct project impacts (note the FWS's conservative estimate of impacted acreage).

We believe that acquisition and management of 50 acres of suitable habitat are essential to fully offset the direct project impacts on important wildlife habitat. Although the acreage difference is small, the precedent for accepting HAM-based assessment of mitigation needs by the Corps' New Orleans District is well-established. The FWS's Lafayette, Louisiana Field Office has utilized HAM analyses to calculate mitigation needs for extensive Section 404 program-related impacts (including 24 large-scale permit mitigation areas) over the last 3 years with little or no disagreement from the New Orleans District.

The FWS's November 1996 Fish and Wildlife Coordination Act Report documents that we do not oppose implementation of the Tentatively Selected Plan, provided adequate mitigation is provided to fully offset project impacts to fish and wildlife resources. Therefore, we recommend that the mitigation issue be resolved to reflect full and equal consideration of the documented fish and wildlife resource needs in the study area.

If there are any questions, please contact Mr. Andy Dolan, FWS's Lafayette Field Office at 313/262-6612 extension 228. Thank you for the opportunity to provide these comments.

Sincerely,


Willie R. Taylor, Director
Office of Environmental
Policy and Compliance

RESPONSE TO THE DEPARTMENT OF INTERIOR



DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, D.C. 20314-1000

REPLY TO
ATTENTION OF:

Planning Division
Central Planning Management Branch

23 DEC 1996

Mr. Willie R. Taylor, Director
Office of Environmental Policy
and Compliance
U.S. Department of the Interior
Office of the Secretary
Washington, D.C. 20240

Dear Mr. Taylor:

I am responding to your letter of December 19, 1996, commenting on my proposed report on hurricane protection for the Lake Cataouatche Area of Louisiana. I am enclosing a copy of the Report of the Chief of Engineers. The report continues to recommend 39 acres of mitigation lands. However, I have added to the report a paragraph recognizing the differing positions of our agencies and stating our intent to reassess our assumptions during the next stage of the project and that the reassessment may result in an increase in mitigation lands to as much as 50 acres. The presence of that paragraph in the report should dispel any future concern as to whether the U.S. Army Corps of Engineers has authority to increase mitigation lands.

This change to the report is not a commitment to change the amount of mitigation lands; rather it is a commitment that the New Orleans District of the Corps of Engineers will work closely with the regional office of the U.S. Fish and Wildlife Service to reassess our assumptions during the next phase of the project.

Thank you for the extraordinary effort your office has put into preparing a response under such tight timing.

Sincerely,

A handwritten signature in black ink, appearing to read "Joe N. Ballard".

Joe N. Ballard
Lieutenant General, U.S. Army
Chief of Engineers

Enclosure

COMMENTS OF THE DEPARTMENT OF COMMERCE



UNITED STATES DEPARTMENT OF COMMERCE
Office of the Under Secretary for
Coast and Atmosphere
Washington, D.C. 20230

November 20, 1996

Policy Review Branch
Policy Division
Attn: CECW-AR (SA)
7701 Telegraph Road
Alexandria, VA 22315-3861

To Whom It May Concern:

Enclosed are comments on the Draft Environmental Impact Statement for Westwago to Harvey Canal, Louisiana Hurricane Protection Project Lake Cataouatche Area. We hope our comments will assist you. Thank you for giving us an opportunity to review this document.

Sincerely,

A handwritten signature in cursive script that reads "Donna S. Wieting".

Donna S. Wieting
Acting Director
Ecology and Conservation Office

Enclosure



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE
National Geodetic Survey
Silver Spring, Maryland 20910-3282

NOV 14 1996

MEMORANDUM FOR: Donna Wieting
Acting Director, Ecology and Conservation
Office
FROM: *[Signature]*
Captain Lewis A. Lapine, NOAA
Director, National Geodetic Survey
SUBJECT: DEIS-9610-05--Westwago to Harvey Canal,
Louisiana Hurricane Protection Project
Lake Cataouatche Area

The subject statement has been reviewed within the areas of the National Geodetic Survey's (NGS) responsibility and expertise and in terms of the impact of the proposed actions on NGS activities and projects.

All available geodetic control information about horizontal and vertical geodetic control monuments in the subject area is contained on the NGS home page at the following Internet World Wide Web address: <http://www.ngs.noaa.gov>. After entering the NGS home page, please access the topic "NGS Products and Services" and then access the menu item "NGS Products." This menu item will allow you to directly access geodetic control monument information from the NGS data base for the subject area project. This information should be reviewed for identifying the location and designation of any geodetic control monuments that may be affected by the proposed project.

If there are any planned activities which will disturb or destroy these monuments, NGS requires not less than 90 days' notification in advance of such activities in order to plan for their relocation. NGS recommends that funding for this project include the cost of any relocation(s) required.

For further information about these monuments, please contact John Spencer; SSMC3, NOAA, N/NGS; 1315 East West Highway; Silver Spring, Maryland 20910; telephone: 301-713-3169; fax: 301-713-4175.

**COMMENTS OF THE DEPARTMENT OF HEALTH AND
HUMAN SERVICES**



DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Centers for Disease Control
and Prevention (CDC)
Atlanta GA 30333

November 25, 1996

Mr. Dave Bastian
Policy Division
ATTN: CECW-AR (SA)
7701 Telegraph Road
Alexandria, VA 22315-3861

Dear Mr. Bastian:

We have completed our review of the Draft Environmental Impact Statement (DEIS) for the Westwego to Harvey Canal, Louisiana Hurricane Protection Project, Lake Cataouatche Area. We are responding on behalf of the U.S. Public Health Service.

The proposed plan would provide protection to the Lake Cataouatche area and would tie the line of protection to the authorized Westwego to Harvey Canal project. We note that the Canal project was authorized by the Water Resources Development Act of 1986, and construction of the project began in early 1991. The proposed modification to the authorized project would extend the protection from Westwego to the St. Charles Parish line, providing Standard Project Hurricane (SPH) protection to an additional 24,000 west bank residents. We concur with this proposed action.

The DEIS is somewhat unclear regarding noise impacts. It is stated that noise "probably varies between 50-80 decibels in most of the project area" (page EIS-31). Noise levels should be more precise than this statement implies, particularly if noise will affect residences or other receptors. Also, it is stated (page 32) that noise above 85 dBA, the EPA limit for eight hours of continuous exposure to protect against permanent hearing loss, "would not occur for periods longer than eight hours." What assurances will be made (i.e. monitoring/mitigation plans) to indicate that compliance with the EPA criteria will in fact be met.

Thank you for the opportunity to review and comment on this DEIS. We would appreciate receiving a copy of the Final EIS, and any future environmental impact statements which may indicate potential public health impact and are developed under the National Environmental Policy Act (NEPA).

Sincerely,

Kenneth W. Holt, M.S.E.H.
Special Programs Group (F29)
National Center for Environmental Health



COMMENTS OF THE ENVIRONMENTAL PROTECTION AGENCY



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

December 13, 1996

Mr. Raleigh H. Leef
Acting Chief, Policy Division
Directorate of Civil Works
Policy Review Branch
ATTN: DECW-AR (SA)
7701 Telegraph Road
Alexsandria, Virgina 22315-3861

Dear Mr. Leef:

In accordance with our responsibilities under Section 309 of the Clean Air Act, the National Environmental Policy Act (NEPA), and the Council on Environmental Quality Regulations for Implementing NEPA, the U.S. Environmental Protection Agency (EPA) has completed its review of the U.S. Army Corps of Engineers' proposed Report of the Chief of Engineers and the Report of the District Engineer and Final Environmental Impact Statement (FEIS) for the Westwego to Harvey Canal, Louisiana, Hurricane Protection Project, Lake Cataouatche Area.

The EPA's letter dated November 1, 1996, expressed lack of objections to the recommended plan described in the Draft EIS. Review of the FEIS indicates no change in our previous findings. Please send us a copy of the signed Chief of Engineers Report.

Thank you for this opportunity to comment.

Sincerely yours,

A handwritten signature in dark ink, appearing to read "Michael P. Jansky".

Michael P. Jansky, P.E.
Regional Environmental Review
Coordinator

cc: R.H. Schroeder
NOD Corps of Engineers

XX



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

November 1, 1996

R.H. Schroeder, Jr.
Chief, Planning Division
Department of the Army
New Orleans District
Corps of Engineers
P.O. Box 602367
New Orleans, Louisiana 70160-0267

Dear Mr. Schroeder:

In accordance with our responsibilities under Section 309 of the Clean Air Act, the National Environmental Policy Act (NEPA), and the Council on Environmental Quality Regulations for Implementing NEPA, the U.S. Environmental Protection Agency (EPA) Region 6 office in Dallas, Texas has completed an expedited review of your agency's Draft Post Authorization Change Report, Environmental Impact Statement (DEIS) for the Westwego to Harvey Canal, Hurricane Protection Project, Lake Cataouatche Area, Louisiana. The purpose of the study/report is to determine the feasibility of modifying the Westwego to Harvey Canal authorized project to provide Standard Hurricane Protection (SHP) to the Lake Cataouatche area. This area includes the communities of Avondale, Waggaman, Bridge City, and the western part of the city of Westwego.

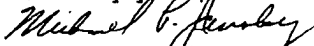
Plans considered include Plan 1B (Levee/Floodwall Combination) and Plan 1C (Modified Levee). Either plan would fulfill the primary objective of providing improved hurricane protection. Plans follow the alignment of the existing levee and would provide protection to the same residential and commercial facilities. The only major difference is the method of construction and the increased level of protection. The benefit-to-cost ratio is 5.5 to 1. The direct environmental impacts of the Tentatively Selected Plan, Plan 1C, would be the possible loss of 57 acres of bottomland hardwoods which would be mitigated through the implementation of a mitigation plan consisting of the acquisition, development, and management of 39 acres of high quality wooded wetlands located adjacent to Bayou Segnette State Park.

We do not oppose implementation of the Tentatively Selected Plan and ask that the mitigation measures be implemented in the interest of equal consideration for environmental resource protection and public safety.

The EPA rates your DEIS as "LO," i.e., EPA has "Lack of Objections" to the tentatively selected plan of action. Since our expedited review is at the request of your agency any subsequent comments received during the environmental review period will be forwarded for your consideration and response in the Final Statement. Our classification will be published in the Federal Register according to our responsibility under Section 309 of the Clean Air Act, to inform the public of our views on proposed Federal actions.

We appreciate the opportunity to review the DEIS. We request that you send our office one copy of the Final EIS at the same time that it is sent to the Office of Federal Activities, (2251A), EPA, 1200 Pennsylvania Avenue, N.W., Washington, D.C. 20044.

Sincerely yours,



Michael P. Japsky, P.E.
Regional Environmental Review
Coordinator

LOUISIANA HURRICANE PROTECTION PROJECT

REPORT OF THE CHIEF OF ENGINEERS



DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, D.C. 20314-1000

REPLY TO
ATTENTION OF:

23 DEC 1996

CECW-PC (10-1-7a)

SUBJECT: Westwego to Harvey Canal, Louisiana, (Lake Cataouatche Area)

THE SECRETARY OF THE ARMY

1. I submit for transmission to Congress my report on Westwego to Harvey Canal, Louisiana (Lake Cataouatche area). It is accompanied by the report of the district and division engineers. The study was conducted as a post authorization change to the Westbank Hurricane Protection Levee Project, Jefferson Parish, Louisiana (subsequently renamed Westwego to Harvey Canal Hurricane Protection Project) which was authorized by Section 401(b) of the Water Resources Development Act of 1986 (WRDA 1986), Public Law 99-662, and is being constructed at this time. Preconstruction engineering and design activities for the Lake Cataouatche area project will be continued under the Westwego to Harvey Canal Hurricane Protection Project authority.

2. Section 101(b)(11) of the Water Resources Development Act of 1996 (WRDA 1996), Public Law 104-303, authorizes construction of the Westwego to Harvey Canal, Louisiana, hurricane damage prevention and flood control project, Lake Cataouatche Area subject to completion of a final report of the Chief of Engineers on or before December 31, 1996, and subject to conditions recommended in the final report. This report constitutes the final report of the Chief of Engineers in response to this legislation. The authorizing language for the Westwego to Harvey Canal, Louisiana, Hurricane Protection Project, Lake Cataouatche Area reflects a total cost of \$14,375,000, with an estimated Federal cost of \$9,344,000 and an estimated non-Federal cost of \$5,031,000. At October 1996 price levels, the current cost of the authorized project is about \$16,310,000 including a deferred construction cost of about \$1,500,000, which was not included in the earlier estimate provided to Congress.

3. The plan developed by the reporting officers provides for increased levels of hurricane protection to the Lake Cataouatche area and will tie the line of protection to the Westwego to Harvey Canal project, previously authorized in WRDA 1986. The plan includes the enlargement and construction of approximately 10 miles of existing non-Federal levees and 2 miles of floodwalls. The existing non-Federal levee will be enlarged from high ground at the southern limits of Bayou Segnette State Park to high ground at U.S. Highway 90 near the St. Charles Parish line. The new levee will be constructed using material excavated from an existing exterior canal. A combination levee/floodwall will be constructed through Bayou Segnette State Park, and swing gates will be provided to maintain pedestrian and vehicular access. The floodwall will be capped with concrete and textured to blend with the natural park setting. The Bayou Segnette Pumping Station will be modified by replacing the existing fronting protection with a pile-supported floodwall. A floodwall constructed along Bayou Segnette will extend the protection north of the pumping station to the Westwego to Harvey Canal project, which is under construction. The project would delete the need for the westside closure from the Westwego to Harvey Canal project, resulting in significant cost savings to the project. The protection along the western boundary of the study area will be accomplished by constructing a levee north of U.S. Highway 90 over the existing South Kenner Road. The primary environmental impacts of the recommended plan will be the possible loss of 57 acres of bottomland hardwoods. All direct losses of habitat value will be mitigated through the implementation of a mitigation plan consisting of the acquisition of 39 acres of wetlands located adjacent to Bayou Segnette State Park for development and management as high quality wooded wetlands.

4. The authorized project provides a standard project hurricane (SPH) level of protection. This plan is not the national economic development (NED) plan. The reporting officers recommend this higher level of protection to provide consistency with other projects in the area which currently provide SPH level

of protection and because protecting to the SPH level of protection provides significantly higher reliability at a minimal cost increase. Prior to authorization, the Assistant Secretary of the Army (Civil Works) approved this deviation from the NED plan.

5. The costs for this project as set out in section 101(b)(11) of WRDA 1996 do not include the costs associated with deferred construction. Deferred construction may be required to address future changes in flood stages due to subsidence and sea level rise. For project evaluation purposes the deferred construction is considered to occur 10 years following completion of initial construction. The actual date of deferred construction will be based on the amount of actual subsidence and sea level rise. Based on October 1996 price levels, the total cost of the project is estimated at about \$16,310,000, which includes about \$14,810,000 for initial construction and \$1,500,000 for deferred construction. Cost sharing is estimated at about \$9,625,000 Federal and about \$5,185,000 non-Federal for initial construction and about \$975,000 Federal and about \$525,000 non-Federal for the deferred construction. The total Federal cost is estimated at about \$10,600,000 and the total non-Federal cost is estimated at about \$5,710,000. The average annual cost, based on a discount rate of 7-3/8 percent and a period of analysis of 100 years, is estimated at \$1,402,000. The equivalent annual benefit is estimated to be \$8,056,000. The resulting benefit-to-cost ratio is 5.74.

6. This report has been coordinated with the State of Louisiana and with other Federal agencies. The State of Louisiana remains fully committed to the project. The Department of Interior disagrees with our determination that 39 acres of mitigation lands are required and recommends that 50 acres of mitigation lands be acquired. The difference is small and is based not on different analysis but on different assumptions about how quickly the reforested mitigation lands will progress to producing habitat value. The project would remain economically justified even if greater mitigation were required. I have informed the

Department of Interior that the Corps of Engineers will reassess our assumptions during the Preconstruction Engineering and Design phase of the project and that, depending upon the results of that reassessment, we may modify our initial recommendation regarding the acreage of mitigation lands. The other Federal agencies either concurred in the report, had no objection to the project, or had no comment.

7. The authorization provided by section 101(b)(11) of WRDA 1996 was subject to the completion of the final report of the Chief of Engineers by December 31, 1996. The Final Environmental Impact Statement (FEIS) was published in the Federal Register on 13 December 1996, beginning a 30-day public comment period. In accordance with the National Environmental Policy Act (NEPA), the final agency action may not be taken until after that comment period has been completed and comments have been considered. The comment period will not close until after the date of this report. Any comments received in the response to the filing of the FEIS will be dealt with in the Record of Decision, which will be the final agency action and will mark the final step in the process defined by the NEPA. The report may be modified based on decisions made as part of the NEPA process.

8. I generally concur in the findings, conclusions, and recommendations of the reporting officers. The authorized project is technically sound, economically justified, and socially and environmentally acceptable. The proposed project conforms with essential elements of the U.S. Water Resources Council's Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies and complies with other Administration and legislative policies and guidelines. Also, the views of interested parties, including Federal, State, and local agencies have been considered.

9. Accordingly, I recommend that the Westwego to Harvey Canal, Lake Cataouatche, project, authorized by Section 101(b)(11) of WRDA 1996, be implemented generally in accordance with the recommendations of the reporting officers and with such

modifications as within the discretionary authority of the Chief of Engineers may be advisable. In addition, the authorized costs of the project for purposes of determining the ceiling under Section 902 of the Water Resources Development Act of 1986 shall be the amounts set out in paragraph 5 of this report. Federal implementation is subject to cost-sharing, financing, and other applicable requirements of Public Law 99-662, as amended. Further, the non-Federal sponsor must agree to comply with all applicable Federal laws and policies and to be responsible for the following items of local cooperation:

a. Provide, during construction, 35 percent of total project costs assigned to hurricane and storm damage reduction, including both initial and deferred construction as further specified below:

(1) Provide all lands, easements, and rights-of-way, including mitigation areas and suitable borrow and dredged or excavated material disposal areas, and perform or ensure the performance of all relocations determined by the Federal Government to be necessary for the construction, operation, and maintenance of the project;

(2) Provide all improvements required on lands, easements, and rights-of-way to enable the proper disposal of dredged or excavated material associated with the construction, operation, maintenance, repair, replacement, and rehabilitation of the project. Such improvements may include, but are not necessarily limited to, retaining dikes, waste weirs, bulkheads, embankments, monitoring features, stilling basins, and dewatering pumps and pipes;

(3) Provide, during construction, any additional amounts as are necessary to make its total contribution equal to 35 percent of total project costs assigned to hurricane and storm damage reduction;

b. For so long as the project remains authorized, operate, maintain, repair, replace, and rehabilitate the completed project, or functional portion of the project, 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;

c. As appropriate, provide for adjudication of all water rights claims resulting from construction, operation, maintenance, repair, replacement, and rehabilitation of the project, and hold and save the United States free from damages due to such claims;

d. Ensure that construction, operation, maintenance, repair, replacement, and rehabilitation of any non-Federally constructed flood features do not diminish the hurricane protection provided by, or jeopardize the structural integrity of the project;

e. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor, now or hereafter, owns or controls for access to the project for the purpose of inspection, and, if necessary after failure to perform by the non-Federal sponsor, for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the project. No completion, operation, maintenance, repair, replacement, or rehabilitation by the Federal Government shall operate to relieve the non-Federal sponsor of responsibility to meet the non-Federal sponsor's obligations, or to preclude the Federal Government from pursuing any other remedy at law or equity to ensure faithful performance;

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

g. Keep, and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project 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;

h. Perform, or cause to be performed, any investigations for hazardous substances as are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for the 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;

i. Assume complete financial responsibility, as between the Federal Government and the non-Federal sponsor, for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for the construction, operation, or maintenance of the project;

j. As between the Federal Government and the non-Federal sponsor, the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability. To the maximum extent practicable, operate, maintain, repair, replace, and rehabilitate the project in a manner that will not cause liability to arise under CERCLA;

k. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way, required for the construction, operation, and maintenance of the project, including those necessary for relocations, borrow materials, and dredged or excavated material disposal, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;

l. Comply with all applicable Federal and State laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army";

m. Provide 35 percent of that portion of total cultural preservation mitigation and data recovery costs attributable to hurricane and storm damage reduction that are in excess of one percent of the total amount authorized to be appropriated for hurricane and storm damage reduction;

n. Participate in and comply with applicable Federal floodplain management and flood insurance programs in accordance with Section 402 of Public Law 99-662, as amended;

o. Within 1 year after the date of signing a project cooperation agreement, prepare a floodplain management plan designed to reduce the impact of future flood events in the project area. The plan shall be prepared in accordance with guidelines developed by the Secretary of the Army and must be implemented not later than 1 year after completion of construction of the project;

p. Prescribe and enforce regulations to prevent obstruction of or encroachment on the project that would reduce the level of protection it affords or that would hinder operation and maintenance of the project;

q. Not less than once each year, inform affected interests of the extent of the protection afforded by the project;

r. Publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in preventing unwise future development in the flood plain and in adopting such regulations as may be necessary to prevent unwise future development and to ensure compatibility with protection levels provided by the project.


JOE N. BALLARD
Lieutenant General, USA
Chief of Engineers

RECOMMENDATIONS OF THE DIVISION ENGINEER

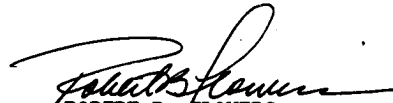
CELMV-ET-PF (CELMN-PD-FG/2 Dec 96) (1105-2-10c)
Mr. Stuart/lr/601-634-5827
SUBJECT: Westwego to Harvey Canal, Louisiana, Hurricane
Protection Project, Post Authorization Change Study (Lake
Cataouatche Area)

CDR, Lower Mississippi Valley Division, Vicksburg, MS 39181-0080

04 DEC 1996

FOR Director, Policy Review Branch, Policy Review and Analysis
Division, Directorate of Civil Works, 7701 Telegraph Road,
Alexandria, VA 22315-3861

1. I concur in the recommendations of the District Commander.
2. 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 for implementation funding. However, prior to transmittal to the Congress, the sponsor, the state, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.


ROBERT B. FLOWERS
Major General, USA
Commanding



REPLY TO
ATTENTION OF: -

DEPARTMENT OF THE ARMY
NEW ORLEANS DISTRICT, CORPS OF ENGINEERS
P.O. BOX 60267
NEW ORLEANS, LOUISIANA 70160-0267

**WESTWEGO TO HARVEY CANAL, LOUISIANA
HURRICANE PROTECTION PROJECT
LAKE CATAOUATCHE AREA**

**POST AUTHORIZATION CHANGE REPORT AND
ENVIRONMENTAL IMPACT STATEMENT**

SYLLABUS

This report presents the results of studies to determine the feasibility of providing increased levels of hurricane surge protection for several communities on the west bank of the Mississippi River in the vicinity of New Orleans. The study area, with a population of nearly 24,000 residents, is bounded by Bayou Segnette to the east, Lake Cataouatche to the south, the Mississippi River to the north, and the St. Charles Parish line to the west. The study area includes approximately 20,000 acres of which approximately 11,000 acres are forested lands.

During the study, investigations identified and analyzed both non-structural and structural alternatives for providing hurricane surge protection in addition to the alternative of "no action." For the Lake Cataouatche area, investigations showed that feasible non-structural measures were already part of the without-project conditions and that structural alternatives were feasible.

The study area has a relatively low level of hurricane protection, and the surge produced by a severe hurricane could result in the catastrophic loss of life and property damage. Hurricane Juan (1985), a category 1 hurricane, battered the Louisiana coast for several days, producing stages in the study area estimated to have a 60-year return frequency. The quick action and massive flood fighting efforts by the West Jefferson Levee District, the Parish of Jefferson, the Louisiana National Guard, and thousands of volunteers prevented the flooding of potentially catastrophic proportions. Hurricane Andrew (1992), a more severe category 3 hurricane threatened the study area as it approached the Louisiana coast, but maintained a more westerly track making landfall in south-central Louisiana. The low level of hurricane protection within the study area, caused local officials to issue evacuation orders approximately 36 hours prior to Andrew's projected landfall. This caused widespread confusion that resulted in very low participation rates among the west bank residents. The low participation rates left much of the population vulnerable if Hurricane Andrew had approached on a more critical path.

The needs of the study area related to hurricane protection can be demonstrated by the fact that of the 7,966 residential structures located within the study area 2,539 (or nearly 32%) are located in areas vulnerable to flooding by the 100-year event and 5,035 (or over 63%) are located in areas vulnerable to flooding from the 500-year storm. A

similar percentage of the commercial facilities within the study area are also susceptible to flooding. Expected damages under the without-project conditions as a result of the 100-year event are in excess of \$102 million. The potential damages increase to over \$165 million for the 500-year event. The equivalent annual damages for the without-project conditions are estimated at \$7,961,000 for existing conditions and \$18,815,000 for future conditions.

Plans considered in detail include Plan 1B (levee/floodwall combination) and Plan 1C (modified levee). Either plan would fulfill the primary objective of providing improved hurricane protection for the study area. The plans were evaluated at the 100-year, 200-year and SPH levels of protection. Both plans follow the same general alignment and would provide protection to the same residential and commercial facilities. The only major difference between the two plans is the method of construction that would be used to increase the level of protection.

The recommended plan (Plan 1C - SPH protection) would provide for the construction of levees and floodwalls extending from Bayou Segnette State Park to the St. Charles Parish line. The existing non-Federal levee would be enlarged from the southern limits of Bayou Segnette State Park to the tie-in at U.S. Hwy. 90. The levee would be constructed using material excavated from the existing exterior canal. A combination levee/floodwall would be constructed through Bayou Segnette State Park and swing gates would be provided to maintain pedestrian and vehicular access. The floodwall would be capped with concrete and textured to blend with the natural park setting. The Bayou Segnette Pumping Station would be modified by replacing the existing fronting protection with a pile supported T-wall. A floodwall constructed along Bayou Segnette would extend the protection north of the pumping station to the authorized Westwego to Harvey Canal project. The proposed tie-in would delete the westside closure from the authorized project resulting in a significant cost savings. The protection along the western boundary of the study area would be accomplished by constructing a levee north of U.S. Hwy. 90 over the existing South Kenner Road.

Implementing the recommended plan would provide protection to the Lake Cataouatche area and would tie the line of protection to the authorized Westwego to Harvey Canal project. The Westwego to Harvey Canal project was authorized by the Water Resources Development Act of 1986, and construction of the project began in early 1991. The proposed modification to the authorized project would extend the protection from Westwego to the St. Charles Parish line, providing SPH protection to an additional 24,000 west bank residents.

The total project first cost of the recommended plan is \$14,806,000. Eliminating the westside closure as a feature of the authorized Westwego to Harvey Canal project would result in a savings of \$5,286,000. These savings are not claimed in the economic analysis for the Lake Cataouatche project, but rather as a cost offset for the Westwego to Harvey Canal project. Total average annual costs for the tentatively selected plan are estimated to be \$1,402,000. Annual operation, maintenance, repair, replacement, and rehabilitation costs, which are included in the previous totals, are \$109,000. The costs are based on October 1996 price levels at an interest rate of $7\frac{3}{8}$ percent with a project life of 100 years. The equivalent annual benefits are estimated to be \$8,056,000. The benefit-to-cost (B/C) ratio is 5.74 to 1. There is a 99.2 percent chance that the B/C ratio would exceed 1.0 and a 95.2 percent chance that the B/C ratio would exceed 2.0. The annual net benefits, the difference in equivalent annual benefits and annual costs, are \$6,654,000. The total project first costs of \$14,806,000 would be apportioned \$9,624,000 Federal and \$5,182,000 non-Federal.

The primary impacts of the recommended plan would be the possible loss of 57 acres of bottomland hardwoods. All direct losses of habitat value would be mitigated through the implementation of a mitigation plan consisting of acquisition, bottomland hardwood habitat development, and management of a 39-acre tract located adjacent to Bayou Segnette State Park. The average annual cost of the mitigation plan is \$12,000. Implementing this mitigation feature would compensate, in-kind, all direct project-induced habitat losses to the fullest extent possible. In addition to meeting the requirements of Section 404(r) of Public Law 92-500, the New Orleans District has completed Section 401, State Water Quality Certification.

INTRODUCTION

This report consists of two volumes. The first volume is a presentation of the study results, including overall project formulation processes; an analysis of the environmental impacts; a summary of the economic analysis; the study recommendations; and the environmental impact statement. The second volume, a set of technical appendixes, contains technical data in support of information presented in the main report. These appendixes are included primarily as an aid to the technical reviewer.

STUDY AUTHORITY

This study is being conducted as a post authorization change (PAC) to the Westwego to Harvey Canal Hurricane Protection Project. The Westbank Hurricane Protection Levee, Jefferson Parish, Louisiana (subsequently renamed Westwego to Harvey Canal Hurricane Protection) was authorized by Section 401(b) of the Water Resources Development Act of 1986, Public Law 99-662, approved November 17, 1986, in accordance with the plan of protection identified in a February 1984 draft environmental impact statement, subject to a final report of the Chief of Engineers, and with such other modifications as recommended by the Assistant Secretary of the Army (Civil Works). The Chief of Engineers report for the West Bank of the Mississippi River in the Vicinity of New Orleans, Louisiana, was dated August 9, 1988. The position of the Assistant Secretary of the Army (Civil Works) was submitted to the Office of Management and Budget on October 11, 1988.

STUDY PURPOSE AND SCOPE

The purpose of this report is to present the results of studies to determine the feasibility of modifying the Westwego to Harvey Canal Hurricane Protection Project to provide additional hurricane surge protection to that portion of the west bank of the Mississippi River between Bayou Segnette and the St. Charles Parish line. The study area is located entirely within Jefferson Parish, Louisiana.

REPORT AND STUDY PROCESS

This report provides the detailed findings of investigations to determine the feasibility of the proposed modifications, including the Environmental Impact Statement (EIS), Real Estate Supplement, Engineering Appendix, and Economics Appendix. The report addresses the feasibility of providing additional hurricane surge protection for the area located on the west bank of the Mississippi River generally bounded by Bayou Segnette to the east, Lake Cataouatche to the south, the Mississippi River to the north, and the Jefferson/St. Charles Parish line to the west.

The draft report and draft EIS were furnished to Federal, state, and local agencies and other interested parties for review on October 4, 1996. On November 7, 1996, following the circulation of these documents, a public meeting was held to discuss the report recommendations. Following the public meeting and receipt of comments on the draft report and EIS, responses were prepared to all comments received and a final report was prepared.

The final report will be submitted to the Lower Mississippi Valley Division Engineer in Vicksburg, Mississippi. The Lower Mississippi Valley Division Engineer will issue a public notice of availability of the report and forward the report, with his recommendations, to the Office of the Chief of Engineers. The Office of the Chief of Engineers will review the report, authorize the filing of the final EIS with EPA, and coordinate the report with other Federal and state agencies and with the Governor of Louisiana. Upon receipt of comments from the Federal and state agencies, the Office of the Chief of Engineers will complete its final assessment. The Office of the Chief of Engineers will then submit its report to the Office of the Secretary of the Army.

The Secretary of the Army will obtain the comments of the President's Office of Management and Budget, sign the Record of Decision, and transmit the report with his recommendation to Congress for action.

PRIOR STUDIES AND REPORTS

A number of studies and reports on water resources development in the vicinity of the study area have been prepared by the U.S. Army Corps of Engineers, other Federal, state, and local agencies, research institutes, and individuals. Previous Federal and non-

Federal studies have established an extensive data base for this report. The more relevant studies, reports, and projects are described in the following paragraphs.

STUDIES AND REPORTS ON WEST BANK HURRICANE PROTECTION

- A feasibility report entitled "West Bank of the Mississippi River in the Vicinity of New Orleans, Louisiana," was published by the U.S. Army Corps of Engineers in December 1986. The report investigated the feasibility of providing hurricane surge protection to that portion of the west bank of the Mississippi River in Jefferson Parish between the Harvey Canal and Westwego and down to the vicinity of Crown Point, Louisiana. The report recommended implementing a plan that would provide hurricane protection to an area on the west bank between Westwego and the Harvey Canal north of Crown Point (see Plate 1). The project was authorized by the Water Resources Development Act of 1986 (Public Law 99-662). Construction of the project was initiated in early 1991. The West Jefferson Levee District is the non-Federal sponsor for the project.

- A feasibility report entitled "West Bank of the Mississippi River in the Vicinity of New Orleans, Louisiana (East of the Harvey Canal)" was completed by the U. S. Army Corps of Engineers in August 1994. The study investigated the feasibility of providing hurricane surge protection to that portion of the west bank of metropolitan New Orleans from the Harvey Canal eastward to the Mississippi River (see Plate 1). The final report recommended that the existing West Bank Hurricane Protection Project, Jefferson Parish, Louisiana, authorized by the Water Resources Development Act of 1986, Public Law 99-662, approved November 17, 1986, be modified to provide additional hurricane protection east of the Harvey Canal. The report also recommended the level of protection for the area east of the Algiers Canal deviate from the NED level of protection and provide protection for the Standard Project Hurricane (SPH). The Division Engineer's Notice was issued on September 1, 1994. The Chief of Engineer's report was issued on May 1, 1995. Preconstruction, engineering, and design was initiated in late 1994 and is continuing. The project was authorized by the Water Resources Development Act of 1996.

- A reconnaissance study entitled "West Bank Hurricane Protection, Lake Cataouatche, Louisiana," was completed by the U. S. Army Corps of Engineers in February 1992. The study investigated the feasibility of providing hurricane surge protection to that portion of the west bank of the Mississippi River in Jefferson Parish between Bayou Segnette and the St. Charles Parish line (see Plate 1). A 100-year level of

protection was found to be economically justified based on constructing a combination levee/sheetpile wall along the alignment followed by the existing non-Federal levee. Due to potential impacts to the Westwego to Harvey Canal project, the study is proceeding as a post authorization change (PAC).

OTHER STUDIES AND REPORTS

- A report entitled "Flood Control, Mississippi River and Tributaries," published as House Document No. 90, 70th Congress, 1st Session, submitted December 8, 1927, resulted in authorization of a project by the Flood Control Act of May 15, 1928. The project provides comprehensive flood control for the lower Mississippi Valley below Cairo, Illinois, and has had a significant impact on water and land resources in the study area. Features of the project pertinent to the study area are:

- (a) The Mississippi River levees extend from Baton Rouge, Louisiana, to Bohemia, Louisiana, on the east bank and from above the study area to Venice, Louisiana, on the west bank. They provide protection from the standard project flood (SPF) on the Mississippi River and Tributaries system. The levees are essentially complete in the study area except in locations where additional work is required to bring them up to project grade.

- (b) The Bonnet Carre Spillway is located upstream of New Orleans, Louisiana, on the east bank of the Mississippi River in the vicinity of Norco, Louisiana. The purpose of the spillway is to divert Mississippi River flows into Lake Pontchartrain to lower flood stages on the Mississippi River in the New Orleans area. The spillway was completed in 1932.

- (c) Revetments and foreshore protection have been constructed along the Mississippi River to prevent erosion. Revetments are constructed where levees or development is threatened by bank caving or where unsatisfactory alignment and channel conditions are developing. Construction of this feature is continuing as needed.

- The U.S. Army Corps of Engineers prepared a final feasibility report, "Louisiana Coastal Area, Freshwater Diversion to Barataria and Breton Sound Basins" in September 1984. The report recommends diverting Mississippi River water near Caernarvon into the Breton Sound and near Davis Pond into the Barataria Basin to enhance habitat conditions and improve fish and wildlife resources. The Davis Pond site is located just west of the Lake Cataouatche study area. The report also recommends that the plan be implemented under the authorized Mississippi Delta Region Project, which is identical in purpose. The diversions would reduce land loss and save about 99,200 acres of marsh. Construction of

the Caernarvon structure was completed in early 1991. Advanced engineering and design studies on the Davis Pond feature are underway.

- The Louisiana Department of Natural Resources published a report entitled "Recommendations for Freshwater Diversion to Louisiana Estuaries East of the Mississippi River" in June 1982. The report recommends that Mississippi River water be diverted to the Lake Pontchartrain Basin and the Breton Sound Basin to improve production of fish and wildlife resources. The report parallels and confirms studies conducted by the U.S. Army Corps of Engineers under the Louisiana Coastal Area and Mississippi and Louisiana Estuarine Area studies.

- The "Louisiana Coastal Wetlands Restoration Plan," a comprehensive plan for restoring and conserving the coastal wetlands of Louisiana, was mandated by the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA). The final report was submitted to higher authority in December 1993, and the Record of Decision on the Programmatic Environmental Impact Statement was signed in March 1994. The report details the process by which wetlands restoration plans were developed for the nine hydrologic basins in the coastal zone. The projects presented in the report far exceed the CWPPRA's funding capacity (approximately \$40 million per year from 1991 to 1997, including 25 percent cost sharing by the state of Louisiana). The task force established by CWPPRA is initiating feasibility studies with a view toward securing authorization and funding for a number of large-scale projects.

- The U.S. Army Corps of Engineers completed a reconnaissance report, "Jefferson and Orleans Parishes, Louisiana Urban Flood Control and Water Quality Management," in July 1992. The study was authorized by Senate and House resolutions to investigate rainfall flooding and water quality problems associated with storm water runoff in Jefferson and Orleans Parishes. A total of nine urban flood control plans, five in Jefferson Parish and four in Orleans Parish, were determined to be economically feasible. The Jefferson Parish Council signed a feasibility cost sharing agreement in January 1994 to participate in a four-year urban flood control feasibility study. The Sewerage and Water Board of New Orleans, the local sponsor for the Orleans Parish study, signed their feasibility cost sharing agreement in June 1994. Both feasibility studies are underway.

- The "Lake Pontchartrain, Louisiana, and Vicinity" project was authorized by the Flood Control Act of 1965 and by the Water Resources Development Act of 1974. The authorized project provided for a standard project hurricane level of protection for the

developed areas on the east bank of the Mississippi River in Jefferson, Orleans, St. Bernard, and St. Charles Parishes. The plan provided for the construction of a system of levees and a hurricane surge barrier across the tidal inlets to Lake Pontchartrain. The hurricane surge barrier allowed levees along Lake Pontchartrain to be lower in elevation. In December 1977, a Federal court injunction stopped construction of portions of the authorized project until a new Environmental Impact Statement could be prepared. A reevaluation study, dated July 1984, recommended construction of the Lake Pontchartrain High Level Plan and the Chalmette Area Plan. The plans consist of raising existing levees and constructing new levees, with no barriers at the entrance to Lake Pontchartrain. Construction of the revised project is continuing.

- The U.S. Army Corps of Engineers completed the "Southeast Louisiana Hurricane Preparedness Study" in August 1994. The purpose of the study was to provide state and local emergency managers with detailed information concerning the potential levels of hurricane surge flooding in nine southeastern Louisiana parishes. Information contained in the report provides a framework within which the state and each parish can update and revise existing hurricane evacuation plans and from which operational procedures and decision guides for future hurricane threats can be developed. Information presented in the report is based on existing conditions and conditions that are expected to occur in the immediate-future. No attempt was made to project future conditions.

- A report entitled "Louisiana-Texas Intracoastal Waterway, New Orleans, Louisiana to Corpus Christi, Texas," was published as House Document No. 230, 76th Congress, 1st Session. The project provides for an inland channel, 12 feet deep and 125 feet wide from the mouth of the Rigolettes to the Sabine River and includes eight primary navigation locks and 384 miles of channel. The Harvey Lock, connecting the inland channel to the Mississippi River, was completed in 1935. The main stem of the waterway was completed to the 12-foot project depth in 1948. The Algiers Canal alternate route and the Algiers Lock were completed in 1956. The Gulf Intracoastal Waterway project was modified by the River and Harbor Act of October 1962 to provide for a channel 16 feet deep and 150 feet wide between the Mississippi River and the Atchafalaya River via the Algiers Canal alternate route and a channel 16 feet deep by 200 feet wide between the Atchafalaya River and the Sabine River. This enlargement has been deauthorized.

- A report entitled "New Orleans to Venice, Louisiana, Hurricane Protection," was published as House Document No. 550, 87th Congress, 2nd Session. The project provides hurricane protection to developed areas in Plaquemines Parish along the Mississippi River.

The locally-constructed back levee on the west bank of the Mississippi River from City Price to Venice would be enlarged and the existing levee from Phoenix to Bohemia on the east bank of the Mississippi River would be raised to provide additional hurricane protection. Work on these features is underway. The General Design Memorandum Supplement No. 5, dated October 1983, provides for the creation of 297 acres of marsh in the Delta-Breton National Wildlife Refuge as mitigation for marsh loss caused by the levees.

- A study of drainage and hurricane protection along the Harvey Canal and Bayou Barataria between the Roussel Pumping Station and Crown Point was authorized by resolutions adopted September 11, 1961, and May 10, 1962, by the U.S. Senate and House Committees. The study was completed and approved for construction on January 22, 1964. Construction of the Harvey Canal-Bayou Barataria levee was initiated under the authority of Section 205 of the Flood Control Act of 1948 (Public Law 87-874). The project has not been completed.

- The Louisiana Department of Natural Resources published a report entitled "Louisiana's Eroding Coastline: Recommendations for Protection," in June 1982. The report recognizes that future losses of coastal wetlands is unavoidable and will require either retreat of development from the coastal zone or increasingly greater levels of protection. Areas with initial erosion problems were identified and ranked according to severity. The report recommends development and implementation of a shoreline protection plan and proposes a number of pilot projects using water and sediment diversions, dredged material placement, and vegetation planting as a means to reduce erosion. A study to determine future coastal conditions, including changes in shoreline configuration and impacts on developed areas, is also recommended.

PROBLEM IDENTIFICATION

INTRODUCTION

To determine the problems and needs of the study area as related to hurricane protection, it is necessary to understand the national objective of water and related land resources planning as well as the past, present, and projected future conditions. This section contains a summary of information related to social, economic, and environmental resources of the study area, and provides a basis for determining the potential economic, social, and environmental effects of hurricane-induced flooding.

THE NATIONAL OBJECTIVE

The national planning objective, as defined by the "Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies" of the U.S. Water Resources Council, is to contribute to the national economic development consistent with protecting the Nation's environment, in accord with national environmental statutes, applicable executive orders, and other national planning requirements. The Principles and Guidelines require formulation of a plan that reasonably maximizes net national economic development benefits, consistent with the national objective. Such a plan is to be identified as the national economic development (NED) plan. The Principles and Guidelines further require that "A plan recommending Federal action is to be the alternative plan with the greatest net economic benefit consistent with protecting the Nation's environment (the NED plan)...."

EXISTING CONDITIONS

LOCATION

This report addresses the need for hurricane protection for the Lake Cataouatche area of Jefferson Parish, Louisiana, as shown on Plate 2. The study area is located on the west bank of the Mississippi River and is generally bounded by Bayou Segnette to the east, Lake Cataouatche to the south, the Mississippi River to the north, and the Jefferson

Parish/St. Charles Parish line to the west. The study area lies within the Barataria Basin which is bounded by the Bayou Lafourche Ridge to the west, the Mississippi River to the north and east, and the Gulf of Mexico to the south. Tidal waters can be carried into the study area through Lakes Cataouatche and Salvador. Freshwater is introduced into the study area primarily by direct rainfall.

PHYSICAL SETTING

Physiography. The study area is located on the Deltaic portion of the Mississippi River Alluvial Plain. Specifically, the area is located on the northern edge of the Barataria Basin on the western side of the Mississippi River between miles 105 to 114 above Head of Passes. The Barataria Basin is an intertributary basin dominated by features which include natural levee ridges, crevasse-splay deposits, marsh, lakes, and swamps. The eastern and northern edge of the basin is defined by the natural levee ridge of the Mississippi River and the western edge of the basin is defined by the Bayou Lafourche natural levee ridge. The Gulf of Mexico constitutes the southern boundary. Natural elevations within the study area vary from approximately +10 feet National Geodetic Vertical Datum (NGVD) along the natural ridges of the Mississippi River to near sea level (0 feet NGVD) in the back swamp and lake areas to below sea level in many of the urbanized areas which are under forced drainage.

The physical and topographic characteristics of the study area have created the need for protection levees, drainage canals, and pumping stations. Protection from high seasonal flows on the Mississippi River is provided by levees constructed as features of the Mississippi River and Tributaries Flood Control Project. The elevation of the Mississippi River levees within the Lake Cataouatche area average between 25.0 and 26.0 feet NGVD. In addition to the threat of flooding from the Mississippi River, the study area is also at risk to inundation from hurricane surge. The surge generated by hurricanes in the Gulf of Mexico can travel across the marsh and through the many natural and man-made channels to threaten the area from the south. To protect the area from tidal and storm surge flooding, local interests have constructed a network of levees that provide a limited degree of protection.

Geology. The geologic history since the end of the Pleistocene Epoch is pertinent to the area. At the close of the Pleistocene, sea level was approximately 360 to 400 feet below present sea level and the Mississippi River was entrenched into the older Pleistocene sediments to the west of the project. As sea level rose to its present stand, the entrenched

valley was filled with sediment by the Mississippi River, resulting in an increase in meandering and channel migration. This meandering and channel migration has resulted in a series of deltas extending into the Gulf of Mexico. Seven Holocene deltas are recognized in the lower Mississippi River Valley; however, only four deltas are relevant to the project area. The oldest of the four deltas in the vicinity of the project was the Cocodrie Delta whose distal edges extended across the New Orleans area from west to east. After a diversion to the west and toe formation of the Teche Delta, the course of the Mississippi River returned to the New Orleans area forming the St. Bernard Delta which followed the same general course as the Cocodrie Delta but extended further to the east. It was during this period that maximum sedimentation into the area occurred via the Bayou Barataria and Bayou des Familles distributaries. A shifting of the river course upstream, in response to a shorter route to the Gulf, resulted in the formation of the Lafourche Delta southwest of the project area. A final shift of the river brought the flow into its present course forming the Plaquemine Delta just south of New Orleans and the present Balize Delta below the Plaquemine Delta. Development of the deltas below New Orleans have resulted in the gradual degradation of the study area through subsidence and shoreline retreat.

Subsidence. The project area lies in a region of active subsidence that is allowing transgression of Gulf waters. Apparent subsidence and land loss are caused by four major natural processes:

- (1) consolidation of soft, compressible sediments,
- (2) eustatic sea level rise,
- (3) decrease in suspended sediments reaching the marsh areas from the Mississippi River, and
- (4) attack of coastal areas by wave action.

Apparent subsidence is estimated to occur at a rate of 1.4 feet per century within the leveed areas and from 0.6 to 1.2 feet per century in unleveed areas. Sea level rise has been measured at approximately 0.50 feet per century. Subsidence within the delta and sea level rise are natural processes that can be expected to continue.

Soils. The surface and shallow subsurface within the study area is composed of natural levee, marsh, swamp, interdistributary, and prodelta deposits. Soil borings taken between March 1991 and April 1993 show that the entire area is overlain by 8 to 22 feet of swamp deposits generally consisting of organic clays, wood, and peat, with occasional sand and silt layers. Underlying swamp deposits are interdistributary deposits located

between elevations +2 and -22 feet NGVD and are up to 40 feet thick. Interdistributary deposits generally consist of very soft, fat clay with occasional lenses of lean clay, silt, and silty sand. Prodelta deposits underlie interdistributary deposits south of U.S. Hwy. 90. Prodelta deposits are found between elevations -30 and -55 feet NGVD and extend to an unknown depth. Prodelta deposits generally consist of homogeneous, medium clays with occasional lenses of silt, and silty sand. Nearshore gulf deposits underlie interdistributary deposits along the eastern boundary of the study area in the vicinity of Bayou Segnette. Nearshore gulf deposits are found at approximately -50 feet NGVD and extend to an unknown depth. These deposits generally consist of silty sand and sand with shell fragments and occasional lenses of silt and clay. Additional information on the soil types located within the study area is provided in Volume 2, Appendix A.

Climatology/Hydrology.

a. Climate. The study area is located in a subtropical latitude. The climate is influenced by the many water surfaces of the nearby lakes, streams, and Gulf of Mexico. Throughout the year, these water areas modify the relative humidity and temperature conditions, decreasing the range between the extremes. When southern winds prevail, these effects are increased, imparting the characteristics of a marine climate.

The area has mild winters and hot, humid summers. During the summer, prevailing southerly winds produce conditions favorable for afternoon thundershowers. In the colder seasons, the area is subjected to frontal movements that produce squalls and sudden temperature drops. River fogs are prevalent in the winter and spring when the temperature of the Mississippi River is somewhat colder than the air temperature.

b. Precipitation. The annual normal precipitation for New Orleans Audubon Park and New Orleans Algiers station over the period 1961-1990 is 60.69 inches. Extreme monthly rainfalls exceeding 12 inches are not uncommon, and as much as 20 inches have been recorded in a single month. The maximum monthly rainfall at Algiers station since 1951 occurred during April 1980 with a total of 22.44 inches, and the 9.78 inches falling on 3 May 1978 was the maximum 24-hour rainfall. There have been several months which recorded no precipitation. The heaviest rainfall usually occurs during the summer, with July being the wettest month with an average monthly normal of 6.61 inches. October is the driest month, averaging 3.04 inches. Snow is rare in the study area with the last measurable snow falling in December 1989. The 30-year normals for New Orleans at Algiers and Audubon Park during the 1961-1990 period are presented in Volume 2,

Appendix A.

c. Temperature. Records of temperatures are available from "Climatological Data" for Louisiana, published by the National Climatic Center. Mean temperatures within the study area can be approximated using data observations from the New Orleans Audubon station and the New Orleans Moisant Airport. The average mean annual temperature based on the period 1961-1990 is 68.8°F with monthly mean temperature normals varying from 52°F in January to 82.4°F in July. Extremes at Audubon Park since 1961 were 102°F on July 6, 1980 and 10°F on December 23, 1989. Temperature normals (1961-1990) for New Orleans at Audubon Park and Moisant Airport are shown in Volume 2, Appendix A.

d. Wind. The average wind velocity, based on anemometer records at New Orleans Moisant Airport over the period 1973-1992 is 8.0 miles per hour. Southeast winds predominate in the spring and summer. The prevailing winds of the fall and winter are from the northeast. Winter storms in the area have produced wind speeds of up to 47 miles per hour. The summer is often disturbed by tropical storms and hurricanes which produce the highest winds in the area. The maximum wind speed observed (highest one minute average) since 1963 was 69 mph and was a result of Hurricane Betsy in September 1965. Average monthly and annual wind speeds for this period are shown in Volume 2, Appendix A.

e. Tropical Storms and Hurricanes. Several hurricanes and tropical storms have passed through or near the study area. Some of the major storms include the 1915 hurricane, the 1947 hurricane, and Hurricanes Flossy (1956), Hilda (1964), Betsy (1965), Carmen (1974), Babe (1977), Bob (1979), Danny (1985), Juan (1985), and Andrew (1992). Hurricane Flossy brought torrential rains and tidal flooding to the study area. Golden Meadow, which is approximately 20 miles south of the study area, received 16.7 inches of rain in a 24-hour period. Hurricane Hilda raised water levels at Barataria and Lafitte to 3.6 and 4.0 feet NGVD, respectively. Hurricanes Betsy and Carmen also caused flooding to some parts of the study area. Hurricane Juan, a minimal Category 1 hurricane which affected the study area for several days, broke several previous high water records. On the west bank of the Mississippi River, three local levees between Westwego and the Harvey Canal were breached and several subdivisions were flooded by tidal inundation. The total storm precipitation for Juan ranged from 8 to 12 inches over the study area. Hurricane Andrew made landfall in southern Florida as a Category 4 hurricane causing extensive damage. After entering the Gulf of Mexico, Hurricane Andrew quickly regained its strength, alarming residents throughout southern Louisiana. The potential for Andrew to

turn to the north and severely impact the study area resulted in the recommended evacuation of west bank residents living in Jefferson, Orleans, and Plaquemines Parishes. Although making landfall in south-central Louisiana, Hurricane Andrew raised water levels and caused gale force winds throughout the study area. Additional information on these hurricanes is presented in Volume 2, Appendix A.

f. Stages, Frequencies, and Duration. Normal astronomical tides at the coastline are diurnal and can have a spring range of as much as 2.0 feet. Inland, this range is usually around 0.5 feet. Winds with a strong southerly component that are sustained for 30 hours or more yield an increase in tide height of about 1 foot for each 10 miles per hour. Sometimes the passage of a front is delayed creating strong winds that lead to abnormally high tides.

Stage records are available at six locations within the study area. Hurricane Juan set record highs at four of these locations. Table 1 gives the period of record and extremes of these stations. Discharge data are not taken due to tidal influence.

Drainage problems are exacerbated when rainfall is accompanied by high tides. During May 1978 and April 1980, short duration, large accumulation rainfalls occurred in this area. On May 3, 1978, the Algiers area received 9.8 inches of rainfall. Heavy rainfall and strong onshore winds resulted in a stage of 2.3 feet NGVD at Barataria on Bayou Barataria, and 2.7 feet NGVD at the Harvey Lock on the Gulf Intracoastal Waterway. On April 13, 1980, the rainfall measured at Algiers was 9.7 inches and the accompanying stage at Barataria was 3.8 feet NGVD. At the Harvey Lock, the maximum stage recorded was 3.2 feet NGVD. The pumping stations that discharge into the marsh were forced to operate against higher than optimum outside stages during these events, reducing their pumping efficiency.

TABLE 1
GAGE DATA

<u>Station</u>	<u>Period of Record</u>	Stage Extremes (ft. NGVD)			
		<u>Max</u>	<u>Date</u>	<u>Min</u>	<u>Date</u>
Mississippi River					
@ Harvey Lock	Jan 1924 - pres	19.42	4/24/27	-0.68	12/17/53
@ Algiers Lock	May 1956 - pres	16.11	4/7/73	-0.15	1/19/81
GIWW					
@ Harvey Lock	Jan 1925 - pres	4.74 ¹	10/29/85	-1.28	1/26/40
@ Algiers Lock	May 1956 - pres	4.45 ¹	10/29/85	-1.64 ¹	9/9/65
Bayou Barataria					
@ Barataria	Nov 1951 - pres	4.25 ¹	10/29/85	-0.58 ¹	9/9/65
@ Lafitte	May 1963 - pres	5.05 ¹	10/29/85	-0.95	12/23/89

¹ Caused by hurricane or storm.

Intense hurricanes such as Betsy have caused high stages along the coastal area of Louisiana (10.5 ft NGVD at Grand Isle) and moderately high stages inland (3.2 ft NGVD at the Harvey Lock). High stages resulting from previous hurricanes are summarized in Volume 2, Appendix A. Detailed hurricane data is presented in a Corps publication entitled, "History of Hurricane Occurrences along Coastal Louisiana." Examination of gage records at the inland gaging stations reveals that Hurricane Juan caused the highest stage of record on October 29, 1985, along Bayou Barataria at both Barataria (4.25 ft NGVD) and Lafitte (5.05 ft NGVD) and at the Algiers Lock (4.45 ft NGVD) and the Harvey Lock (4.74 ft NGVD).

Normal tidal influence within the study area is relatively insignificant. However, wind effects can mask the daily ebb and flow variations, and during periods of sustained southerly winds, tides rise in direct response to the duration and intensity of the wind stress. This was demonstrated in 1985 by Hurricane Juan. Although a relatively weak storm in terms of maximum sustained windspeed, Hurricane Juan caused higher stages in

much of the study area than the more intense Hurricane Betsy. This is directly attributable to the hurricane's erratic, almost stationary, path across southern Louisiana. Gale force winds over a period of five days caused tides 3 to 6 feet above normal across the entire coastal area of southern Louisiana.

EXISTING PROTECTION AND DRAINAGE

The initial development within the New Orleans metropolitan area occurred primarily along the banks and natural ridges of the Mississippi River. As development continued to expand away from the river and into the lower more vulnerable areas, the need for levees, drainage canals and pumping stations became apparent. As a result, both Federal and non-Federal projects providing flood control, hurricane protection, and navigation are located throughout southeast Louisiana and within the study area.

Federal flood control measures within the study area include the mainline Mississippi River and Tributaries levee system. Elevations of the west bank Mississippi River levees in the Avondale area range from 25.0 feet to 26.0 feet NGVD. The average stage in the Mississippi River at the Carrollton gage during the months of June through November (hurricane season) ranges from approximately 3 to 10 feet NGVD. The largest documented increase in stage on the Mississippi River resulting from hurricane surge was 9 feet above normal river stage. This occurred at the Carrollton gage during Hurricane Betsy. As a result, the Mississippi River levees within the study area were determined to provide adequate protection against a hurricane surge moving up the river.

The system of local levees has evolved over an extended period. Some of these began simply by placing dredged material on the banks of a drainage canal as a result of channel improvement or maintenance work. Many of these levees were constructed without regard for sound engineering practice for levee design and construction. While preventing high waters from intruding, these levees also prevent any rainwater that falls within their perimeter from draining onto the adjacent lower lands and lakes. As a solution to this problem, leveed areas are webbed with drainage outfall canals that terminate at pumping stations. These pumping stations are used to remove the flood waters that pond within the leveed areas. Several of the low lying areas within the study area are prone to flooding from frequent rainfall events. Feasibility studies are being conducted as part of the Jefferson and Orleans Parishes, Urban Flood Control Study, to address the problems associated with storm water runoff in Jefferson and Orleans Parishes.

The existing Lake Cataouatche levee was constructed in the mid-1960's by the Lafourche Basin Levee District using material excavated from the interior and exterior canals. The levee was completely reshaped into its present configuration in 1974 and 1975. Maintenance of the levee is currently performed by the West Jefferson Levee District. Existing levee heights vary from around 5.5 feet NGVD in some locations to over 10 feet NGVD in others. Poor foundation conditions and the close proximity of the interior and exterior canals have prevented the levee district from raising the levee crown. Recent profiles show that the levee heights are continually fluctuating due to natural processes, structural failures, and ongoing maintenance work.

Interior drainage is provided to the Lake Cataouatche area by a series of drainage canals and pumping stations, as shown on Plate 2. Lake Cataouatche Pumping Station #1 was constructed in the mid 1970's with a capacity of approximately 500 cubic feet per second. A second pumping station was added in 1985 to handle the increased drainage requirements. Lake Cataouatche Pumping Station #2, located adjacent to the first station, increased the capacity of the Lake Cataouatche complex to 1,100 cubic feet per second. Continued development on the west bank created the need for a new pumping station along the eastern boundary of the study area. The Bayou Segnette Pumping Station was constructed in 1986 with a capacity of approximately 900 cubic feet per second. Although constructed to provide drainage for the Bridge City and Westwego areas, the Bayou Segnette Pumping Station is also connected to other portions of the study area through a series of drainage canals. Smaller, less significant pumping stations are also located within the study area at the southern end of Bayou Segnette State Park and near the junction of U.S. Hwy. 90 and the existing levee. Pumping of the area to an artificially low water table in order to provide additional storage capacity has caused consolidation and decay of the organic materials. The resulting subsidence has placed those residents living within the Lake Cataouatche area at even greater risk to storm surge.

Hurricane Juan (1985) was classified by the National Weather Service as a minimal hurricane (Category 1 on the Saffir-Simpson Scale). Although a weak hurricane, Juan produced stages with return frequencies of 50 to 100 years at gages on the landward edge of the coastal zone in Louisiana. At the coastline, however, the stages had a return frequency on the order of 10 to 25 years. Juan's progress across the coast of Louisiana was dilatory and, therefore, produced stages at the coast that exceeded 5 feet for a period of 4 to 5 days. As a result of this extended duration of abnormally high tides, the inland fringes of the coastal zone experienced very high stages. Stages estimated to be about the 60-year event were recorded in the Harvey Canal. Although the existing Lake Cataouatche

levee did not fail during Hurricane Juan, the resulting surge came very close to overtopping the levee. Hurricane Juan clearly illustrated that the existing levee system is unable to provide adequate protection against tidal surge. Hurricane Andrew (1992) also illustrated the lack of protection within the study area. Although Andrew ultimately made landfall in south-central Louisiana, the lack of protection within the study area caused local officials to order an early evacuation of residents within the study area.

The existing non-Federal levees which have been constructed within the study area do not provide adequate levels of protection against tidal surge. This can be demonstrated by the fact that of the 7,966 residential structures in the area, 3,250 are located in areas vulnerable to the 100-year storm and 5,054 (over 63 percent) are located in areas vulnerable to the 500-year storm. The equivalent annual damages for the without-project conditions are estimated at \$11.3 million.

DEVELOPMENT AND ECONOMY

Business/Industrial Activity and Regional Growth. The study area is part of the New Orleans Metropolitan Statistical Area (MSA), which includes Jefferson, Orleans, Plaquemines, St. Bernard, St. Charles, St. James, St. John the Baptist, and St. Tammany Parishes. Until recent years, the economy in this part of the state was dominated by oil and gas activities. However, with the decline of this industry that began in 1981, the mining of oil and gas has become less important for job creation relative to other sectors of the New Orleans economy. While the count of operating oil and gas rigs in Louisiana remained stable in 1994, it was up considerably from the near record lows of 1992 and 1993. This trend reflects a recent effort to replenish reserves of oil and natural gas through domestic exploration. Consolidations and cutbacks are expected to continue among large companies.

The west bank economy is currently centered around the port and related commercial and manufacturing activities such as shipbuilding, grain transport, and storage. The value of imports passing through New Orleans area ports was up 24.3 percent in 1994, while export cargos decreased by 8.2 percent. The North American Free Trade Agreement (NAFTA) should have a significant positive effect on the maritime sector and on the New Orleans economy.

Most of the heavy industrial complexes on the west bank are located along the Mississippi River. The largest of these companies is Avondale Shipyards, which employs

over 6,500 people. A large number of these employees also live on the west bank. With new vessel designs and new construction techniques, Avondale is placing greater emphasis on the commercial shipbuilding market. This will help to compensate for a reduction in the availability of new military contracts brought about by continued efforts to reduce defense spending. A new assembly line factory building encompassing 9-acres is currently under construction. With the passage of the Pollution Control Act of 1990, which requires all domestic ships to be double-hulled, the demand for Avondale's services, as well as its current level of employment, should remain stable throughout the next decade.

The industrial base of the west bank has attracted retail trade and services to the surrounding area. The opening of the twin span of the Crescent City Connection Bridge, and the completion of the elevated Westbank Expressway will continue to benefit the retail activity in the area. Plans to widen the Huey P. Long Bridge will further improve the transportation network on the west bank.

One of the fastest growing industries on the west bank, as well as in the entire New Orleans Metropolitan area, is health care. Several new hospitals, medical complexes, and extended care facilities have been constructed on the west bank during the past few years. The medical industry generated more than \$5 billion in 1994, and directly employed more than 48,000 people. According to American Hospital Association statistics, the average 1994 salary of these employees was \$31,130.

With the advent of the Louisiana gaming industry and the opening of a gambling boat on the Harvey Canal (just outside of the study area), the west bank has the potential for a growing tourist industry. Revenues derived by the hotel/motel industry in the New Orleans metropolitan area reached a record high of \$547.9 million in 1994, an increase of 18.5 percent from 1993.

Employment. According to a March 1995 report prepared by the Louisiana Department of Labor, the total non-agricultural employment in the New Orleans Metropolitan Statistical Area (MSA) was estimated to be 590,900, as of February 1995. This represents an increase of 13,400 jobs since February 1994. The majority of the increase occurred in the hotel, health, and education segments of the services industry and in the wholesale and retail trade segment which gained 8,900 jobs and 6,100 jobs, respectively. Government and the transportation and public utilities segments showed employment declines during the same period. Along with the increase in the number of jobs, the unemployment rate for the New Orleans MSA decreased from 7.0 percent in

February 1994 to 6.2 percent in February 1995. The unemployment rate for the state of Louisiana decreased from 8.0 percent to 7.3 percent during the same period. Table 2 provides a summary of the non-agricultural wage and salary employment in the New Orleans MSA.

TABLE 2
NEW ORLEANS METROPOLITAN STATISTICAL AREA
NON-AGRICULTURAL WAGE AND SALARY EMPLOYMENT
(In Thousands by Industry)

Non-agricultural Employment	Feb. 1995	Jan. 1995	Feb. 1994	Net Change From	
				Jan. 1995	Feb. 1994
TOTAL	590.9	592.6	577.5	-1.7	+13.4
Manufacturing	48.6	48.7	47.6	-0.1	+1.0
Mining	13.1	13.3	13.6	-0.2	-0.5
Construction	27.3	27.3	26.8	0.0	+0.5
Transportation & Public Utilities	42.5	43.5	43.4	-1.0	-0.9
Wholesale & Retail Trade	147.6	148.2	141.5	-0.6	+6.1
Finance, Ins., & Real Estate	29.7	29.7	29.6	0.0	+0.1
Services	180.5	180.1	171.6	+0.4	+8.9
Government	101.6	101.8	103.4	-0.2	-1.8

Source: State of Louisiana, Department of Labor, "Louisiana Labor Market Information", March 27, 1995. Includes data for Jefferson, Orleans, Plaquemines, St. Bernard, St. Charles, St. James, St. John the Baptist, and St. Tammany Parishes.

The University of New Orleans Division of Business and Economic Research predicts that total employment in metropolitan New Orleans will continue to grow during the next two years. The UNO Model projects that by the end of 1995, total employment will reach the record level set in 1982 during the oil boom. While the oil and gas industry

is expected to remain stable, the services industry, state and local government, and retail trade are predicted to experience rapid growth. Employment in the gaming industry is also expected to increase.

Income. Table 3 shows per capita personal income levels for Jefferson Parish, the New Orleans Metropolitan Statistical Area, and the state of Louisiana. Between 1981 and 1986, the growth rate in per capita income for Jefferson Parish averaged a modest 3.4 percent per year. As the economy improved between 1987 and 1991, the annual percentage increase in per capita income rose an average of 6.8 percent.

TABLE 3
PER CAPITA PERSONAL INCOME 1991, 1992, and 1993

Area	1991	1992	1993	Percent	Average Annual	
				Change	Change	Change
				1992-93	1987-91	1981-86
Jefferson Parish	\$17,617	\$18,340	\$19,100	4.1%	6.8%	3.4%
New Orleans MSA	17,227	18,087	18,882	4.4%	7.6%	3.8%
Louisiana	15,100	15,931	16,612	4.3%	7.8%	3.6%

Source: U.S. Dept. of Commerce, Bureau of Economic Analysis, "Survey of Current Business," April 1995.

According to recent statistics released by the Commerce Department, Louisiana is one of the few states where per capita income growth exceeded the national average from 1992 to 1993. The per capita income of Louisiana averaged \$16,612 in 1993. This represents a gain of 4.3 percent between 1992 and 1993 which compares favorably to the increase in the national per capita income average of 3.2 percent during the same period. However, per capita income in this state is still well below the 1993 national per capita income average of \$20,800.

The University of New Orleans reports that the per capita income of the New

Orleans MSA increased 8.3 percent between 1993 and 1994. However, if the local inflation rate matches that of the nation over the next two years, real per capita income will remain fairly constant.

Population. Table 4 summarizes the 1990 Census Bureau population for the New Orleans MSA, Jefferson Parish, the west bank of Jefferson Parish, and the study area. The 1993 and 1994 population estimates for the New Orleans MSA and Jefferson Parish have also been provided.

The total population in the New Orleans Metropolitan Area decreased during the 1980's primarily due to the decline of the oil and gas industry. The majority of this outmigration occurred on the east bank of Orleans Parish, and to a lesser extent, on the east bank of Jefferson Parish. While the population of the study area showed a slight decline, the number of people living on the west bank of Jefferson Parish increased.

TABLE 4
TOTAL POPULATION 1980, 1990, 1993, AND 1994

Area	1980	1990	1993	1994	% Change	% Change
					'80 - '90	'93 - '94
New Orleans MSA	1,304,212	1,286,270	1,306,548	1,311,658	-1.38	0.39
Jefferson Parish						
West Bank	179,970	187,597	n/a	n/a	+4.24	n/a
Total Parish	454,593	448,306	457,069	457,481	-1.40	0.09
Study Area	25,772	23,795	n/a	n/a	-7.67	n/a

Note: New Orleans Metropolitan Statistical Area (MSA) included population for Jefferson, Orleans, St. Bernard, St. Tammany, St. Charles, St. John the Baptist, Plaquemines, and St. James Parishes. Plaquemines and St. James Parishes were added to the New Orleans MSA per OMB Bulletin No. 93-50, December 28, 1992.

Sources: U.S. Census Bureau; and 1993 and 1994 figures are preliminary unpublished estimates provided by Louisiana Tech University, College of Administration and Business, Research Division.

The University of New Orleans has estimated that the population in Jefferson Parish increased at least 3 percent between 1990 and 1994, while the Census Bureau estimated the growth to be only 1.8 percent. The UNO estimate is based on the fact that Jefferson Parish had the highest employment growth in the metro area. Jefferson Parish has drawn many families and individuals who are seeking employment during the last several years. According to UNO, employment gains in excess of 7,500 jobs per year will support a 1 percent annual population growth.

Property Values and Housing. Table 5 shows the change in the total number of housing units for the New Orleans MSA, Jefferson Parish, the west bank of Jefferson, and for the study area.

TABLE 5
NUMBER OF HOUSING UNITS
1980 AND 1990

Area	1980 Census Housing Units	1990 Census Housing Units	Housing Unit Change
New Orleans MSA	494,638	540,422	45,784
Jefferson Parish	166,124	185,072	18,948
Jefferson Parish, West Bank	61,703	72,577	10,874
Study Area	7,113	7,966	853

Source: U.S. Department of Commerce, Bureau of the Census

Although housing prices in the metropolitan area generally showed a downward trend during the mid to late 1980's, they have increased between 6 and 7 percent per year since 1990. According to the Real Estate Market Analysis prepared by the University of New Orleans, the price of an average house in the metropolitan area increased from \$82,613 in 1990 to \$107,112 in 1994. By national standards, however, the prices of homes in the New Orleans area still remain 20 percent or more below the national average. The most recent UNO Real Estate Market Analysis shows that an average single family

residence in the Lake Cataouatche study area sold for \$45,688 during 1994.

During the past year, there has been a shift in the real estate market throughout the metropolitan area to purchases of larger homes. If the market continues its recovery and the demand for larger houses increases, there exists the potential for the average price of a house in the metropolitan area to rise above \$110,000. However, this price increase will only be sustained if employment gains occur in the metro area.

Economic Outlook. The establishment of a more diversified economy, along with the continued expansion of tourism and health services, is important for future economic growth. With the decline of the oil and gas industry and the continued loss of jobs in manufacturing, the area must create the climate for growth in other sectors of the economy. This growth must be in addition to the potential job gains in gaming construction and employment.

As the 21st century approaches, the strategic geographical location of the New Orleans metro area could allow it to take advantage of the increased trade associated with the development of the North American Free Trade Agreement (NAFTA). With proper positioning, the New Orleans metro area could gain a share of the increased north/south commerce generated by the bill and expand its port activities. This could also create the potential for the development of satellite industries connected with the flow of trade.

The economy of the study area will be greatly enhanced by the proposed widening of the Huey P. Long Bridge which spans the Mississippi River between the east bank of Jefferson Parish and the Lake Cataouatche study area. The initial plans for the project are nearing completion, but the financing for the project remains uncertain.

ENVIRONMENTAL AND NATURAL RESOURCES

Biological. A total of approximately 11,000 acres of forested lands, the majority of which were bottomland hardwoods, remained within the study area in 1990. However, very few tracks of bottomland hardwoods retain their natural drainage characteristics because of drainage improvements which have been provided to the area beginning in the mid 1960's. The majority of the forested area, although under pumped drainage, is classified as wetlands. Providing the area with interior drainage has resulted in the loss of much of the non-habitat wetland value and function. Bottomland hardwoods located on

high ground near the Mississippi River are dominated by water oak, American elm, and hackberry, with live oak, cherrybark oak, and boxelder also being present. Bottomland hardwoods located south of U.S. Hwy. 90 are typically dominated by green ash, Nuttall oak, overcup oak, Drummond red maple, and black willow. In recent years the Chinese tallow has become a prolific invader of drying marshes, especially in the southern reaches of the study area. Providing the area with interior drainage is also causing the remaining cypress swamps to rapidly change to bottomland hardwoods.

A diversity of wildlife species are present within or adjacent to the study area. The bottomland hardwood forests provide habitat for many game and non-game species such as deer, squirrel, rabbit, and song birds. Early successional-bottomland hardwood forests have reduced habitat value as compared to mature bottomland hardwood forests. The habitat value of these areas is also reduced as a result of being parcelled into smaller non-contiguous areas. Some of the forested areas near the existing levee are pastured, further reducing the habitat value to wildlife.

Aquatic Resources. There are approximately 26 miles of drainage canals and bayous within the study area. Flow is generally sluggish to non-existent in most of the smaller canals except during and shortly after a rain. Many of the smaller canals become choked with aquatic vegetation during the summer months and are subjected to large variations in flow because of their drainage function. Fish in the interior canals are represented by species tolerant of low dissolved oxygen such as shortnose and longnose gar and bowfin. The exterior canal, which parallels the existing levee, is approximately 7 miles in length. It has some similarity to natural waterways in that it receives tidal flushing. Fish in the exterior borrow canal consist of both fresh and saltwater species including sunfishes, channel catfish, shortnose and longnose gar, striped mullet, menhaden, and gizzard shad. Bayou Segnette, which forms the eastern boundary of the study area, is heavily used by sport and commercial fisherman. The docking of commercial fishing boats along with the outflow from a nearby sewage treatment plant and the discharge from the Bayou Segnette Pumping Station all contribute to the low aquatic habitat in the upper portions of Bayou Segnette. The lower portions of Bayou Segnette offer significantly higher habitat value than the watercourses of the remainder of the area.

Water Quality. The waters within the protected area of the proposed hurricane protection project have been classified "Effluent Limited" by the State of Louisiana. The "Effluent Limited" classification indicates that water quality is meeting and will continue to meet applicable water quality standards, or that water quality will meet those standards

in the future after application of effluent limitations required by the Federal Clean Water Act or Louisiana Water Quality Regulations. Water quality data collected by Jefferson Parish indicates that despite the "Effluent Limited" designation, water quality in the drainage canal system often does not meet applicable water quality standards. The most serious water quality problems are likely due to sanitary wastewater contamination on the drainage system. Raw or partially treated wastewater is often combined with stormwater runoff as the result of overflows and infiltration from the sanitary wastewater conveyance system. Stormwater runoff also contributes urban pollution to the canal system. Water quality samples do not indicate that the problem is associated with runoff from the landfills located along the western boundary of the study area. Additional information on the existing water quality within the study area is presented in Volume 2, Appendix C.

The waters adjacent to, and on the floodside, of the proposed levee and floodwall have been classified "Water Quality Limited" by the State. These waters include Lake Cataouatche, its tributaries, and Bayou Segnette. The "Water Quality Limited" classification indicates that water quality is not meeting, and will not meet applicable water quality standards even after the application of effluent limitations required by the Federal Clean Water Act or Louisiana Water Quality Regulations.

Cultural Resources. The study area was used by man in prehistoric as well as historic times. Most prehistoric archeological sites date to the Coles Creek period (A.D. 700 - A.D. 1200). Europeans began to settle in the region in the early 1700's. Many archeological sites in the area have been lost over time. These losses were caused by dredging, erosion, subsidence, and construction.

There are no National Register of Historic Places properties recorded in the project area. Seventeen archeological sites are recorded within a five mile radius of the project area. Nine of these sites cluster along the east or west shoreline of Lake Cataouatche. The remaining sites are situated on higher elevations along the Mississippi River. The high frequency of flooding and the total amount of fresh water entering the project area, historically, has affected the density of prehistoric and historic site occurrences in the project area. Significant cultural resources are most likely to occur along the Lake Cataouatche shoreline where natural levees of distributary networks enter the lake. Unrecorded cultural resources would continue to be affected by both physical and chemical processes of erosion and site destruction.

Recreation. Major recreational opportunities on the west bank of the Mississippi

River consist of water-oriented sports such as fishing, boating, and hunting in the sparsely populated southern portions of the study area. Four major recreational areas of significance located adjacent to, or within, the project area are the Lake Cataouatche-Lake Salvador complex (which includes the Salvador Wildlife Management Area), the Jean Lafitte National Historical Park, the Bayou Segnette State Park, and the Bayou Aux Carpes 404(c) area. Bayou Segnette State Park is the most heavily used state park in the system. The number of visitors passing through Bayou Segnette State Park continues to increase, approaching 200,000 annually, as the park continues to expand.

CONDITIONS IF NO FEDERAL ACTION IS TAKEN

SOCIOECONOMIC RESOURCES

The lands being considered for additional hurricane protection are located within a 20,400 acre leveed area on the west bank of the Mississippi River in Jefferson Parish. The majority of urban development within the study area has taken place in the vicinity of the Huey P. Long Bridge, as well as along U.S. Highway 90, River Road, and the Westbank Expressway. The major residential communities include Avondale, Bridge City, Kennedy Heights, Waggaman, and the western part of Westwego. Approximately 60 percent of the total acres within the study area are currently undeveloped.

Population growth is projected to occur in the undeveloped portions of the Lake Cataouatche study area during the next 50 years, with or without a Federal project. A population increase of 8,000 people was estimated for the study area between 1990 and 2049. This represents a compound annual growth rate of 0.5 percent. This projection was based on the population growth that took place throughout the west bank of Jefferson Parish during the last decade, as well as recent transportation improvements, land availability, recent construction activity, and the rural setting of the area. The future without-project conditions assume that all future development within the study area would occur at, or above, the 100-year floodplain through the use of fill material or piers.

Transportation in the area has been greatly facilitated by the recent completion of the second span of the Crescent City Connection bridge across the Mississippi River and the elevated Westbank Expressway. Plans are currently being formulated for widening the Huey P. Long Bridge, which directly connects the study area to the Metairie/Kenner area and to the New Orleans Central Business District via the Earhart Expressway. The recent

completion of Live Oak Boulevard and the Nicole Extension have greatly improved access from within the study area to the major transportation arteries on the west bank.

Construction activity is currently taking place within the study area. New residential development has taken place in the Live Oak Subdivision and plans are being finalized for a new 30 acre residential and commercial development. A new Winn-Dixie Supermarket was recently opened in Avondale. Funding is being considered by the state legislature for the construction of a \$9.5 million sports and civic center at Bayou Segnette State Park.

The economic potential of the area appears favorable in spite of the recent declines in the petrochemical industry. The potential for continued expansion of port activities due to the passage of NAFTA, the health care industry, and the tourism industry are major factors that should encourage economic growth. The recent opening of the second span of the Crescent City Connection bridge and the connecting elevated Westbank Expressway, along with the proposed widening of the Huey P. Long Bridge, should also encourage economic growth to continue.

Without Federal action, the general pattern of land use within the study area should continue. However, future growth and development will depend on future economic conditions in the area. Future patterns and directions of development expected to occur through the year 2049 are as follows:

- Residential land use will continue to expand in those portions of the study area where there are large tracts of undeveloped land. During the next 50 years, it has been projected that an additional 3,000 residential structures will be constructed within the study area.
- Commercial land use in the area should increase in order to support the population growth.
- Industrial land uses along the Mississippi River have the potential to grow with the recent passage of NAFTA. Also, Avondale Shipyard's decision to enter the commercial shipbuilding market ensures its economic stability throughout the next decade.
- The opening of the second span of the Crescent City Connection bridge and the proposed widening of the Huey P. Long Bridge will benefit commercial activity. However, the driving force has to be the establishment of a more diverse economy. Port

activity along the Mississippi River, the health care industry, and tourism should be major factors in encouraging economic growth.

The 1990 OBERS projections for Jefferson Parish were based on historical trends for population, per capita income, and employment. These projections, which are shown in Table 6, include only six parishes rather than the newly expanded eight parish metropolitan area. The OBERS projected compound annual population growth rate is 0.07 percent during the 50-year period, while the per capita income and employment were projected at 0.89 percent and -0.08 percent, respectively, during the same period. According to the Louisiana Tech population estimates, the current population of Jefferson Parish has already surpassed the OBERS population projection for the year 2005. Also, according to the University of New Orleans, the population estimates developed by the U.S. Census appear to be conservative relative to the number of jobs created in Jefferson Parish during the period 1990 to 1994. Thus, OBERS projections were not used for future development projections in the economic analysis. As with any long term projections, a high degree of uncertainty is implicit. Population projections are addressed in more detail in Volume 2, Appendix B.

ENVIRONMENTAL RESOURCES

Biological. Based on historical trends, the demand for residential and commercial property would continue to deplete bottomland hardwoods within the study area. Development in the area is expected to continue because of the location (close proximity to Metairie and downtown New Orleans), the lack of available land for development, and the existence of levees, drainage canals, and pumping stations. Permitting requirements associated with the presence of wetlands should not change development trends in this area from those of the past, as almost any sizeable development in the New Orleans metropolitan area would encounter wetlands. Remaining wooded lands would continue to be developed, but sizeable tracts of forested area should remain throughout the project life. Forested tracks are expected to remain for the next 100 years providing at least a limited habitat for wildlife. The overall acreage of wildlife habitat would continue to decrease as would the quality of the habitat as remaining bottomland hardwoods are segmented and parceled by development. As subsidence and saltwater intrusion continue to occur, fishery resources in the canals outside of the protection would gradually become more saltwater oriented. Inside of the protection, there would be little change in the fishery resources when compared to existing conditions.

TABLE 6
JEFFERSON PARISH, LA (MSA)
Population, Per Capita Income, and Employment, 1973-1988, and Projected, 1995-2040

	1973	1979	1983	1988	1995	2000	2005	2010	2020	2040
Population as of July 1 (thousands)	386	447	478	471	452	455	457	460	470	467
Per capita personal income (1982 dollars)	9,385	11,518	11,817	11,660	13,528	14,445	15,215	15,904	17,048	20,153
Thousands of Jobs										
Total employment	125.4	178.7	203.6	216.7	228.0	236.2	240.2	241.3	233.1	219.5
Farm	.1	.2	.2	.2	.1	.1	.1	.1	.1	.1
Nonfarm	125.3	178.5	203.5	216.5	227.8	236.1	240.1	241.2	233.0	219.4
Private	108.3	155.7	179.1	194.0	205.6	213.8	218.0	219.4	212.3	200.4
Agricultural services, forestry, fisheries, ...	.7	1.0	1.1	1.4	1.7	1.9	2.0	2.1	2.1	2.1
Mining	5.0	4.7	5.1	3.9	3.5	3.4	3.2	3.1	2.8	2.4
Construction	12.2	17.9	17.9	14.4	14.0	13.9	13.6	13.3	12.3	11.1
Manufacturing	19.7	19.3	13.4	17.0	17.5	17.8	17.5	17.9	17.2	16.1
Nonurable goods	6.1	4.9	4.4	4.5	4.3	4.2	4.1	4.0	3.7	3.4
Durable goods	13.6	14.5	11.0	12.6	13.2	13.6	13.8	13.9	13.5	12.7
Transportation and public utilities	9.9	14.8	16.3	15.0	15.1	15.3	15.3	15.2	14.4	13.4
Wholesale trade	9.3	13.4	15.9	15.4	15.6	15.7	15.8	15.8	15.1	14.1
Retail trade	24.5	38.4	45.4	50.6	53.0	55.1	56.0	56.1	54.0	50.6
Finance, insurance, and real estate	5.5	10.0	14.6	17.3	18.2	18.9	19.2	19.3	18.7	17.6
Services	21.5	36.0	47.3	58.8	66.9	71.8	75.0	76.7	75.7	73.0
Government and government enterprises	17.0	22.9	24.4	22.5	22.3	22.3	22.1	21.8	20.6	19.0
Federal, civilian	.8	1.4	1.5	1.7	1.7	1.7	1.7	1.7	1.6	1.5
Federal, military	2.3	2.0	2.1	2.4	2.4	2.4	2.4	2.4	2.4	2.4
State and local	13.9	19.6	20.7	18.5	18.2	18.2	18.0	17.7	16.7	15.2

Source: OBER'S Bureau of Economic Analysis, Regional Projections to 2040, Volume 2, 1990

Please Note: Revised to include 1990 Census Data and only includes Six Parishes as part of the N. O. Metro area: Jefferson, Orleans, St. Bernard, St. Charles, St. John the Baptist, and St. Tammany.

The projected population increase was utilized to project a rate of development (i.e., transition from bottomland hardwoods to urban). Based on the projected annual rate of development of 0.5 percent, the 11,000 acres of forested land which existed in 1990 would be reduced to approximately 6,370 acres in the year 2099. The projected quantity of bottomland hardwoods remaining within the study area over the next 100 years are shown in Table 7.

TABLE 7
ESTIMATED ACREAGE OF BOTTOMLAND HARDWOODS
REMAINING WITHIN THE STUDY AREA

<u>Year</u>	<u>Acres¹</u>
1990	11,000
2000	10,642
2024	9,276
2049	8,184
2074	7,270
2099	6,370

¹ Assuming a declining annual growth rate of -0.5 percent.

Aquatic Resources. Physical conditions in the various canals within the project area would be expected to change very little within the next 100 years. Pollutants would continue to enter the aquatic system from the surrounding development. Water quality of the interior canals would continue to be extremely poor because of increased input of urban runoff, including that from the landfill areas along the western boundary of the project area. This would result in a continuation of, or possibly a decrease in, the poor quality of the aquatic habitat. As residential/industrial development continues, there would likely be an increase in pollutant levels in the canals leading to the existing pumping stations. Many of these pollutants would ultimately end up in the Barataria Basin. Legislation requiring improvements in both point and non-point source discharges may alleviate some of the future water quality problems. The exterior canals as well as Bayou Segnette would have a slow rise in mean salinity resulting in brackish conditions being more likely to occur. As this change occurs, estuarine organisms would become more dominant.

Sea Level Rise and Subsidence. The climate, water, and land resources of the study area are significantly influenced by the Gulf of Mexico. The gulf is also influenced by the rise in sea level caused by global warming which results in thermal expansion of water and melting of glaciers. The historical rate of sea level rise is estimated at 0.5 feet per century. The study area is also influenced by subsidence. Apparent subsidence is estimated to occur at a rate of 1.4 feet per century within leveed areas and from 0.6 to 1.2 feet per century in unleveed areas. Subsidence within the protected areas occurs as pumping stations lower the water table and soft, compressible sediments become consolidated. Developed areas provided with inadequate hurricane protection become even more vulnerable as sea level rise increases potential surge heights and natural ground elevations within the developed areas continue to subside.

Water Quality. It is not likely that the general level of water quality in the project area will be significantly improved in the foreseeable future. Improvements to the sanitary wastewater system and urban runoff quality control would lead to improved water quality within the area. The landfills located within the project area should not adversely effect water quality as long as the monitoring is continued and they are properly operated. If constructed, the Davis Pond Freshwater Diversion Project would periodically discharge Mississippi River water into Lake Cataouatche. The additional source of fresh water would decrease average salinities and provide increased water circulation and dilution of urban runoff in the water bodies outside the project area.

Cultural Resources. It is probable that known cultural resources, as well as those that have not yet been discovered, would continue to be adversely affected as a result of urban growth, industrialization, and other development. Development would soon expand into presently undeveloped areas. Destructive natural forces such as erosion and possible subsidence would have an adverse impact on cultural resources. Other adverse impacts resulting from indiscriminate human actions would most likely increase with an increase in population. Not only could potential vandalism of cultural properties occur, but many recorded and unrecorded sites could be unknowingly destroyed.

Recreation. Future recreational use of the study area should increase due to the proximity of recreation/natural areas such as Lake Cataouatche-Lake Salvador (including the Salvador Wildlife Management Area), Jean Lafitte National Historical Park, Bayou Segnette State Park, Bayou Aux Carpes 404(c) area, and Willowdale Country Club. Bayou Segnette State Park has recently completed construction of a wave pool and has begun construction of an olympic size swimming pool. Further expansion of the state park is expected to continue as visitation rates increase. Wetlands in the Salvador Wildlife Management Area and other wetlands surrounding the project area would continue to be lost due to sea level rise, erosion, and subsidence. This could result in a loss of recreational opportunities within the project area.

PLAN FORMULATION

PROBLEMS, NEEDS, AND OPPORTUNITIES

The primary problems, needs, and opportunities identified in this study relate to the need for improving hurricane protection in the study area and the need to protect natural resources.

PROBLEMS AND NEEDS RELATED TO HURRICANE PROTECTION

Early development within the study area occurred primarily along the banks of the Mississippi River. Land near the river was built up by years of overflow and was less susceptible to flooding. These areas also provided easy access to navigation. As developments expanded away from the river and into lower, more vulnerable areas, it became necessary to construct drainage canals, pumping stations and levees. Improving interior drainage within these developments lowered the water table causing the sediments to consolidate. The levees constructed along the banks of the Mississippi River have further compounded the problem by eliminating the seasonal, sediment-laden overflow that once nourished adjacent wetlands. The consolidation of existing sediments and the loss of overflow from the Mississippi River has resulted in high rates of subsidence in some areas. The resulting ground elevations within the developed areas are often below sea level, placing additional importance on interior drainage and hurricane protection.

The population of the study area based on the 1990 Census is approximately 23,795. Population growth in the New Orleans metropolitan area is expected to increase as the local economy continues to improve. The west bank economy is largely centered around the port and related commercial and manufacturing activities, mineral production, and in recent years, a growing tourist industry. Most of the heavy industrial complexes on the west bank are located along the Mississippi River. Avondale Shipyards, located within the study area, is the largest of these complexes with an employee base of over 6,500.

Currently, there are no Federally authorized hurricane protection projects on the west bank of the Mississippi River for the Lake Cataouatche study area. Construction of the Westwego to Harvey Canal Hurricane Protection Project was authorized by the Water

Resources Development Act of 1986. This project, located adjacent to the study area, will provide a standard project hurricane (SPH) level of protection to the area between Bayou Segnette and the Harvey Canal. The Water Resources Development Act of 1996 authorized SPH protection from the Harvey Canal east to the Mississippi River. When completed, these two projects will provide a continuous line of protection extending from Westwego (Jefferson Parish) to Oakville (Plaquemines Parish) providing protection to over 210,000 west bank residents.

Hurricane protection within the study area is currently provided by Federal levees along the Mississippi River and by non-Federal levees located adjacent to Lake Cataouatche. These levees provide various levels of hurricane protection to the study area. The Federal levees, which have been constructed along both the east and west banks of the Mississippi River, range in elevation from 25.0 ft to 26.0 ft NGVD. Historical records show that stages on the Mississippi River during hurricane season (June through November) vary from 3 to 10 ft NGVD. Historical records also provide evidence that the maximum stage increase on the Mississippi River in the vicinity of the study area as a result of hurricane surge can be projected at 10 feet. Even with the maximum projected stage increase, the Mississippi River levees provide adequate protection against tidal surge.

A limited degree of hurricane protection is also provided to the Lake Cataouatche study area by the existing non-Federal back levee. The levee begins at Bayou Segnette and extends in a southeasterly direction for approximately 9 miles before tying into U.S. Hwy. 90 near the St. Charles Parish line. The existing levee varies in elevation from 5.5 ft NGVD in some locations to over 10 ft NGVD in others. There is a wide variability in the side slopes and the crown width of the existing levee. The non-Federal levees are maintained by the West Jefferson Levee District. Poor foundation conditions and the close proximity of borrow and drainage canals have prevented the levee district from raising the levees to provide a higher level of protection. The existing levees are subject to minor wave overtopping at around the 10-year event and overtopping from tidal surge at around the 50-year event. Under future conditions, these levees would be subject to overtopping from tidal surge at around the 30-year event (assuming the levees are maintained at their current levels).

The existing Lake Cataouatche levee was not constructed to Federal standards and is deficient in both side slope and height in many locations. Levee profiles taken in 1981, 1989, and 1993 show that levee heights are continually fluctuating due to natural processes, structural failures, and maintenance work performed by the Jefferson Parish

Drainage Department and the West Jefferson Levee District. Policy Guidance Letter No. 26 (dated December 23, 1991) provides guidance on determining without-project conditions for reconnaissance and feasibility studies involving existing non-Federal levees. Based on the guidance provided in PGL No. 26, a probable failure point (PFP) and a probable non-failure point (PNP) were determined for the existing levee. The PFP is defined as a point on the levee at which a failure would be likely should the water surface reach that elevation. The PNP is defined as a point at which a failure would be unlikely should the water surface reach that elevation. The PFP and the PNP were not defined by specific water elevations due to the wide variability in the height of the existing levee, but rather at points relative to the crown of the levee.

The location of the PFP and the PNP relative to the existing levee crown were established using available hydraulic and geotechnical information. The PFP was determined to be located at the crown of the existing levee from both a geotechnical and a hydraulic standpoint. The location of the PNP was governed by hydraulics due to the potential for wave overtopping to cause severe erosion on the back side of the levee. Erosion occurring as a result of wave overtopping could compromise the integrity of the levee potentially causing a failure. Rates of overtopping were computed based on the height of the existing levee relative to the predicted surge height for a given storm. Previous experience indicated that severe erosion could occur when wave overtopping approaches 1 cubic foot per second per linear foot (cfs/ft) of levee. The results of the hydraulic analysis indicate that the 1 cfs/ft criteria would likely be exceeded when the still water elevation encroaches within 2 feet of the crown of the levee. The PNP was therefore designated as a point 2 feet below the crown of the existing levee. With a levee that constantly varies in elevation, the length of levee subject to failure increases as the stage increases. A detailed analysis of the failure and non-failure points is contained in Volume 2, Appendixes A and B.

Hurricane Juan demonstrated a recognizable potential for the occurrence of hurricane flooding events that would easily exceed any protection afforded by existing levees within the study area. Hurricane Juan began as a tropical depression on October 26, 1985 and grew into a category 1 hurricane by October 27th. The storm remained along the Louisiana coast for 2 days before moving east and making landfall between Alabama and the Florida panhandle. Torrential rain for several days, coupled with tides as high as 8 feet above normal, caused extensive flooding in coastal Louisiana. Stages reached in the Harvey Canal during Hurricane Juan were estimated at about a 60-year event. More than 2,200 homes on the west bank of Jefferson Parish were affected by storm waters. This

resulted in \$46 million in damages to homes with an additional \$6 million in damages to vehicles. Although the majority of damages on the west bank were located between Westwego and the Harvey Canal, Hurricane Juan clearly demonstrated the need for increased protection in the Lake Cataouatche area. The quick action and massive flood fighting efforts by the West Jefferson Levee District, the Parish of Jefferson, the Louisiana National Guard, and thousands of volunteers prevented more extensive flooding of potentially catastrophic proportions. The lack of adequate hurricane protection within the study area also caused local officials to issue evacuation orders during Hurricane Andrew (1992). As the population and development in the area increases, the potential for loss of life and property damage from a hurricane will escalate. Therefore, improved hurricane protection is critically needed in the study area.

The needs of the study area related to hurricane protection can be demonstrated by the fact that of the 7,966 residential structures located within the study area, 2,539 are located in areas vulnerable to the 100-year storm and 5,035 (over 63 percent) are located in areas vulnerable to the 500-year storm. Of the estimated 260 commercial facilities also located within the study area, 45 are located in areas vulnerable to the 100-year storm, and 126 (over 48 percent) are located in areas vulnerable to the 500-year storm. These inundation statistics are based on the existing levee remaining intact until hurricane stages reach the top of the existing levee (the PFP). Using the assumption that the existing levee begins to fail when stages encroach within 2 feet of the crown of the levee (the PNP), 3,520 residential structures are located within the 100-year floodplain and 5,054 are located within the 500-year floodplain. The number of commercial facilities vulnerable to flooding also increases to 91 for the 100-year storm and 143 (over 55 percent) for the 500-year storm. The equivalent annual damages for the without-project conditions for the PFP are estimated at \$6.6 million. The equivalent annual damages increase to \$18.8 million for the PNP.

PROBLEMS RELATED TO HURRICANE EVACUATION

Between 1886 and 1994, 35 hurricanes passed within 125 miles of New Orleans. With the widespread use of satellite and radar images, there is a perception that technology has greatly increased the ability to predict the path of a hurricane. However, recent improvements in hurricane forecasting for lead times in excess of 24 hours falls far short of the public's perception. Errors in the National Hurricane Center's official forecast track for hurricanes issued 24 hours prior to projected landfall average 100 miles. The forecast error increases to 220 miles for 48 hour forecasts and 400 miles for 72 hour forecasts.

Thus, if a storm were forecast to make landfall due south of New Orleans in 24 hours, and if, in fact, it made landfall anywhere between Dauphin Island, Alabama and Marsh Island, Louisiana, the error would be no worse than average. These error statistics are based on the use of present day surveillance methods, including the most accurate method, hurricane hunter aircraft. Other surveillance methods are not as accurate until the center of the hurricane is within the range of coastal radar, about 200 miles.

Not only do errors occur in predicting the path of a hurricane, but also in predicting the hurricane's strength. A hurricane can intensify by as much as 50 percent in a 24-hour period. A hurricane projected to impact the coast within 24 hours could intensify from a 100-year storm to a 500-year storm prior to making landfall. An evacuation order based on the limits of inundation for a 100-year storm could potentially leave residents living in areas vulnerable to a 500-year storm at the mercy of the hurricane. Hurricane Andrew (August 1992) increased from a minimal category 1 hurricane with maximum sustained winds of 75 mph to a strong category 4 hurricane with maximum sustained winds of 150 mph in only 33 hours. Additional protection is a needed safety factor given the difficulty in predicting the path and intensity of a hurricane.

The evacuation roadway network for the New Orleans metropolitan area is largely east-west, linked by elevated highways, bridges, and tunnels, and is inadequate for a massive evacuation (see Figure 1). Estimated clearance times for evacuating the New Orleans metropolitan area in response to a hurricane threat exceed 48 hours for a category 4 or 5 hurricane. Depending on when the evacuation is ordered, residents may require an additional 6 hours to mobilize in response to the evacuation order. Evacuation orders should be issued with sufficient warning that all evacuees are able to leave the risk area prior to the arrival of gale force winds (40 mph). Continuing an evacuation beyond the arrival of gale force winds would endanger the lives of those evacuating. Winds in excess of 40 mph can arrive up to 12 hours before the eye of the hurricane, depending on the storm's size and forward speed. An additional 4-12 hours should therefore be added to the clearance time to account for pre-landfall hazards time. A category 4 or 5 hurricane with a projected landfall along the southeastern Louisiana coast would place local officials in the difficult position of needing to issue widespread evacuation orders nearly 60 hours prior to the projected landfall. Evacuation orders issued in excess of 48 hours prior to landfall would, in 9 out of 10 instances, be issued for areas not directly impacted by the storm.

Behavioral patterns suggest that residents living in threatened communities do not begin evacuating in significant numbers until an evacuation order has been issued. A

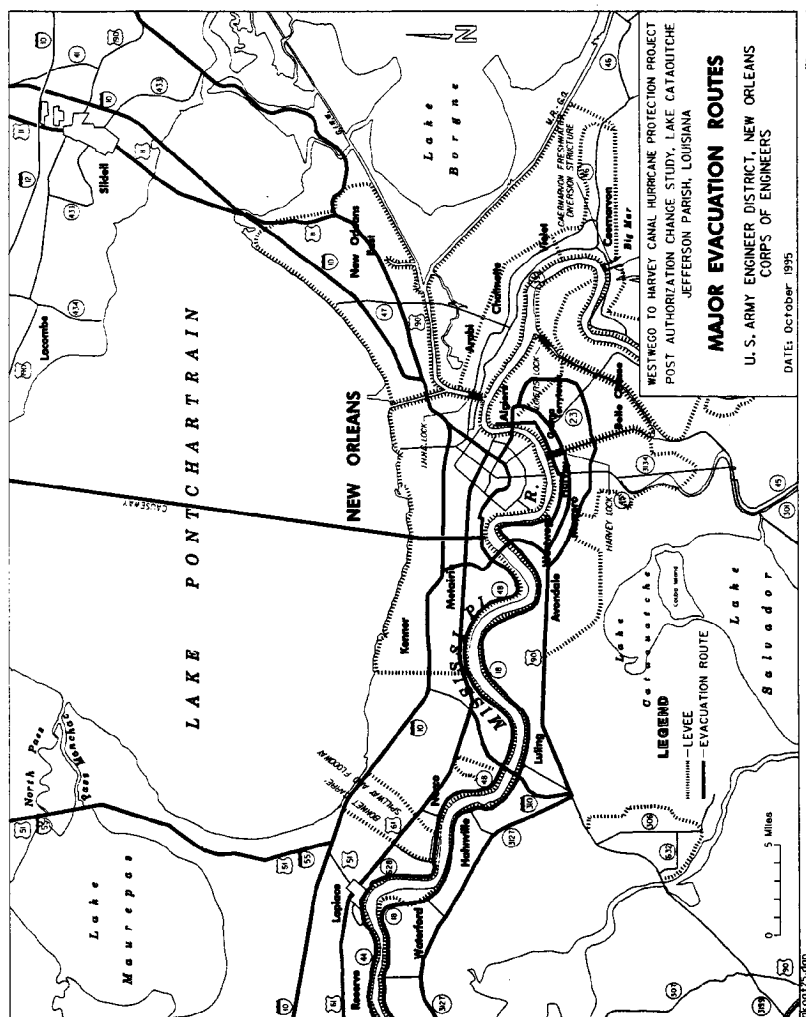


Figure 1

"Hurricane Watch" is issued by the National Hurricane Center covering a 300-mile stretch of coastline 36 hours before the eye of the hurricane is expected to make landfall. This is changed to a "Hurricane Warning" 24 hours prior to landfall. The inability to accurately predict the path of a hurricane in excess of 24 hours prior to landfall is responsible for the reluctance of local officials to order early evacuations. Hurricane Andrew (1992) provides a recent example of the problems associated with evacuating the New Orleans metropolitan area. Although Hurricane Andrew ultimately made landfall in south-central Louisiana, the potential for the storm to take a more northerly track caused local officials to issue evacuation orders for most of the west bank, including the Lake Cataouatche study area. Prior to entering the Gulf of Mexico, Hurricane Andrew left its mark on southern Florida. This allowed coverage of the widespread devastation in Florida to be broadcast to Louisiana residents before evacuation orders were issued. Even with this added incentive, evacuation rates throughout southeast Louisiana were still quite low. Upon returning to their homes and learning that the hurricane had in fact made landfall well to the west of New Orleans, many evacuees criticized local officials for ordering an evacuation in the first place.

Historical data suggests that a category 1 hurricane can be expected to pass within 75 miles of New Orleans once every nine years. The frequency of occurrence decreases as the size of the storm increases. A category 2 hurricane has a mean return period of 18 years; a category 3 storm, 30 years; a category 4 storm, 60 years; and a category 5 storm, 130 years. Based on the current level of protection, significant flooding within the study area could begin with the occurrence of a slow moving category 2 hurricane. The frequent threat of hurricanes coupled with long evacuation times and reduced levels of protection create the potential for repeated evacuations of the study area. Increasing the level of hurricane protection would reduce the frequency of evacuation, thereby increasing evacuation rates when evacuation orders are necessary.

NEEDS AND OPPORTUNITIES FOR NATURAL RESOURCE PROTECTION

Wetlands located within the study area have lost much of their value as a result of being almost entirely enclosed in a levee system and under forced drainage since the mid 1960's. Projected future development within the study area will result in the continued loss of existing wetlands and the remaining tracts will have further reduced wetland functions and value within 100 years. However, wooded wetlands remaining within the study area offer valuable habitat for wildlife species. There is a need to protect the remaining wooded wetlands and other woodlands in the study area. The development of

hurricane protection or any other land development plans should, therefore, avoid and/or mitigate impacts to existing woodlands .

IMPROVEMENTS DESIRED

The West Jefferson Levee District, Jefferson Parish, and the State of Louisiana desire a Federal project to provide increased levels of hurricane protection for the study area. The desire for improvements in the study area stems from the natural growth and development occurring on the west bank of the Mississippi River opposite New Orleans. Continued growth has resulted in the development of lands more vulnerable to flooding from storm tides and local rainfall. The area is likely to continue to develop given the lack of available land on the east bank, the presence of an existing interior drainage system, the close proximity to metropolitan New Orleans, and plans for continued improvements in the transportation system.

Hurricane Betsy was the impetus for the congressional resolutions that provide authorization for the west bank studies. More recently, Hurricane Juan inflicted severe damage on portions of the west bank. Had it not been for the extensive flood fighting efforts by several state and local agencies for an extended period of time during Hurricane Juan, damage would have been considerably worse. Hurricane Andrew, the last hurricane to make landfall in Louisiana, caused local officials to recommend the evacuation of residents living on the west bank of the Mississippi River in Jefferson, Orleans, and Plaquemines Parishes. Although Andrew ultimately made landfall in south-central Louisiana, the actions by local officials clearly illustrated a lack of protection within the study area. Public officials and residents living in the study area fear a hurricane on a critical path to their area and desire protection comparable to that provided to other portions of metropolitan New Orleans. The Lake Pontchartrain, Louisiana, and Vicinity Hurricane Protection Project was authorized in 1965 to provide a standard project hurricane (SPH) level of protection to residents of Jefferson, Orleans, St. Bernard, and St. Charles Parishes living on the east bank of the Mississippi River. The Westwego to Harvey Canal Hurricane Protection Project was authorized in 1986 to provide SPH protection to residents living on the west bank of the Mississippi River between Westwego and the Harvey Canal. The Water Resources Development Act of 1996 authorized extending the protection from the Harvey Canal, east to the Mississippi River. Lake Cataouatche is one of the few remaining areas in metropolitan New Orleans for which a Federal hurricane protection project has not been either authorized or recommended.

PLANNING CONSTRAINTS

Legislative and executive authorities have specified the range of impacts to be assessed, and have set forth the planning constraints and criteria that must be applied when evaluating alternative plans. Plans must be developed with due regard to the benefits and costs, both tangible and intangible, as well as associated effects on the ecological, social and economic well-being of the region. Federal participation in developments should also ensure that any plan is complete in itself, efficient and safe, economically feasible in terms of current prices, environmentally acceptable, and consistent and acceptable in accordance with local, regional, and state plans and policies. As far as practical, plans should be formulated to maximize the beneficial effects and minimize the adverse impacts of the considered improvements.

PLANNING OBJECTIVES

The following planning objectives were established in response to the identified problems, needs, and opportunities:

- Provide improved hurricane protection for the west bank of the Mississippi River in the vicinity of New Orleans for the area generally bounded by Bayou Segnette to the east, the Mississippi River to the north, Lake Cataouatche to the south, and the St. Charles Parish line to the west. The study area as delineated is also referred to as the Lake Cataouatche area.
- Contribute to the Nation's economic development by reducing hurricane-related flood damages.
- Minimize adverse impacts to the natural environment and social well-being.
- Retain unhindered access to Bayou Segnette State Park.

MANAGEMENT MEASURES

Structural management measures considered for providing hurricane protection to the study area were limited to levees, floodwalls, floodgates and pumping stations, and other

available means to reduce flooding from hurricane driven tides.

Non-structural measures, such as flood-forecasting, combined with evacuation and the national flood insurance program, are currently being employed in the study area and will continue to be employed, with or without further Federal action. A hurricane task force consisting of emergency managers from the state and nine southeastern Louisiana parishes was formed in late 1988. Their goal was to develop comprehensive regional evacuation plans for a wide range of hurricane scenarios. The Corps of Engineers, in conjunction with the Federal Emergency Management Agency (FEMA) and the National Weather Service (NWS), completed a hurricane preparedness study for southeast Louisiana in August 1994. The purpose of the study was to provide pertinent, quantitative information for state and local agency use in the further development of local and regional hurricane evacuation plans. Information contained in the report, along with input from the hurricane task force, was used by the Louisiana Office of Emergency Preparedness to develop a regional evacuation and sheltering plan for southeast Louisiana. This plan provides a framework within which the parishes can coordinate with state government in order to deal with a catastrophic hurricane. There are no other practical non-structural measures for improving hurricane protection in the study area.

FORMULATION PRINCIPLES

The Guidance for Conducting Civil Works Planning Studies (ER 1105-2-100) requires the systematic development of alternative plans which contribute to the Federal objective. Alternatives should be formulated in consideration of four criteria: completeness; effectiveness; efficiency; and acceptability.

- 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.
- Effectiveness is the extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities.
- 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.

- 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.

In general, when formulating alternative plans, an effort is made to include only increments that increase the net NED benefits on a first- and last-added basis.

PLAN FORMULATION RATIONALE

In the development of plans for addressing the problems and needs relative to hurricane flooding within the study area, structural and non-structural alternatives were considered. Due to the extent and types of existing development, limitations on the times for advance flood forecasting, and limitations on the capacities of hurricane evacuation routes, the development of strictly non-structural measures would not be responsive to the problems and needs of the area relative to hurricane flooding. Structural alternatives for addressing the problems and needs of the study area were limited to barriers to hurricane surges, such as levees, floodwalls, floodgates, and pumping stations.

Two alternative alignments were considered for providing increased levels of hurricane protection to the Lake Cataouatche area. Both alignments would provide protection to essentially the same residential and commercial areas and would produce similar levels of benefits. The first alternative alignment (Plan 1) follows the existing non-Federal levee. This alignment is also referred to as the exterior alignment. The existing levee begins at Bayou Segnette and extends in a southwesterly direction for approximately 9 miles before tying back to U.S. Hwy. 90 near the St. Charles Parish line. Providing protection to the study area would also require the protection to extend north of the Bayou Segnette Pumping Station to a common tie-in point with the authorized Westwego to Harvey Canal project. Along the western boundary of the study area, the protection would extend north from U.S. Hwy. 90 along South Kenner Road, to the existing Southern Pacific railroad embankment. The alignment for Plan 1 is shown on Plate 4.

The second alignment (Plan 2) would generally follow the interior drainage canal (Main Canal) located just beyond the existing limits of development. This alignment, which is also referred to as the interior alignment, was considered in an attempt to enclose

less undeveloped lands within the protection. As described for Plan 1, the protection along the eastern boundary of the study area would extend north from the Bayou Segnette Pumping Station to a common tie-in point with the authorized Westwego to Harvey Canal project. To prevent the potential for end-around flooding, the protection along the western boundary of the study area would extend north of U.S. Hwy. 90 adjacent to the community of Waggaman. The alignment for Plan 2 is shown on Plate 5.

Alternative methods of construction were considered for providing increased levels of protection for both the exterior alignment (Plan 1) and the interior alignment (Plan 2). The first method would provide for the construction of an all earthen levee using adjacent cast material. Material would be hauled to the site in areas where the use of adjacent material is not feasible. The second method would provide for the construction of a combination levee/sheetpile wall. This alternative would require less rights-of-way and was considered to avoid potential stability problems associated with the construction of a traditional earthen levee and to minimize environmental impacts. All Plan 1 alternatives were designed to maximize the use of the existing non-Federal levee.

The alternatives for providing hurricane protection to the study area were evaluated at various levels of protection, generally the 100-year, 200-year, and standard project hurricane (SPH). Levels of protection lower than the 100-year were not considered because the existing levee provides approximately a 50-year level of protection. Lower levels of protection would also not be acceptable to local residents and parish officials given the areas vulnerability to storm surge. The costs and benefits for each plan were evaluated using a traditional analysis to determine the plan which provides greater net annual benefits. The plans were also evaluated based on their environmental impacts. The plan identified as providing greater net annual benefits using a traditional analysis was then evaluated using a risk based approach in accordance with EC 1105-2-205. The risk based analysis provides the decision maker with a broader range of information upon which to determine the best overall plan for providing increased hurricane protection to the study area. The results of the risk analysis were used to determine the NED plan and, if different, the recommended plan.

PLANS CONSIDERED

A brief description of each of the alternatives considered in this study is presented below:

PLAN 1A (Exterior Alignment - Levee Alternative)

Plan 1A would provide for the enlargement of the existing Lake Cataouatche levee. The existing levee begins at Bayou Segnette and extends in a southwesterly direction for approximately 9 miles before tying back to U.S. Hwy. 90 near the St. Charles Parish line. The existing levee is bounded by a floodside borrow canal and a protected side drainage canal. These canals parallel the levee throughout the reach except for within the limits of Bayou Segnette State Park where there is no drainage canal. The close proximity of the canals to the existing levee severely restricts the room available for the construction of a conventional levee enlargement. The problem is further compounded by poor foundation conditions. A stability analysis based on soil borings and cross-sections has shown that the existing foundation is not sufficient to enlarge the levee without significantly impacting the adjacent canals. Enlarging the levee using traditional construction techniques would require a levee set-back (shifting the levee toward the protected side). Constructing a levee set-back would necessitate the backfilling of the adjacent interior drainage canal. Material to backfill the drainage canal and to construct the new levee would be excavated from a borrow canal located adjacent to the new levee. Upon completion of construction, the borrow canal would also be used to provide drainage to the area. The existing non-Federal levee would be degraded and the material would be pushed back and used in the construction of the new levee. Degrading the existing levee would reduce the quantity of borrow material required and would allow for proper surface drainage.

Providing increased levels of protection within the limits of Bayou Segnette State Park would be accomplished by the construction of a levee/floodwall combination. A levee/floodwall combination would maximize use of the existing levee, thereby minimizing impacts to existing state park operations. The floodwall would be capped with concrete and textured to blend into the natural park setting. Swing gates would be provided within the state park to maintain existing pedestrian and vehicular access. The construction of a floodwall (inverted T-wall) would be required at the Bayou Segnette Pumping Station. North of the pumping station, a floodwall would be constructed along Bayou Segnette to a common tie-in point with the Westwego to Harvey Canal project. The proposed tie-in would eliminate the westside closure of the authorized Westwego to Harvey Canal project.

The protection along the western boundary of the study area would be extended north of U.S. Hwy. 90, eliminating the possibility of end-around flooding. The existing lanes of U.S. Hwy. 90 provide adequate protection at the location of the proposed crossing; thus, they do not need modification. A small levee would be constructed adjacent to South Kenner Road extending the protection from U.S. Hwy. 90 to the Southern Pacific railroad embankment. Flap gates would be installed on culverts through the existing railroad embankment located between South Kenner Road and the existing Jefferson Parish levee. The Jefferson Parish levee, which extends approximately 5,000 feet north of the railroad embankment, is located along the Jefferson-St. Charles Parish line. Extending the protection north of the railroad embankment is not required. The proposed alignment for Plan 1A is shown on Plate 4.

PLAN 1B (Exterior Alignment - Levee/Floodwall Alternative)

Plan 1B would provide for the construction of a combination levee/sheetpile wall along the alignment followed by Plan 1A. The poor foundation conditions and the close proximity of the interior and exterior canals prevent the enlargement of the existing levee using traditional construction techniques. A levee/sheetpile wall was evaluated to determine if increased levels of protection could be provided without impacting the interior or exterior canals. The existing levee would first be degraded to a stable configuration. Steel sheetpiling would then be driven into the levee to provide the required protection. The sheetpiling would remain uncapped except for that portion of the floodwall which extends through Bayou Segnette State Park. Wildlife ramps would be constructed at 1/4 mile intervals along the alignment to allow animals to pass from one side of the protection to the other. Wave action is only a concern along the southern portion of the alignment nearest Lake Cataouatche. A wave berm would be constructed along that portion of the alignment which extends from the southern limits of Bayou Segnette State Park to approximately 1 mile west of the Lake Cataouatche Pumping Station. The wave berm would be constructed using excess material from the degrading operation and additional material hauled from a nearby borrow pit.

The floodwall through Bayou Segnette State Park would be capped with concrete and textured to blend with the natural park setting. Swing gates would be provided within the state park to maintain existing pedestrian and vehicular access. A floodwall (inverted T-wall) would be constructed in front of the Bayou Segnette Pumping Station and the discharge pipes would be passed through the floodwall. The protection would be extended north of the pumping station by the construction of a floodwall along Bayou Segnette.

The floodwall would tie the protection to the authorized Westwego to Harvey Canal project. The proposed tie-in would delete the westside closure, resulting in a savings to the authorized project.

The protection along the western boundary of the study area would extend north of U.S. Hwy. 90 to prevent the potential for end-around flooding. The existing lanes of U.S. Hwy. 90 provide adequate protection and do not need modification. A small levee constructed adjacent to South Kenner Road would extend the protection north from U.S. Hwy. 90 to the Southern Pacific railroad embankment. As discussed for Plan 1A, extending the protection north of the existing railroad embankment is not required. The alignment for Plan 1B is shown on Plate 4.

PLAN 1C (Exterior Alignment - Modified Levee Alternative)

Plan 1C was developed in an attempt to determine if the existing levee could be enlarged along the current alignment without significantly impacting the adjacent canals. As described for Plan 1A, the land available to enlarge the existing levee is severely restricted due to the close proximity of the interior and exterior canals. In order to minimize impacts to the adjacent canals, Plan 1C would provide for the construction of a straddle enlargement (maintaining the existing levee centerline) to take full advantage of the increased soil strengths of the existing foundation. The first enlargement of the levee would provide for a crown width of 7 feet to minimize potential stability problems. A 10-foot crown width would be obtained on the second enlargement. The portion of the alignment which extends from the southern limits of Bayou Segnette State Park to approximately one mile west of the Lake Cataouatche Pumping Station is subject to wave action and would require the construction of a floodside wave berm. In some locations the wave berm would extend a short distance into the exterior canal. Water depths in the canal along the existing bankline are very shallow allowing for the placement of material.

The enlargement of the existing levee as well as the construction of a wave berm would be accomplished using borrow material excavated from the exterior canal. Material would be excavated from within the limits of the existing canal and cast into place using a barge mounted dragline. The enlargement of the existing levee creates potential stability problems due to the close proximity of the interior drainage canal. In order to improve the existing stability, the interior drainage canal would be shifted away from the levee in several locations. A dragline would excavate material from the back of the existing canal and cast it to the front of the canal, effectively shifting the canal away from the levee.

The current dimensions of the canal would be maintained and impacts to the canal would be minimized.

Plan 1C would also include the construction of a levee/floodwall combination through Bayou Segnette State Park. The floodwall would be capped with concrete and textured to blend with the natural park setting. Swing gates would be provided within the state park to maintain existing pedestrian and vehicular access. As discussed for Plans 1A and 1B, a new floodwall (inverted T-wall) would be constructed in front of the Bayou Segnette Pumping Station, and the existing discharge pipes would be passed through the floodwall. The protection would be extended north of the pumping station by the construction of a floodwall along Bayou Segnette. The floodwall would tie the protection to the authorized Westwego to Harvey Canal project. The proposed tie-in would delete the westside closure resulting in a savings to the authorized project.

The protection along the western boundary of the study area would be extended north of U.S. Hwy. 90 to prevent the potential for end-around flooding. The existing lanes of U.S. Hwy. 90 provide adequate protection against hurricane surge and do not need modification. A small levee constructed adjacent to South Kenner Road would extend the protection north from U.S. Hwy. 90 to the Southern Pacific railroad embankment. As discussed for Plans 1A and 1B, extending the protection north of the railroad embankment is not required. The alignment for Plan 1C is shown on Plate 4.

PLAN 2A (Interior Alignment - Levee Alternative)

Plan 2 alternatives were considered to determine if an interior alignment which enclosed less undeveloped land within the protection would be more economical and result in fewer environmental impacts. Plan 2A would provide for the construction of an all-earthen levee generally following an existing drainage canal (Main Canal). The protection would extend south from the Bayou Segnette Pumping Station, cross under the Lapalco Bridge, and follow Main Canal until tying back into U.S. Hwy. 90 near the community of Avondale. The protection would parallel U.S. Hwy. 90 for a short distance before crossing the highway and extending further north. Main Canal would be enlarged and material excavated from the canal would be used to construct the levee. Guide levees would also be constructed along the canal which connects Main Canal to the Lake Cataouatche Pumping Station. The guide levees would ensure that interior drainage would be maintained even during periods of high tide.

A combination levee/floodwall would be constructed along that portion of the alignment passing through Bayou Segnette State Park. The floodwall would be capped with concrete and textured to blend with the natural park setting. Swing gates would also be provided within the state park to maintain existing pedestrian and vehicular access. A floodwall (inverted T-wall) would be constructed in front of the Bayou Segnette Pumping Station and the existing discharge pipes would be passed through the floodwall. The construction of a floodwall along Bayou Segnette would extend the protection north of the Bayou Segnette Pumping Station to a common tie-in point with the Westwego to Harvey Canal project. The proposed tie-in would delete the westside closure, resulting in a savings to the authorized project. The tie-in with the Westwego to Harvey Canal project would be the same as described for the Plan 1 alternatives.

The protection along the western boundary of the alignment would need to extend north of U.S. Hwy. 90 to prevent the potential for end around flooding. The lanes of U.S. Hwy. 90 provide adequate protection at the location of the proposed crossing; thus, they do not need modification. A small levee, constructed along the western limits of the community of Waggaman, would extend the protection from U.S. Hwy. 90 to the Southern Pacific railroad embankment. Natural ground elevations north of the railroad tracks are in excess of potential surge heights and would prevent the possibility for end-around flooding. The alignment for Plan 2A is shown on Plate 5.

PLAN 2B (Interior Alignment - Levee/Floodwall Alternative)

Plan 2B would follow the same alignment as Plan 2A, but it would provide for the construction of a levee/floodwall combination as opposed to an all earthen levee section. The construction of a combination levee/floodwall significantly reduces the size of the levee section reducing both the required rights-of-way and borrow material. The levee would be constructed using material excavated from the existing interior drainage canal. Steel sheetpiling would then be driven into the completed levee to provide the required protection. The sheetpiling would remain uncapped except for that portion which extends through Bayou Segnette State Park. The floodwall through the state park would be capped with concrete and textured to blend with the natural park setting. Swing gates would also be provided within the state park to maintain existing pedestrian and vehicular access. A floodwall (inverted T-wall) would be constructed in front of the Bayou Segnette Pumping Station as described for other Plan 1 and Plan 2 alternatives. A floodwall constructed along Bayou Segnette would extend the protection north of the pumping station to a common tie-in point with the Westwego to Harvey Canal project. The proposed tie-in

would delete the westside closure resulting in a savings to the authorized project. The tie-in with the Westwego to Harvey Canal project would be the same as described for other Plan 1 and Plan 2 alternatives.

The protection along the western boundary of the alignment would need to extend north of U.S. Hwy. 90 to prevent the potential for end around flooding. The existing lanes of U.S. Hwy. 90 provide adequate protection and would not require modification. A small earthen levee would be constructed along the western limits of the community of Waggaman extending the protection from U.S. Hwy. 90 to the Southern Pacific railroad embankment. The existing ground elevations north of the railroad embankment are greater than the maximum surge heights in the area preventing the possibility for end-around flooding. The alignment for Plan 2B is shown on Plate 5.

PLAN ASSESSMENT AND EVALUATION

A detailed analysis was conducted to determine the ability of each alternative plan to provide hurricane protection to the study area, protect natural resources, and be accepted by the public. The economic and environmental impacts associated with each alternative serve as the basis for the analysis. Impacts to known or suspected hazardous, toxic, or radioactive waste (HTRW) sites were also considered in the analysis.

The alternative plans were evaluated from an economic standpoint by comparing estimated equivalent annual benefits with estimated average annual costs. A description of the methodology used to determine economic damages and benefits for both the with- and without-project conditions is presented in Volume 2, Appendix B.

Alternative plans were also evaluated based on environmental impacts. Each of the alternatives considered would cause similar adverse environmental impacts. Impacts do, however, differ in magnitude from plan to plan. A comprehensive analysis is discussed in detail in the Environmental Impact Statement (EIS) and is supported by the environmental documentation contained in Volume 2, Appendix C. Mitigation plans provide for land acquisition measures to offset project induced impacts. To offset habitat losses, the same general mitigation measures would be used. The variable for all plans would be the amount of land acquisition necessary to fully offset these impacts.

Habitat evaluation processes were conducted utilizing two separate but comparable

methods. The Habitat Evaluation System (HES) methodology is included within the Mitigation Report/Incremental Analysis found in Volume 2, Appendix C. The methodology of the Louisiana Department of Natural Resources Habitat Assessment Models for Fresh Swamp and Bottomland Hardwoods in the Louisiana Coastal Zone are included within the Fish and Wildlife Coordination Act Report found in Volume 2, Appendix D.

PLAN 1A (Exterior Alignment - Levee Alternative)

Plan Description. Plan 1A would provide for the construction of an earthen levee along the alignment generally followed by the existing non-Federal levee. The close proximity of the adjacent canals along with the poor foundation conditions do not allow for the enlargement of the existing levee using traditional construction techniques. A levee set-back (shifting the levee to the landside and away from the current alignment) would be required. The levee set-back would begin at the southern limits of Bayou Segnette State Park and continue for approximately 8 miles before tying back to U.S. Hwy. 90 near the St. Charles Parish line. The relocated levee would be placed in the general vicinity of the existing interior drainage canal. The existing canal would be backfilled prior to construction of the new levee. Material to backfill the existing canal and to construct the new levee would be excavated from an adjacent borrow canal. Excavation of material from the borrow canal would be performed in such a manner as to provide interior drainage upon completion of construction. In order to allow for proper surface drainage, the existing levee would be degraded and used in the construction of the new levee.

A levee/floodwall combination would be constructed through Bayou Segnette State Park, and swing gates would be provided to maintain existing pedestrian and vehicular access. A floodwall (inverted T-wall) would be constructed in front of the Bayou Segnette Pumping Station, and the existing discharge pipes would be passed through the floodwall. A floodwall constructed along Bayou Segnette would extend the protection north of the pumping station to a common tie-in point with the authorized Westwego to Harvey Canal project. A small levee would also be constructed along the western boundary of the study area adjacent to South Kenner Road, extending the protection north from U.S. Hwy. 90 to the Southern Pacific railroad embankment.

Cost estimates were developed for Plan 1A for providing both a 100-year and SPH level of protection. Although an earthen levee constructed using adjacent cast material is usually less expensive than a floodwall, the requirement to backfill the existing interior

drainage canal significantly increased the overall project cost. Plan 1A would require the excavation and placement of between 8.5 and 10 million cubic yards of material.

Although the material would be cast into place from an adjacent borrow canal, the large quantity of material makes this alternative cost-prohibitive. Shifting the levee away from the existing alignment and constructing a new borrow/drainage canal also requires greater quantities of new rights-of-way and results in more severe adverse environmental impacts than other alternatives. The total first cost for Plan 1A was estimated at \$47,300,000 for 100-year protection and \$55,700,000 for SPH protection.

Rationale for Elimination. The average annual costs developed for Plan 1A were estimated at \$3,688,000 for 100-year protection and \$4,342,000 for SPH protection. These costs are at least 2½ times greater than the average annual first costs of other Plan 1 alternatives. All Plan 1 alternatives follow the same general alignment and would produce similar levels of benefits. Shifting the levee away from the current alignment and constructing a new interior drainage/borrow canal would adversely impact in excess of 400 acres of wooded lands. As a result of excessive cost and greater environmental impacts, Plan 1A was eliminated from further consideration.

PLAN 1B (Exterior Alignment - Levee/Floodwall Alternative)

Plan Description. Plan 1B would provide for the construction of a combination levee/sheetpile wall along the alignment followed by the existing Lake Cataouatche levee. This alternative to conventional levee construction was evaluated as a result of the poor foundation conditions and the close proximity of the interior and exterior canals. The existing levee would first be degraded to a stable configuration. Sheetpiling would then be driven into the levee to provide the required protection. The sheetpiling would remain uncapped except within Bayou Segnette State Park. The floodwall through the state park would be capped with concrete for aesthetic reasons and swing gates would be provided to maintain existing pedestrian and vehicular access. A floodwall (inverted T-wall) would be constructed in front of the Bayou Segnette Pumping Station and the existing discharge pipes would be passed through the floodwall. A floodwall constructed along Bayou Segnette would extend the protection north of the existing pumping station to a common tie-in point with the authorized Westwego to Harvey Canal project. Wave action is a concern along the southern portion of the alignment which fronts Lake Cataouatche. A wave berm would be constructed from the southern limits of Bayou Segnette State Park to just west of the Lake Cataouatche Pumping Station. The wave berm would be constructed using excess material from the degrading operation and material hauled from a nearby

borrow pit.

To prevent the potential for end-around flooding, the protection would be extended north of U.S. Hwy. 90 along the western boundary of the study area. Extending the protection north of U.S. Hwy. 90 would be accomplished by the construction of a small levee along the east side of South Kenner Road. The levee would extend the protection from U.S. Hwy. 90 to the Southern Pacific Railroad embankment. This plan was analyzed for the 100-year, 200-year, and SPH levels of protection.

Impacts to Westwego to Harvey Canal Project. The authorized Westwego to Harvey Canal Hurricane Protection project provides for the construction of a westside closure just north of Bayou Segnette State Park. The purpose of the westside closure is to ensure that protection to the project area is maintained even if the deficient Lake Cataouatche levee were to be overtopped. The closure plan includes construction of an earthen levee along the east shoulder of the Bayou Segnette State Park entrance road, along the south shoulder of the Westbank Expressway, and north from the Westbank Expressway to the Southern Pacific Railroad tracks. The closure plan would also provide for the construction of a ramp in the Westbank Expressway in the vicinity of the Bayou Segnette State Park entrance. A small drainage canal would be constructed parallel to the levee north of the Westbank Expressway to maintain interior drainage to the adjacent residential area. The alignment of the authorized westside closure for the Westwego to Harvey Canal project is shown on Plate 3.

An analysis was conducted to determine if increasing the protection provided to the Lake Cataouatche area would impact the requirement for the westside closure. Based on projected rates of overtopping, it was determined that a minimum 100-year level of protection would be sufficient to prevent end-around flooding. The large undeveloped sump area located within the Lake Cataouatche area would be sufficient to contain the overflow up to a 500-year event. The sump area includes approximately 8,000 acres of undeveloped land south of U.S. Hwy 90 and impacts to the storage capacity of the sump as a result of future development would not be sufficient to jeopardize protection to the Westwego to Harvey Canal area. Future development is projected to effect less than 6 percent of the total number of acres located within the sump. In addition, the northern reaches of the sump area (high ground) are likely to be developed first minimizing impacts to the overall storage capacity. Development within the sump area would require the extensive use of fill material to raise slab elevations to above the 100-year floodplain. The deposition of fill material would be subject to the provisions of Section 404 of the Clean

Water Act, limiting development within the sump area. Measures to prevent encroachment of the sump area for alternatives providing less than SPH protection is not be required.

The savings associated with deleting the westside closure from the authorized project (\$4,969,000) can only be claimed as a cost offset if the modification does not result in a delay in project benefits. The current schedule for construction of the Westwego to Harvey Canal project would provide for the completion of the westside closure in the year 2001. Beneficial completion of the Westwego to Harvey Canal project is also scheduled for 2001. The construction schedule for Plan 1B would provide for completion of the Lake Cataouatche project in the year 2000. With the Lake Cataouatche project scheduled for completion a year prior to the westside closure, there would be no delay in project benefits. The savings associated with deleting the westside closure are not included in the economic analysis for the Lake Cataouatche area, but rather as a reduction in the first cost for the Westwego to Harvey Canal project.

Environmental Impacts. Environmental impacts would include the potential loss of early successional bottomland hardwoods from the areas adjacent to U.S. Hwy. 90 and South Kenner Road and from the borrow pit sites located near Bayou Segnette State Park and the Lake Cataouatche Pumping Station. The construction of Plan 1B would result in the direct loss of approximately 20 acres of early successional bottomland hardwoods. Indirect impacts of any increase in the size of the interior borrow/drainage canal and subsequent increased drainage effects on basin wetlands are essentially non-existent. The adverse environmental impacts would be essentially the same for all three levels of protection (100-yr, 200-yr, and SPH). These impacts would result in the loss of an associated 5 annualized habitat unit value (AHUV's). Mitigation would be provided to compensate for unavoidable impacts. The mitigation plan would provide for the purchase, bottomland hardwood habitat development, and management of a 15-acre tract located adjacent to Bayou Segnette State Park. The average annual mitigation costs are estimated at \$21,000. Wildlife ramps would be constructed to allow wildlife to move back and forth across the protection. The ramps would be constructed at 1/4 mile intervals along that portion of the alignment between Bayou Segnette State Park and U.S. Hwy. 90.

Hazardous, toxic, and radioactive waste investigations revealed the presence of several facilities that warranted concern. A seafood processing facility is located near Bayou Segnette Pumping Station, and three landfills are located near U.S. Hwy. 90 along the western boundary of the study area. No evidence of contamination was found in the vicinity of the seafood processing facility, and, although the landfills do present a potential

problem, no excavation would be accomplished in these areas. Borrow material to construct the levee which parallels the Greater New Orleans landfill, and extends from U.S. Hwy. 90 to the Southern Pacific Railroad embankment, would be hauled from a nearby borrow source. No records of underground storage tanks were identified along the proposed alignment for Plan 1B. Based on our investigations, Plan 1B would present a minimal risk of encountering HTRW problems during construction. Additional information on the environmental impacts of Plan 1B are presented in Volume 2, Appendix C.

Economic Summary. The total project first costs for Plan 1B are estimated at \$11,507,000 for 100-year protection, \$12,065,000 for 200-year protection, and \$18,280,000 for SPH protection. Average annual costs were determined using a project life of 100 years and an interest rate of $7\frac{3}{4}$ percent. The period of construction for Plan 1B is approximately 3 years. A summary of the gross investment and average annual costs for Plan 1B for the three levels of protection are shown in Table 8.

TABLE 8
LAKE CATAOUATCHE, PLAN 1B
SUMMARY OF GROSS INVESTMENT COSTS
AND AVERAGE ANNUAL CHARGES
 $7\frac{3}{4}$ PERCENT

	<u>100-yr</u>	<u>200-yr</u>	<u>SPH</u>
Project First Cost	11,507,000	12,065,000	18,280,000
Interest During Const.	800,000	837,000	1,227,000
Gross Investment	12,307,000	12,902,000	19,507,000
Proj. Avg. Annual Cost ¹	1,027,000	1,079,000	1,593,000
Mitigation Avg. Annual Cost	21,000	21,000	21,000
Total Avg. Annual Cost	1,048,000	1,100,000	1,614,000

¹ This figure includes interest, amortization, future protection, and operations, maintenance, repair, replacement, and rehabilitation costs.

PLAN 1C (Exterior Alignment - Modified Levee Alternative)

Plan Description. Plan 1C would provide for the enlargement of the existing non-Federal levee from Bayou Segnette State Park to the tie-in at U.S. Hwy. 90 near the St. Charles Parish line. A straddle enlargement would be constructed to take full advantage of the increased soil strengths of the existing foundation. In order to minimize potential stability problems, the initial enlargement would only provide a crown width of 7 feet. The crown width of the levee would be increased to 10 feet during the second lift. The portion of the alignment which extends from the southern limits of Bayou Segnette State Park to approximately 1 mile west of the Lake Cataouatche Pumping Station is subject to wave action. A wave berm would be constructed in this area to dissipate potential waves. The close proximity of the floodside canal would require the wave berm to extend beyond the existing bankline in a couple of locations. Shallow water depths in the canal near the existing bank would easily accommodate the placement of material. Borrow material for the enlargement of the existing levee and for construction of the wave berm would come from the existing floodside canal. A barge mounted dragline would excavate material from the canal and cast it directly into place. Material would only be excavated from within the existing canal (no additional wetlands would be impacted).

The enlargement of the existing levee would create potential stability problems with respect to the interior drainage canal. Minor adjustments to the drainage canal would be required to ensure that adequate factors of safety are provided. A dragline would be used to excavate material from the back (landside) of the canal and cast to the front of the canal effectively shifting the canal away from the levee. The dimensions of the canal would be maintained, and impacts to drainage would be minimized. Material excavated from the interior drainage canal would also be used to construct the protected side stability berm.

Plan 1C would also provide for the construction of a combination levee/sheetpile wall through Bayou Segnette State Park. The floodwall would be capped with concrete for aesthetic purposes, and swing gates would be provided to maintain existing pedestrian and vehicular access. A floodwall (inverted T-wall) would be constructed in front of the Bayou Segnette Pumping Station, and the discharge pipes would be passed through the floodwall. A floodwall constructed along Bayou Segnette would extend the protection north of the pumping station to a common tie-in point with the Westwego to Harvey Canal project. The protection along the western boundary of the study area would be extended north of U.S. Hwy. 90 to prevent the potential for end-around flooding. A small levee would be constructed adjacent to South Kenner Road extending the protection from U.S.

Hwy. 90 to the Southern Pacific railroad embankment. This plan was analyzed for the 100-year, 200-year, and SPH levels of protection.

Impacts to the Westwego to Harvey Canal Project. As described for Plan 1B, the authorized Westwego to Harvey Canal Hurricane Protection project provides for the construction of a westside closure in the vicinity of Bayou Segnette State Park. The purpose of the westside closure is to ensure that protection to the Westwego project area be maintained even if the deficient Lake Cataouatche levee were to be overtopped. As discussed for Plan 1B, enlarging the existing levees to provide a minimum 100-year level of protection to the Lake Cataouatche area would eliminate the need for the westside closure. The savings attributable to deleting the westside closure (\$4,969,000) are not included in the economic analysis for Lake Cataouatche, but rather as a cost offset for the Westwego to Harvey Canal project.

An analysis of the construction schedules is required to determine possible limitations on claiming the savings as a cost offset. The current schedule for construction of the Westwego to Harvey Canal project would provide for the completion of the westside closure in the year 2001. Although Plan 1C would not provide for completion of the Lake Cataouatche project until the year 2006, completion of all first lifts (beneficial completion) is scheduled for the year 2000. Beneficial completion is the point at which the design grade for all features of the project are first obtained and is the point at which full benefits are attributable to the project. With Lake Cataouatche scheduled for beneficial completion prior to completion of the westside closure of the Westwego to Harvey Canal project, there would be no delay in benefits. This allows for the entire savings associated with eliminating the westside closure to be claimed as a reduction in the first cost of the authorized project.

Environmental Impacts. Environmental impacts would include the loss of approximately 57 acres of early successional bottomland hardwoods. The losses would be similar to those described for Plan 1B; however, an additional strip of land along the interior borrow/drainage canal would be impacted, and the borrow area located near the Lake Cataouatche Pumping Station would be excluded. These losses would result in an associated 15 AHUV's. The potential losses would be the same for the 100-yr, 200-yr, or SPH level of protection. The mitigation plan would provide for the purchase, bottomland hardwood habitat development, and management of a 39-acre tract located adjacent to Bayou Segnette State Park. The average annual mitigation costs are estimated at \$43,000. As a result of Plan 1C providing for the enlargement of the existing levee between Bayou

Segnette State Park and U.S. Hwy. 90, wildlife ramps would not be required.

Hazardous, toxic, and radioactive waste investigations revealed the presence of several facilities that warranted concern. A seafood processing facility is located near Bayou Segnette Pumping Station and three landfills are located near U.S. Hwy. 90 along the western boundary of the study area. No evidence of contamination was found in the vicinity of the seafood processing facility, and, although the landfills do present a potential problem, no excavation would be accomplished in these areas. Material to construct the levee north of U.S. Hwy. 90, parallel to the Greater New Orleans landfill, would be hauled from a nearby borrow source. Excavation would also not be permitted along the existing bank of the interior drainage canal in the vicinity of the Area 90 landfill to avoid potential impacts. Another concern was the potential contamination of the interior drainage canals as a result of runoff from the adjacent landfills. Sediment and water quality samples collected from the drainage canals in the vicinity of the landfills showed contamination levels similar to the background samples collected throughout the area. The potential to disturb or release these contaminants into the water column during construction would be minimal and would not significantly degrade the water quality. No records of underground storage tanks were identified along the proposed alignment for Plan 1C. Based on our investigations, Plan 1C would present a minimal risk of encountering HTRW problems during construction. Additional information on the environmental impacts of Plan 1C can be found in Volume 2, Appendix C.

Economic Summary. The total project first costs for Plan 1C are estimated at \$8,003,000 for 100-year protection, \$9,238,000 for 200-year protection, and \$10,101,000 for SPH protection. Average annual costs were determined using a project life of 100 years and an interest rate of $7\frac{3}{4}$ percent. The period of construction for Plan 1C, including 2 lifts on the levee enlargement, is approximately 9 years. A summary of the gross investment and average annual costs for Plan 1C for three levels of protection are shown in Table 9.

TABLE 9
LAKE CATAOUATCHE, PLAN 1C
SUMMARY OF GROSS INVESTMENT COSTS
AND AVERAGE ANNUAL CHARGES
7³/₄ PERCENT

	<u>100-yr</u>	<u>200-yr</u>	<u>SPH</u>
Project First Cost	8,003,000	9,238,000	10,101,000
Interest During Const.	362,000	365,000	348,000
Gross Investment	8,365,000	9,603,000	10,449,000
Proj. Avg. Annual Cost ¹	688,000	793,000	860,000
Mitigation Avg. Annual Cost	43,000	43,000	43,000
Total Avg. Annual Cost	731,000	836,000	903,000

¹ This figure includes interest, amortization, future protection, and operations, maintenance, repair, replacement, and rehabilitation costs.

PLAN 2A (Interior Alignment - Levee Alternative)

Plan Description. Plan 2A would provide for the construction of an all-earthen levee which generally follows an existing interior drainage canal (Main Canal). The protection would extend south from the Bayou Segnette Pumping Station, cross under the Lapalco Bridge, and follow Main Canal until tying back to U.S. Hwy. 90 near the community of Avondale. The protection would parallel U.S. Hwy. 90 for a short distance before crossing the highway and extending further north. The levee would be constructed using adjacent cast material excavated from the existing drainage canal. Guide levees would be constructed along the canal which connects Main Canal to the Lake Cataouatche Pumping Station. These levees would ensure that interior drainage to the area is maintained even during periods of high tide.

A floodwall would be constructed within Bayou Segnette State Park to minimize

impacts to existing operations. The floodwall through the state park would be capped with concrete, and swing gates would be provided to maintain existing pedestrian and vehicular access. A floodwall (inverted T-wall) would be constructed in front of the Bayou Segnette Pumping Station, and the discharge pipes for the existing pumping station would be passed through the floodwall. The construction of a floodwall along Bayou Segnette would extend the protection north from the pumping station to a common tie-in point with the Westwego to Harvey Canal project. The protection along the western boundary of the study area would be extended north of U.S. Hwy. 90 to prevent the potential for end around flooding. The construction of a levee parallel to the community of Waggaman would extend the protection from U.S. Hwy. 90 to the Southern Pacific railroad embankment.

Cost estimates were developed for Plan 2A (providing both a 100-year and SPH level of protection). Although the alignment for Plan 2 alternatives is shorter than the alignment for Plan 1 alternatives, full utilization of the existing non-Federal levee significantly reduces the costs for the exterior alignment. The lack of an existing levee along the interior alignment increases the quantity of fill material required for Plan 2 alternatives. All lands required for the construction of Plan 2A would be new rights-of-way resulting in significantly higher real estate costs. The total first costs for Plan 2A were estimated at \$16,920,000 for 100-year protection and \$20,646,000 for SPH protection.

Rationale for Elimination. The average annual costs developed for Plan 2A were estimated at \$1,455,000 for 100-year protection and \$1,793,000 for SPH protection. These costs are approximately 85 percent greater than the average annual first costs for either Plan 1B or Plan 1C. Plan 1 and Plan 2 alternatives would generally provide protection to the same areas and would result in similar levels of benefits. The direct environmental impacts would be significantly greater for Plan 2A than for either Plan 1B or Plan 1C due to the large quantity of new rights-of-way required along Main Canal. The construction of Plan 2A would adversely impact in excess of 300 acres of high quality bottomland hardwoods. As a result of excessive cost and greater environmental impacts, Plan 2A was eliminated from further consideration.

PLAN 2B (Interior Alignment - Levee/Sheetpile Alternative)

Plan Description. Plan 2B would follow the same general alignment as Plan 2A. To reduce required rights-of-way and minimize adverse environmental impacts, Plan 2B would provide for the construction of a combination levee/sheetpile wall. A reduced levee

section would first be constructed using material excavated from the existing interior drainage canal (Main Canal). Sheetpiling would then be driven into the levee to provide the required protection. The sheetpiling would remain uncapped except for that portion which is located within Bayou Segnette State Park. The floodwall within the state park would be capped with concrete for aesthetic purposes, and swing gates would be provided to maintain existing pedestrian and vehicular access. A floodwall (inverted T-wall) would be constructed in front of the Bayou Segnette Pumping Station, and the discharge pipes would be passed through the floodwall. Extending the protection north from the pumping station to a common tie-in point with the Westwego to Harvey Canal project would be accomplished by the construction of a floodwall along Bayou Segnette.

To ensure that interior drainage to the area is maintained, even during periods of high tides, guide levees would be constructed along the canal which connects Main Canal to the Lake Cataouatche Pumping Station. As described for Plan 2A, the protection would be extended north of U.S. Hwy. 90 along the western boundary of the study area. A levee constructed parallel to the community of Waggaman would extend the protection from U.S. Hwy. 90 to the Southern Pacific railroad embankment.

Cost estimates were developed for Plan 2B for providing both a 100-year and SPH level of protection. The lack of an existing levee along the interior alignment increases the quantity of fill material required for Plan 2 alternatives and requires the acquisition of additional rights-of-way. The total first costs for Plan 2B were estimated at \$17,891,000 for 100-year protection and \$22,756,000 for SPH protection.

Rationale for Elimination. The average annual costs developed for Plan 2B were estimated at \$1,528,000 for 100-year protection and \$1,929,000 for SPH protection. These costs are approximately 90 percent greater than the average annual first costs for Plan 1C. Plan 1 and Plan 2 alternatives would generally provide protection to the same areas and would result in similar levels of benefits. The direct environmental impacts would be greater for Plan 2B than for either Plan 1B or Plan 1C due to the additional rights-of-way required along Main Canal and the loss of associated bottomland hardwoods. The construction of Plan 2B would adversely impact in excess of 100 acres of high quality bottomland hardwoods. As a result of excessive cost and greater environmental impacts, Plan 2B was eliminated from further consideration.

SUMMARY OF PLAN ASSESSMENT

A detailed analysis was conducted to determine the ability of each plan to provide hurricane protection to the study area and to protect natural resources. Alternative plans were evaluated from an economic standpoint by comparing estimated equivalent annual benefits with estimated average annual costs. The amount of environmental impacts that would likely result from the implementation of each plan was also considered in the analysis. Plan 1A and Plans 2A and 2B were eliminated from further consideration due to excessive cost and greater environmental impacts. The remaining plans are Plan 1B at the 100-year, 200-year, and SPH levels of protection and Plan 1C at the 100-year, 200-year, and SPH levels of protection. Each of these plans will be evaluated further using a traditional analysis in the following section.

COMPARISON OF PLANS

Comparative information on the remaining plans is presented in this section, along with the rationale for determining which of the plans provides greater net annual benefits. The plan which is determined to provide greater net annual benefits will be further evaluated using a risk based approach to determine the level of protection for the NED plan and, if different, the recommended plan.

Each of the remaining plans fulfill the primary objective by providing increased levels of hurricane protection to the study area. Plans 1B and 1C have been determined to warrant further evaluation. Both of these plans are structural plans. Practical non-structural measures, such as zoning and building regulations, flood-forecasting and warning, and flood-fighting and evacuation plans are currently in place in the study area and will remain in use as features of any plan, including the no action plan. The remaining plans are economically justified and would result in benefit-to-cost ratios of greater than unity. Environmental impacts would be associated with each plan. Significant environmental damages would be mitigated to the extent justified. A summary comparison of the plans is shown in Table 10, "Effects Display and System of Accounts".

TABLE 10
EFFECTS DISPLAY AND SYSTEM OF ACCOUNTS

ITEM	NO FEDERAL ACTION	LAKE CATAOUCHE	
		PLAN 1B	PLAN 1C
I. PLAN DESCRIPTION	No Federal Project and continued maintenance of existing local levees.	This plan would provide for the construction of a combination levee/sheeping wall along the alignment followed by the existing non-Federal levee. The levee begins at Bayou Segnette and extends in a southwesterly direction for approximately 9 miles before tying back into U.S. Hwy. 90 near the St. Charles Parish line. The existing levee is unstable in many locations due to the poor foundation conditions and the close proximity of the interior and exterior drainage canals. The non-Federal levee would be degraded to a stable configuration and steel sheetpiling would be driven into the levee. The floodwall would remain uncapped except for that portion which extends through Bayou Segnette State Park. The floodwall through the state park would be capped with concrete for aesthetic reasons. Swing gates would be provided within the state park to maintain existing access. A new floodwall (inverted T-wall) would be constructed at the Bayou Segnette Pumping Station and the discharge pipes for the pumping station would be passed through the floodwall. The floodwall would extend north from the Bayou Segnette Pumping Station to a common tie-in point with the authorized Westwego to Harvey Canal project. The protection would also extend north of U.S. Hwy. 90 along the western boundary of the study area. A small levee would be constructed adjacent to South Kanter Road from U.S. Hwy. 90 to the Southern Pacific Railroad embankment. Unavoidable impacts would be mitigated by the acquisition, bottomland hardwood habitat development, and management of up to 15 acres located adjacent to Bayou Segnette State Park.	This plan would follow the same alignment as described for Plan 1B. The difference between the two plans is that Plan 1C would allow for the construction of an all earthen levee from the southern limits of Bayou Segnette State Park to the tie-in point at U.S. Hwy. 90. The existing levee would be enlarged using material excavated from the floodside borrow canal. Modification of the protected side drainage canal would be required to avoid potential stability problems associated with the enlargement of the levee. Material would be excavated from the back of the canal and cast to the front of the canal effectively shifting the canal away from the levee. A combination levee/floodwall would be constructed through Bayou Segnette State Park to minimize impacts to existing park operations. The floodwall would be capped with concrete for aesthetic purposes. Swing gates would be constructed within the state park to maintain vehicular and pedestrian access. As described for Plan 1B, the floodwall would extend north along Bayou Segnette to a common tie-in point with the Westwego to Harvey Canal project. The protection north of U.S. Hwy. 90 along the western boundary of the study area would also be identical to that described for Plan 1B. Unavoidable impacts would be mitigated by the acquisition, bottomland hardwood habitat development, and management of up to 39 acres located adjacent to Bayou Segnette State Park.

TABLE 10
EFFECTS DISPLAY AND SYSTEM OF ACCOUNTS

ITEM	NO FEDERAL ACTION	LAKE CATAGUATCHE				
		PLAN 1B		PLAN 1C		
		SPH	200 year 100 year	SPH (USP)	200 year (NETS)	100 year
11. SIGNIFICANT IMPACTS						
1. Net Economic Development						
a. Equivalent Annual Benefits ¹	Not Applicable	\$8,534,000	\$8,534,000	\$8,534,000	\$8,534,000	\$8,534,000
b. Total Ave. Annual Costs ²		\$1,614,000	\$1,100,000	\$903,000	\$876,000	\$731,000
1) Interest & Amortization		\$1,512,000	\$1,001,000	\$854,000	\$745,000	\$649,000
2) Operations & Maintenance ³		\$11,000	\$11,000	\$11,000	\$10,000	\$10,000
3) Mitigation		\$21,000	\$21,000	\$43,000	\$43,000	\$43,000
4) Future Protection		\$70,000	\$67,000	\$38,000	\$38,000	\$29,000
c. First Cost		\$18,200,000	\$12,085,000	\$10,101,000	\$9,238,000	\$8,003,000
d. Net Annual Benefits		\$6,920,000	\$7,434,000	\$7,631,000	\$7,668,000	\$7,640,000
e. Benefit/Cost Ratio (BCR)		5.29	7.75	9.45	10.19	11.43
2. Environmental quality						
a. Bottomland Hardwoods ⁴	Undeveloped lands within the study area would continue to be developed for residential and commercial purposes. A reduction of bottomland hardwoods, from approximately 11,000 in 1990 to 6,370 acres in 2099, can be expected	20 acres 5 AHU	20 acres 5 AHU	57 acres 15 AHU	57 acres 15 AHU	57 acres 15 AHU

¹ Based on Oct 1994 price levels with a project life of 100 years and an interest rate of 7 3/4 percent

² Operations and maintenance costs include operations, maintenance, repair, replacement, and rehabilitation

³ Implementation of either Plan 1B or Plan 1C would result in a savings of \$4,969,000 by deferring the wetlands closure from the Westwego to Harvey Canal project. These savings have not been included in the economic analysis for Lake Cataouatche, but rather as a decrease in the project first cost of the authorized project

⁴ Impacts for Plan 1B or Plan 1C would be in addition to the impacts for "No Federal Action"; all losses would be mitigated

TABLE 10
EFFECTS DISPLAY AND SYSTEM OF ACCOUNTS

ITEM	NO FEDERAL ACTION	LAKE CATAOUATCHIE	
		PLAN 1B	PLAN 1C
II IMPACTS (continued)			
b. Water Quality	Urban runoff would continue to deteriorate water quality in interior canals	The construction of Plan 1B would have minimal impacts on water quality in the area. The levee/floodwall combination would not alter existing hydrologic conditions.	The construction of Plan 1C would have minimal impacts on water quality in the area. Some short-term impacts would be associated with construction. The release of contaminants into the water column would be minimal.
c. Aquatic Resources	Deterioration of water quality in interior canals would result in decreased numbers of species able to tolerate polluted waters.	The aquatic resources would be the same as described for "No Federal Action." There would be about 22 acres of new borrow pit habitat created.	The aquatic resources would be the same as described for "No Federal Action." There would be an additional 12 acres of borrow pit habitat created.
d. National Register of Historic Places	Unrecorded cultural resources would continue to be lost.	Same as "No Federal Action."	Same as "No Federal Action."
e. Recreation	Loss of recreational opportunities due to continued loss of wetlands.	Similar to "No Federal Action," with additional short term impacts (minor) within Bayou Segnette State Park and along the existing levee due to construction activities.	Similar to No "Federal Action," with additional short term impacts (minor) within Bayou Segnette State Park and along the existing levee due to construction activities.
f. Air Quality	Not evaluated	Minor adverse impacts during construction from dust and internal combustion engines.	Minor adverse impacts during construction from dust and internal combustion engines.
g. ITRW Impacts	Not evaluated	Results of the initial assessment indicate a low probability of encountering ITRW problems.	Results of the initial assessment indicate a low probability of encountering ITRW problems.
3. Regional Development			
a. Effects on Employment and Income	Not Evaluated	Minor Additional opportunities generated by construction	Minor additional opportunities generated by construction
b. Land Use	Continued urban growth	Urban growth is expected to continue with or without a Federal project	Urban growth is expected to continue with or without a Federal project

TABLE 10
EFFECTS DISPLAY AND SYSTEM OF ACCOUNTS

ITEM	NO FEDERAL ACTION	LAKE CATAOAUCHIE	
		PLAN 1B	PLAN 1C
III IMPACTS (continued)			
c. Regional Growth and Business Activity	Continued growth to support development.	Continued growth should occur to support protected residential development.	Continued growth should occur to support protected residential development.
d. Tax Revenue	Increases in tax revenue.	Increases in tax revenue due to additional development.	Increases in tax revenue due to additional development.
4. Other Social Effects			
a. Community Cohesion	No impact.	Positive impact to residents confidence in hurricane protection system.	Positive impact to residents confidence in hurricane protection system.
b. Property Values	Increases related to economic factors.	Same as "No Federal Action," however, the additional flood protection would have a qualitative impact on property in the area.	Same as "No Federal Action," however, the additional flood protection would have a qualitative impact on property in the area.
c. Community Growth, Public Facilities, and Services	Continued growth.	Same as "No Federal Action."	Same as "No Federal Action."
d. Leisure/Recreation Opportunities	Continued loss of wetlands to development.	Increased protection to Bayou Segnette State Park provides for continued use of existing resources. Potential for mitigation site to add to state park resources.	Increased protection to Bayou Segnette State Park provides for continued use of existing resources. Potential for mitigation site to add to state park resources.
e. Security of Life, Health, and Safety	No change	Providing SPH protection would reduce the risk of hurricane flooding and disaster including loss of life, property, and essential services; lesser levels of protection would provide less security.	Providing SPH protection would reduce the risk of hurricane flooding and disaster including loss of life, property, and essential services; lesser levels of protection would provide less security.
f. Displacement of People	Frequent evacuations due to lack of protection.	Reduction in number of future evacuations. Higher probability that residents would evacuate when asked to do so.	Reduction in number of future evacuations. Higher probability that residents would evacuate when asked to do so.

TABLE 10
EFFECTS DISPLAY AND SYSTEM OF ACCOUNTS

ITEM	NO FEDERAL ACTION	LAKE CATAOUATCHÉ	
		PLAN 1B	PLAN 1C
II. IMPACTS (continued) g. Esthetic Values	No impact.	Esthetic values would be reduced along the existing levee alignment due to construction of uncapped sheet pile wall. Texturing of floodwall in Bayou Segnette State Park would mitigate for additional impacts to the esthetic values.	Texturing of floodwall in Bayou Segnette State Park would mitigate for adverse impacts to esthetic values. No impacts to aesthetic values along existing levee alignment.
	No impact.	Impacts due to construction noise would be minimal due to isolated nature of the area.	Impacts due to construction noise would be minimal due to isolated nature of the area.
III. OTHER FACTORS IN PLAN FORMULATION a. Acceptability	Does not alleviate the possibility of catastrophic damages and loss of life by a hurricane.	Locals would accept plan, however, concern has been expressed about lack of concrete cap on sheetpiling and potential impacts to access that would be created by construction of a floodwall.	This plan is strongly supported by local, state, and regional entities.
	Not Applicable	The SPH plan would afford maximum protection and would prevent possible loss of life and property thus minimizing risks and uncertainty. The 200-year and 100-year levels of protection would provide lesser protection.	The SPH plan would afford maximum protection and would prevent possible loss of life and property thus minimizing risks and uncertainty. The 200-year and 100-year levels of protection would provide lesser protection. This plan has the support of the public and is compatible with local plans.
c. Effectiveness	The existing condition is the least effective condition in meeting the primary objectives.	SPH - Very effective 200 year - Effective 100 year - Less effective	SPH - Very effective 200 year - Effective 100 year - Less effective
d. Efficiency	Least efficient	200 year - Very efficient SPH - Slightly less efficient 100 year - Less efficient	200 year - Determined to be the most efficient SPH - Slightly less efficient 100 year - Less efficient

TABLE 10
EFFECTS DISPLAY AND SYSTEM OF ACCOUNTS

ITEM	NO FEDERAL ACTION	LAKE CATAOUATCHE					
		PLAN 1B			PLAN 1C		
		SPH	200 year	100 year	SPH	200 year	100 year
IV. IMPLEMENTATION POSSIBILITIES							
1. Design Parameters							
a. Still Water Level (SWL)	Not Applicable	7.5 ft	6.7 ft	6.0 ft	7.5 ft	6.7 ft	6.0 ft
b. Levee Crest Elevation ¹	3.5 ft (PNP) 5.5 ft (PPP)	10.5 ft	10.0 ft	9.0 ft	10.5 ft	10.0 ft	9.0 ft
2. First Cost							
a. Federal	Not Applicable	\$11,852,000	\$7,842,000	\$7,480,000	\$6,566,000	\$6,005,000	\$5,202,000
b. Non-Federal		\$6,398,000	\$4,223,000	\$4,027,000	\$3,535,000	\$3,233,000	\$2,801,000
c. Total		\$18,250,000	\$12,065,000	\$11,507,000	\$10,101,000	\$9,238,000	\$8,003,000
3. Annual Cost ²							
Total	Not Applicable	\$1,614,000	\$1,100,000	\$1,048,000	\$903,000	\$836,000	\$731,000

¹ The levee crest elevation provided is only applicable for that portion of the alignment which is subject to wave run-up and overtopping. Those portions of the alignment which are protected from waves would have reduced levee crest elevations. A complete description of wave run-up is provided in Volume 2, Appendix A.

² Based on Oct 1994 price levels with a project life of 100 years and an interest rate of 7 3/4 percent.

ECONOMIC CONSIDERATIONS

A traditional economic analysis was performed using the Hydrologic Engineering Center - Flood Damage Analysis Package, which includes the Structure Inventory for Damage Analysis (SID) and the Expected Annual Damage Computation (EAD) interactive computer programs. Inputs to these programs include floodplain structure inventory, depth damage relationships, and stage probabilities obtained from stage-frequency curves. A field survey was conducted to determine the slab elevation and value of each structure at risk within the study area. The depreciated replacement value of each residential structure was calculated using the Marshall and Swift Residential Estimator Program. Ground elevations were determined using 1-foot contour maps. First floor elevations were based on visual observations, using hand levels to ensure accuracy. This information was used by the SID program to generate elevation-damage curves for each hydrologic reach for both existing and future conditions. The results were then used by the EAD program to determine expected average annual damages. The stream of expected annual flood damages was then discounted back to the base year and amortized over the period of analysis in order to calculate equivalent annual damages.

The remaining alternatives consist of Plan 1B (Exterior Alignment - Levee/Floodwall Alternative) and Plan 1C (Exterior Alignment - Modified Levee Alternative). These alternatives were evaluated by comparing estimated equivalent annual benefits that would accrue to the study area over the life of the project with estimated average annual costs. Average annual costs were determined using a Federal discount rate of $7\frac{3}{4}$ percent and a project life of 100 years. The results of the traditional analysis (SID and EAD programs) were used to determine the alternative plan that provides greater net benefits. A risk-based analysis was performed on this alternative to determine the NED plan and, if different, the recommended plan.

Plans 1B and 1C generally follow the same alignment and would provide similar benefits for a given level of protection. The difference between Plans 1B and 1C is the method of construction used to provide increased levels of protection along the portion of the alignment that extends from the southern limits of Bayou Segnette State Park to the tie-in at U.S. Hwy. 90. Both plans would maximize the use of the existing non-Federal levee in order to reduce costs and minimize adverse environmental impacts. For Plan 1B, the existing levee would be degraded to a stable configuration. Material from the degrading operation would be used to flatten the existing side slopes and to construct the floodside wave berm. The additional protection would be obtained by driving steel

sheetpiling into the degraded levee. Plan 1C would provide increased levels of protection by enlarging the existing non-Federal levee. A straddle enlargement would be utilized to take full advantage of the increased soil strengths within the existing levee foundation. Material to enlarge the levee would be excavated from the existing exterior canal. The estimated first costs for Plan 1B are considerably higher than for Plan 1C because of the large quantity of steel sheetpiling that would be required.

Plans 1B and 1C would provide positive equivalent annual benefits and would result in benefit-to-cost ratios (BCR's) of greater than unity. Plan 1C, providing 200-year protection, produces the greatest amount of equivalent annual net benefits, \$7,688,000, followed by Plan 1C with SPH protection, \$7,631,000; Plan 1C with 100-year protection, \$7,630,000; Plan 1B with 200-year protection, \$7,424,000; Plan 1B with 100-year protection, \$7,314,000; and Plan 1B with SPH protection, \$6,920,000. Plan 1C with a 200-year level of protection has a BCR of 10.19. The BCR for Plan 1C changes to 9.45 for SPH protection and 11.43 for 100-year protection. The BCR for Plan 1B drops to 7.75 for 200-year protection, 7.98 for 100-year protection, and 5.29 for SPH protection. The equivalent annual net benefits for Plan 1C are greater than the net benefits for Plan 1B at each of the three levels of protection.

The quantity of equivalent annual net benefits for Plan 1C are very similar for each of the three levels of protection. Although the 200-year level of protection provides the greatest quantity of net benefits, the SPH level of protection produces only \$57,000 less net benefits (a difference of less than 1 percent). The net benefits of the 100-year level of protection are also approximately 1 percent less than for the 200-year level of protection.

SOCIAL CONSIDERATIONS

Residents living throughout southeast Louisiana have become accustomed to the sight of levees and floodwalls. These common features of the landscape are needed to prevent flooding from high stages on the Mississippi River and from hurricane-induced tidal surge. The social impacts of the alternative plans vary primarily with the level of protection provided to the study area. The construction of Federal hurricane protection projects providing SPH protection have been authorized for the Westwego to Harvey Canal and East of Harvey Canal areas on the west bank of the Mississippi River, and for most of Jefferson, Orleans, St. Bernard, and St. Charles Parishes on the east bank of the Mississippi River. The protection provided by these levees and floodwalls has, in many cases, tended to create a false sense of security to the residents living within the project

area. Behavioral surveys have shown that the biggest challenge facing emergency managers is to effectively communicate the actual risk faced if a major hurricane were to threaten the New Orleans metropolitan area. Providing less than the SPH level of protection to one portion of the metropolitan area while remaining portions are provided with SPH protection would only complicate the job facing emergency managers. Residents could find themselves in the unenviable position of being told to evacuate when neighboring communities are not being evacuated. The effectiveness of an evacuation depends heavily on minimizing confusion among residents being asked to evacuate. Most residents would be unable to distinguish between a project that provides a 100-year or 200-year level of protection and one that provides SPH protection, and would probably not understand the implications of each. Providing similar levels of hurricane protection throughout the metropolitan area is the only effective way to minimize confusion.

The close proximity of metropolitan New Orleans to the Gulf of Mexico places approximately 1 million people living in areas at risk to inundation from storm surge. The potential problems associated with evacuating the entire metropolitan area are further complicated by the limited number of evacuation routes available to evacuees. With evacuation times for the New Orleans metropolitan area exceeding 48 hours, the decision to evacuate must be made when the hurricane is still hundreds of miles away. The probability of being directly impacted by the storm is only between 10 and 15 percent when making decisions in excess of 48 hours prior to projected landfall. When a hurricane is threatening, residents must decide if the severity of the storm warrants evacuating. The inability to accurately predict the behavior of hurricanes coupled with long evacuation times creates the potential for repeated evacuations of the study area. Based on information contained in the Southeast Louisiana Hurricane Preparedness Study, a 200-year level of protection would generally provide protection up to a slow moving category 2 storm. The SPH level of protection would provide the additional levee height necessary to protect residents against tidal surge for slow moving category 2 and fast moving category 3 storms. Providing the area with SPH protection would reduce the number of times that public officials would be forced to recommend an evacuation of the study area, thereby increasing participation rates when evacuation orders are necessary.

Levees and floodwalls have historically proven to be extremely effective at preventing inundation from hurricane surge. These barriers are, however, vulnerable to events which exceed their design criteria. Once overtopped, these levees and floodwalls are just as effective at preventing the water from draining out of the protected areas. The only way to remove the water is to pump it out. Depending on the condition of the

pumping stations and the extent of flooding, it could take a few days to several weeks to completely drain an area which had been inundated by storm surge. Flood waters remaining in the homes and businesses for several days results in additional damages, not to mention the extremely difficult living conditions that would exist for those who did not evacuate. Providing SPH protection would reduce the potential for overtopping of the protection.

The alternative plans would not noticeably impact such factors as property values, housing, community growth, or public facilities and services. The existing non-Federal levee has, to a great extent, established the limits of growth within the Lake Cataouatche area. The plans under consideration would generally follow the existing line of protection and would not impact the limits of development. With the large tracts of undeveloped land within the existing protection, additional development occurring outside the protected area would most likely be minimal.

ENGINEERING CONSIDERATIONS

The remaining plans are feasible from an engineering standpoint and would provide a higher level of hurricane protection to the study area. These plans include Plan 1B (Exterior Alignment - Levee/Floodwall Alternative) and Plan 1C (Exterior Alignment - Modified Levee Alternative). Each plan was evaluated at the 100-year, 200-year, and SPH levels of protection. Similar levels of detail were prepared for each plan. The types of construction required in these plans are similar to other work which has been performed by the New Orleans District. Designs were based on previous jobs which involved similar construction techniques. The cost engineers met with the design engineers to determine the appropriate contingencies for each item in the cost estimates.

Designs of the flood protection features for Plans 1B and 1C were prepared using detailed alignment and cross-sectional data taken in 1993. Design parameters were determined using the results from 12 general type borings and 4 undisturbed borings taken between 1991 and 1993. The foundation soils are predominantly fat clays varying in consistency from very soft to medium, with occasional layers of silt and lean clays. Layers of organic clays, which typically display high moisture contents, exist in many areas from the original ground surface down to approximately -20 ft NGVD. The proposed alignment, which is identical for both Plan 1B and Plan 1C was divided into four distinct reaches based on hydraulic considerations and on boring information. Additional Information on the detailed foundation investigations is presented in Volume 2,

Appendix A.

Design considerations and cost estimates for the structural features of the study included I-walls, I-wall/levee combinations, vehicular gates, pile supported inverted T-walls, and modifications of existing pumping stations. These structures assure a continuity of protection between full earthen levee sections and pumping stations, and allow economical protection through congested areas while minimizing adverse effects. The floodwall within Bayou Segnette State Park will be capped with concrete and provided with architectural finishes for aesthetic purposes. Vehicular and pedestrian access is provided at existing roads and walkways by gates in the floodwalls. Cost estimates for each alternative are presented in Volume 2, Appendix A.

Potential levels of flooding within the Lake Cataouatche area were determined using standard hydrologic and hydraulic methods. Stage-hydrographs were developed using four different analytical models (HURWIN, ADCIRC, PBLWIND, and WIFM). Assumptions concerning the performance of the existing levee were critical in determining the without-project damages. Policy Guidance Letter (PGL) No. 26 requires an engineering evaluation to determine the integrity of non-Federal levees which do not meet Corps of Engineers criteria. An evaluation of the integrity of the existing Lake Cataouatche levee was based not only on past performance but also on the condition of the levee from a geotechnical and a hydraulic perspective. The guidance provided in PGL No. 26 provides for the determination of a probable non-failure point (PNP) and a probable failure point (PFP). The PNP is defined as that point on the levee below which it is highly unlikely that a failure would occur. The PFP is that point on the levee above which it is highly likely that a failure would occur. For the existing Lake Cataouatche levee, these points were determined to be located at an elevation 2 ft below the levee crown (PNP) and at the existing levee crown (PFP). These points were not defined by specific water elevations but rather at points relative to the crown. Using the results of the analysis, routings were performed to determine the without-project stages for each interior reach. A detailed analysis of the failure and non-failure points along with a set of without-project stage-frequency tables is presented in Volume 2, Appendix A.

Interior stages for the with-project conditions were determined assuming that the protection remains in place (i.e. no failure occurs) and that overtopping is prevented for storms of equal or lesser intensity than the design storm. The cross-section of the protection (crest elevation, side slope, and wave berm configuration) were designed to prevent wave run-up, as calculated using methods described in the Shore Protection

Manual, from overtopping the protection. The required crest elevations of the protection for the Lake Cataouatche area vary from 2 to 3 feet above the still water level depending on susceptibility to waves. Overtopping of the levees and floodwalls will occur only when the intensity of the storm exceeds the assumed level of protection. The amount of overtopping may not be significant if the intensity of the storm slightly exceeds the level of protection. However, with a 100-year or 200-year level of protection in place, substantial overtopping could occur from the SPH event. As the rate of overtopping increases, parts of the levee would likely begin to erode. Erosion occurring in the crown of a levee or along the backside of a floodwall could reach a point at which the integrity of the protection is compromised. Continued erosion could lead to a complete failure in the protection. The potential loss of life and property damage resulting from a failure in the protection would be catastrophic. By providing SPH protection, the project would eliminate overtopping from storms, except those exceeding the 500-year event, and reduce the probability for a catastrophic levee failure.

Historical evidence of sea level rise and subsidence indicates the need for a projection of future storm surge heights and their effect on the alternative plans. Using a projected sea level rise of 0.5 feet in the next 100 years and the appropriate subsidence rate in coastal zones bordering the study area, expected hurricane surge for the year 2049 was computed (see Volume 2, Appendix A). The stages increased by 1.0 ft for the SPH storm, 1.1 ft for the 200-year storm, and 1.1 ft for the 100-year storm. The remaining plans were evaluated to determine which features should be designed based on projected future conditions. The levees and floodwalls would initially be overbuilt to account for projected subsidence and sea level rise during the first 10 years of the project life. This would ensure that the authorized level of protection is maintained during the early years of the project. The protection would be raised to account for future conditions around year 10 or when deemed necessary based on actual subsidence and sea level rise. The additional cost of raising the protection was between 75 and 100 percent higher for Plan 1B than for Plan 1C. The additional costs are due to the length of uncapped sheetpile wall that would need to be raised for Plan 1B. The costs for raising the protection to account for sea level rise and subsidence have been included in the economic analysis.

Consideration was given to alternative methods for raising the protection to account for future conditions. The levees, floodwalls, and floodgates could be initially constructed to account for changes projected to occur throughout the project life. Overbuilding the levees and floodwalls to account for future conditions would likely require the acquisition of additional rights-of-way, thereby significantly increasing the cost. Enlarging the levee

to account for future conditions could not be accomplished for Plan 1C at the SPH level of protection without backfilling the existing interior drainage canal. The design of the project would also be based on conditions which are only projected to occur during the next 50 years. Even though sea level rise and subsidence are based on past historical trends, our ability to accurately predict future changes in these parameters is highly suspect. If the projections were found to be in error at some point in the future, additional work on the levees and floodwalls would likely be required. Another option would be to periodically (approximately every 10 years) raise the protection. In order to maintain SPH protection, the levees and floodwalls would be raised by a total of 1.0 feet during the next 50 years. This equates to an increase of 0.2 feet every 10 years. A large portion of the cost to raise the protection by such a small amount would be associated with items (mobilization, clearing, grubbing, fertilizing, seeding, and demobilization) which are relatively independent of the increase in protection. These costs would be incurred on a periodic basis increasing the overall costs for raising the protection. This option would also disrupt the lives of residents and businesses located adjacent to the protection on a periodic basis. Monitoring the effects of sea level rise and subsidence and determining the appropriate time to raise the protection is the best available option.

ENVIRONMENTAL CONSIDERATIONS

The primary environmental concerns, aside from avoiding any possible spread of contaminants to the aquatic as well as human environment, consist of minimizing adverse impacts to bottomland hardwood and swamp forests and, thus, wildlife habitat. There is also concern for avoiding impacts to any proposed or listed threatened or endangered species. Environmental impacts have been minimized in the planning process by following developed corridors and by using the existing levee alignment. The primary impacts of either alternative would be the possible loss of wildlife habitat as a result of new levee construction, levee upgrading, and possible borrow pit construction. The direct impacts resulting from the construction of either Plan 1B or Plan 1C are not considered of major significance. Plan 1B and Plan 1C would adversely impact approximately 20 and 57 acres, respectively, of wooded lands. The additional impacts associated with Plan 1C are due to the excavation of material from the bank of the interior drainage/borrow canal. The adverse impacts associated with either plan are the same for the 100-year, 200-year, or SPH level of protection. Indirect impacts of any increase in the size of the interior borrow/drainage canal and subsequent increased drainage effects on basin wetlands are essentially non-existent. Measures are included in each of the alternative plans to mitigate unavoidable impacts. Additional discussions on the environmental impacts and proposed

mitigation plans are included in the EIS and in Volume 2, Appendix C.

HTRW CONSIDERATIONS

An initial assessment was conducted to gather and evaluate data regarding the existence or potential for encountering hazardous, toxic, or radioactive waste (HTRW) located within the study area. The assessment relies on site inspections, existing literature, aerial photography, land-use studies, agency coordination, and document research.

Sites of interest identified within the study area include three landfills located along U.S. Hwy. 90 near the St. Charles Parish line. These landfills include the Kelvin Tract landfill, the Area 90 landfill, and the Greater New Orleans (GNO) landfill. Files on these landfills are presently maintained by the Louisiana Department of Environmental Quality (LDEQ). The GNO landfill is currently operating under a settlement agreement with the LDEQ with waste being accepted through 1999 or until a designated elevation is achieved. An application has been made for a proposed landfill (River Birch) to be located between the existing Kelvin Tract landfill and South Kenner Road. The request for a permit for the landfill has been denied by the LDEQ and the Jefferson Parish council. The State 5th Circuit Court of Appeals upheld the permit denial by the Jefferson Parish council, however, the case is still in litigation. A seafood processing plant was identified within the study area near the Bayou Segnette Pumping Station, and several pipelines were found to traverse the area. Two sewage treatment plants are also located in the vicinity of the study area. One treatment plant is located just east of the study area near Bayou Segnette State Park, and the other is located near South Avondale. No indication of underground storage tanks along the proposed alignment was identified in the research. The results of the Initial Assessment and Land Use History are presented in Volume 2, Appendix C.

Plans 1B and 1C follow the same general alignment and would have similar risks for encountering HTRW materials. The excavation of material in the vicinity of the landfills would not be permitted in order to minimize potential HTRW impacts. Aside from the pipeline crossings, the only remaining area of concern is the interior drainage canal parallel to the existing levee which is subject to direct surface runoff from the landfills. Further investigations were required to address the possibility of contaminant accumulation and the effects of disposal upon the surrounding environment. The test results of water and sediment samples taken from the interior drainage canal located adjacent to the existing levee between U.S. Hwy. 90 and the Lake Cataouatche Pumping Station indicated contamination levels well below the Environmental Protection Agency's alert levels. The

disturbance or potential release of any contaminants into the water column during construction would be minimal and would not significantly degrade the water quality. Based on the results of the initial assessment, HTRW risk during construction is minimal for either Plan 1B or Plan 1C.

PUBLIC INTEREST CONSIDERATIONS

A project providing increased levels of hurricane protection to west bank residents living between Westwego and the Harvey Canal was authorized in 1986. Hurricane protection on the west bank was expanded by the Water Resources Development Act of 1996, which authorized SPH protection to those areas east of the Harvey Canal. These projects, when completed, will provide SPH protection to over 210,000 west bank residents. To be acceptable to local entities and the public, an equivalent level of protection should be provided for the Lake Cataouatche area.

The only significant difference between Plans 1B and 1C is the type of construction used for the protection between Bayou Segnette State Park and U.S. Hwy. 90. Plan 1B would provide for the construction of a combination levee/sheetpile wall. In order to reduce costs, the sheetpiling would remain uncapped. Plan 1C would provide for the enlargement of the existing levee using material excavated from the adjacent canals. The aesthetic values of a levee are considerably higher than for an uncapped sheetpile wall. Although the area adjacent to the alignment is relatively undeveloped, the esthetics of the protection could become more important as the area continues to develop.

A behavioral survey was recently conducted as part of the Southeast Louisiana Hurricane Preparedness Study to determine expected participation rates in response to a hurricane evacuation order. Even with aggressive action taken by local officials, participation rates in metropolitan New Orleans can be expected to average only 80 percent. With less aggressive action by local officials, the participation rate would likely drop to around 60 percent. This means that between 4,800 and 9,600 residents living within the study area would decide to ignore the evacuation order. Those remaining behind would be left at the mercy of the storm. Providing SPH protection would minimize the potential for catastrophic loss of life due to flooding among those who do not evacuate.

CONCLUSIONS

The purpose of the traditional analysis was to formulate and evaluate alternatives for providing increased hurricane protection to the Lake Cataouatche area. Plans 1A, 2A, and 2B were eliminated during plan formulation due to excessive costs and greater environmental impacts. A comparison of the remaining alternatives (Plans 1B and 1C) was conducted to determine the plan which provides greater net benefits and minimizes impacts to the environment. Based on the results of the economic analysis, Plan 1C provides greater net benefits than Plan 1B at each level of protection. Although Plan 1C would result in slightly greater environmental impacts, the direct impacts associated with either plan are considered relatively insignificant. Both plans are feasible from an engineering standpoint and have a low potential for encountering HTRW materials during construction. Plans 1B and 1C have very similar social and public interest considerations. Plan 1C was, therefore, carried forward into the risk analysis to determine the NED and the recommended levels of protection.

RISK-BASED ANALYSIS

Risk and uncertainty are intrinsic in water resources planning and design. The uncertainties arise from measurement errors and the inherent variability of complex physical, social, and economic situations. All measured or estimated values in project planning and design are, to various degrees, inaccurate. The "actual" values are invariably different from the single point estimates used in the traditional project formulation, evaluation, and design. Sensitivity analysis has been the primary tool for considering uncertainty in project planning and design. A sensitivity analysis, however, assumes that the appropriate range of values is identified and that all values in that range are equally likely. A risk-based analysis (EC 1105-2-205) provides an approach to evaluation and decision making that explicitly, and to the extent practical, analytically incorporates considerations of risk and uncertainty.

A variety of planning and design variables may be incorporated into a risk-based analysis. In the Lake Cataouatche PAC study, risk and uncertainty was performed on four key economic variables: structure values, first floor elevations, contents values, and depth-damage relationships. Each of these variables was analyzed for their impact on the elevation-damage curve. A mean and standard deviation was assigned to each variable in

an attempt to represent the range of possible values. It should be noted that non-residential contents were not evaluated for risk and uncertainty in the development of the elevation-damage curve. Only 1 percent of the total inundation reduction damages involved non-residential contents, and the error associated with this variable was difficult to quantify. A further discussion of the economic variables used in the risk analysis can be found in Volume 2, Appendix B.

A generic elevation-damage with error curve was first developed for each reach within the study area using the @Risk program and the specified range of key economic variables. The generic elevation-damage with error curves were used along with the interior stage-frequency curves to determine frequency-damage with error relationships for each interior reach. The frequency-damage relationships for each interior reach were combined to develop a study area frequency-damage with error relationship for existing and future without-project and with-project conditions. An exterior elevation/interior damage relationship with error was then derived by combining the exterior stage-frequency relationships with the corresponding interior frequency-damage relationships. The exterior elevation/interior damage relationships were developed for with- and without-project conditions for both existing (1994) and future (2049) conditions.

The risk-based analysis also gave consideration to predicting the uncertainties associated with the hydrologic parameters. The computer program "LIMIT", which was developed by the Hydrologic Engineering Center (HEC) for non-analytical frequency curves, was used in the computation of confidence limits for the exterior stage-frequency curve. The program extrapolated the stage-frequency for existing and future conditions from the 99.9 percent chance of exceedance (1-year storm) to the 0.01 percent chance of exceedance (10,000 year storm). The study area was divided into four major drainage areas and a total of 19 hydrologic subareas. The stage within each subarea is dependent on both the severity of the event and the routing of water within the study area. In order to simplify the analysis, a direct relationship between the exterior stage and the interior damage was assumed (i.e., an exterior stage of 6.0 feet results in a given damage regardless of the frequency of the event). The results of a risk-based analysis of the hydraulic parameters can be used to more clearly illustrate the likelihood of a project performing at a given level. Table 11 provides a summary of performance probabilities for the Lake Cataouatche area for a range of levee elevations.

The final step in determining the with- and without-project damages in a risk-based format involved using a project sizing template developed by the HEC. The project sizing

TABLE 11
PERFORMANCE PROBABILITIES

Still Water Level (SWL)	Crest Elevation ¹	Probability of Stage Reaching ² SWL	Probability of Levee Failure ³	Avg. Failure Exceedance Interval ⁴	Chance of Failure in 50 yrs
3.5	5.5	.1413	.1355	7 yrs	99.9%
4.0	6.0	.0875	.0891	11 yrs	99.1%
4.5	6.5	.0545	.0574	17 yrs	94.8%
5.0	7.0	.0320	.0335	30 yrs	81.8%
5.5	7.5	.0180	.0203	49 yrs	64.1%
6.0	9.0	.0100	.0114	88 yrs	43.6%
6.5	9.5	.0061	.0077	130 yrs	32.1%
7.0	10.0	.0036	.0053	189 yrs	23.3%
7.5	10.5	.0020	.0027	370 yrs	12.6%
8.0	11.0	.0011	.0019	526 yrs	9.1%

¹ The crest elevation is not a constant throughout the alignment, but varies depending on location and susceptibility to wave run-up. The crest elevation for the purposes of this table is the still water level (SWL) plus 2 feet for stages below 5.5 ft and the SWL plus 3 ft for stages above 5.5 ft. The additional levee height is required to account for wave run-up.

² The probabilities were determined using the results of the limits program which gives the probability of a given stage occurring in a 1 year period.

³ The protection is designed to prevent overtopping from not only hurricane surge, but also wave run-up. Failure for the with-project conditions is assumed to occur when the actual stage exceeds the still water elevation. The probability of levee failure was determined using the results of the @Risk runs.

⁴ The "Failure Exceedance Interval" is determined by converting the probability of levee failure into a recurrence interval.

template integrates the results of the economic uncertainty (elevation-damage with error curve) with the results of the hydrologic/hydraulic uncertainty (stage-frequency with error curve) to produce existing and future with- and without-project expected annual damages in a risk-based framework. The output from the program is the expected value, or mean damage with error, which together with the probability distributions, forms a comprehensive picture of all possible outcomes. The project benefits were determined by subtracting the with-project damages from the without-project damages using the @Risk program to ensure that the results included a probability distribution. A final spreadsheet was then developed to convert the benefits with error to an equivalent annual value. Table 12 shows the first costs, the equivalent annual costs, the mean equivalent annual benefits from the risk analysis, the net benefits, and the B/C ratios for each of the three levels of protection for Plan 1C.

TABLE 12
LAKE CATAOUATCHE, PLAN 1C
SUMMARY OF EQUIVALENT ANNUAL COSTS AND BENEFITS
USING RESULTS OF THE PROJECT SIZING TEMPLATE
(1994 Price Levels, 7³/₄% Interest Rate)

<u>Level of Protection</u>	<u>First Costs</u>	<u>Equivalent Annual Benefits¹</u>	<u>Costs</u>	<u>Net Benefits</u>	<u>B/C Ratio</u>
100-yr	\$8,003,000	\$7,277,000	\$731,000	\$6,546,000	9.95
200-yr	\$9,238,000	\$7,447,000	\$836,000	\$6,611,000	8.91
SPH	\$10,101,000	\$7,467,000	\$903,000	\$6,564,000	8.27

¹ The savings from deleting the westside closure from the Westwego to Harvey Canal project are not included in the analysis for the Lake Cataouatche area, but rather as a cost offset for the Westwego to Harvey Canal project.

One of the advantages of the risk-based analysis approach is to provide better information about the functional performance of the project. The results of the analysis

enable a determination of the reliability of a particular project size to contain a specific frequency flood event. The reliability of various design stages for the Lake Cataouatche levee are presented in Table 13. Using this table, the project performance for a series of hurricane events can be determined for different design stages. For example, a design stage of 6.0 ft NGVD (1-percent event) would have a 98.6 percent chance of containing the 25-year storm, a 82.0 percent chance of containing the 50-year event, a 50 percent chance of containing the 100-year storm, a 22.5 percent chance of containing the 200-year storm, and a 8.4 percent chance of containing the 500-year storm.

TABLE 13
RELIABILITY OF DESIGN STAGE FOR
VARIOUS FREQUENCY EVENTS

Design Stage	Percent Chance of Non-Exceedance ¹				
	25-Year Event	50-Year Event	100-Year Event	200-Year Event	SPH
5.0	64.7	27.1	10.0	3.3	1.2
6.0 (100-yr)	98.6	82.0	50.0	22.5	8.4
6.5	100	95.4	74.0	41.4	17.9
6.7 (200-yr)	100	97.7	81.6	50.0	23.1
7.0	100	99.3	91.1	62.7	32.3
7.5 (SPH)	100	100	97.3	80.8	50.0
8.0	100	100	99.5	92.2	67.8

¹ Probability distributions are based on 1,000 iterations of Latin Hypercube sampling using @Risk. Percentages reflect the probability of a given event being contained within the design stage.

NATIONAL ECONOMIC DEVELOPMENT (NED) PLAN

The NED plan is defined as the plan that most reasonably maximizes net tangible economic development benefits (the difference between equivalent annual benefits and average annual costs) consistent with the Federal objectives. Benefits are maximized at the

point where the excess benefits over costs is the greatest and marginal costs equal marginal benefits. The net benefits of the project begin to decrease at any level of protection past this point.

During the formulation and analysis of alternatives, Plan 1C was found to produce the greatest net benefits at each level of protection. A risk-based analysis was conducted on Plan 1C to determine the level of protection that would optimize net benefits. A review of the economic data presented in the previous section shows that the 200-year level of protection best approximates maximization of net tangible benefits. The NED plan is estimated to have a total project first cost of \$9,238,000, average annual cost of \$836,000, mean equivalent annual net benefits of \$6,611,000, and a B/C ratio of 8.9. Probabilities of possible benefit-cost ratios can be determined using the results of the risk analysis to plot an equivalent annual benefits probability curve (see Volume 2, Appendix B). There is a 99.7 percent chance that the B/C ratio for the NED plan would be greater than 1.0 and a 98.4 percent chance that the B/C ratio would exceed 2.0. If the benefits were based only on existing conditions, there would still be 98.3 percent chance that the B/C ratio would be greater than 1.0.

Although Plan 1C providing a 200-year level of protection is identified as the NED plan, the total difference in mean (expected) annual net benefits between the three levels of protection is less than 1 percent. The mean annual net benefits decrease from \$6,611,000 for 200-year protection to \$6,654,000 (-0.71%) for SPH protection and to \$6,546,000 (-0.98%) for 100-year protection. The results of the risk-based analysis provide a distribution (standard deviation) showing the possible range of mean annual net benefits for each level of protection. This information can be used to determine the level of confidence in the single point values reported for the project benefits of the alternatives. The standard deviation of the equivalent annual benefits for each of the Plan 1C alternatives is in excess of 40 percent of the total project benefits (probability distributions are shown in Figures 2, 3, and 4 of the Economics Appendix). The probability distribution for the 200-year level of protection shows that there is only a 50 percent chance that the benefits would fall between \$5,000,000 and \$9,500,000. The difference in net benefits between the 200-year level of protection and the SPH level of protection (\$47,000) is less than 1.5 percent of the smallest standard deviation (\$3,246,000) among the plans. Given the small difference in net benefits between the levels of protection and the large standard deviation in project benefits, consideration of additional factors (tangible and intangible) is required before a recommended plan can be identified.

DETERMINATION OF THE RECOMMENDED PLAN

The recommended plan for the Lake Cataouatche area should not be identified based solely on economics, but should also give consideration to a number of additional factors. These factors include maintaining a consistent level of protection with the surrounding areas, estimated project first cost, environmental impacts, ability to accurately predict the behavior of hurricanes, potential for future development to occur within the area, and project reliability. After a comprehensive review of the results of the risk-based analysis and the economic, environmental, social, engineering, and public interest considerations, Plan 1C constructed to the SPH level of protection was identified as the recommended plan for the Lake Cataouatche area. The recommended plan is estimated to have a total project first cost of \$10,101,000, average annual cost of \$903,000, mean equivalent annual net benefits of \$6,564,000, and a B/C ratio of 8.3. Based on the results of the risk-based analysis, there is a 99.6 percent chance that the B/C ratio for the recommended plan would exceed 1.0 and a 97.9 percent chance that the B/C ratio would exceed 2.0. The equivalent annual benefits probability curve for the recommended plan is shown in Figure 2. Selecting the SPH level of protection is a deviation from the NED plan as previously discussed.

The Lake Cataouatche area is expected to experience continued growth throughout the project life, and providing less than SPH protection would jeopardize the lives of the current and future residents of the area. The Westwego to Harvey Canal Hurricane Protection Project, the Lake Pontchartrain and Vicinity Hurricane Protection Project, and the East of Harvey Canal Hurricane Protection Project were authorized to provide SPH protection to the surrounding New Orleans metropolitan area, and residents of the Lake Cataouatche area desire a comparable level of protection. Implementing the recommended plan would tie the protection for the Lake Cataouatche area to the Westwego to Harvey Canal and East of Harvey Canal projects resulting in a continuous line of protection extending from the St. Charles Parish line to the community of Oakville in Plaquemines Parish. These projects combined would provide protection to over 235,000 west bank residents living in Jefferson Parish.

RATIONALE FOR DEVIATING FROM THE NED LEVEL OF PROTECTION

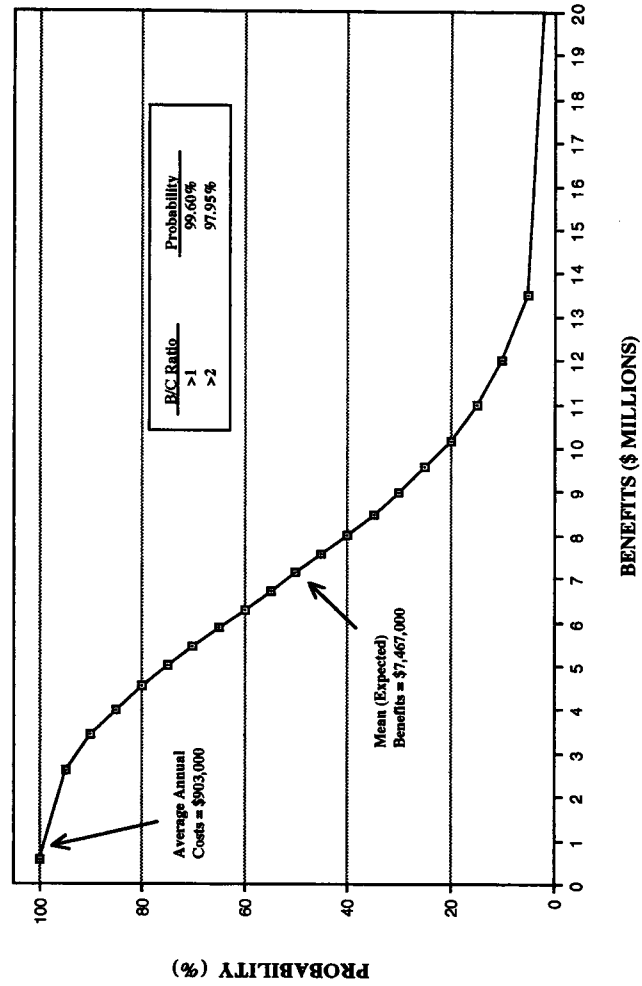
The NED plan for the Lake Cataouatche area is Plan 1C providing a 200-year level of protection. Providing SPH protection to the area would provide an additional \$20,000

FIGURE 2

LAKE CATAQUATCHE

EQUIVALENT ANNUAL BENEFITS PROBABILITY CURVE

RECOMMENDED PLAN



in mean equivalent annual benefits. The difference in first cost between the NED level of protection (\$9,238,000) and the SPH level of protection (\$10,101,000) is \$863,000. This results in an increase in the average annual cost of \$67,000 (including OMRR&R and mitigation costs). The resulting incremental B/C ratio (based on single point values for the equivalent annual benefits) is 0.30. Although the SPH level of protection does not provide the greatest quantity of mean annual net benefits, there were a number of other factors that were also considered in the selection of the recommended plan.

The construction of Federal hurricane protection projects have been authorized for the residents living on the east and west banks of the Mississippi River in metropolitan New Orleans. The Lake Pontchartrain and Vicinity Hurricane Protection Project was authorized to provide SPH protection to residents living on the east bank of the Mississippi River in Jefferson, Orleans, St. Bernard, and St. Charles Parishes. The Westwego to Harvey Canal Hurricane Protection Project was authorized to provide SPH protection to residents living on the west bank of the Mississippi River in Jefferson Parish. The East of Harvey Canal Hurricane Protection Project was authorized to provide SPH protection to residents living on the west bank in portions of Jefferson, Orleans, and Plaquemines Parishes. Providing SPH protection to the Lake Cataouatche area would ensure that a comparable level of hurricane protection is provided to residents living throughout metropolitan New Orleans.

Expenditures on the Lake Pontchartrain and Vicinity and the Westwego to Harvey Canal Hurricane Protection projects through Fiscal Year 1993 have totaled in excess of \$410 million. Future expenditures on these projects are estimated at nearly \$400 million. The East of Harvey Canal project was authorized at a first cost of approximately \$120 million. This brings the total cost for providing SPH protection to the New Orleans metropolitan area to over \$930 million. The additional first cost to provide SPH protection to the Lake Cataouatche area (\$863,000) is less than 0.1 percent of the total cost of protecting the metropolitan area.

The probability of the protection functioning as designed based on the uncertainty in the hydraulic and hydrologic parameters is another factor which must be considered. A project constructed to provide a 200-year level of protection (NED plan) would have a 97.7 percent chance of containing the 50-year event, a 81.6 percent chance of containing the 100-year event, a 50 percent chance of containing the 200-year event, and only a 23.1 percent chance of containing the 500-year event. The recommended plan (SPH protection) would have a 100 percent chance of containing the 50-year event, a 97.3 percent chance of

containing the 100-year event, a 80.8 percent chance of containing the 200-year event, and a 50.0 percent chance of containing the 500-year event. Constructing a Federal project with only a 50 percent chance of containing the 200-year event and a 23.1 percent chance of containing the 500-year event does not seem adequate given the projections for continued development within the area. Providing the area with SPH protection increases the probability of containment by over 30 percent for the 200-year storm and by over 25 percent for the 500-year storm. Providing the area with SPH protection as opposed to a 200-year level of protection results in a dramatic increase in the project reliability.

Providing the Lake Cataouatche area with SPH protection also reduces potential damages from extreme events. Total expected damages from the 500-year event with only a 200-year level of protection in place are estimated at \$13,113,000. Total expected damages from the 500-year storm with SPH protection are reduced to \$8,334,000. Total expected damages from the 500-year event are reduced by nearly \$5 million by providing the area with SPH protection.

Recent improvements in forecasting the track of an approaching hurricane for lead times in excess of 24 hours falls far short of the public's perception. Forecast errors for hurricane predictions issued 24 hours prior to projected landfall average 100 miles. This increases to 220 miles for 48 hour forecasts and 400 miles for 72 hour forecasts. Thus, if a storm were forecast to make landfall due south of New Orleans in 24 hours, and if, in fact, it made landfall between Dauphin Island, Alabama, and Marsh Island, Louisiana, the forecasting errors would be no worse than average. Not only do errors occur in predicting the path of a hurricane but also in predicting the hurricane's strength. A hurricane can intensify by as much as 20 percent in a 24-hour period. A hurricane projected to impact the coast within 24 hours could intensify from a 200-year storm to a 500-year storm prior to making landfall. Additional protection is a needed safety factor given the difficulty in predicting the path and intensity of a hurricane.

Considering the tangible and intangible benefits, the costs, the risks and uncertainties in predicting the behavior of hurricanes, and the obvious potential for considerable loss of life within the study area, the benefits of providing the area with SPH protection far outweigh the additional costs. Thus, we recommend that the Lake Cataouatche area be provided with SPH protection.

RECOMMENDED PLAN

PLAN DESCRIPTION

The recommended plan would provide SPH protection to the west bank of the Mississippi River in the vicinity of New Orleans for the area generally bounded by Bayou Segnette to the east, Lake Cataouatche to the south, the Mississippi River to the north, and the Jefferson/St. Charles Parish line to the west. Implementation of the recommended plan would provide SPH protection to nearly 25,000 residents living in Jefferson Parish, Louisiana. The recommended plan is shown on Plate 6 in the main report (Volume 1) and on Plates 2 through 14 of the Engineering Investigations (Volume 2, Appendix A).

Implementation of the recommended plan would provide for the enlargement of the existing non-Federal levee from just beyond the southern limits of Bayou Segnette State Park to the tie-in at U.S. Hwy. 90 near the St. Charles Parish line, a distance of approximately 7.5 miles. A straddle enlargement (maintaining the existing levee centerline) would be used in order to take full advantage of the increased soil strengths of the existing foundation and to minimize impacts to the adjacent canals. The levee would be constructed with a crest elevation of 9.5 ft NGVD from the tie-in at U.S. Hwy. 90 to approximately 1 mile west of the Lake Cataouatche Pumping Station. A levee crest elevation of 10.5 ft NGVD would be maintained from approximately 1 mile west of the Lake Cataouatche Pumping Station to the southern limits of Bayou Segnette State Park. The levee crown width during the initial construction would be limited to 7 ft in order to minimize impacts to the adjacent canals. The southern two thirds of the alignment is subject to wave action and would require the construction of a floodside wave berm. The wave berm would be armored to prevent erosion from wind generated waves and recreational boaters. Material to enlarge the levee and to construct the wave berm would be excavated from the existing exterior canal using a barge mounted dragline. Borrow material would be excavated from within the existing limits of the canal in order to avoid additional environmental impacts. Material would also be excavated from the interior drainage canal in order to construct the protected side stability berm. The existing floodwall at the Lake Cataouatche Pumping Station complex provides adequate protection and would only require minor modifications to the transition areas.

In order to minimize disruptions to existing operations, approximately 2 miles of

levee/floodwall combination would be constructed through Bayou Segnette State Park. A reduced levee section would first be constructed to an elevation of 5.5 ft NGVD. Sheet piling would then be driven into the levee and capped with concrete. The concrete would be provided with an architectural finish for aesthetic purposes. The crest elevation of the floodwall within the state park would vary in elevation from 10.5 ft NGVD at the southern limits of the park to 9.5 ft NGVD at the tie-in with the Westwego to Harvey Canal project. Landscaping within the state park would also be provided to ensure that the natural park setting is maintained. Swing gates would be provided to maintain existing pedestrian and vehicular access. The Bayou Segnette Pumping Station would be modified by replacing the existing fronting protection with a pile supported T-wall. The existing discharge pipes would be extended through the new floodwall and butterfly valves would be installed for positive cut-off. The construction of a floodwall north of the pumping station along Bayou Segnette would tie the protection to the authorized Westwego to Harvey Canal project. The proposed tie-in would delete the westside closure from the Westwego to Harvey Canal project resulting in a savings of \$4,969,000. These savings have not been included in the economic analysis for Lake Cataouatche, but rather as a cost offset for the Westwego to Harvey Canal project.

The protection along the western boundary of the study area would be extended north of U.S. Hwy. 90 to prevent the potential for end-around flooding. The existing traffic lanes of U.S. Hwy. 90 provide adequate protection at the location of the proposed crossing and would not need modification. A small levee would be constructed north from U.S. Hwy. 90 to the Southern Pacific Railroad embankment, a distance of approximately 2.5 miles. The levee would be constructed over the existing access road for the Greater New Orleans landfill (South Kenner Road). Following the existing access road would minimize the required section and avoid impacting the adjacent landfills. The levee would be constructed with a levee crest elevation of 6.5 ft NGVD. A protected side slope of 1 vertical on 10 horizontal along with 7-inches of crushed stone surfacing would allow for continued use of the existing access road. Excess material stockpiled during construction of the Davis Pond Freshwater Diversion project would be used as a borrow source to construct the levee along South Kenner Road. Flap gates would be installed on the culverts which extend through the Texas and Pacific and Southern Pacific railroad embankments between South Kenner Road and the existing Jefferson Parish levee.

A second lift would be required along that portion of the alignment which extends from U.S. Hwy. 90 to the southern limits of Bayou Segnette State Park. Based on historical data, shrinkage and settlement of the levee can be expected to range from 15 to

25 percent during the 3 to 4 years between lifts. Settlement projected to occur over the remainder of the project life would be compensated for in the design of the second lift. The crown width of the levee would be increased to 10 feet during the second enlargement to provide adequate access for inspection and maintenance. Construction of the second lift would be accomplished using borrow material excavated from the interior drainage canal.

Environmental impacts of the recommended plan have been minimized by using existing levee alignments and developed corridors and by minimizing the destruction of bottomland hardwoods. The primary impact of the recommended plan would be the possible loss of 57 acres of bottomland hardwoods. All direct losses of habitat value would be mitigated through the implementation of a mitigation plan consisting of acquisition, bottomland hardwood habitat development, and management of a 39-acre tract of land to be located adjacent to Bayou Segnette State Park. Implementation of this mitigation feature would compensate all significant project-induced fish and wildlife losses to the fullest extent possible. The complete environmental analysis is described in the EIS and in Volume 2, Appendix C, Section 4.

PLAN ACCOMPLISHMENTS

The recommended plan would provide SPH protection for the area bounded by Bayou Segnette to the east, Lake Cataouatche to the south, the Mississippi River to the north, and the Jefferson/St. Charles Parish line to the west; would maintain access to Bayou Segnette State Park; and would mitigate for significant direct environmental losses.

The recommended plan would provide the nearly 25,000 residents living within the Lake Cataouatche area a level of protection consistent with the protection provided to the surrounding New Orleans metropolitan area. The total number of structures inundated from the 500-year storm would be reduced from 5,161 under the without-project conditions to 130 with the recommended plan in place; this represents a decrease of over 97 percent. Using the results of the risk-based analysis, the mean equivalent annual damages would decrease from \$10,302,000 under existing conditions to \$2,835,000 (a decrease of 72.5 percent) with implementation of the recommended plan. Total equivalent annual benefits for the study area are estimated to be \$7,467,000. These benefits result from the prevention of flood damages to existing and future development. The proposed modification to the Westwego to Harvey Canal project would eliminate the authorized westside closure resulting in a savings of \$4,969,000.

SUMMARY OF ECONOMIC ANALYSIS

Upon selection of the recommended plan, an M-CACES cost estimate, Gross Appraisal, Real Estate Supplement, and Attorney's Opinion of Compensability were prepared for this plan only. The revised costs for the recommended plan are presented in Table 14. The economic analysis for the recommended plan is based on October 1996 price levels and an interest rate of $7\frac{3}{8}$ percent. The base year for the recommended plan is 2001, not 2000 as used in all previous analyses.

TABLE 14
RECOMMENDED PLAN
SUMMARY OF PROJECT COSTS AND BENEFITS¹

Project First Cost	\$14,806,000
Equivalent Annual Benefits	\$8,056,000 ²
Total Avg. Annual Cost	\$1,402,000
Interest & Amortization	\$1,241,000
Operations & Maintenance	\$109,000
Mitigation	\$12,000
Future Protection	\$40,000
Net Annual Benefits	\$6,654,000
Benefit Cost Ratio	5.74

¹ The equivalent annual benefits and average annual costs for the recommended plan were computed for a base year of 2001 using October 1996 price levels, an interest rate of $7\frac{3}{8}$ %, and a project life of 100 years.

² The savings which result from the deletion of the westside closure are not included in the analysis for Lake Cataouatche, but rather as a cost savings to the Westwego to Harvey Canal project.

The additional level of detail prepared for the recommended plan resulted in a significant increase in the M-CACES estimate over that presented in the Plan Formulation section of this report. The total estimated cost increased from \$10,101,000 to \$14,806,000, an increase of \$4,705,000. This represents an increase of approximately 46 percent. The increased costs are due to a number of factors, including price level change, design modifications, revised unit prices, increased contingencies for "Engineering and Design" and "Construction Management", and increased real estate costs. A brief discussion of the increases is presented in the following paragraphs. The costs presented for the recommended plan in the remainder of the report cannot be compared to the costs for the alternative plans because they contain different levels of detail.

The price level change from October 1994 to October 1996 increased the project first cost by approximately \$956,000. The cost estimates prepared for the evaluation of alternatives were based on the assumption that fertilizing and seeding would be adequate to prevent erosion of the wave berm constructed along the southern two thirds of the exterior alignment. During the preparation of a detailed design for the recommended plan, it became apparent that some additional means of erosion protection would be required. The exterior canal is heavily used by recreational boaters for waterskiing and by fisherman for access to the surrounding lakes and bayous. In order to prevent erosion from wind generated waves and from recreational boaters, the wave berm would be provided with stone armorment. Providing erosion protection to approximately 5 miles of wave berm increased the project cost by approximately \$1.6 million. The protection north of U.S. Hwy. 90 was initially assumed to consist of a small levee constructed adjacent to South Kenner Road extending from the highway to the Southern Pacific Railroad embankment. South Kenner Road is a private road that is used only for access to the Greater New Orleans Landfill. In order to minimize potential HTRW impacts, the design was modified to allow for the placement of the levee directly over the existing road. The levee would include a protected side slope of 1 vertical on 10 horizontal along with 7-inches of crushed stone surfacing to allow for the continued use of the road for access to the landfill. These changes increased the cost of the protection north of U.S. Hwy. 90 by approximately \$200,000.

Refinements to the individual unit prices during preparation of the M-CACES cost estimate resulted in increased costs of approximately \$150,000. Bayou Segnette State Park is currently the most heavily used state park in the system. In order to ensure that the natural park setting is maintained, a lump sum item of "Landscaping" was added to the M-CACES cost estimate. This increased the M-CACES cost estimate by \$150,000. The

preparation of a Gross Appraisal and Real Estate Supplement resulted in an increase in the real estate costs of \$221,000. The above mentioned items combined for approximately 70 percent (\$3,277,000) of the total increase in cost for the recommended plan.

The remainder of the increased costs for the recommended plan were due to increases in the contingencies used for "Engineering and Design" and "Construction Management". Engineering and Design increased from \$830,000 during plan formulation to \$1,379,000 with preparation of the M-CACES estimate. Construction Management increased from \$987,000 in plan formulation to \$1,860,000 in the M-CACES estimate. These two items resulted in increased costs of \$1,422,000. The contingencies for Engineering and Design for the M-CACES estimate are based on uncertainties involved in the preparation of plans and specifications and in engineering during construction. These uncertainties include the cost of field data collection; unanticipated design problems; design changes; and changes in the overhead rates. The contingencies used for Construction Management are based on using a historical average of time growth for similar type contracts in the area which result from unusually severe weather and contract modifications.

The increased costs for the recommended plan, although significant, would not effect plan formulation. Virtually all of the increased costs would also be applicable to Plan 1C alternatives providing less than SPH protection and to other alternatives considered during plan formulation. The requirement to armor the wave berm to prevent erosion would be applicable to all Plan 1 alternatives. The revisions to the protection north of U.S. Hwy. 90 would also be applicable to all Plan 1 alternatives. The revised unit prices and the addition of "Landscaping" would be applicable to all of the alternatives considered during plan formulation. Increased real estate costs would also be expected on the other alternatives. The increased percentage of Engineering and Design and Construction Management are based on actual construction contracts within the New Orleans District and would be applicable to all of the alternatives.

To ensure that increased costs would not affect plan formulation, a cost estimate was prepared to an equivalent level of detail, although not in the M-CACES format, for the 200-year level of protection. The cost for Plan 1C at the 200-year level of protection increased from \$9,238,000 in plan formulation to \$13,715,000. This represents an increase of \$4,477,000 (approximately 48%). The cost difference between the 200-year level of protection and the SPH level of protection increased from \$863,000 during plan formulation to \$1,091,000, an increase of only \$228,000. The benefits of providing SPH

protection still far outweigh the additional costs. The equivalent annual benefits probability curve for the SPH level of protection for the recommended plan is shown in Figure 3. Even with the increased M-CACES cost estimate, there is a 99.2 percent chance that the B/C ratio for SPH protection would exceed 1.0 and a 95.2 percent chance that the B/C ratio would exceed 2.0.

ENGINEERING DESIGN

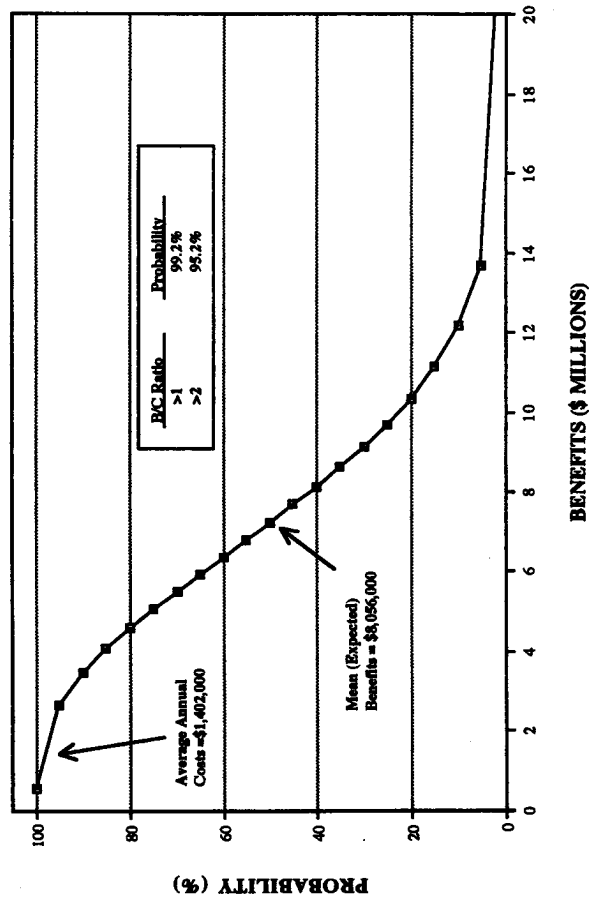
The recommended plan involves typical flood control structures (floodwalls, floodgates, levees, etc.) which have been designed and constructed by the New Orleans District in the past. The designs and cost estimates presented for the recommended plan are based on previous jobs which involved similar construction techniques. The designs were prepared with the benefit of detailed surveys and soil borings. The estimated costs were based upon an analysis of each line item evaluating quantity, production rate, and time, together with the appropriate equipment, labor, and material costs. Each line item in the cost estimate was subjected to a risk analysis to determine the degree of uncertainty and appropriate contingency value. Additional details on the design of the flood control features can be found in the Engineering Investigations (Volume 2, Appendix A).

LEVEES

The recommended plan would provide for the construction or improvement of approximately 10 miles of levees. The levee north of U.S. Hwy. 90 would be constructed over a portion of the existing access road for the Greater New Orleans landfill (South Kenner Road). A gentle landside slope (1V on 10H) would be used along with a crushed stone surfacing to allow for the continued use of the access road. Excess material stockpiled during construction of the Davis Pond Freshwater Diversion project would be used as a borrow source to construct the levee along South Kenner Road. The protection would turn east at U.S. Hwy. 90 and parallel the shoulder of the westbound lanes for approximately 700 feet before turning south and crossing the highway. At the location where the protection crosses U.S. Hwy 90, the existing traffic lanes and median provide sufficient protection. Only the shoulders of the existing highway would need slight modifications.

The existing non-Federal levee would be enlarged from the south side of U.S. Hwy. 90 to the southern limits of Bayou Segnette State Park. A wave berm would also be

FIGURE 3
LAKE CATAQUATCHE
EQUIVALENT ANNUAL BENEFITS PROBABILITY CURVE
RECOMMENDED PLAN
M-CACES COST ESTIMATE
SPH LEVEL OF PROTECTION



constructed along that portion of the levee which extends from approximately 1 mile west of the Lake Cataouatche Pumping Station to the southern limits of Bayou Segnette State Park. Borrow material for the enlargement of the levee and for construction of the wave berm would be excavated from the adjacent exterior canal using a barge mounted dragline. The wave berm would be armored with riprap to prevent erosion from waves generated by wind and recreational boaters. A protected side stability berm would be constructed throughout the reach using borrow material excavated from the interior drainage canal. The interior drainage canal would be shifted landside in some locations to provide adequate stability for the enlarged levee. A second lift would be performed on that portion of the levee which extends from U.S. Hwy. 90 to the southern limits of Bayou Segnette State Park. The second lift would be constructed approximately 3 to 4 years after the first lift is completed. Borrow material for the second lift would be excavated from the interior drainage canal. The first enlargement of the levee would only provide for a 7-foot crown width in order to minimize impacts to the adjacent canals. Increased soil strengths would allow for providing a 10-foot crown width during the second lift. All levees would be fertilized and seeded upon completion of both the first and second lifts to minimize erosion.

FLOODWALLS

Design considerations and cost estimates for the structural features of the study included I-walls, I-wall/levee combinations, pedestrian and vehicular gates, pile supported inverted T-walls, and modifications of existing pumping station discharges (front-end protection). These structures assure a continuity of protection between full earthen levee sections and pumping stations, and allow economical protection through congested areas while minimizing adverse effects. T-wall, I-wall, and/or I-wall/earthen levee sections are proposed through Bayou Segnette State Park and in the vicinity of the Bayou Segnette Pumping Station. The exposed areas of the floodwalls would be provided with architectural finishes for aesthetic reasons.

Vehicular and pedestrian access would be provided at existing roads and walkways by gates in the floodwalls. Swing gates are considered advantageous at these crossings due to their ease of operation and low construction and maintenance costs.

PUMPING STATIONS

The Bayou Segnette Pumping Station would be modified by replacing the existing

steel sheetpile bulkhead fronting protection with a pile supported T-wall constructed on a granular fill embankment in the discharge canal. The discharge pipes for the existing pumping station would be extended, passed through the floodwall, and fitted with butterfly valves for positive cut-off. The existing tie-rod anchor piles, required for stability of the existing sheet pile cells supporting the pumping station, would be removed and the tie-rods would be anchored to the new T-wall base. These modifications would have negligible effects on the existing discharge capacity of the pumping station. At the Lake Cataouatche Pumping Station complex, only minor revisions are required along the transition floodwalls.

RELOCATIONS

There are several relocations, consisting of gas and oil pipelines; waterlines; and telephone, electrical, water, and sewer service to the Bayou Segnette State Park cabins that would be impacted by the project. These utilities would be relocated to cross the project in accordance with the existing hurricane protection standards. Disruptions to existing facilities would be kept to a minimum. The cost associated with the performance or construction of the relocations is estimated at \$366,000.

REAL ESTATE CONSIDERATIONS

The study area includes approximately 20,000 acres located on the west bank of the Mississippi River in Jefferson Parish between Bayou Segnette and the St. Charles Parish line. The Louisiana Department of Transportation and Development (LDOTD) will serve as the non-Federal sponsor for the project. A secondary agreement between LDOTD and the West Jefferson Levee District will provide for the local assuring agency to acquire the lands necessary for construction of the project. The real estate requirements for the recommended plan are presented in Table 15. Additional information on the real estate requirements are presented in Volume 2, Appendix E.

The total acreage required for construction of the project is approximately 316 acres. The total estimated costs for acquiring the real estate interests are \$370,000. There are no houses, other dwellings, or places of business located within the proposed limits of work that are eligible for URA benefits. There are no churches, schools, or cemeteries within the project area that would be affected. The Government will require surface rights only; therefore, no evaluation of minerals was conducted. Since the land needed for the project

does not lie along a natural navigable stream, the navigational servitude will not be invoked. Ingress and egress to the work site will be via existing Federal, State, and local roadways in the area.

TABLE 15
REAL ESTATE REQUIREMENTS

<u>FEE (Mitigation)</u>	<u>ACREAGE</u>
Wet Woodland	39.2
<u>PERPETUAL LEVEE EASEMENT</u>	
Commercial	4.1
Woodland/Pasture	69.4
Wet Woodland	16.3
Road Right-of-way	7.3
Levee Right-of-way	166.1
<u>PERPETUAL BORROW EASEMENT</u>	
Woodland/Pasture	13.6
Total Acreage	316.0

OPERATION AND MAINTENANCE CONSIDERATIONS

The leveed portion of the study area is currently drained by gravity to pumping stations. The pumping stations lift the water over the levees and into canals and bayous that discharge into Bayou Segnette and Lake Cataouatche. Operation and maintenance of the pumping stations is a local responsibility.

Initial construction of the levees and floodwalls would include projected subsidence and sea level rise during the first 10 years of the project life. The protection would be raised to account for future subsidence and sea level rise around year 10 or when deemed necessary based on actual conditions. The cost of raising the protection would be considered deferred construction and would be included as a project cost.

Operation and maintenance would include mowing of levees and the periodic inspection and repair of levees, floodwalls and floodgates. Operation and maintenance does generally not include potential repair costs that would be involved should the occurrence of an extreme event exceed the design criteria and cause extensive failures in the protection. These costs, once multiplied by the probability of occurrence and amortized over the life of the project, would likely be insignificant. Operation, maintenance, repair, replacement, and rehabilitation costs for the recommended plan are estimated to be approximately \$109,000 per year. This includes approximately \$1,000 associated with the operation and maintenance of the mitigation feature. Operation and maintenance of the project, including the mitigation features, is a non-Federal responsibility.

SUMMARY OF SOCIAL, ENVIRONMENTAL, HTRW, AND PUBLIC INTEREST EFFECTS

SOCIAL EFFECTS

Implementation of the recommended plan would result in improved hurricane protection for the residents, businesses, and industries within the study area. Providing the area with SPH protection would reduce the number of times that public officials would be forced to recommend an evacuation, thereby increasing participation rates when evacuation orders are necessary. There may be some minor, temporary degradation of air quality and temporary noise impacts during construction. Aesthetic values in some areas could also be reduced during construction.

ENVIRONMENTAL EFFECTS

Approximately 57 acres of wildlife habitat could be lost as a direct result of levee and floodwall construction and the excavation of borrow material. These lands are predominantly early successional bottomland hardwood forests. Some species commonly associated with these habitats include swamp rabbit, gray squirrel, and mink. Indirect impacts of rate of drainage on adjacent wetlands would be essentially non-existent. Aquatic resource impacts would result from the excavation of material from the interior and exterior canals located adjacent to the existing non-Federal levee. Adverse impacts would generally be temporary and limited to the construction period, and following construction, until slope vegetation occurs.

Wildlife losses would be mitigated by the purchase of 39 acres of early successional bottomland hardwoods located adjacent to Bayou Segnette State Park. Mitigation would include habitat development, which initially would consist of aerial application of herbicide and subsequent reforestation of the area with selected tree species, to eventually produce an area of high quality bottomland hardwood forest. Implementation of the mitigation feature would compensate all significant direct project-induced fish and wildlife losses to the fullest extent possible.

HTRW EFFECTS

The excavation of material in the vicinity of the landfills would not be permitted in order to minimize potential HTRW impacts. Aside from the pipeline crossings, the only remaining area of concern is the interior drainage canal which parallels the existing levee and receives direct runoff from the surrounding landfills. Sediment and water quality samples were collected from the interior drainage canal located between U.S. Hwy. 90 and the Lake Cataouatche Pumping Station. Test results showed levels of contamination similar to background samples collected throughout the area and well below the Environmental Protection Agency's alert level. No indication of underground storage tanks along the proposed alignment was identified in the research. Based on the results of the initial assessment, HTRW risk during construction is minimal.

The project is in compliance with the Clean Water Act, Public Law 92-500. A Section 404(b)(1) Evaluation has been prepared for the portion of the proposed action that would include material being deposited into the waters of the United States. Compliance with the requirements of Section 404(r) has been achieved, however, Section 401, State Water Quality Certification, was pursued. The letter of approval from the Louisiana Department of Environmental Quality completed certification of the proposed action.

PUBLIC INTEREST EFFECTS

The recommended plan would provide a level of protection to the Lake Cataouatche area that is consistent with the protection provided to the surrounding metropolitan area. Impacts to existing interior drainage facilities would be minimal and would only occur during construction. Measures would be taken to ensure that the increased protection does not detract from the natural setting within Bayou Segnette State Park.

RELATIONSHIP TO WESTWEGO TO HARVEY CANAL PROJECT

Implementation of the recommended plan for the Lake Cataouatche area would tie the line of protection to the authorized Westwego to Harvey Canal project. The location of the tie-in would allow for the deletion of the westside closure from the authorized project. The westside closure as presently authorized would extend the protection north from the seafood processing plant located along Bayou Segnette, across the Westbank Expressway, and north to the Southern Pacific Railroad tracks. The closure plan would require the construction of a ramp in the Westbank Expressway and a drainage canal parallel to the protection north of the expressway. The current alignment for the westside closure is shown on Plate 3. The estimated first cost for the westside closure is \$5,286,000. The total savings, including interest during construction, is estimated at \$6,216,000. In addition to being very costly, the westside closure would exclude a portion of the city of Westwego from the protection. Construction of the recommended plan for the Lake Cataouatche area would not only result in a significant cost savings but would also eliminate a controversial feature of the Westwego to Harvey Canal project.

The savings associated with eliminating the westside closure from the Westwego to Harvey Canal project can be claimed as a benefit only if the modification does not delay benefits to the authorized project. The westside closure is currently scheduled for construction beginning in 1998, with completion in 2001. Beneficial completion of the Westwego to Harvey Canal project is also currently scheduled for 2001. Beneficial completion of the Lake Cataouatche project, which would be obtained upon completion of all first lifts, is currently scheduled for 2001. The proposed modification to the Westwego to Harvey Canal project would, therefore, not result in a delay in benefits. The savings associated with deleting the westside closure are not included in the economic analysis for Lake Cataouatche, but rather as a cost offset for the Westwego to Harvey Canal project. Table 16 shows that the combination of the Westwego to Harvey Canal project modified to include the recommended plan for Lake Cataouatche provides greater net benefits than the Westwego to Harvey Canal project alone. The figures presented for the Westwego to Harvey Canal project in Table 16 were taken from the LMV Form 23C-R, dated September 3, 1996, and represent remaining costs and benefits indexed to 1996 price levels.

TABLE 16
COMPARISON OF AUTHORIZED PROJECT
AND PROPOSED MODIFICATION

	Westwego to <u>Harvey</u> ¹	Lake <u>Cataouatche</u>	Sum of <u>Projects</u>
<u>Westwego to Harvey Canal</u>			
<u>Project Alone</u> (Existing Project)			
First Cost	\$57,771,000	N/A	\$57,771,000
Gross Investment	\$62,258,000	N/A	\$62,258,000
Avg. Annual Costs	\$4,595,000	N/A	\$4,595,000
Equivalent Annual Benefits	\$31,779,000	N/A	\$31,779,000
Net Benefits	\$27,184,000	N/A	\$27,184,000
Benefit/Cost Ratio	6.92	N/A	6.92
<u>Westwego to Harvey Canal Modified to Include</u>			
<u>Lake Cataouatche</u> (Recommended Plan)			
First Cost	\$52,485,000 ²	\$14,806,000	\$67,291,000
Gross Investment	\$56,042,000 ²	\$16,812,000	\$72,854,000
Avg. Annual Costs	\$4,136,000 ²	\$1,402,000	\$5,538,000
Equivalent Annual Benefits	\$31,779,000	\$8,056,000	\$39,835,000
Net Benefits	\$27,643,000	\$6,654,000	\$34,297,000
Benefit Cost Ratio	7.68	5.74	7.19

¹ The remaining cost and benefit figures for the Westwego to Harvey Canal project were taken from the LMV Form 23C-R, dated September 3, 1996. The benefit figures were updated from the 1989 to 1996 price levels using the Marshall and Swift Estimator program.

² The project first costs and gross investment have been reduced by \$5,286,000 and \$6,216,000 respectively, to account for deleting the westside closure from the Westwego to Harvey Canal project. This resulted in a reduction of \$459,000 in the average annual costs.

PLAN IMPLEMENTATION

INTRODUCTION

The purpose of this section is to present pertinent information concerning the Federal and non-Federal responsibilities regarding cost apportionment and the division of responsibilities for construction and subsequent operation and maintenance of the recommended project. Such cost apportionment is based on Federal legislative and administrative policies.

COST APPORTIONMENT

All costs associated with the construction and subsequent operation and maintenance of the recommended project will be allocated to hurricane protection. The Water Resources Development Act of 1986 requires the non-Federal interest to pay 35 percent of the first cost of construction for hurricane and storm damage reduction projects. In addition, all operation, maintenance, repair, replacement, and rehabilitation costs are a non-Federal responsibility. Tables showing a breakdown of Federal and non-Federal expenditures by fiscal year are presented in Exhibit 2.

The West Jefferson Levee District has been granted authority to administer the project, see Exhibit 1. The non-Federal share of the total project first cost is estimated at \$5,182,000. Lands, easements, rights-of-way, including suitable borrow and dredged or excavated material disposal areas necessary for construction are a non-Federal requirement and creditable toward the non-Federal share of the project cost. The total cost to acquire all lands, easements and rights-of-way for the Lake Cataouatche project is estimated at \$370,000. The non-Federal sponsor is also required to accomplish or arrange for the accomplishment of all utility and facility alterations and relocations. The cost for all utility and facility alterations and relocations is estimated at \$366,000. The non-Federal sponsor will provide the remaining non-Federal share of the project costs (\$4,446,000) as cash.

DIVISION OF RESPONSIBILITIES

Federal Responsibilities. The Federal government will be responsible for planning, engineering, design, and construction of the project in accordance with the provisions of PL 99-662 (WRDA of 1986).

Non-Federal Responsibilities. In accordance with Federal policy, non-Federal interests must, at the appropriate time, assure the Secretary of the Army that they will, without cost to the United States:

- a. Furnish all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas necessary for construction (including mitigation), operation, maintenance, repair, replacement, and rehabilitation of the project;
- b. Accomplish or arrange for the accomplishment of all utility and facility alterations and relocations determined by the Secretary of the Army to be necessary for the construction, operation, maintenance, repair, replacement, and rehabilitation of the project;
- c. Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, replacement, and rehabilitation of the project, except for damages due to the fault or negligence of the United States or its contractors;
- d. Provide for adjudication of all water right's claims resulting from construction, operation, maintenance, repair, replacement, and rehabilitation of the project, and hold and save the United States free from damages due to such claims;
- e. Bear 35 percent of the total cost of project construction;
- f. Operate, maintain, repair, replace, and rehabilitate, as necessary, all features of the project, at no cost to the Government, in accordance with regulations prescribed by the Secretary of the Army, including levees, floodwalls, floodgates and approach channels, drainage structures, drainage ditches or canals, and all mitigation features;
- g. Publicize floodplain information in the areas concerned and provide this information to zoning and other regulatory agencies for their guidance and leadership in preventing unwise development in the floodplain and in adopting such regulations as may be necessary to prevent unwise future development and to ensure compatibility between

future development and protection levels provided by the project;

h. Within 1 year after the date of signing a project cooperation agreement, prepare a floodplain management plan designed to reduce the impact of future flood events in the project area. This plan shall be prepared in accordance with guidelines developed by the Government. The plan must be implemented no later than 1 year after completion of construction of the project.

i. Prescribe and enforce regulations to prevent obstruction of or encroachment on the project that would reduce the level of protection it affords or that would hinder operation and maintenance of the project.

j. Assure that construction, operation, maintenance, repair, replacement, and rehabilitation of any non-Federally constructed flood features do not diminish the hurricane protection provided by or jeopardize the structural integrity of the project;

k. Assure compliance with applicable Federal floodplain management and flood insurance programs;

l. Inform affected interests, at least annually, regarding the limitations of the protection afforded by the project;

m. Perform, at the time of initiation of construction and thereafter, any environmental investigations as determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675 on lands necessary for project construction, operation, maintenance, repair, replacement, and rehabilitation;

n. Assume complete financial responsibility for the cleanup of any hazardous materials located on project lands and regulated under CERCLA and be responsible for operating, maintaining, repairing, replacing, and rehabilitating the project in a manner that will not cause liability to arise under CERCLA;

o. Comply with the applicable provisions of the Uniform Relocations and Real Property Acquisition Policies Act of 1970 (PL 91-646), as amended by Title IV of the Surface Transportation and Uniform Relocations Assistance Act of 1987 (PL 100-17);

p. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, approved December 31, 1970, which provides that the construction of any water resource project by the Corps of Engineers shall not be started until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project; and

q. Comply with Section 601 of Title VI of the Civil Rights Act of 1964 (PL 88-352) that no person shall be excluded from participation in, denied the benefits of, or subjected to discrimination in connection with the project on the grounds of race, creed, or national origin.

SUMMARY OF COORDINATION

The New Orleans District, Corps of Engineers, had the responsibility of conducting and coordinating the study, consolidating information from other agencies and interested parties, formulating the alternative plans and associated recommendations, and preparing the report. During the course of this study, coordination was initiated and maintained with the U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, National Marine Fisheries Service, Louisiana Department of Transportation and Development, Louisiana Department of Environmental Quality, Louisiana Department of Wildlife and Fisheries, Louisiana Office of State Parks, West Jefferson Levee District, Jefferson Parish Department of Drainage, Jefferson Parish Citizens' Service, and other Federal, state, and local agencies.

Public meetings concerning the need for increased levels of hurricane protection for the west bank of the Mississippi River were held in 1966, 1972, 1984, 1986, 1989, 1994, and 1996. The earlier meetings held in 1966 and 1972 were broad in scope and were primarily concerned with protection of the multi-parish area. The meetings in 1984 and 1986 were concerned with the area between Westwego, Louisiana and the Harvey Canal. The final feasibility report for the West Bank of the Mississippi River in the Vicinity of New Orleans, Louisiana, study was issued in 1986. In addition to recommending a Standard Project Hurricane (SPH) level of protection to the area between Westwego and the Harvey Canal, this report also recommended further studies for remaining areas covered by the study resolutions. The Westwego to Harvey Canal project was authorized for construction in November 1986.

The East of Harvey Canal study was initiated in 1988. Two public meetings were held in 1989 to discuss the preliminary findings of the study, including alternative alignments being considered. A preliminary draft of the feasibility report was submitted to higher authority for review in July 1992. A feasibility review conference was held in October 1992 to discuss comments on the preliminary draft report. The draft feasibility report and draft EIS were distributed to the public for review in June 1994. A public meeting was held in July 1994 to discuss the recommendations presented in the report. A final feasibility report was submitted in August 1994 recommending SPH protection for the areas east of the Harvey Canal. A final EIS was filed with the Environmental Protection Agency on September 30, 1994. The Chief of Engineers report was signed on May 1, 1995. The East of Harvey Canal project was authorized for construction by the

Water Resources Development Act of 1996.

The Lake Cataouatche study was initiated in 1991, and a reconnaissance report was submitted in February 1992. The post authorization change (PAC) study was initiated in December 1992. A notice of intent to prepare a draft EIS was published in the Federal Register on May 20, 1993, and a scoping document was mailed to all interested parties. Concerns expressed in response to the scoping document included potential impacts to fish and wildlife resources and water quality. A preliminary draft of the post authorization change report was submitted to higher authority for review in December 1995. A technical review of the draft report was conducted by the Lower Mississippi Valley Division. A waiver to deviate from the NED level of protection (200-year), and to provide the area with SPH protection, has been granted by the Assistant Secretary of the Army. The draft report and EIS were distributed to the public for review in October 1996. A public meeting was held on November 7, 1996 to discuss the recommendations presented in the report. A Fish and Wildlife Coordination Act Report, dated November 1996, was provided by the Fish and Wildlife Service and is included in Volume 2, Appendix D.

Close coordination was maintained throughout the study with the Louisiana Department of Transportation and Development (non-Federal sponsor) and the West Jefferson Levee District. Meetings were held on a monthly basis during the latter stages of the study to discuss alternative plans, estimated project costs, and cost sharing responsibilities. Act 1012 of the 1993 Legislative Session named the Louisiana Department of Transportation and Development as the non-Federal sponsor for the construction of the Westwego to Harvey Canal Hurricane Protection Project and modifications which include East of Harvey Canal and Lake Cataouatche. Authority to administer the projects was granted to the West Jefferson Levee District in a letter dated November 5, 1993 (Exhibit 1).

The draft post authorization change report was transmitted to all agencies, groups, and individuals who normally review such documents and to additional agencies, groups, and individuals who have expressed an interest in the project. A copy of all comments received along with responses, where appropriate, are included in Volume 2, Appendix F. All comments received during the review process were considered in the preparation of the final report.

LOCAL COOPERATION

VIEWS OF LOCAL SPONSORS

The Lake Cataouatche study area is located on the west bank of the Mississippi River in Jefferson Parish. The West Jefferson Levee District is the local agency responsible for providing hurricane protection to residents living on the west bank of the Mississippi River in Jefferson Parish. Close coordination with the West Jefferson Levee District has been maintained throughout the planning process. The Louisiana Department of Transportation and Development has also been involved throughout the planning process. These agencies have expressed their support for the project. The West Jefferson Levee District expressed their support for the recommended plan in a letter dated February 2, 1996. A letter has also been received from the Louisiana Department of Transportation and Development expressing their intent to provide the non-Federal share of the project costs. A copy of these letters are included in Exhibit 1.

PRELIMINARY FINANCING NEGOTIATIONS

Several meetings have been held between the Corps of Engineers, Louisiana Department of Transportation and Development, and the West Jefferson Levee District. The purpose of these meetings was to discuss alternative plans, the recommended plan, estimated project costs, and cost sharing responsibilities. The Louisiana Department of Transportation and Development will serve as the non-Federal sponsor for the project. Secondary agreements between the Louisiana Department of Transportation and Development and the West Jefferson Levee District will provide for the local assuring agency to acquire the lands necessary for construction. A breakdown of the Federal and non-Federal expenditures by fiscal year, both with and without inflation, has been prepared and is attached as Exhibit 2. A detailed breakdown of the project first cost by construction contract is attached as Exhibit 3.

ASSESSMENT OF FINANCIAL CAPABILITY

Act 1012 of the 1993 Legislative Session has named the Louisiana Department of Transportation and Development (DOTD) as the non-Federal sponsor for the authorized

Westwego to Harvey Canal project and all modifications including East of Harvey Canal and Lake Cataouatche. Secondary agreements will be required between DOTD and the West Jefferson Levee District (WJLD) concerning the acquisition of lands, easements, rights-of-way, relocations, and disposal areas (LERRDs). An agreement is currently being developed to outline the collective duties between DOTD and the WJLD. In the interim, the West Jefferson Levee District has been granted the authority by DOTD to administer the project. DOTD expects to fund the non-Federal cost share of the project through either the State General Fund or the State Bond Program. For the past five years, these two appropriations have averaged \$4.3 billion and \$200 million, respectively. The bonds of the state of Louisiana are currently rated A- by Standard and Poor's, and Baa1 by Moody's.

A breakdown of the Federal and non-Federal share of the project cost is displayed by fiscal year in Exhibit 2. As shown in the exhibit, the largest non-Federal outlay for any year during the construction of the project is approximately \$2.4 million in FY 1998. This amount is less than 0.1 percent of the State General and approximately 1 percent of the State Bond Program.

The Louisiana Department of Transportation and Development has been an active participant throughout the study. Its representatives are familiar with the terms of cooperation and have provided the Corps with a letter of intent indicating that the agency understands the responsibilities incumbent on the local sponsor. The agency intends to enter into a binding agreement with the Corps at the appropriate time. The letter of intent for participation in the recommended plan is contained in Exhibit 1.

**FINAL
ENVIRONMENTAL IMPACT STATEMENT
WESTWEGO TO HARVEY CANAL, LOUISIANA
HURRICANE PROTECTION PROJECT
POST AUTHORIZATION CHANGE REPORT
LAKE CATAOUATCHE**

December 1996

Lead Agency: U.S. Army Corps of Engineers, New Orleans District
Cooperating Agency: West Jefferson Levee District

ABSTRACT: The study area is bounded by the Mississippi River on the north, Sala Avenue to the Company Canal and Bayou Segnette on the east, by the Jefferson/St. Charles Parish line on the west, and by the Cataouatche levee on the south. This is an area of heavy residential, commercial, and light agricultural development. The majority of the area has been developed into some form of higher economic use. Although there are sizeable forested tracts remaining in the project area, the total of which is approximately 11,000 acres, most of this acreage will be subject to development at some time in the future, either with or without the proposed project. Disastrous flooding can occur due to low elevations in the study area and the inadequacy of existing levee systems. Pumped drainage since the 1960's has resulted in slab elevations of some houses below zero feet National Geodetic Vertical Datum. Flooding was experienced in 1985 during Hurricane Juan, which was not classed as a major storm. The District evaluated two protection alignments and three levels of protection (100-year, 200-year, and standard project hurricane (SPH)). The late stage detailed alternatives were limited to the exterior alignment. Plan 1B, would be the environmentally least damaging alternative. The Recommended Plan is Plan 1C (SPH level), modified levee with some floodwall. This plan maximizes flood protection, maintains low costs, and results in a relatively minor increase in environmental damage over Plan 1B. Environmental features of the plan include using existing levee or road alignments wherever possible, obtaining construction material primarily from within an adjacent exterior borrow canal, constructing a floodwall that is aesthetically acceptable through the levee segment in Bayou Segnette State Park, and mitigating unavoidable losses of forested wetlands by acquiring a nearby potential bottomland hardwood forest site and developing and maintaining 39 acres of quality bottomland hardwood wetlands.

COMMENTS: Please send your comments to the U.S. Army Corps of Engineers, Policy Review Branch CECW-AR, Kingman Bldg, 7701 Telegraph Road, Alexandria, VA 22315-3861. Comments should arrive within 30 days of the publication of the Notice of Availability in the Federal Register. If you would like further information on the Environmental Impact Statement (EIS), please contact Mr. Bill Wilson, U.S. Army Engineer District, New Orleans, P.O. Box 60267, New Orleans, Louisiana 70160-0267. Commercial telephone: (504) 862-2527.

NOTE: Information, displays, maps, etc., discussed in the Post Authorization Change report are incorporated by reference in the EIS.

ENVIRONMENTAL IMPACT STATEMENT

1. SUMMARY

1.1. CONCLUSIONS AND FINDINGS

1.1.1. Purpose and Alternatives. The purpose of this study is to determine the feasibility of providing hurricane surge protection for populated areas of the west bank of the Mississippi River, west of the Harvey Canal. The study area is bounded by the Mississippi River on the north, Sala Avenue to the Company Canal and Bayou Segnette on the east, by the Jefferson / St. Charles Parish line on the west, and by the Cataouatche levee on the south (see Plate 2). Two alternatives were studied in detail. Within those alternatives, three levels of protection: 100-year, 200-year, and standard project hurricane (SPH) were analyzed for each alternative (see Post Authorization Change (PAC) Report). Several environmental features were also evaluated. These would serve to reduce or offset environmental losses that could result from using structural measures to provide hurricane protection.

1.1.2. Rationale For The Recommended Plan. Plan 1C, constructed to the SPH (500-year) level of protection, is the Recommended Plan. This plan would reduce the potential for catastrophic loss of life and property damage as a result of hurricane surge flooding. Adverse environmental impacts would be minimized by following the existing non-Federal levee. The SPH level of protection corresponds to the level of protection already provided to the surrounding New Orleans metropolitan area.

1.1.3. Environmental Features. The project is designed to use existing rights-of-way and levees wherever possible to minimize environmental damage. Borrow material would be obtained from an area of early-successional stage forests and from canals that would be excavated as part of the work plan. The slopes of the resulting interior pit and both borrow canals would be graded to 1.0 vertical on 4.0 horizontal. This slope would provide areas suitable for fish spawning. The recommended mitigation plan for this project calls for the purchase of 39 acres of early successional stage bottomland hardwoods within the study area near Bayou Segnette State Park and would include bottomland hardwood habitat development. This acreage is planned to be annexed to the Louisiana Office of State Parks. Material for levee construction near the state park would be obtained from a borrow pit just off the park property but adjacent to the interior borrow/drainage canal. Material for the remainder of the levee and berm construction would be obtained from both the exterior and the interior borrow canals. Material for the South Kenner Road upgrading would come from the Davis Pond Freshwater Diversion outlet channel area excavation. Mitigation features would be implemented simultaneously with other project construction. The analysis indicates that these mitigation measures would offset project-caused wildlife and fishery-related losses (see Appendix C, Section 4, Habitat Mitigation).

1.1.4. Environmental Impacts. The Recommended Plan would directly impact approximately 57 acres of drained early successional bottomland hardwoods. The vast majority of lands that would be directly impacted by construction are within an existing levee or road right-of-way. Almost all lands that would be enclosed by the proposed protection systems are already enclosed and have been under forced drainage for approximately 30 or more years. Undeveloped drained lands would be developed at a similar rate with or without the proposed protection system; therefore, indirect impacts to those resources and associated resources due to the proposed action would be essentially non-existent. There would be temporary adverse impacts to aquatic resources during construction in the area of the floodwall in front of the Bayou Segnette pumping station, in the exterior borrow canal, and to a lesser extent, in the interior borrow/drainage canal.

1.1.5. Threatened and Endangered Species. Letters of inquiry were sent to the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) regarding threatened and endangered species in the study area and possible adverse affects. Responses from both agencies were negative as to the probability of any significant adverse affects. A telephone call to Mr. Andy Dolan of the USFWS on August 8, 1996, reaffirmed the validity of their response.

1.1.6. Executive Order (E.O.) 11988. E.O. 11988, Floodplain Management, deals with minimizing or avoiding adverse impacts associated with the base floodplain unless there are no practicable alternatives. It also involves giving public notice of proposed actions that may affect the base floodplain. The proposed action would not accelerate development of the floodplain for the following reasons. Development of the study area is more closely related to access routes and the need for affordable housing space than flooding potential. Conditions conducive for development were established initially when the area was leveed and forced drainage was initiated in the middle 1960's.

1.1.7. Executive Order 11990. E.O. 11990, Protection of Wetlands, has been important in project planning. It is acknowledged that much of the area enclosed by the existing levee consists of wetlands. However, by following the existing alignments and working in developed areas, there would be minimal direct adverse impacts to wetlands for this project. Any increased size of the interior borrow/drainage canal as a result of levee enlargement would result in increased capacity; however, this would have essentially no indirect effect on the rate of drainage from the basin. No increased pumping station capacities are a part of this action. The acquisition, habitat development, protection, and management of the 39-acre mitigation site would mitigate all lost habitat value attributable to direct construction as determined by the Habitat Evaluation System.

1.1.8. Clean Water Act: Section 404(b)(1) Evaluation and Section 401, State Water Quality Certification.

1.1.8.1. General. Section 404(b)(1) guidelines were used to evaluate the discharge of dredged or fill material for adverse impacts to the aquatic ecosystem (see Appendix C, Section 2). The following actions would be taken to minimize the potential for adverse environmental impacts. The existing levee alignment would be followed in construction of the proposed levee. A cofferdam would be constructed at the area in front of the Bayou Segnette Pumping Station. Dredged material placement would be accomplished by dragline or bucket dredge which would minimize turbidity and suspended solids. Riprap stone armorment would be included in the wave berm in areas subject to significant wave impact and to minimize erosion into the exterior borrow canal. All sloped areas would be seeded. Impacts to forested wetlands would be mitigated as described previously. Non-forested wetlands, consisting of mown levee grasses or grazed pasture, were not mitigated because of their low value to fish and wildlife resources. The proposed project complies with the requirements of the guidelines. State water quality certification (Section 401) by the Louisiana Department of Environmental Quality (DEQ) was pursued instead of Section 404(r). The DEQ approval letter completed the certification process.

1.1.8.2. Regulatory Requirements. Any action not described in paragraph 4.3.3, 4.3.4, and 4.3.5 would consist of actions not covered by the Section 404(b)(1) evaluation within Appendix C or any other environmental documentation. Any such development action would quite likely require a 404 permit from the New Orleans District since much of the land within the levee is considered to be regulated wetlands.

1.1.9. Consistency with Coastal Zone Management (CZM) Program. The New Orleans District, U.S. Army Corps of Engineers, has determined that construction of required protective features in conjunction with the proposed Westwego to Harvey Canal, Louisiana, (Lake Cataouatche) Post Authorization Change Study is consistent, to the maximum extent practicable, with the guidelines of the State of Louisiana's approved Coastal Zone Management Program. A CZM consistency determination was prepared and provided to the Louisiana Department of Natural Resources (DNR) (see copy in Appendix C, Section 3). The letter of approval from the Louisiana DNR completed consistency requirements.

1.2. AREAS OF CONTROVERSY AND UNRESOLVED ISSUES

There has been considerable public concern regarding landfills in the study area; however, there has not been any controversy regarding the proposed action. The alignment of the levee from U.S. Highway 90 (U.S. Hwy. 90) to the railroad is currently planned on the South

Kenner Road. The Greater New Orleans landfill on the west side of South Kenner Road has been scheduled for closure, and as of late 1996 is operating under a settlement agreement (an extension of its current permit) with the Louisiana Department of Environmental Quality. This settlement agreement allows the landfill to continue to operate until a designated capacity is reached, but no later than through 1999. Also, the original closure plan has been revised and amended to incorporate additional requirements. There is considerable public pressure for ceasing operation without the recommended closure. If closure is accomplished as planned, the levee alignment may be changed in that area to take advantage of the closed landfill. An application for another landfill proposed to be located on the opposite side of South Kenner Road had been denied; however, the denial is in litigation.

TABLE 1.3

ENVIRONMENTAL COMMITMENTS
WESTWEGO TO HARVEY CANAL, LOUISIANA
LAKE CATAOUATCHE AREA
POST AUTHORIZATION CHANGE ¹

APPLICABLE RESOURCE	CONCERN	COMMITMENT	LOCATION IN EIS
Bottomland Hardwood Forests	Wildlife Habitat	Unavoidable direct habitat losses of these resources would be mitigated by the acquisition of a nearby 39-acre early successional stage bottomland hardwood forest tract and would include fencing, habitat development, and operation and management of the tract for bottomland hardwood wetland habitat.	4.3.3
Recreation Resources (Also Noise, Air Quality, and Aesthetics)	Floodwall Impact on Aesthetics and Noise	Aesthetic treatment of floodwall and gates within the state park boundary on approximately 1.4 miles of levee. Aesthetic plantings are included. Floodwall construction would be done during low-use season, as possible and practical, to minimize recreation impacts, especially in high-use areas such as the boat launching and cabin areas.	4.3.3, 5.2.5, & 5.2.7
Hazardous, Toxic, & Radioactive Wastes	Construction in Landfill area	The upgrading of South Kenner Road would be done by depositing hauled materials, compaction of the materials, and finally, rebuilding a road surface on them. Thus, construction in landfill area would be done with no excavation in landfill.	4.3.3 & 5.2.8

¹ Commitment to be met by inclusion in the plans and specifications with subsequent transmittal to the field.

2. TABLE OF CONTENTS

<u>Title</u>	<u>Page</u>
1. SUMMARY	124
1.1. Major Conclusions and Findings	124
1.2. Area of Controversy and Unresolved Issues	126
1.3. Environmental Commitments	127
2. TABLE OF CONTENTS	128
3. NEED FOR AND OBJECTIVES OF STUDY	129
3.1. Study Authority	129
3.2. Public Concerns	129
3.3. Planning Objectives	129
4. ALTERNATIVES	130
4.1. Plans Eliminated from Further Study	130
4.2. Future Conditions With No Federal Action	130
4.3. Plans Considered in Detail	131
4.4. Comparative Impacts of Alternatives	133
5. AFFECTED ENVIRONMENT \ ENVIRONMENTAL EFFECTS	139
5.1. General Environmental Conditions	139
5.2. Significant Resources	140
5.2.1. Introduction	140
5.2.2. Bottomland Hardwoods	140
5.2.3. Aquatic Resources	147
5.2.4. Threatened and Endangered Species	149
5.2.5. Recreation Resources	150
5.2.6. Cultural Resources	151
5.2.7. Noise, Air Quality, & Esthetics	152
5.2.8. HTRW	154
5.2.9. Socioeconomic Resources	156
5.3. Cumulative Impacts	174
5.4. Operation and Maintenance	175
6. List of Preparers	176
7. Public Involvement	177
7.1. Public Involvement Program and Study History	177
7.2. Required Coordination / Compliance	178
7.3. Statement Recipients	178
7.4. Public Views and Responses	180
7.5. Recommendations of the U.S. Fish and Wildlife Service	180
8. Literature Cited	181

3. NEED FOR AND OBJECTIVES OF ACTION

3.1. STUDY AUTHORITY

The study was authorized by resolutions adopted November 10, 1965 and May 6, 1966 by the Committee on Public Works of the United States Senate, and by resolutions adopted May 5, 1966 and October 5, 1966 by the Committee on Public Works of the U.S. House of Representatives. The text of these resolutions is quoted in the report. The purpose of the study is to determine the feasibility of providing hurricane protection to that portion of the west bank of the Mississippi River in the area known as the Lake Cataouatche area and located between Bayou Segnette and the St. Charles Parish line.

3.2. PUBLIC CONCERNS

The public is concerned about the present inadequate hurricane surge protection in the project area. Local and Federal levees exist in the area, but local levees are deficient in grade and cross-section to the extent that flooding occurred in October - November, 1985, during minimal hurricane Juan. During the scoping process, segments of the public expressed the desire that environmental impacts associated with increased hurricane protection be minimized.

3.3. PLANNING OBJECTIVES

The following planning objectives were established in response to the identified problems, needs, and opportunities. These include 1) provide adequate hurricane protection to that area of the West Bank of the Mississippi River in the vicinity of New Orleans from approximately Sala Avenue westward to approximately the Jefferson/St. Charles Parish line; 2) maximize the proposed action's contribution to the nation's economic development by reducing hurricane-related flood damages; and 3) minimize adverse impacts to the natural environment and to the social well-being of those individuals located in the study area.

4. ALTERNATIVES

4.1. PLANS ELIMINATED FROM FURTHER STUDY

4.1.1. The PAC report presents a detailed description of the alternative plans considered and eliminated during the study. A brief description of those plans is presented in this section.

4.1.2. Plan 1A (Exterior Alignment/Levee) 100/200/SPH Protection. Alternatives involving 100-year, 200-year, and SPH protection consisting of a new enlarged levee constructed along the existing perimeter levee were eliminated. This alternative included levee material being taken from the protected side of the interior borrow area. The close proximity of the interior and exterior canals do not provide for the enlargement of the existing levee. This alternative was eliminated due to high relative costs with no additional benefits.

4.1.3. Plan 2A (Interior Alignment/Levee) 100/SPH Protection. A levee alternative that followed an interior alignment adjacent to existing drainage canals (see Plate 5) was eliminated due to high construction costs, and excessive direct adverse impacts to forested lands. The local sponsor strongly opposed this alternative.

4.1.4. Plan 2B (Interior Alignment/Floodwall) 100/200/SPH Protection. The floodwall alternative that followed the same alignment as Plan 2A was eliminated due to high construction costs, and excessive direct adverse impacts to forested lands. The local sponsor also strongly opposed this alternative.

4.2. FUTURE CONDITIONS WITH NO FEDERAL ACTION

4.2.1. Without implementation of the proposed project, it is probable that flooding as a result of inadequate hurricane protection and the possibility of catastrophic flooding with the occurrence of a hurricane with a less frequent chance of occurrence would occur. Social and economic impacts would continue to affect those individuals affected directly by flooding and those persons who pay higher flood insurance because of the inadequate protection system.

4.2.2. The area would continue to be developed since it has been leveed and under pumped (forced) drainage since the middle 1960's. This drainage would result in the continued development of wooded sites into cleared sites. Subsidence would continue to occur as the foundation soils of the entire area are dried by the forced drainage system.

4.2.3. Three landfills are located on the west side of the study area. The landfill on the west side of South Kenner Road (Greater New Orleans landfill) has been ordered for closure by

the Louisiana Department of Environmental Quality (LDEQ), but a time extension was granted in 1995. Detailed plans for closure have been developed with final closure anticipated by approximately 1999. An application has been made for a proposed landfill east of South Kenner Road and adjacent to the Kelven tract landfill. The application has been denied both by the Jefferson Parish Council and the LDEQ. The Jefferson Parish denial of the permit has been upheld by the Louisiana 5th Circuit Court of Appeals. However, one phase of the Jefferson Parish Council denial was still in litigation in November, 1996.

4.3. PLANS CONSIDERED IN DETAIL

4.3.1. The alternatives are described in detail in the PAC report. The alternatives are described concisely below.

4.3.2. Plan 1B (Exterior Alignment Floodwall 100/200/SPH). A floodwall would be constructed to Standard Project Hurricane (SPH) level of protection from the end of the authorized Westwego to Harvey floodwall on the west side of Bayou Segnette past the Bayou Segnette Pumping Station, along the alignment of the existing perimeter levee to U.S. Highway (Hwy.) 90 (see Plate 4). The floodwall would contain both pedestrian and vehicular access gates in that segment within Bayou Segnette State Park and would be capped and textured to blend into the park setting. From where the floodwall meets Hwy. 90, a tie-in levee would be constructed on the north side of, and parallel to, the highway and would extend westward approximately 1,000 feet to a point of tie-in with South Kenner Road. From that point, a small levee would be constructed to the required grade over South Kenner Road. The levee/road upgrading would extend from Hwy. 90 to the Texas and Pacific and Southern Pacific Railroad. Material for that levee construction would come from the excess material excavated from the outlet channel of the authorized Davis Pond Freshwater Diversion Structure. Material necessary for any required levee upgrading within the park would come from a borrow area just west of the park boundary. Material necessary for any remaining required levee upgrading would come from a borrow area just east of the Catouatche Pumping Station. Mitigation measures include wildlife crossings spaced to allow access over the floodwall and acquisition of approximately 15 acres adjacent to Bayou Segnette State Park with planting of tree seedlings and bottomland hardwood habitat development on that area.

4.3.3. Plan 1C (Exterior Alignment Modified Levee 100/200/SPH). (Recommended Plan). A modified levee would be built to SPH level of protection. The protection would extend, as with Plan 1B, from the end of the authorized Westwego to Harvey floodwall on the west side of Bayou Segnette past the Bayou Segnette Pumping Station, along the alignment of the existing perimeter levee to U.S. Hwy. 90, to the Southern Pacific Railroad (see Plate 6). A floodwall with both pedestrian and vehicular access gates as required would be constructed in

that segment of the existing levee within Bayou Segnette State Park. That floodwall segment would be capped and textured to blend into the park setting. The remainder of the levee would have one on three side slopes and a crown width of seven feet and would be constructed in two lifts to achieve the desired level of protection. A floodside wave berm would be constructed from the park boundary to approximately 1.1 miles west of the Cataouatche Pumping Station. The material for that berm as well as the levee upgrading would be obtained from the existing exterior borrow canal and the interior borrow/drainage canal. Erosion protection consisting of rock armorment would be constructed on the flood side of the wave berm. This would be required for that area where the wave berm extends into the existing floodside borrow canal. The interior borrow/drainage canal would be moved minimally with material taken from the land side being relocated to the levee side of the canal to create a more stable levee section. After the levee meets Hwy. 90, a tie-in levee would be constructed north of, and parallel to, the highway, and would extend westward approximately 1,000 feet to a point of tie-in with South Kenner Road. From that point, a small levee would be constructed to the required grade over South Kenner Road. The levee/road upgrading would extend from U.S. Hwy. 90 to the Texas and Pacific and Southern Pacific Railroad. Material for that levee construction would come from the excess material excavated from the outlet channel of the authorized Davis Pond Freshwater Diversion Structure. Material necessary for any required levee upgrading within the park would come from a borrow area just west of the park boundary. Habitat mitigation measures include acquisition of approximately 39 acres adjacent to Bayou Segnette State Park and habitat development on that area. Esthetic mitigation at the park would include concrete capping and texturing of the floodwall through the park and would include landscaping with appropriate trees and/or shrubs at the vicinity of the boat dock.

4.3.4. Operation and Maintenance. Maintenance of any plan would consist of mowing levees and annual inspection and repair of the levees, floodgate, floodwalls, etc., along the entire alignment, any necessary vector control, and stewardship of any mitigation described.

4.3.5. Mitigation. Design has incorporated following existing levees wherever possible. Material for construction of the levee and berm on the flood side would be obtained from the existing exterior borrow canal. Material on the protected side would be obtained from the land side of the interior borrow/drainage canal. Compensatory mitigation would include acquisition and development, including fencing, of approximately 39 acres of land adjacent to the Bayou Segnette State Park for reforestation with species providing habitat for native wildlife of the area and development of that habitat. Development would include the initial aerial application of herbicide to establish some control and advantage over the invading Chinese tallow trees with subsequent reforestation of the area with several species of oaks as well as baldcypress. Proper equipment (microfoil boom) and application techniques to assure

uniform droplet size to result in precise extent of application would be included. Operation and maintenance of the mitigation site would include stewardship and protection to insure adequate seedling survival with the plantings developing to be a major component of the eventual mature forest of the area. Monitoring of the site would be conducted to verify that the intended result is achieved. It is anticipated that operation and maintenance of the area would be accomplished by the Louisiana Office of State Parks as a component of Bayou Segnette State Park with the tract being used as a natural/interpretive area (see letter of intent from Louisiana Office of State Parks). Mitigation requirements would include the agreement to manage the tract as a bottomland hardwood wetland.

4.3.6. Implementation Responsibility. The Federal Government would prepare detailed designs, plans, and specifications and bear 65 percent of the final cost. Non-Federal interests would provide lands, easements, and rights-of-way, accomplish all relocations, hold and save the U.S. free from damages, provide all interior drainage, and operate and maintain all features.

4.4. COMPARATIVE IMPACTS OF ALTERNATIVES

Table 4.4 describes in comparative form, the base conditions, the impacts of No Action and the detailed plans on significant resources, and plan economic characteristics. More detailed information on the impacts described in these tables is presented in Section 5, Environmental Effects.

TABLE 4.4
COMPARATIVE IMPACTS OF ALTERNATIVES

ALTERNATIVES	EFFECTS ON SIGNIFICANT RESOURCES		
	BOTTOMLAND HARDWOODS	AQUATIC RESOURCES	THREATENED/ ENDANGERED SPECIES
BASE CONDITION	Approximately 11,000 acres existed in 1990 within the area afforded protection by the proposed hurricane protection project. Acreage generally provides excellent habitat. Some is lower quality.	Approximately 29 miles of canals interior of levee and 9 miles exterior of levee system. Interior canals are of low-to-moderate fishery value; exterior canals of moderate fishery value.	USFWS and NMFS responded that no species would be affected by implementation of the proposed action.
NO-ACTION	Losses of approximately -0.5% per year would occur due to development. Approximately 8,184 acres would remain in 2049 and 6,370 acres would remain in 2099. Decline in habitat acres would produce corresponding decline in wildlife populations.	Amount of canals would remain near the same. Urban runoff would continue to be a detriment to water quality. Average salinity in waters outside levee system would increase slowly over time resulting in a shift to greater dominance by estuarine species.	No species would be affected.
PLAN 1B 100/200/SPH	Same as No Action, but with 20 additional acres lost due to new levee construction and upgrade of existing levees. 5 AHUV lost. Loss of habitat value would be mitigated near B. Segnette State Park.	Similar to no action. Two new borrow pits totalling approximately 22 acres would be created that would provide moderate quality habitat for fish.	No species would be affected.
PLAN 1C 100/200/SPH	Same as No Action, but with 57 additional acres lost due to levee construction and upgrading. 15 AHUV lost. Loss of habitat value would be mitigated near B. Segnette State Park.	Similar to no action. One borrow pit of approximately 12 acres would be created. Approx 9 miles of exterior borrow canal would be deepened considerably. Interior canal would be moved but would remain near current size.	No species would be affected.

TABLE 4.4 (continued)
COMPARATIVE IMPACTS OF ALTERNATIVES

ALTERNATIVES	EFFECTS ON SIGNIFICANT RESOURCES
	CULTURAL RESOURCES
BASE CONDITION	There are no National Register of Historic Places properties recorded in the project area. Seventeen archeological sites are recorded within a five mile radius of the project area. Seven of these archeological sites front the right (west) descending bank of the Mississippi River. Five sites are clustered near the southwest shoreline of Lake Cataouatche and four are clustered on the southeast shoreline near bayou's Bardeaux and Segnette. One isolated site, 16JE133, is located on the north shore of Lake Cataouatche and is just outside the project area.
NO-ACTION	Any, as yet unrecorded, cultural resources located within the project area would continue to be affected by both physical and chemical processes of erosion.
PLAN 1B 100/200/SPH	Efforts to identify significant cultural resources which may become impacted by excavations within planned borrow and mitigation areas are underway. Any investigations will be completed in advance of construction. Efforts are currently being coordinated with the SHPO.
PLAN 1C 100/200/SPH	Similar to Plan 1B 100/200/SPH, however, additional project impacts could occur from construction of the exterior wave berm and excavation and relocation of the interior borrow/drainage canal. Any investigations will be completed in advance of construction. Efforts are currently being coordinated with the SHPO.

TABLE 4.4 (continued)
COMPARATIVE IMPACTS OF ALTERNATIVES

ALTERNATIVES	EFFECTS ON SIGNIFICANT RESOURCES		
	RECREATION RESOURCES	NOISE, AIR QUALITY, AND AESTHETICS	HTRW
BASE CONDITION	Primary public outdoor recreation areas in the vicinity include: Jean Lafitte National Historic Park and Preserve, Bayou Segnette State Park, and Salvador Wildlife Management Area (WMA). Passive or non-consumptive activities that occur in the area include levee walking, jogging, golfing, and nature study. Consumptive recreational activities are predominantly hunting, fishing, and crawfishing.	Noise in area is from land, waterborne, and aircraft traffic. La DEQ 1987 info reported there were no violations of state air quality standards in New Orleans. July 1995 communication confirmed that still accurate. Jefferson Parish is "in attainment" and is operating under a "full maintenance" plan for air quality. Most of area is heavily developed but remaining forested areas as well as some waterways provide some amount of aesthetics to the area.	Significance is from possible negative effects to the human environment and resulting in potential financial liability responsibility.
NO-ACTION	Wetlands in Salvador WMA and other wetlands surrounding the project area would continue to be lost due to erosion and subsidence; thus, recreational opportunities, including hunting and fishing, would be reduced.	With growth an increase in noise is expected as well as some deterioration of air quality. Aesthetic quality would be reduced with the development (reduction) of forested areas over the general area.	More stringent regulations may result in cleaner environment.
PLAN 1B 100/200/SPH	Limited short-term adverse impacts would occur to recreational use of the levee due to disruption caused by construction activities. Construction of the floodwall would minimally affect recreational resources. Implementation of the mitigation plan would offer the potential to recoup the non-consumptive losses caused by construction activities.	Construction would result in increased levels of noise caused by construction equipment during daylight hours. Noise would be annoying to any nearby building occupants. Air quality standards should not be violated. Aesthetic quality would be reduced over the short term but would be near the same over the long term. Enclosure of existing wooded lands would be replaced by expansiveness of levee. Texturing of floodwall through park would produce acceptable rather than harsh floodwall structure.	Results of initial assessment indicate low probability of encountering HTRW problems if carried out as described with no excavation in landfill.
PLAN 1C 100/200/SPH	Similar to above.	Similar to above. Air quality applicability determination completed. Projected emissions do not exceed threshold limits for maintenance areas.	Similar to above.

TABLE 4.4 (Continued)
COMPARATIVE IMPACTS OF ALTERNATIVES
SOCIOECONOMIC IMPACT MATRIX

	Alternatives	
	No Action	All Plans
Land Use	+	+
Property Values	+	+
Business/Industrial Activity	+	+
Employment	+	+
Displacement of People <u>1/</u>	-	+
Housing	+	+
Community Growth	+	+
Tax Revenues	+	+
Public Facilities & Services	+	+
Displacement of Farms	o	-
Noise <u>2/</u>	o	--
Esthetic Values <u>2/</u>	o	--
Community Cohesion	o	+
Regional Growth <u>3/</u>	+	+

++ positive impact

+ slight positive impact

o no impact

- slight negative impact

-- negative impact

1/ Temporary displacements due to periodic flooding may occur, but permanent relocations are not anticipated.

2/ Construction of the floodwall and pumping station will cause temporary noise and esthetic negative impacts within Bayou Segnette State Park in the vicinity of the cabin and boat launch areas.

3/ The New Orleans metropolitan area is expected to grow at the same rate with or without the project.

TABLE 4.4 (Continued)
COMPARATIVE IMPACTS OF ALTERNATIVES
ECONOMIC SUMMARY¹

Plan	Average Annual Benefit (\$1,000)	Average Net Costs (\$1,000)	Net Benefit (\$1,000)	B/C Ratio
1B 100-yr	8,362	1,048	7,314	7.98
1B 200-yr	8,524	1,100	7,424	7.75
1B SPH	8,534	1,614	6,920	5.29
1C 100-yr	8,362	731	7,630	11.43
1C 200-yr	8,524	836	7,688	10.19
1C SPH	8,533	903	7,631	9.45

¹ See Appx. B, Table 28F

5. AFFECTED ENVIRONMENT / ENVIRONMENTAL CONSEQUENCES

5.1. GENERAL ENVIRONMENTAL CONDITIONS

5.1.1. The study area (approximately 20,400 acres) lies within Jefferson Parish on the west bank of the Mississippi River. The study area is bounded by the Mississippi River on the north, Sala Avenue to the Company Canal and Bayou Segnette on the east, by the Jefferson/St. Charles Parish line on the west, and by the Cataouatche levee on the south (see Plate 2). U.S. Hwy. 90 extends from the western side and turns north before it approaches the area where it crosses the river. Where it turns north, the Westbank Expressway branches off and extends easterly across the remainder of the area. There are approximately 10,800 acres above and approximately 9,600 acres below Hwy. 90. Bayou Segnette is included in the study area. Some of the area is highly urbanized and includes the communities of Bridge City, Avondale, Waggamon, Live Oak Manor, and South Kenner. Almost all land within the proposed hurricane protection system has some type of hurricane protection in place. Flooding from the Mississippi River is prevented by the mainline levee system.

5.1.2. The area is located on the Mississippi River alluvial plain in the Barataria Basin. Elevations range from 10-15 feet National Geodetic Vertical Datum (NGVD) along the natural levee of the Mississippi River to several feet (-4.0 feet) below sea level within the levee system near the Cataouatche Pumping Station. Flooding occurs from water originating in the Gulf of Mexico that travels across marshes and the numerous natural and man-made channels south of the project area. A levee was constructed around the southern portion of the area in the mid-1960's, but that levee is inadequate for many storm events. A significant portion of the area has already been developed, but there are still about 11,000 acres of remaining forested lands. The majority of the forested area, although under pumped drainage, is still considered as wetlands. Aquatic sites consist primarily of drainage canals and generally offer low habitat value to fish and other aquatic organisms. Bayou Segnette State Park is on the east side of the area. The bayou culture of south Louisiana is one of the points of emphasis of this park. A group of park cabins overlook Bayou Segnette and are located immediately adjacent to the existing non-Federal levee. The park is heavily utilized.

5.1.3. The study area is within the New Orleans Metropolitan Statistical Area (MSA). The study area had a population of 23,795 compared to 1,286,270 in the MSA in 1990, or about 1.8 percent of the total population. The main employers in the study area are the port and commercial and manufacturing industries.

5.1.4. The study impact area is defined as any lands that would be directly or indirectly changed by the proposed construction. The forthcoming sections describe the effects of no

action and action alternatives on significant resources. A comparison of the impacts of the alternatives are given under each resource category.

5.2. SIGNIFICANT RESOURCES

5.2.1. Introduction. A resource is considered to be significant if it is identified in the laws, regulations, guidelines, or other institutional standards of national, regional, and local public agencies; or if specifically identified as a concern by local public interests; or if judged by the responsible Federal agency to be of sufficient importance to be designated as significant (Table 5.1 and Table 5.2). In addition, other specific statutes not listed in this table may be considered when establishing the institutional significance of some specific resources. This section contains a discussion of each resource determined to be significant and previously listed in Table 4.4.

5.2.2. Bottomland Hardwoods.

5.2.2.1. Significance. Bottomland hardwood (BLH) forests are considered to be significant because of their economic value for forest products and their fish and wildlife habitat value. Bottomland hardwood forests are considered to be the most productive wooded habitats of the nation. They are also considered to be significant because of their wetland characteristics. Bottomland hardwoods are productive ecosystems that are said by many authorities to depend upon water fluctuations for the maintenance of their structure and function (Wilkinson et al., 1987), and are said by others to be ecologically, recreationally, and aesthetically valuable (EPA.1984). In the following list, the potential wetland functions exhibited by these resources are ranked in descending order of their probability and extent of occurrence on a nationwide scale (from Adamus and Stockwell, 1983).

1. Passive recreation and heritage value
2. Habitat for aquatic wildlife and fisheries
 - Sediment trapping (short term)
 - Ground water discharge
3. Nutrient retention (short term)
 - Food chain support (nutrient export)
 - Dissipation of erosive forces
 - Active recreation potential
4. Flood desynchronization
 - Food chain support (of clearly food-limited species of commercial sport value)
5. Nutrient retention / removal (long term)

TABLE 5.1
ATTRIBUTES OF SIGNIFICANT RESOURCES

RESOURCE	ECOLOGICAL ATTRIBUTES	CULTURAL ATTRIBUTES	AESTHETIC ATTRIBUTES
BOTTOMLAND HARDWOODS	Provides valuable habitat for wildlife including game and non-game species; provide several non-habitat wetland functions.	Supports the traditional extractive economy of the Barataria basin. Also protects archeological and historic sites located within these areas.	Provides escape from concrete and steel of urbanization.
AQUATIC RESOURCES	Numerous species of fish and shellfish utilize project area.	Supports traditional economy of Barataria Basin.	Bayou Segnette provides above average aesthetic values. Other waterbodies provide minimal value.
ENDANGERED SPECIES	Indicators of man's impact upon environment.	N/A	Sightings are few and memorable.
RECREATION RESOURCES	N/A	Jean Lafitte National Historical Park; B. Segnette State Park; & Salvadore WMA nearby.	Pleasing environment, moss-draped trees in lowlands add to interest in this resource.
NATIONAL REGISTER OF HISTORIC PLACES	N/A	Serves as the Nations official list of properties worth of preservation for significance in American history, architecture, archeology, and culture.	No National Register properties in study area.
NOISE, AIR QUALITY AND AESTHETICS	Non-toxic air is essential for humans and other forms of wildlife.	A pleasant visual perception is a component of the culture of an area.	N/A
HAZARDOUS, TOXIC, AND RADIOACTIVE, WASTE, (HTRW)	Presence of HTRW reflects negatively on many organisms. Existence is especially manifest through bioaccumulation.	Presence of HTRW reflects negatively on social well-being of area.	Presence of HTRW reflects negatively on perception of area.
SOCIO-ECONOMIC RESOURCES	N/A	Significant reasons for people inhabiting particular areas.	N/A

TABLE 5.2
RECOGNITION OF SIGNIFICANT RESOURCES

RESOURCE	INSTITUTIONAL RECOGNITION	TECHNICAL RECOGNITION	PUBLIC RECOGNITION
BOTTOMLAND HARDWOODS	Water Resources Development Act of 1986, Fish and Wildlife Coordination Act, EO 11990, EO 11988, Coastal Zone Management Act of 1972, La State and Local Coastal Resources Mgmt. Act of 1978, Protection of Cypress Trees (La EO 1980-3)	Habitat for many wildlife species. Present area is small % of original area. Fairly rare in Barataria Basin.	Public strongly desires preservation of this resource. Resource is of importance to consumptive and to non-consumptive users.
AQUATIC RESOURCES	Clean Water Act of 1977, La. Water Control Law, Estuary Protection Act, Fish & Wildlife Coordination Act.	Nursery area.	Resource important to recreational and commercial fishing industries.
ENDANGERED SPECIES	Endangered Species Act, Bald Eagle Act	Bald eagles have made remarkable comeback in response to protection offered by legislation.	High degree of interest in resource.
RECREATION RESOURCES	Land and Water Conservation Fund Act of 1965	Various facilities exist which currently satisfy numerous user-days of recreation annually.	High demand for recreation in and near urban areas.
NATIONAL REGISTER OF HISTORIC PLACES	National Historic Preservation Act of 1966, as amended; the Reservoir Salvage Act of 1960, as amended; EO 11593; Archeological Resources Protection Act of 1979.	No National Register properties on study area. Seventeen archeological sites are within 5-mile radius of the area.	Public recognition and support of historic preservation is strong, reflecting national trends.
NOISE, AIR QUALITY AND AESTHETICS	Occupational Noise Exposure (29 CFR1926.52); Clean Air Act; USACE ER 1105-2-100; National Environmental Policy Act	High noise levels and poor air quality may have adverse effects on residents.	Public puts value on low noise levels and high air quality. Public also puts value upon appealing scenes as reflected by land prices, trees on lots, and demand for parks, etc.
HTRW	RCRA, CERCLA, E.O. Order 12088, State of La. safety and health regulations (40 CFR 1920), OSHA standard 29 CFR 1910.120	Three landfills are near levee route. GNO landfill was once assessed for the National Priority List but did not rank high enough for placement. Leachate and runoff are concerns.	Public expects protection from hazardous materials.
SOCIO- ECONOMIC RESOURCES	River and Harbor Flood Control Act, National Environmental Policy Act.	Significant potential benefits to area residents.	Social concerns and items affecting area economy are of significant interest to community.

- 6. Sediment trapping (long term)
Shoreline anchoring
- 7. Ground water recharge

A Department of the Interior Report (1994) places the values of wetlands in simpler terms. "Wetlands are a vital element in the biosphere and produce numerous benefits for society. They provide critical nursery habitat for many species of fish and wildlife. By temporarily storing large quantities of water, wetlands play an important role in reducing flooding problems and recharging ground water. They help to maintain water quality by filtering out pollutants and sediment, and serve to control erosion by trapping soil washed from nearby uplands. In addition, wetlands are a source of recreation, timber, and other natural products for commercial use."

Bottomland hardwoods occur throughout the study area. However, hardly any tracts retain natural drainage characteristics, since pumped drainage of the area has been going on since the 1960's. Pumped drainage is evidenced by deep subsidence (1-2 ft) around the base of trees with many individual trees having the appearance of being unusually elevated on top of their root systems and holes in the ground that remain after roots have rotted. Some forests exhibit more wetland characteristics than others in the study area. This does not mean that little of the bottomland hardwoods are wetlands. On the contrary, a large majority of the forested areas are wetlands. Actually, a more accurate assumption in the area is that all forested lands are wetlands other than those on and near the natural river levee. The criteria currently utilized for determination of wetland/non-wetland status is the 1987 Corps of Engineers Wetland Identification Manual which uses the three parameter approach of determination involving vegetation, soils, and hydrology.

In 1990, there were approximately 11,000 acres of forested lands in the study area, the majority of which are bottomland hardwoods, and the majority of those are wetlands. The pumped drainage has resulted in the loss of much of the non-habitat wetland value and functions. Segmentation of the remaining bottomland hardwoods into smaller parcels has reduced functional values, also. Of the 10 wetlands functions and values listed by Adamus et al. (1987), all have been reduced in their effectiveness because of levees and pumping, and some, such as groundwater recharge and discharge, have essentially been eliminated.

The woodlands on higher sites are dominated by water oak, American elm, and hackberry, with live oak, cherrybark oak, and boxelder also being present. Those on lower sites are typically dominated by green ash, Nuttall oak, overcup oak, Drummond red maple, and black willow. Black willow has typically been the early successional stage woody species following drying marshes and does occur in some areas; however, in recent years the

Chinese tallow is a much more prolific invader and has become the dominant in forest succession from drying marshes in the southern portion of the area. The Chinese tallow reproduces beneath its own canopy. Thus, it is very competitive against other species in succession towards a mature bottomland hardwood forest. Since pumped drainage has been going on for such a long time, sites in the interior of the area that were cypress swamps now are covered with large willows, in addition to large cypress trees, and include hackberry, American elm, boxelder, and pumpkin ash intermixed. In other words, what was cypress swamp is under rapid transition to bottomland hardwoods as a result of long-term pumping. For this report, these prior swamp areas are considered to be bottomland hardwoods. Although previous discussion emphasizes that wetland values are significantly lost when these forests are drained, by no means does this mean that the wildlife habitat value becomes insignificant under these conditions. Predominant species utilizing the area may change somewhat; however, bottomland hardwood forests not receiving seasonal inundation still maintain a diversity of floral and faunal species. Habitat value for many species is actually increased because of the increased cover that is present in areas not receiving frequent inundation. A diversity of wildlife species are present within or adjacent to the study area. The bottomland hardwood forests provide habitat for many game and non-game species such as deer, squirrel, rabbit, and songbirds. Early-successional bottomland hardwood forests have reduced habitat value as compared to mature bottomland hardwood forests. The habitat value of these areas is also reduced as a result of being parceled into smaller non-contiguous areas. Some of the forested areas near the existing levee are pastured for cattle grazing. Pasturing also reduces the habitat value of wooded land to wildlife.

The trees on the area of potential impacts adjacent to the interior borrow/drainage canal and the areas proposed for the two borrow areas are Chinese tallow with some willow and scattered sugarberry. The narrow area of potential impacts adjacent to U.S. Hwy. 90 is covered by sparse black willows with buttonbush underneath. The area of potential impact adjacent to South Kenner Road is an early-successional bottomland hardwood community including Chinese tallow, boxelder, and scattered American sycamore.

5.2.2.2. No Action. The projected population increase was utilized to project a development rate i.e., development from bottomland hardwoods to urban land, for the area. Based upon the annual development rate projected, -0.5 percent, the current 11,000 acres (1990) of forested areas would be reduced to approximately 10,462 in 2000 (project year 1) and to approximately 6,370 in 2099 (project year 100). Table 5.2 shows the projected residual acreage of bottomland hardwoods for the given target years for the projection period.

TABLE 5.3
ESTIMATED ACREAGE OF BLH IN PROJECT AREA OVER PROJECT LIFE

<u>Year</u>	<u>Acres</u> ¹
1990	11,000
2000	10,462
2024	9,276
2049	8,184
2074	7,270
2099	6,370

¹ Assuming annual loss rate due to development of 0.5 percent

Demand for residential and commercial property will continue to deplete bottomland hardwoods in the study area, especially because of completion of the Interstate 310 Mississippi River Bridge connecting the eastbank and westbank areas. Public and private development in the area will occur because of its location and the existence of levees and pumps. Permitting requirements because of the presence of wetlands, should not change development trends in this area from those of the past, as almost any sizeable development in the New Orleans area would encounter wetlands. Health of the local economy and need for a particular project will be the driving forces behind development. Remaining wooded lands would continue to be developed, but sizeable tracts of forested area should exist throughout the projected economic life. Because some forested areas would continue to remain for the next 100 years, there always would be limited habitat for wildlife. The overall acreage of wildlife habitat would continue to decrease as would the quality as the remainder is segmented and parceled by development. All areas would continue to provide habitat for species inhabiting wooded lands until development occurs.

5.2.2.3. Plan 1B, 100/200/SPH. It is estimated that 20 acres of early successional BLH would be lost directly to levee construction and upgrading. Losses would occur adjacent to U.S. Hwy. 90, adjacent to South Kenner Road, and on the two borrow areas near Bayou Segnette State Park and just east of the Cataouatche Pumping Station. This loss would result in an associated 5 annualized habitat unit value (AHUV) above the losses that would occur with no Federal action. The AHUV is a unit that expresses habitat value over a given analysis period (100 years for the proposed project) and is a product of the Habitat Evaluation System (HES) developed by the Corps of Engineers. This system is readily accepted for use in the Lower Mississippi Valley and has been in use since 1980. The system and analysis procedure for developing appropriate and cost-effective mitigation recommendations are described in detail in Appendix C, Section 4. The USFWS utilized the Louisiana Departmen

of Natural Resources' Habitat Assessment Models for Fresh Swamp and Bottomland Hardwoods (LDNR-HAM). That analysis is described in detail in Appendix D, the Fish And Wildlife Coordination Act Report. All direct losses of habitat value determined by the HES would be mitigated through the implementation of the mitigation plan consisting of acquisition, bottomland hardwood habitat development, and management of a 15-acre tract to be located adjacent to the Bayou Segnette State Park. The development would initially include the aerial application of herbicide on the existing exotic Chinese tallow and subsequent reforestation with several species of oaks. Use of a microfoil boom in the aerial herbicide application would assure uniformity of droplet size and allow precision of extent of application. The herbicide used would be that approved for use on wetlands or aquatic sites. Use of the herbicide on the foliage of plants would result in the death of essentially all plants whose leaves were covered by the herbicide. The target tree, of course, is the Chinese tallow. It is expected that sprouting would recur afterward, however, seedlings of desirable trees would be planted following herbicide application. The herbicide application would greatly improve the survival and chance of success of the planted seedlings. A definite indirect impact of the proposed action would include minimizing the chance of these resources from receiving hurricane flooding. Although this would remove a source of wetland recharge which definitely affects plant species occurrence, the recharge associated with hurricane flooding without the proposed action is so infrequent that it is of negligible influence. The increased size of the interior borrow/drainage canal resulting from levee construction would provide a larger reservoir for stormwaters, but any indirect increase of the speed of drainage of basin wetlands would not occur. Since the implementation of any alternative is not projected to result in any increased development (see paragraph 5.2.9.1.3), any other indirect impacts to wooded lands are projected to be negligible.

5.2.2.4. Plan 1C 100/200/SPH (Recommended Plan). It is estimated that 57 acres of early successional BLH would be lost to direct construction. This loss would result in an associated 15 AHUV above the losses that would occur with no Federal action. Losses would occur in some of the same locations as would occur in Plan 1B but would also include a strip along the land side of the interior borrow/drainage canal. The borrow area near the Cataouatche Pumping Station would not be included in this alternative. Losses due to levee upgrading (one acre) within the existing levee right-of-way from the Bayou Segnette Pumping Station to the Westwego to Harvey Canal levee were considered in the original Westwego to Harvey Canal project impact computations. All direct losses of habitat value would be mitigated through the implementation of the mitigation plan consisting of acquisition, bottomland hardwood habitat development, and management of a 39-acre tract to be located adjacent to the Bayou Segnette State Park. The same development techniques including aerial herbicide application would be used. The same herbicide application measures that results in precise application and minimization of chance of drift would be used with this alternative.

The effects of herbicide application would be the same as with Plan 1B. As with Plan 1B, no indirect impacts to wooded lands are projected to occur. The increased size of the interior borrow/drainage canal resulting from levee construction would provide a larger reservoir for stormwaters, but any indirect increase of the speed of drainage of basin wetlands would not occur. The mitigation recommendations of the USFWS include the acquisition of 50 acres with management as discussed previously. Indirect impacts of levee construction would be similar to those described in Plan 1B.

5.2.3. Aquatic Resources.

5.2.3.1. Significance. There are approximately 26 miles of drainage canals and bayous within the interior of the study area. Flow is sluggish to non-existent in most of the smaller canals except during and shortly after a rain. Almost all of the interior waterbodies are designed and function for human uses. Many of the smaller waterbodies (canals) become choked with aquatic vegetation during the summer and most are subjected to large variations in flow because of their drainage function. Bayou Segnette is outside the levee system and north of Lapalco Boulevard is located adjacent to the existing levee (see Plate 2). It is used heavily by commercial fishermen. Three factors contribute to lower aquatic habitat in the upper portions. The present Bayou Segnette essentially "dead-ends" approximately 500 feet from the Westbank Expressway. From the end to immediately upstream of the Bayou Segnette Pumping Station, the bayou is currently used for boat docking by various users. Waste waters from a sewage disposal plant enters Bayou Segnette in this segment. Bayou Segnette also receives the outflow from the Bayou Segnette Pumping Station, the discharge capacity of which is almost half (900 cubic feet per second) of that of the entire area pumping system. This results in high levels of introduced pollutants from urban runoff. Tidal flow results in significant dispersal, however. Fish in the interior canals are represented by species tolerant of low dissolved oxygen such as mosquitofish, killifish, shortnose and spotted gar, yellow bullhead, and redfin shad.

The exterior borrow canal is approximately 9 miles in length. It has some similarity to natural waterways in that it receives tidal flushing. Fish in the exterior borrow canal consist of both fresh and saltwater species including sunfishes, channel catfish, shortnose and spotted gar, striped mullet, menhaden, and gizzard shad. The lower portions of Bayou Segnette has significantly higher habitat value than the watercourses of the remainder of the area.

5.2.3.2. No Action. Physical conditions in the various canals within in the project area would change very little over the life of the project. Pollutants would continue to enter the aquatic system from the development of surrounding residential/industrial areas, thereby causing on-going water quality problems. Water quality of the interior canals would continue

to be extremely poor because of the increased input of urban runoff including that from the landfill areas on the west side of the area. This would result in a continuation of, or even a further decrease of, poor aquatic habitat quality in those canals. As residential/industrial development continues, there will probably be an increase in pollutant levels in those canals which ultimately would go to the Barataria Basin. Legislation requiring improvements in both point and nonpoint source discharges may alleviate some water quality problems. The exterior borrow canal outside the levee system would have a slow rise in mean salinity resulting in brackish conditions being more likely to occur in the next century. Species composition and number of organisms would be slowly changed with estuarine organisms becoming more dominant.

5.2.3.3. Plan 1B, 100/200/SPH. The excavation of the two borrow pits to obtain material for construction would result in creation of a total of approximately 22 acres of additional aquatic habitat. A side slope of 1 vertical on 4 horizontal of the borrow pit near the state park would provide some shallow water for fish spawning. Runoff from levee degrading preparatory to sheet pile erection would result in temporary increases in turbidity in the adjacent borrow canal. Any development that may occur from whatever source could be a contributing factor to increased amounts of stormwater runoff. Pollutants generated by new development would further degrade the water quality of stormwater runoff from the project area as with no action. Construction of any level of protection for this alternative would not directly cause a significant decrease in water quality in the project area. Any increased size of the interior borrow/drainage canal as a result of levee enlargement would result in increased capacity; however, this would have essentially no indirect effect on rate of drainage from the basin. Some minimal further degradation of water quality in the drainage canals may possibly be an indirect result of plan implementation.

5.2.3.4. Plan 1C, 100/200/SPH (Recommended Plan). The excavation of the borrow pit near Bayou Segnette State Park to obtain material for construction would result in creation of approximately 12 acres of additional aquatic habitat. Water quality impacts, due to excavation within the interior and exterior borrow pits, and runoff from the levee as well, would occur to a greater extent with construction of this alternative than would with construction of Plan 1B. Excavation of material from the interior borrow/drainage canal downstream of the outflow of the three landfills would not result in dispersal of contaminants at levels to be significant (see Appendix C, Section 1, Water Quality). Sampling was done on the interior borrow/drainage canal downstream of the outflow of the landfills. No water sample results exceeded the criteria. Of the three parameters for which levels of the elutriate exceeded that of the water, sample locations and test results revealed little relationship to the landfill. One sample showed the elutriate result for cyanide in a sample nearest to the landfill to exceed the chronic criterion when other samples showed no exceedance. The use of bucket

rather than cutterhead dredge would minimize contaminant dispersal. The elutriate test is more applicable to hydraulic dredging rather than bucket dredging. Due to the temporary nature of the proposed construction, the acute is the applicable criteria. The chronic is the criteria that is applicable to long-term levels, such as those to which most creatures would be exposed for a significant portion of their entire life. These construction activities would be temporary rather than continuous, and perturbations generally return to normal within 30 minutes to two hours after cessation of dredging activities. Also, since the canal is hydraulically isolated from the more significant aquatic resources outside the levee, the effects of contaminant dispersal during excavation would not be significant. Some change in size of the interior borrow/drainage canal area may occur as a result of excavation; however, the canal after construction would not be significantly larger. Adverse impacts to water quality would occur during actual excavation and when waters run off the construction site into the adjacent canals. This impact would be of minimal significance in the interior canal. This impact would be realized until a vegetative cover becomes established over the levee and berms. It would be realized again when the second lift is constructed. The use of rock armorment at the edge of the wave berm would help to hold materials from eroding from the levee in this segment into the adjacent exterior borrow canal. A sheet pile cofferdam would be constructed around the proposed location of the floodwall work at the Bayou Segnette Pumping Station so that any excavation at the site would be done in the dry. Initial construction of the cofferdam would disturb some sediments in the canal bottom, but this should have a minimal adverse impact on aquatic resources. Water pumped from inside the cofferdam during construction would have a temporary adverse impact on water quality of adjacent waters. Suspended sediments would be concentrated near the dredge. The same impacts resulting from continued development in the project area as described for Plan 1B would also occur for all levels of this alternative. Any increased size of the interior borrow/drainage canal as a result of levee enlargement would result in increased capacity; however, this would have essentially no indirect effect on rate of drainage from the basin. Any development that may occur from whatever source could also be a contributing factor to increased amounts of stormwater runoff with this alternative as with the previous alternative. Pollutants generated by new development would further degrade the water quality of stormwater runoff from the project area if that development occurs as with no action. Construction of any level of protection for this alternative would not directly cause a significant decrease in water quality in the project area. Some further degradation of water quality in the drainage canals may be an indirect result of plan implementation.

5.2.4. Threatened and Endangered Species

5.2.4.1. Significance. A request for information on any threatened and endangered species in the study area was sent to the U.S. Fish and Wildlife Service (USFWS) and the National

Marine Fisheries Service (NMFS). Both agencies responded negatively (see Appendix C, Section V). The USFWS responded on December 21, 1994, with a simple stamp on the requesting letter, that the proposed activity would not significantly affect listed or proposed threatened or endangered species. NMFS responded on December 30, 1994 that the floodwalls and/or levee in the project area is unlikely to adversely affect endangered or threatened species under their purview. A telephone request to the USFWS, on August 8, 1996, to reaffirm the response revealed no change to the previous response. (Andy Dolan, USFWS, Lafayette, LA; pers. comm.).

5.2.4.2. No Action. No listed threatened or endangered species or candidate species would be affected with no Federal action.

5.2.4.3. Plan 1B, 100/200/SPH. No listed threatened or endangered species or candidate species would be affected by this alternative.

5.2.4.4. Plan 1C, 100/200/SPH (Recommended Plan). No listed threatened or endangered species or candidate species would be affected by this alternative.

5.2.5. Recreation Resources.

5.2.5.1. Significance. Outdoor recreational opportunities adjacent to the project are predominantly fishing and hunting. Hiking, bird watching, and many other nature-oriented activities also occur. Three major recreational areas of significance exist on the west bank, including the Lake Salvador Wildlife Management Area, the Jean Lafitte National Historic Park, and the Bayou Segnette State Park. The Bayou Segnette State Park is within the area protected by the Lake Cataouatche area levee (see Plate 3). Bayou Segnette provides fishing and boating, and the wooded and shrubby area adjacent to the levee provides both small and large game hunting. Elevated deer stands are present and shooting areas are frequently mowed. The privately owned lands are leased and used by private hunting clubs.

5.2.5.2. No Action. Recreational areas in the vicinity of the project area would experience increased use in the future and possibly some expansion of facilities due to increased population demand for outdoor recreation facility development and use. Bayou Segnette State Park has a development package that includes the construction of a sports and civic center, a 250-room resort hotel with golf course, and an Acadian Village visitors center.

5.2.5.3. Plan 1B, 100/200/SPH. Limited adverse impacts would occur to the recreation environment due to the potential conversion of approximately 20 acres of bottomland hardwood forest land to project use. Use of pasture, bottomland hardwood forest, and

wooded swamp, which serve as borrow areas, would impact recreation. Potential hunting use would be decreased by loss of land due to project implementation. Short-term minimal impacts would be imposed on existing recreational activities occurring on the levees, such as walking, jogging, birdwatching, and nature study. There would be localized turbidity in that portion of Bayou Segnette while the work is being done on the pumping station outflow area. Development of the floodwall would minimally affect recreational resources. The deeper water of the exterior borrow canal and the borrow pit following project construction would provide increased fishery habitat. Fishing and other recreation opportunities (bird watching and photography) would result from the creation of the borrow pit.

5.2.5.4. Plan 1C, 100/200/SPH (Recommended Plan). Impacts imposed by this plan are similar to those of Plan 1B; however, approximately 57 acres of forested land would be transformed into project land. This acreage loss would impact hunting use of the area. All other impacts including those affecting non-consumptive recreational use would be the same. Lost man-days of bird watching, nature study, and other non-consumptive recreation uses would be replaced with implementation of the mitigation plan feature. Approximately 39 acres would be annexed to the state park for use as a natural area.

5.2.6. Cultural Resources.

5.2.6.1. Significance. There are no National Register of Historic Places properties recorded in the project area. Seventeen archeological sites are recorded within a five-mile radius of the project area. Seven of these archeological sites front the right (west) descending bank of the Mississippi River. Five sites are clustered near the southwest shoreline of Lake Cataouatche and four are clustered on the southeast shoreline near bayou's Bardeaux and Segnette. One isolated site, 16JE133, is located on the north shore of Lake Cataouatche and is just outside the project area. None of these sites will be impacted by the project. Cultural resources surveys for various Mississippi River levee and revetment projects were surveyed in the vicinity of the project area during the 1980s and 1990s. Surveys were completed along Bayou Segnette during the 1970s. Cultural resources surveys also have been completed on Bayou Verret and connecting tributary systems in 1993 as part of the Davis Pond Freshwater Diversion project. Efforts to predict site locations in the region have emphasized site placement on natural levees near or at the interface of distinct ecozones (Jones, et al., 1994). The Lake Cataouatche shoreline and the natural levee/ tributary systems along bayou's Verret and Segnette and the Mississippi River are typically considered to have a high probability for containing both historic and prehistoric sites. Recent investigations suggest, however, that the density of both prehistoric and historic site occurrences in the project area is lower than in other tributary/natural levee systems in the Barataria basin.

This is due, in part, to the high frequency of flooding and the total amount of fresh water in the distributary system.

5.2.6.1. No Action. There are different perceptions concerning the existence and placement of cultural resources within the project area. It is assumed, however, that any, as yet, unrecorded cultural resources located within the project area would continue to be affected by both physical and chemical processes of erosion.

5.2.6.2. Plan 1B, 100/200/SPH. No project impacts to National Register properties or significant cultural resources are anticipated to occur within the planned levee construction corridor. Excavation within the two planned borrow sites east of the Lake Cataouatche Pumping Station and habitat preparation in the planned mitigation area are project features most likely to impact significant cultural resources. Cultural resource investigations are currently underway. The investigations will be completed prior to construction. Those investigations are being coordinated with the State Historic Preservation Officer (SHPO).

5.2.6.3. Plan 1C, 100/200/SPH (Recommended Plan). No project impacts to National Register properties or significant cultural resources are anticipated to occur within the planned levee construction corridor or the adjacent exterior borrow canal. There is a low probability that excavation and relocation of the interior borrow/drainage canal and construction of the exterior wave berm may impact as yet unrecorded significant cultural resources. Impacts from excavations within the planned borrow site and the planned mitigation area are the same as those for Plan 1B. The investigations for the Plan 1B area also include the area for either of these alternatives.

5.2.7. Noise, Air Quality, and Esthetics

5.2.7.1. Significance. Noise in the study area is generated by various forms of traffic on highways and railroads. Boat traffic on Bayou Segnette is an additional, however minor, source of noise for areas adjacent to this waterway. Noise probably varies between 50-80 decibels in most of the project area. Based upon ambient air quality data from 1987, collected by the LDEQ (1987), there were no violations of state air quality standards at monitoring stations in New Orleans, indicating that air quality in the study area is fairly good. A July 28, 1995, telephone communication with knowledgeable officials of the Jefferson Parish Environmental Control Department reports that air quality violations are not a problem in Jefferson Parish. The LDEQ State Implementation Plan (SIP) for general conformity indicates that Jefferson Parish is in attainment for ozone, but it is operating under a full maintenance plan as of December 1, 1995. Landfills are on the western side of the area. These, if not concealed from public view and sufficiently controlled, make a negative

contribution to area esthetics. In the past, some open burning has occurred; however, this has not been a problem in recent years. Road dust in the immediate area is a common problem associated with access roads to this landfill and other landfills.

Portions of the area are heavily developed and industrialized, but the remaining large forested tracts do retain some esthetic value. Esthetic conditions, predominately in the area of the Bayou Segnette State Park, are enhanced by the enclosure created by trees lining the bankline, paralleling the protected side of the levee, and adjacent to the campsites. Individuals walking these areas have the opportunity to encounter a positive visual experience through the existence of various landscapes. The opportunity exists to further enhance esthetic conditions through the occasional sighting of aquatic and terrestrial wildlife. Within the isolation of the levee area adjacent to the park, the views of boats upon the bayou enhances the esthetic experience.

5.2.7.2. No Action. With the anticipated residential and business growth that will occur in the project area, noise levels would increase slightly. Noise, primarily from the Westbank Expressway and U.S. Hwy. 90, would continue to occur. Air quality would worsen slightly as development continues, but state air quality standards should be maintained due to the designation of this general area for operation as a full maintenance area under the SIP guidelines. Forested areas would continue to be cut and developed (see Table 5.2), reducing the esthetic quality provided by the presence of numerous trees and green spaces in the study area.

5.2.7.3. Plan 1B, 100/200/SPH. Noise levels would increase temporarily over the without-project conditions in the areas of construction. The pile-driving of floodwall construction would definitely be objectionable to users of the state park while work is underway in that area. However, a concerted effort will be made to complete this construction in the low-use season. At places other than in the park area, construction noise would be heard by very few. Construction workers at the sites would definitely hear the increased levels of noise, but they would have protective hearing devices. Since construction would take place during daylight hours, sleep interference would be minimal. The noise could be annoying to workers and inhabitants in the few occupied buildings near the construction area. EPA has a limit of 85 dBA for eight hours of continuous exposure to protect against permanent hearing loss. Noise above this level would not occur for periods longer than eight hours. Any adverse impacts to air quality near construction areas would be temporary and minor. Noise from construction equipment and dust from moving equipment would occur during construction. Esthetics would be adversely impacted in the short-term due to the temporary loss of linear vegetation lining both sides of the levee. The feeling of enclosure created by bankline vegetation would diminish as well as the appearance of

protection provided to area wildlife. However, in time, volunteer vegetation would become re-established and would replace some of the lost visual and habitat quality. Temporary short-term impacts would also occur due to the presence of mud, machinery, and heavy equipment associated with construction. The presence of the floodwall in the state park would be a change to the view that currently exists, but would be acceptable because of the cap and texture that would be applied. The uncapped floodwall on the remainder of the existing levee would present a more non-natural landscape view than currently exists, but the number of sightings of that floodwall would be minimal per linear segment as compared to that within the state park.

5.2.7.4. Plan 1C. 100/200/SPH (Recommended Plan). Impacts to air quality and esthetics would be similar to that described for Plan 1B. Noise in the park area would be identical since the plan would be identical in that segment. In the remainder of the area, it would be different because the sounds of pile driving and dozers would be replaced by sounds of bucket dredges (draglines), dozers, and dump trucks. Any adverse impacts to air quality near construction areas would be temporary and minor. An applicability determination was conducted for general conformity in accordance with the Clean Air Act and LAC 33:III., Chapter 14, Subchapter A, Section 1405. The annual total of direct and indirect emissions for criteria pollutants emitted do not exceed threshold limits as established in the SIP. Levee construction, would result in a harsh view following initial construction and the second lift. However, following greenup after the second lift, it would result in aesthetic conditions similar to no action. The small levee adjacent to U.S. Hwy. 90 would present a non-obtrusive view that would hardly be distinguishable as a levee from passing vehicles.

5.2.8. HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE (HTRW)

5.2.8.1. Significance. HTRW is significant not from a positive standpoint, but because of the possible negative effects upon the environment including the human environment. The ever-increasing knowledge and interest in the adverse effects of man-made products upon the environment is of significant public concern. Far-reaching legislation has been promulgated that has had the effect of categorizing; significantly regulating; and establishing financial cleanup responsibility for, wastes. The area of the three landfills on the western side of the area has been an area of concern regarding this issue. The landfills are the Greater New Orleans (GNO) landfill, the Kelven tract landfill, and the Area 90 landfill. The GNO and Kelven tract landfills are on the north side of U.S. Hwy. 90, while the Area 90 site is on the south side of Hwy.90. The GNO landfill is utilized by the City of New Orleans, the Kelven tract landfill is utilized by Jefferson Parish, and the Area 90 landfill is not accepting waste and is currently undergoing closure. An assessment was done on the GNO landfill by the Environmental Protection Agency for consideration for the National Priorities List (a list

commonly called the Superfund list. The area did not score sufficiently high for placement on the list. The GNO landfill is currently operating under a settlement agreement with the LDEQ with waste being accepted through 1999 or until a designated elevation is achieved, whichever occurs first. An application was made for a proposed landfill between the existing Kelven landfill and South Kenner Road. The request for a permit for the landfill has been denied by the LDEQ as well as by the Jefferson Parish Council. The permit denial by the parish council was upheld by the State of Louisiana 5th Circuit Court of Appeals (5th Circuit Court). One part of the permit denial is still in litigation, however.

5.2.8.2. Effects of No Action. The area would continue to be used for landfills until no more is available. The Area 90 landfill is being closed at the present time (late 1995). The GNO landfill would be covered for closure as it is filled, but wastes would not be accepted after 1999. Final capping is projected to be completed shortly thereafter. Digging into the landfills would disturb any materials and could release them into adjacent and possibly other areas. Leachate from the Area 90 and Kelven landfills would be collected and would be transported to any municipal wastewater treatment plant for treatment or treated on the site. Site runoff from within those landfills would continue to go into outside drainage canals, then to the interior borrow/drainage canal, and, eventually, on to the Cataouatche Pumping Station. After the planned closure of the GNO landfill, site runoff from that landfill would then be directed to the west and ultimately to the Sellers Canal, instead of to the east as currently occurs. Since denial for the proposed landfill has occurred and the parish council denial was upheld by the 5th Circuit Court, it is assumed that a permit will not be granted and the landfill will not be constructed. However, if the appeal of any part of the denial is successful, that proposed landfill could possibly become a reality.

5.2.8.3. Effects of Plan 1B, 100/200/SPH. Any substances contained within the soil of the area would be transported as that soil is moved to another location as required by levee construction. Movement of any soil containing these substances would spread the effects of the particular substance. The construction of any alternative in this area would involve minimal amount of risk of encountering problems with contaminants and/or hazardous wastes since the majority of the construction site is in non-developed areas. Excavation in pipeline locations would provide the most significant risks. However, the risk of encountering problems with HTRW is minimal provided normal precautions are taken around pipelines. Movement of substances within the soils of the area would be minimal by construction of the floodwall since driving of floodwall sheetpiles would require a minimal amount of earth movement. The upgrading of South Kenner Road would be done by depositing hauled materials, compaction of the materials, and finally, rebuilding a road surface on them. This would be done in such a manner as to include no excavation in the landfill. Therefore, the effects of the construction of this alternative would not result in HTRW problems in that it

would affect the safety of workers or affect the viability of the alternative provided it is carried out in the manner so described. If the proposed landfill is permitted, design of any levee in the South Kenner Road area would have to take the landfill in consideration.

5.2.8.4. Effects of Plan 1C, 100/200/SPH (Recommended Plan). Any substances contained within the soil of the area would be transported as that soil is moved to another location as required by levee construction. Movement of any soil containing these substances would spread the effects of the particular substance. The construction of any alternative in this area would involve minimal amount of risk of encountering problems with contaminants and/or hazardous wastes since the majority of the construction site is in non-developed areas. Excavation in pipeline locations would provide the most significant risks. However, the risk of encountering problems with HTRW is minimal provided normal precautions are taken around pipelines. Movement of substances within the soils of the area would be minimal by construction of the floodwall in the segment within the state park since driving of floodwall sheetpiles would require a minimal amount of earth movement. The upgrading of South Kenner Road would be conducted in exactly the same way with this alternative as would the other alternative. The interior borrow/drainage canal would not receive excavation nor enlargement adjacent to the Area 90 landfill. Excavation of materials from the interior borrow/drainage canal downstream of the outflow of the three landfills would not result in dispersal of contaminants at levels considered to be significant (see paragraph 5.2.3.4. and Appendix C, Section 1, Water Quality) because of the temporary nature of the construction. Therefore, the effects of the construction of this alternative would not result in HTRW problems in that it would affect the safety of workers or affect the viability of the alternative. If the proposed landfill is permitted, design of any levee in the South Kenner Road area would have to take the landfill in consideration.

5.2.9. Socioeconomic Resources

5.2.9.1. Land Use

5.2.9.1.1. Significance. The lands considered for additional hurricane protection are located in Jefferson Parish and are bounded by the Mississippi River on the north, Bayou Segnette to the east, Lake Cataouatche to the south, and the St. Charles Parish line to the west. The 20,400-acre study area lies within an area of tidal influence and is currently provided with a limited degree of hurricane protection by non-Federal levees located adjacent to Lake Cataouatche. The majority of the urban development in the Lake Cataouatche study area has taken place in the area surrounding the Huey P. Long Bridge, as well as along U.S. Hwy. 90, River Road, and Westbank Expressway. The major communities located within the study area include Avondale, Bridge City, Waggaman, and the western part of Westwego. However,

approximately 70 percent of the land in the study area is currently undeveloped. As shown in Table 5.4, the study area contains approximately 11,000 acres of wooded undeveloped land. While the majority of these acres are located south of U.S. Hwy. 90, approximately 3,000 acres remain undeveloped between U.S. Hwy. 90 and the Mississippi River. Bayou Segnette State Park encompasses approximately 600 acres of undeveloped land and is situated at the intersection of Bayou Segnette and Lapalco Blvd.

The potential for the development of remaining vacant lands has increased due to recent improvements in transportation. The completion of the twin span of the Crescent City

TABLE 5.4
LAKE CATAOUATCHE
LAND USAGE BY NUMBER OF ACRES
1990

Land Usage	No. of Acres	Percent
Forested	11,000	54
Commercial/Industrial	1,800	9
Residential	2,400	12
Agricultural	1,800	9
Other	3,400	16
Total Study Area	20,400	100

Note: The number of acres and its usage was estimated from infrared photography.

Connection bridge and the elevated Westbank Expressway will enhance conversion of vacant lands to residential and commercial development. In addition, two new roads connect the study area to the major transportation arteries of the West Bank. The Nicole Extension, a two-lane road connecting Lapalco Boulevard to the Avondale Subdivision south of U.S.Hwy. 90, has recently been completed. Lapalco Boulevard is a major thoroughfare that connects the study area to the more urbanized areas in the eastern portions of the West Bank. The completion of Live Oak Boulevard, a two-lane road that connects the Live Oak

Subdivision and other commercial developments along River Road to U.S. Hwy. 90, has improved the flow of traffic to the western portion of the study area.

Between 1980 and 1990, there was an increase of 853 housing units in the area. Approximately 40 new homes were recently constructed in the Live Oak Subdivision which is located in the northwestern portion of the study area. Other new construction in the study area include the April 1995 opening of the Winn-Dixie Supermarket, and the opening of a new church in the Avondale subdivision south of U.S. Hwy. 90. The opening of Bayou Segnette State Park in 1987 has quickly enhanced development and tourism in the area. The park offers fully furnished waterside cabins, improved camping sites, boat launches, swamp tours, banquet facilities, a wave pool, playgrounds, and picnic facilities. It is the most visited of the Louisiana state parks and has become a popular recreational attraction, especially for residents of the New Orleans metropolitan area.

Much of the existing land used for industrial development is located between the Mississippi River and the Texas & Pacific and the Southern Pacific rail lines. Avondale Shipyards, which employs over 6,500 people, is planning to enter the commercial shipbuilding market with new vessel designs and new construction techniques. A nine-acre assembly line factory building is currently under construction. Ready access to rail service and river transportation make the area ideal for further industrial development.

5.2.9.1.2. No Action. Without Federal action, the general pattern of land use within the project area should continue. Plans are currently being formulated for widening the Huey P. Long Bridge across the Mississippi River. This narrow bridge directly links the Lake Cataouatche study area to the east bank of Jefferson Parish. The addition of a third lane of traffic in each direction will greatly improve the flow of traffic from the study area to the Metairie/Kenner area on the east bank of Jefferson Parish, and to the New Orleans Central Business District via the Earhart Expressway. Recent improvements in the transportation network, the continuation of residential and commercial construction activity, plans for expansion of Bayou Segnette State Park facilities, and the performance of the local economy are the most important factors that will affect development in the study area.

Plans for additional residential and commercial development on the 30 acres surrounding the Live Oak subdivision are currently underway. The area surrounding Bayou Segnette State Park has tremendous potential for growth. The development package for the park includes the construction of a \$9.5 million sports and civic center, a 250-room resort hotel with golf course, and an Acadian Village visitors center. Any future development of the park will be designed to retain its rural setting and to preserve the wetlands character.

Approximately 7,445 acres of land will be required to support the future population growth on the west bank of Jefferson Parish. This estimate was derived assuming a compounded annual growth rate of 0.5 percent through the year 2049 for population growth on the west bank of Jefferson Parish. According to Hebert/Smolkin Associates Inc., 0.1160 acres per person are required to support the residential, commercial, and industrial development associated with population growth. (See page I-15 of the Hebert/Smolkin Associates Inc. report "Eight to Twenty-Five Year Housing and Land Needs Analysis for West Bank Jefferson," dated 7 June 1988.) Aerial photography shows that there are approximately 5,000 undeveloped wooded acres between the Mississippi River and the Federal and/or local levee system used as the southern boundary of the West Bank. This estimate does not include the undeveloped areas south of the levee system and the undeveloped acres in the Lake Cataouatche study area. The development of the area in question may involve the deposition of fill material and be subject to Section 404 of the Clean Water Act. This act regulates the deposition of dredged or fill materials in waters of the U.S. including wetlands. With projected land requirements on the west bank exceeding the number of available undeveloped acres within a protected area, it can be assumed that future residential and commercial development will take place in the study area. It has been projected that 944 acres will be developed in the project area.

Given recent growth trends and the lack of vacant land on the east bank of Jefferson Parish, it is reasonable to assume that development in the study area will continue to occur with or without the project, and will not conflict with Planning Guidance Letter # 25 and Executive Order 11988, which state that the primary objective of flood control projects must be the protection of existing development, not the protection of land to be converted to more valuable uses. Similar growth has taken place within other portions of the New Orleans Metropolitan Area without Federally constructed hurricane protection levees, including Ormond Estates in Destrehan, Jesuit Bend Estates in Plaquemines Parish, English Turn Development on the west bank of Orleans Parish, and Stonebridge Subdivision on the west bank of Jefferson Parish. The projected future development in the study area will not be attributable to the construction of a Federal project, but rather to the continued improvements in these other factors, as well as the general economic trends.

5.2.9.1.3. All Plans. The alternative plans considered would provide increased levels of protection to the study area. However, the future growth rate for the Lake Cataouatche area is projected to be the same with or without a Federal project. This is based upon the Lake Cataouatche area currently being provided with a limited degree of hurricane protection by a non-Federal levee which extends from Bayou Segnette to the Jefferson/St. Charles Parish line. Also, interior drainage is already in place which consists of a series of interconnected canals located throughout the area which terminate at pumping stations dating to the mid-1970's from which storm runoff is removed from the area. The proposed alternatives for providing

increased levels of protection to the study area would generally follow the alignment of the existing non-Federal protection and would not enclose any additional land within the protection other than the area east of South Kenner Road. Implementation of a Federal hurricane protection project would not change the potential limits of development. The future growth rate for the Lake Cataouatche area is based on the continuation of improvements in transportation, construction activity, further development of Bayou Segnette State Park, and land availability throughout the metropolitan area. Thus, while future development is expected to occur in the study area, it is based on non-project related factors.

The projected future growth rate for this study area is different from that previously described for the related Westwego to Harvey Canal project area for two reasons. First - prior to authorization and construction of a project, the Westwego to Harvey Canal area did not have a continuous line of protection (non-Federal) against tidal surge. Second - the recommended alignment for the Westwego to Harvey Canal project also resulted in the addition of undeveloped land to the protected area. The combination of those factors led to the projection of a future growth rate for that area to be 10 percent higher with a Federal hurricane protection project in place than for this area.

5.2.9.2. Property Values and Housing

5.2.9.2.1. Significance. Table 5.5 shows the change in the total number of housing units for the New Orleans MSA, Jefferson Parish, the west bank of Jefferson, and for the study area. Although housing prices in the metropolitan area generally showed a downward trend during the mid to late 1980's, prices have increased between 6 and 7 percent per year since 1990. For the Gulf Coast and the New Orleans area, 1994 marked the highest number of units sold in the history of the real estate market. According to the Real Estate Market Analysis prepared by the University of New Orleans, the price of an average house in the metropolitan area increased from \$82,613 in 1990 to \$107,100 in 1995. By national standards, however, the prices of homes in the New Orleans area still remain 20 percent or more below the national average. The most recent UNO Real Estate Market Analysis, July 1995, shows that an average single family residence in the Lake Cataouatche study area sold for \$47,099 during 1995.

During the past year, there has been a shift in the real estate market throughout the area to purchases of larger homes. If the market continues its recovery and the demand for larger houses increases, there exists the potential for the average price of a house in the area to rise above \$110,000. However, this price increase will only be sustained if employment gains occur in the metro area.

TABLE 5.5
LAKE CATAOUATCHE
NUMBER OF HOUSING UNITS
1980 - 1990

	1980 Census Housing Units	1990 Census Housing Units	Change
New Orleans MSA	494,638	540,422	45,784
Jefferson Parish	166,124	185,072	18,948
Jefferson Parish, West Bank	61,703	72,577	10,874
Study Area	7,113	7,966	853

SOURCE: U.S. Department of Commerce, Bureau of the Census

After nearly a decade of falling occupancy rates and rents, the apartment market has also stabilized and has begun to improve. The average occupancy rate in the metro area increased from 90.3 percent in mid-1993 to almost 93 percent by July of 1995. Apartment occupancy ranged from 88.6 percent in Orleans Parish to 95 percent in Jefferson Parish. The July rates do not reflect the increase in occupancy due to the May 1995 flood. These rates are expected to continue rising if employment gains occur due to the construction of activities related to the gaming industry. Table 5.6 shows the changes in housing prices during the past year in both the metro and project areas. A comparison of occupancy rates and rents in the apartment complexes of both the study area and the metro area is shown in Table 5.7.

TABLE 5.6
LAKE CATAOUATCHE
SINGLE FAMILY HOUSE PRICES
AVERAGE PRICE BY NEIGHBORHOOD
LAKE CATAOUATCHE AND METROPOLITAN AREA
1994 - 1995

AREA	1994	1995	PERCENT CHANGE
LAKE CATAOUATCHE			
Avondale	\$43,301	\$46,891	8.29
Bridge City	\$48,874	\$47,308	-3.20
WEST BANK			
Jefferson Parish	\$76,681	\$70,163	-8.50
Orleans Parish	\$112,810	\$105,312	-6.65
METRO AREA			
Orleans, Jefferson, St. Bernard, St. Charles, St. John, St. Tammany	\$107,100	\$107,100	0.0

SOURCE: Real Estate Market Analysis, University of New Orleans, Vol. XXV, July 1995.

TABLE 5.7
LAKE CATAOUATCHE
COMPARISON OF OCCUPANCY RATES AND RENTS
IN APARTMENT COMPLEXES
LAKE CATAOUATCHE AND METROPOLITAN AREA
1994 - 1995

AREA	OCCUPANCY	OCCUPANCY	CHANGE	AVG.RENT	AVG.RENT	CHANGE
	1994	1995		1994	1995	
ORLEANS PARISH WEST BANK						
Algiers	88.28%	88.58%	.30 %	\$392	\$399	1.85%
JEFFERSON PARISH WEST BANK						
Harvey Canal						
West	98.47%	95.14%	-3.38 %	\$313	\$295	-5.75%
East	90.03%	92.46%	2.43 %	\$392	\$399	1.79%
METRO AREA						
ALL	92.87%	92.93%	.06 %	\$440	\$450	2.27%

SOURCE: Real Estate Market Analysis, University of New Orleans, Vol. XXV, July 1995.

5.2.9.2.2. No Action. While the construction of housing in the area of Live Oaks subdivision is an encouraging sign for the future, the stability of the overall housing market will depend on the economic vitality of the larger community, with or without the hurricane protection project in place. There are three main factors that will affect the future housing market. First, the continuation of lower interest rates and tax incentives for first time home owners will keep housing affordable. Second, the improvements in the local economy including the potential employment gains generated by the passage of the North American Free Trade Agreement (NAFTA) could increase job growth and thereby increase the effective demand for housing. Finally, fluctuations in the national economy will have an effect on the local housing market.

The Bayou Segnette State Park future development package should encourage commercial activity in adjacent areas, without or with the project. The rural setting, as well as the improved access to vehicular traffic between the New Orleans Central Business District (CBD) and the Metairie/Jefferson areas should be major factors promoting future growth.

Because the population of the study area is expected to grow during the next 50 years, a projection was made of the future residential development to take place in the area. A total of 3,015 residential structures were placed on the developed and undeveloped land within the study area.

5.2.9.2.3. All Plans. The project would provide hurricane surge protection to both existing residential communities and to future developments. Improved flood protection would reduce physical damages to houses and apartments and prevent the disruption of normal daily activities which occurs due to flooding.

Once the project is completed, the amount of fill material needed to bring new structures up to the 100-year base flood elevation required by the Federal Emergency Management Agency (FEMA) will be reduced. However, due to the vulnerability of the area to heavy rainfall events, the amount of required fill must accommodate rainfall stages. Thus, the effects of the fill reduction will be minimal.

5.2.9.3. Business/Industrial Activity and Regional Growth

5.2.9.3.1. Significance. The study area is part of the New Orleans Metropolitan Statistical Area (MSA), which includes Jefferson, Orleans, Plaquemines, St. Bernard, St. Charles, St. James, St. John the Baptist, and St. Tammany Parishes. According to the UNO Real Estate Market Data Center, the Louisiana economy has grown more in the last year than almost any other period in the decade. Until recent years, the economy in this part of the state was dominated by oil and gas activities. With the decline of this industry that began in 1981, the mining of oil and gas has

become less important for job creation relative to other sectors of the New Orleans economy. The count of operating oil and gas rigs in Louisiana remained stable in 1994, it was up considerably from the near record lows of 1992 and 1993 and reflects a effort by industry to replenish reserves of oil and natural gas through domestic exploration. However, consolidations and cutbacks are expected to continue among large companies, although any drastic declines appear to be over. Tables 5.8-5.10 provide a breakdown of commercial occupancy rates by office, retail, and warehouse markets.

The West Bank economy is currently centered around the port and related commercial and manufacturing activities, such as shipbuilding, grain transport, and storage. The value of imports passing through New Orleans area ports was up 24.3 percent in 1994, while export cargos decreased by 8.2 percent. The recent ratification of the North American Free Trade Agreement (NAFTA) is expected to have a significantly positive effect on the maritime sector and on the New Orleans economy.

Most of the heavy industrial complexes on the west bank are located along the Mississippi River. The largest of these companies is Avondale Shipyards, which employs over 6,500 people. A large number of Avondale employees live on the West Bank. Avondale is planning to enter the commercial shipbuilding market with new vessel designs and new construction techniques. This will help to compensate for the reduced military demand that has adversely affected the industry. A nine-acre assembly line factory building is also currently under construction. With the passage of the Pollution Control Act of 1990, which requires all domestic ships to be double-hulled, the demand for Avondale's services, as well as its current level of employment, should remain stable throughout the next decade.

The industrial base of the West Bank has attracted retail trade and services to the surrounding area. The opening of the twin span of the Crescent City Connection Bridge, and the completion of the elevated Westbank Expressway will continue to benefit the retail activity in the area. Plans to widen the Huey P. Long Bridge will further improve the transportation network on the West Bank.

One of the fastest growing industries on the West Bank, as well as in the entire New Orleans Metropolitan area, is health care. Several new hospitals, medical complexes, and extended care facilities have been constructed on the West Bank during the past few years. The medical industry generated more than \$5 billion in 1994 and directly employed more than 48,000 people. According to American Hospital Association statistics, the average 1994 salary of these employees was \$31,130.

TABLE 5.8
LAKE CATAOUATCHE
OFFICE BUILDING OCCUPANCY AND RENTS
1994 - 1995

AREA	OCCUPANCY 1994	OCCUPANCY 1995	CHANGE	RENT PER SF 1994	RENT PER SF 1995	% CHANGE
ORLEANS PARISH						
Westbank	86.8%	75.8%	-11%	\$9.05	\$9.09	.4%
JEFFERSON PARISH						
Westbank	81.8%	84.9%	3.0%	\$9.63	\$9.74	1.1%

SOURCE: Real Estate Market Analysis, University of New Orleans, Vol. XXV, JULY 1995.

TABLE 5.9
LAKE CATAOUATCHE
RETAIL OCCUPANCY
WESTBANK
1994 - 1995

AREA	OCCUPANCY 1994	OCCUPANCY 1995	CHANGE
ORLEANS PARISH			
Westbank	90.0%	90.1%	.1%
JEFFERSON PARISH			
Westbank	90.7%	92.6%	1.9%

SOURCE: Real Estate Market Analysis, University of New Orleans, Vol. XXV, July 1995.

TABLE 5.10
LAKE CATAOUATCHE
WAREHOUSE OCCUPANCY
WESTBANK
1994 - 1995

AREA	OCCUPANCY		CHANGE
	1994	1995	
ORLEANS PARISH			
Westbank	81.9%	85.1%	3.2%
JEFFERSON PARISH			
Westbank	86.6%	75.0%	11.6%

SOURCE: Real Estate Market Analysis, University of New Orleans, Vol. XXV, 1995.

With the advent of the Louisiana gaming industry and the opening of a gambling boat on the Harvey Canal (just outside of the study area), the West Bank has the potential for a growing tourist industry. 1994 was a record year for hotel/motel revenues in the metro area, which increased 18.5 percent from 1993 to an all-time high of \$547.9 million.

The economic downturn of the past decade left a large surplus of commercial space. Due to the recent growth of the local economy, the absorption of this space has increased to 84.9 percent as of July 1995.

5.2.9.3.2. No Action. The economic potential of the area appears favorable in spite of the recent declines in the petrochemical industry. The potential for continued expansion of port activities due to the passage of NAFTA, the health care industry, and the tourism industry are major factors that should encourage economic growth. With the recent opening of the Crescent City Connection Bridge and the connecting elevated Westbank Expressway, and the proposed widening of the Huey P. Long Bridge, overall growth trends are expected to continue. The expansion of facilities within the Bayou Segnette State Park will continue to benefit commercial activity in the area and encourage the new growth of recreation related business.

The establishment of a more diversified economy to offset declines in the oil and gas industry is important for future economic growth. Port activity along the Harvey Canal and the expansion of the tourist and health services industries will be major factors in promoting future economic growth. Employment gains from improvements in the local economy could reduce the excess square footage that exists in the office, retail, and warehouse markets.

5.2.9.3.3. All Plans. Improved flood protection would reduce physical damages to businesses and industries, as well as reduce possible disruption of normal business activities, with an accompanying income loss during these periods of temporary closure.

5.2.9.4. Employment and Income

5.2.9.4.1. Significance. According to a March 1995 report prepared by the Louisiana Department of Labor, the total non-agricultural employment in the New Orleans MSA was estimated to be 590,900, as of February 1995. This represents an increase of 13,400 jobs since February of 1994. The majority of the increase occurred in the hotel, health, and education segments of the services industry, and in the wholesale and retail trade segment, which gained 8,900 jobs and 6,100 jobs, respectively. Government and the transportation and public utilities segments showed employment declines during the same period. Along with the increase in the number of jobs, the unemployment rate for the New Orleans MSA decreased from 7.0 percent in February 1994 to 6.2 percent in February 1995. The unemployment rate for the state of Louisiana decreased from 8.0 percent to 7.3 percent during the same period. Table 5.11 provides a summary of the non-agricultural wage and salary employment in the New Orleans MSA.

The University of New Orleans Division of Business and Economic Research predicts that total employment in metropolitan New Orleans will continue to grow during the next two years. The UNO Model projects that by the end of 1995, total employment will reach the record level set in 1982. While the oil and gas industry is expected to remain stable, the services industry, state and local government, and retail trade are predicted to experience rapid growth. Employment in the gaming industry is also expected to increase.

Table 5.12 shows per capita personal income levels for Jefferson Parish, the New Orleans Metropolitan Statistical Area, and the state of Louisiana. Between 1981 and 1986, the growth rate in per capita income of the New Orleans MSA averaged a modest 3.4 percent per year. As the economy improved between 1987 and 1991 the annual percentage increase in per capita income rose to an average of 8.0 percent.

Table 5.11
LAKE CATAOUATCHE
NEW ORLEANS METROPOLITAN STATISTICAL AREA
NON-AGRICULTURAL WAGE AND SALARY EMPLOYMENT
(IN THOUSANDS BY INDUSTRY)

Non-Agricultural Employment	Feb. 1995	Jan. 1995	Feb. 1994	Percent Change From	
				Jan. 1995	Feb. 1994
TOTAL	590.9	592.6	577.5	-0.3	+ 2.3
Manufacturing	48.6	48.7	47.6	-0.2	+2.1
Mining	13.1	13.3	13.6	-1.5	-3.7
Construction	27.3	27.3	26.8	0.0	+1.9
Transportation & Public Utilities	42.5	43.5	43.4	-2.3	-2.1
Wholesale & Retail Trade	147.6	148.2	141.5	-0.4	+4.3
Finance, Ins., & Real Estate	29.7	29.7	29.6	0.0	+0.3
Services	180.5	180.1	171.6	+0.2	+5.2
Government	101.6	101.8	103.4	-0.2	-1.7

Source: State of Louisiana, Department of Labor, "Louisiana Labor Market Information", March 27, 1995. Includes data for Jefferson, Orleans, Plaquemines, St. Bernard, St. Charles, St. James, St. John the Baptist, and St. Tammany Parishes.

Table 5.12
LAKE CATAOUATCHE
PER CAPITA PERSONAL INCOME
1991, 1992, and 1993

Area	1993	1992	1991	% Change	Average Annual % Change	
				1992-93	1987-91	1981-86
Jefferson Parish	\$19,100	\$18,340	\$17,617	4.1%	7.0%	3.3%
New Orleans MSA	18,882	18,087	17,227	4.4%	7.7%	3.4%
Louisiana	16,612	15,931	15,100	4.3%	8.0%	2.8%

Source: U.S. Dept. of Commerce, Bureau of Economic Analysis, "Survey of Current Business," April 1995.

According to recent statistics released by the Commerce Department, Louisiana is one of the few states where per capita income growth exceeded the national average from 1992 to 1993. The per capita income of Louisiana averaged \$16,612 in 1993. This represents a gain of 4.3 percent between 1992 and 1993, which compares favorably to the national average increase rate of 3.2 percent. However, per capita income in this state is still well below the 1993 national per capita income average of \$20,800.

The University of New Orleans reports that the per capita income of the New Orleans MSA increased 3.7 percent between 1992 and 1993, and 8.3 percent between 1993 and 1994. However, if the local inflation rate matches that of the nation over the next two years, real per capita income will remain fairly constant.

5.2.9.4.2. No Action. The establishment of a more diversified economy, along with the continued expansion of tourism and health services, is important for future economic growth. With the decline of the oil and gas industry and the continued decline in manufacturing, the area must create the climate for growth in other sectors of the economy. This growth should be separate from the potential job gains due to gaming construction and employment.

As the 21st century approaches, the unique geographical location of the New Orleans metro area could allow it to take advantage of the increased trade associated with the development of the North American Free Trade Agreement (NAFTA). With proper positioning, the New Orleans metro area could gain a share of the increased north/south commerce generated by the agreement bill and expand its port activities. This could also create the potential for the development of satellite industries connected with the flow of trade.

The 1990 projections for the New Orleans MSA prepared by the Bureau of Economic Analysis (OBERS) were based on historical trends for population, per capita income, and employment. These projections, which are shown in Table 5.13, include only six parishes rather than the

expanded eight parish area. OBERS projects a compounded annual population growth rate of 0.03 percent during the 50-year period. The per capita income and employment were projected at 0.9 percent and -0.2 percent, respectively, during the same period.

5.2.9.4.3. All Plans. Construction of the hurricane protection levees would temporarily create additional jobs. Hurricane protection would also tend to provide an additional increment of employment stability over the long run. Any residual impacts to employment would be considered minor.

TABLE 5.13
LAKE CATAOUATCHE NEW ORLEANS, LA (MSA)
Projected Population, Per Capita Income, and Employment, 2000-2040

	2000	2005	2010	2020	2040
Population as of July 1 (thousands)	1,306	1,307	1,312	1,333	1,322
Per capita personal income (1982 dollars)	13,383	14,116	14,772	15,862	18,750
	Thousands				
Total employment	671.0	676.6	674.7	646.4	604.9
Farm	1.3	1.3	1.3	1.1	1.0
Nonfarm	669.7	675.3	673.4	645.2	603.9
Private	574.9	581.7	581.4	558.4	524.2
Agricultural services, forestry, fisheries	4.3	4.6	4.7	4.8	4.7
Mining	16.0	15.5	14.9	13.6	11.9
Construction	29.2	28.6	27.9	25.9	23.3
Manufacturing	44.8	44.5	43.9	41.6	38.3
Nondurable goods	20.5	20.0	19.5	18.1	16.3
Durable goods	24.3	24.4	24.4	23.5	22.0
Transportation and public utilities	48.3	47.9	47.3	44.7	41.3
Wholesale trade	34.2	34.0	33.8	32.2	29.9
Retail trade	123.9	125.2	125.0	119.7	111.7
Finance, insurance, and real estate	52.8	53.2	53.0	50.7	47.6
Services	221.3	228.2	231.0	225.3	215.4
Government and government enterprises	94.8	93.6	92.0	86.67	79.7
Federal, civilian	52.8	53.2	53.0	50.7	47.6
Federal, military	10.1	10.1	10.1	10.1	10.1
State and local	69.2	68.3	67.0	62.8	57.0

Source: OBERS, Bureau of Economic Analysis, Regional Projections To 2040, Volume 2, 1990

Note: Revised to reflect 1990 Census Data but includes only six Parishes as part of the New Orleans Metropolitan area: Jefferson, Orleans, St. Bernard, St. Charles, St. John the Baptist, and St. Tammany.

5.2.9.5. Population and Community, including Displacement of People.

5.2.9.5.1. Significance. Table 5.14 provides the 1980 and 1990 Census Bureau population estimates for the individual communities within the project area.

TABLE 5.14
LAKE CATAOUATCHE
TOTAL POPULATION
1980, 1990, 1993, AND 1994

Area	1980	1990	1993	1994	% Change '80 - '90	% Change '93 - '94
New Orleans MSA	1,304,212	1,286,270	1,306,548	1,311,658	-1.38	0.39
Jefferson Parish	454,593	448,306	457,069	457,481	-1.40	0.09
Jefferson Parish - West Bank	179,970	187,597	n/a	n/a	+9.59	n/a
Study Area	25,772	23,795	n/a	n/a	-8.30	n/a

Note: New Orleans Metropolitan Statistical Area (MSA) included population for Jefferson, Orleans, St. Bernard, St. Tammany, St. Charles, St. John the Baptist, Plaquemines, and St. James Parishes. Plaquemines and St. James Parishes were added to the New Orleans MSA per OMB Bulletin No. 93-50, December 28, 1992.

Sources: U.S. Census Bureau; and 1993 and 1994 figures are preliminary unpublished estimates provided by Louisiana Tech University, College of Administration and Business, Research Division.

The University of New Orleans has estimated that the population in Jefferson Parish increased at least three percent between 1990 and 1994, while the Census Bureau estimated the growth to be only 1.8 percent. The UNO estimate is based on the fact that Jefferson Parish had the highest employment growth in the metro area. The parish has drawn many families and individuals who are seeking employment during the last several years. According to UNO, employment gains in excess of 7,500 jobs per year will support a one percent annual population growth.

The total population in the metropolitan area decreased during the 1980's primarily due to the decline of the oil and gas industry. A majority of this out-migration occurred on the east bank of Orleans Parish. Preliminary population estimates prepared by Louisiana Tech University show that by 1993 the population in Jefferson and Plaquemines Parishes, as well as the entire New

Orleans MSA, had surpassed the 1980 levels. Only the population of Orleans Parish continued in a downward trend.

5.2.9.5.2. No Action. Population growth is expected to continue paralleling the local economic activity. The exact location of the population growth will be influenced by many factors, including land availability, improvements to the transportation network, and improvements in the local economy.

As shown in Table 5.13, the OBERS projection, which utilizes 1990 Census data, assumes a compounded annual population growth rate of 0.07 percent for Jefferson Parish through the year 2040. However, according to the Louisiana Tech population estimates, the current population of Jefferson Parish has already surpassed the OBERS population projection for the year 2005. Also, according to the University of New Orleans, the population estimates developed by the U.S. Census appear to be conservative relative to the number of jobs created in Jefferson Parish during the period 1990 to 1994. Thus, OBERS population projections were not used for future development projections in this economic analysis.

Despite the population decline that occurred between 1980 and 1990, an increase of over 8,000 people was estimated for the study area between 1990 and 2049. This represents a compounded annual growth rate of 0.5 percent during the 50-year period. The projection is consistent with the compounded annual growth rate of 0.42 percent that took place on the west bank of Jefferson Parish between 1980 and 1990, and with the 0.51 percent compounded annual growth in the population of Jefferson Parish that occurred between 1990 and 1994. The trend is also consistent with the population projections for the years 1990 through 2010 prepared by Louisiana State University for the State Planning Commission. These projections assume a 0.71 percent compounded annual growth rate for the New Orleans MSA, and a 0.68 percent compounded annual growth rate for Jefferson Parish. The projected growth rate for the Lake Cataouatche study area can easily be supported by the transportation improvements, land availability, construction activity, and the rural setting of the area.

Table 5.15 shows the 1970, 1980, and 1990 population of the study area, and of the west bank of Jefferson Parish, based on U.S. Census Bureau data. It also shows the projected population for the year 2049 developed by New Orleans District.

5.2.9.5.3. All Plans.

Improved flood protection would have a qualitative impact on community development by increasing protection in specific neighborhoods. Since residential relocations would not be required by the project, there would be no displacement of people. As an indirect impact,

TABLE 5.15
LAKE CATAOUATCHE
HISTORICAL AND PROJECTED POPULATION

AREA	<u>Historical</u>		<u>Projected</u>
	1970	1980	1990
STUDY AREA	10,961	25,772	23,795
JEFFERSON PARISH			
- WEST BANK	125,797	179,970	187,597

SOURCE: Historical - U.S. Census data (1970, 1980, and 1990).

Projected - Estimates prepared by New Orleans District.

however, inundation reduction resulting from the project would also reduce the potential for temporary displacement of people living in the path of a hurricane.

5.2.9.6. Public Facilities and Services and Tax Revenue

5.2.9.6.1. Significance. The types of public facilities and services that might be impacted by a hurricane surge are streets, drainage and sewerage systems, fire and police protection, schools, and local, state, and Federal emergency support systems. The Bayou Segnette State Park is located in the project area and is a source of business and revenue for the local area. Adequate drainage and flood control are necessary to sustain the continued maintenance and development of these public facilities and services.

5.2.9.6.2. No Action. Without additional hurricane protection, which the project would provide, additional tax revenues would be needed to mitigate the effects of periodic hurricane surges and flood damage in the study area. The growth, expected in the study area without the project, would require the normal expansion of public facilities and services and related tax revenues.

5.2.9.6.3. All Plans. Potential damage to public facilities and services would be reduced under with-project conditions. Local tax revenues would still be needed to maintain the normal expansion of public facilities and services needed for growth in the protected area. However, no additional tax revenues would be needed to reduce the effects of periodic hurricane surges.

5.2.9.7. Displacement of Farms

5.2.9.7.1. Significance. Historically, the pattern of urban expansion has resulted largely from the conversion of agricultural and forested land to urban land for residential, commercial, industrial, recreational, and institutional purposes. There is no land classified as prime and unique farmland in the project area (Appendix C, Section VI).

5.2.9.7.2. No Action. Under without-project conditions, the pattern of urban expansion is expected to continue as the population grows.

5.2.9.7.3. All Plans. There would be no displacement of farms as a result of the different alternative plans.

5.2.9.8. Community Cohesion

5.2.9.8.1. Significance. Due to the vulnerability of the area to hurricanes, the consensus of community opinion strongly favors additional flood protection.

5.2.9.8.2. No Action. The community is expected to be strongly in favor of additional protection from periodic hurricane flooding. As such, community cohesion is expected to be enhanced.

5.2.9.8.3. All Plans. Most members of the community favor the flood protection provided by the alternative projects. As such, community cohesion is expected to be enhanced.

5.3. CUMULATIVE IMPACTS

Land clearing for residential and commercial development has reduced the total forested lands including wetlands significantly since demand for land is so great. Development involving the clearing of wooded lands under the future without project condition would result in the loss of considerable forested lands over the entire west bank area. The projected development associated with the selected plan of the originally authorized Westwego to Harvey project would occur at a rate projected to be approximately 10 percent faster than without that project. Development of wooded lands associated with the related authorized East of Harvey project are not projected to occur at a rate faster than would occur without that authorized (East of Harvey) project.

Development is projected to occur at the same rate with the proposed action of this study as would occur without it (see 5.2.9.1.3).

Habitat mitigation associated with the Westwego to Harvey project would result in the acquisition and thus preservation of approximately 1,024 acres in the Davis Pond area of the west bank. Authorized habitat mitigation associated with the authorized East of Harvey project would result in the acquisition and protection of 312 acres of high quality woodlands in the Bayou Bois Piquant finger ridge area adjacent to the Davis Pond area. Also, any projected development to be caused by any subsequent actions resulting from the current study would be mitigated by actions to fully replace any lost habitat quality. The loss of BLH caused by the proposed action would be minimal when compared to the losses caused by development, subsidence, etc. The effect of the proposed action would result in direct losses of 57 acres of early successional bottomland hardwood forests with losses of 15 associated annualized habitat units according to HES. The mitigation plan would offset those direct project losses by the acquisition of approximately 39 acres of lower quality woodlands, tree planting, and development of higher quality bottomland hardwood habitat on that site adjacent to the study area that could otherwise eventually be subject to some form of development to higher economic use.

5.4. OPERATION AND MAINTENANCE

5.4.1. Operation and maintenance of the hurricane protection system would have minimal impact on the significant resources of the study area. The levees would be mowed periodically, which would cause minor disturbance to those wildlife species that utilize grassed areas such as levees. Herbicides may be used on a very limited basis around control structures. The floodwalls, floodgates, and levees would be subject to annual inspection and repair as necessary. Temporary and localized adverse impacts such as noise, esthetics, air quality, etc. are probable during repair work. Impacts would be minimal. Operation and maintenance on the mitigation area would consist of all activities necessary to allow the development and maintenance of habitat quality, including possible herbicide application to help control the exotic Chinese tallow, and would include monitoring to see that the bottomland hardwood habitat projected is realized.

6. LIST OF PREPARERS

The following people were primarily responsible for preparing this statement.

NAME	DISCIPLINE EXPERTISE	EXPERIENCE	ROLE IN PREPARATION
Mr. William Wilson	Wildlife Biologist	6 Yrs Ga DNR, 17 Yrs USACE NOD	EIS Coordinator; Biol. Resources, Mitigation
Mr. Brett Herr	Planner/ Civil Engineer	13 Yrs USACE, NOD	Study Manager
Mr. Russell Young	Civil Engineer	27 Yrs Engrn., 25 Yrs USACE NOD	Levee Design Supervision
Mr. Jorge Romero	Structural Engineer	18 Yrs USACE NOD	Structure Design
Mr. Brian Maestri	Regional Economist	11 Yrs USACE NOD	Socioeconomics
Mrs. Lisa Leonard	Regional Economist	12 Yrs USACE NOD	Socioeconomics
Mr. Keven Lovetro	Regional Economist	11 Yrs USACE NOD	Socioeconomics & Economic Review
Mr. Ted Hokkanen	Outdoor Recreation Planner	5 Yrs. PA State Pks, 4 Yrs VXD, 17 Yrs USACE NOD	Effects on Recreation Resources
Mr. James Wojtala	Archeologist	15 Yrs Archelolgist, 5 Yrs USACE NOD	Effects on Cultural Resources
Mr. Rodney Mach	Environmental Engineer / Water Quality	16 Yrs USACE NOD	404(b)(1) (Physical Components) & Water Quality
Mr. David Carney	Wildlife Biologist	1 Yr USFWS 17 Yrs USACE NED/ NOD	Overall Environmental Review

7. PUBLIC INVOLVEMENT, REVIEW, AND CONSULTATION

7.1 PUBLIC INVOLVEMENT PROGRAM AND STUDY HISTORY

7.1.1. Public meetings were held in 1966, 1972, 1984, and 1986 regarding various proposals for hurricane protection on the West Bank of the Mississippi River. The proposals discussed at the 1966 and 1972 meetings were broad in scope and were primarily concerned with protection over the multi-Parish area. The 1984 and 1986 meetings were concerned with the area between Westwego, Louisiana, and the Harvey Canal.

7.1.2. In December 1986, a feasibility report and final EIS for the West Bank of the Mississippi River in the Vicinity of New Orleans, Louisiana, was completed and a final plan was approved by the New Orleans District in July 1988. This project is now described as the Westwego to Harvey Project. On September 30, 1994, a final EIS was filed with the Environmental Protection Agency for the West Bank of the Mississippi River in the Vicinity of New Orleans, Louisiana, East of Harvey Canal. The proposed project is a continuation of plans for adequate hurricane protection for the West Bank area.

7.1.3. A notice of intent to prepare a draft EIS for the proposed action (Lake Cataouatche) was published in the Federal Register on May 20, 1993. It explained the proposed action and scoping process for the draft EIS.

7.1.4. A scoping document dated May 28, 1993, was mailed to all addresses on the mailing list. The major concerns as a result of responses were alternatives, potential impacts to fish and wildlife resources, and water quality.

7.1.5. The Notice of Availability of the draft EIS report appeared in the Federal Register on October 11, 1996. The required 45-day review period began on that date. Those on the mailing list were provided copies prior to that date. The public review period for the draft EIS ended on November 25, 1996. Comments to the draft PAC/EIS with responses are included in Appendix F, Public Views and Responses.

7.1.6 A public meeting was held on November 7, 1996 at the Jefferson Parish School Board Media Center in Harvey, Louisiana, to provide additional opportunity for public input into the planning process. Five individuals spoke, in addition to representatives of the New Orleans District and the West Jefferson Levee District. Comments ranged from support of the project to a request for being included within the protection area to changing the location of the habitat mitigation site.

7.1.7. During the course of this study, coordination was maintained with the Jefferson Parish government officials, West Jefferson Levee District, U.S. Fish and Wildlife Service, National Marine Fisheries Service, U.S. Environmental Protection Agency, National Park Service, Louisiana Department of Transportation and Development, Louisiana Department of Wildlife and Fisheries, Louisiana Department of Environmental Quality, Louisiana Department of Natural Resources, and Louisiana Department of Culture, Recreation, and Tourism (Office of State Parks and State Historic Preservation Officer).

7.2. REQUIRED COORDINATION AND COMPLIANCE

7.2.1. The draft EIS was furnished to Federal agencies, state agencies, and other interested parties for their review and comments.

7.2.2. Table 7.1 shows the various environmental laws that apply and how compliance is achieved.

7.3. STATEMENT RECIPIENTS

7.3.1. Draft Statement Recipients. All U.S. Senators and Congressmen representing Louisiana, Federal and state agencies, state officials, and interested groups and individuals were mailed copies of the draft EIS. Additionally, copies were furnished to the local libraries listed below. A complete list of those receiving a copy of the PAC Report and EIS is found in Appendix C.

LIBRARIES

Louisiana State University
 University of New Orleans
 Tulane University
 Dillard University
 Xavier University
 New Orleans Public Library
 Loyola University Library
 St. Charles Parish Library
 State Library of Louisiana
 Lafayette Natural History Library
 Coastal Studies Institute
 LA Office of Commerce and Industry
 Jefferson Parish Westbank Regional
 Jefferson Parish Live Oak Branch
 Jefferson Parish Westwego Branch

**TABLE 7.1
ENVIRONMENTAL COMPLIANCE**

STATUTE (includes any amendments)	DOCUMENT	NOTE	LOCA- TION	STATUS
Bald Eagle Act	USFWS response to request			Full
Clean Air Act	EIS & Applicability Determination	*1		Full
Clean Water Act	401 State WQ Certification 404(b)(1) Evaluation	*2	Appx C	Full
Coastal Zone Management Act	Consistency Determination	*3	Appx C	Full
Endangered Species Act	NMFS letter & USFWS stamp		Appx C	Full
Estuary Protection Act	EIS			Full
Farmland Protection Policy Act	EIS and Farmland Rating form		Appx C	Full
Fed. Water Project Recreation Act	EIS			Full
Fish and Wildlife Coordination Act	FWS Coordination Act Report		Appx C	Full
Land & Water Conservation Fund Act	EIS			Full
Marine Prot., Research and Sanctuary Act	EIS			Full
National Environmental Policy Act	EIS	*4		Full
National Historic Preservation Act	EIS			Full
Archeological & Historical Preservation Act	EIS			Full
River and Harbor Act	EIS			Full
Wild and Scenic Rivers Act	EIS			Full
Water Resource Develop. Act of 1976	EIS			Full
Water Resource Develop. Act of 1986	EIS & Mitigation Report		Appx C	Full
E.O. 11988	EIS			Full
E.O. 11990	EIS			Full
Memo on Prime and Unique Farmlands	EIS & Farmland Rating form		Appx C	Full
La. Protection of Cypress Trees Act	EIS			Full
La. Coastal Zone Management Act	Consistency Determination	*3	Appx C	Full

*1 Applicability Determination in files of New Orleans District

*2 State WQ Certification letter completed process

*3 Approval letter from La. DNR finalized consistency.

*4 Signing of Record of Decision will complete process.

7.3.2. Final Statement Recipients. Copies of the statement are being furnished to all Federal agencies having jurisdiction by law or special expertise with respect to any environmental impact involved and any Federal, State, or local agency authorized to develop and enforce environmental standards as well as parish and state libraries. Copies of the statement are also being furnished to any person, organization, or agency that submitted substantive comments on the draft EIS.

7.4 PUBLIC VIEWS AND RESPONSES

The views of the public were considered in detail during the study and planning of the proposed project. The Recommended Plan minimizes environmental impacts and costs while maximizing protection benefits as much as possible. The Recommended Plan achieves an excellent balance between these factors by using existing alignments wherever possible, obtaining material from existing canals, completing SPH protection for the West Bank, providing mitigation for losses of wetlands and wildlife habitat, and utilizing the least costly alignment.

7.5 RECOMMENDATIONS OF THE U.S. FISH AND WILDLIFE SERVICE

7.5.1. Approximately 50 acres of scrub/shrub habitats should be acquired and managed to offset project related direct impacts to fish and wildlife resources.

Response: The District bases its mitigation acreage determination of 39 acres upon the assumption that future without project (FWOP) habitat values would not escalate over time on the impact area, but would remain the same as when sampled. This assumption was made because the impact area consists almost entirely of Chinese tallow trees with no nearby seed source for mast-producing species such as oaks. The Service assumed escalating FWOP values on the impact area (see Table C-4-4, within Appendix C, Section 4) which resulted in their higher mitigation compensation requirement of 50 acres.

7.5.2. Mitigation lands should be acquired in fee simple; administration and management of those lands should be accomplished in accordance with the General Plan process contained in Section 3(b) of the Fish and Wildlife Coordination Act. Acquisition, operation, and management of mitigation lands should be at project expense.

Response: Concur.

7.5.3. Detailed design of the hurricane protection and mitigation features should be coordinated with the Service, the Louisiana Department of Wildlife and Fisheries, and other interested natural resource agencies.

Response: Concur.

7.5.4. Mitigation should be implemented simultaneously with other project features.

Response: Concur. This is required in Section 906(a)(1) of the Water Resources Development Act of 1986 (PL 99-662).

8. LITERATURE CITED

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- Wilkinson, D.L., K. Schneller-McDonald, R.W. Olson, and G.T. Auble. 1987. Synopsis of Wetland Functions and Values: Bottomland Hardwoods with Special Emphasis on Eastern Texas and Oklahoma. U.S. Fish and Wildlife Service, Biological Report 87/12, Washington, D.C.

CONCLUSION

I find that the recommended plan to provide hurricane surge protection to that portion of the west bank of the Mississippi River in the vicinity of New Orleans, Louisiana, between Bayou Segnette and the St. Charles Parish line, as developed in this report, is based on a thorough analysis and evaluation of all practicable alternatives, in view of applicable economic, engineering, and environmental criteria. I have analyzed the data and concluded that Plan 1C providing a 200-year level of protection is the NED plan.

I have given special consideration to the risks and uncertainties associated with the unpredictability of hurricanes, loss of evacuation routes, the potential for loss of life and property, the human suffering that hurricane surge flooding could cause in this particular area, and the unknown consequences of sea level rise, subsidence, and loss of coastal marsh which serves as a buffer against hurricanes. I have also considered the fact that the Lake Pontchartrain and Vicinity, the Westwego to Harvey Canal, and the East of Harvey Canal Hurricane Protection Projects have been authorized to provide SPH protection to the surrounding metropolitan area. The additional cost of providing SPH protection to the Lake Cataouatche area is less than 0.1 percent of the total cost of these previously authorized projects. The NED plan would have a 97.7 percent chance of containing the 50-year event, a 81.6 percent chance of containing the 200-year event, and only a 23.1 percent chance of containing the 500-year event. Providing the area with SPH protection increases the probability of containing the 200-year storm by over 30 percent and the probability of containing the 500-year storm by over 25 percent.

Implementing the recommended plan would provide increased levels of hurricane protection to the Lake Cataouatche area and would tie the line of protection to the authorized Westwego to Harvey Canal project. These two projects combined would provide a high degree of protection to approximately 90,000 west bank residents. The total project first cost of the recommended plan is \$14,806,000. The recommended plan, with estimated average annual costs of \$1,402,000 and mean equivalent annual benefits of \$8,056,000, provides a benefit-to-cost ratio of 5.74 to 1.0. There is a 99.2 percent chance that the benefit-to-cost ratio would exceed 1.0, a 95.2 percent chance that the benefit-to-cost ratio would exceed 2.0, and a 75 percent chance that the benefit-to-cost ratio would exceed 3.5.

The primary impacts of the recommended plan would be the possible loss of approximately 57 acres of bottomland hardwoods. Mitigation of significant environmental losses would be accomplished by the acquisition, bottomland hardwood habitat development, and management of a 39-acre tract located adjacent to Bayou Segnette State Park. The mitigation plan would compensate, in-kind, all direct project-induced habitat losses to the fullest extent possible.

Improvements for hurricane surge protection in the adjacent Westwego to Harvey Canal area were authorized by the Water Resources Development Act of 1986, Public Law 99-662, approved November 17, 1986. The recommended plan described in this report would modify the authorized project and would provide for a continuation of the protection from Bayou Segnette to the St. Charles Parish line. A waiver to deviate from the NED level of protection (200-year), and to provide the area with SPH protection, has been granted by the Assistant Secretary of the Army.

RECOMMENDATIONS

As the District Engineer, I have considered the significant environmental, social, and economic effects, the engineering feasibility, and the input received from the public and have determined that the recommended plan presented in this report is in the overall public interest.

I recommend that the existing, West Bank Hurricane Protection Project, Jefferson Parish, Louisiana, authorized by the Water Resources Development Act of 1986, Public Law 99-662, approved November 17, 1986, be modified to provide additional hurricane protection to that portion of the west bank of the Mississippi River in the vicinity of New Orleans, located between Bayou Segnette and the St. Charles Parish line. I also recommend that the level of protection deviate from the NED level of protection and provide protection for the Standard Project Hurricane (SPH). This plan is being recommended with such modifications thereof as in the discretion of the Commander HQUSACE, may be necessary.

The total first cost of the recommended plan is \$14,806,000 based on October 1996 price levels, an interest rate of $7\frac{3}{8}$ percent, and a project life of 100 years. Operation, maintenance, repair, replacement, and rehabilitation costs are estimated to be \$109,000 annually. The recommended plan produces net excess benefits over costs and has a favorable benefit to cost ratio.

These recommendations are made with the provisions that prior to implementation, the non-Federal interests will agree to comply with the following requirements:

- a. Furnish all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas necessary for construction (including mitigation), operation, maintenance, repair, replacement, and rehabilitation of the project;
- b. Accomplish or arrange for the accomplishment of all utility and facility alterations and relocations determined by the Secretary of the Army to be necessary for the construction, operation, maintenance, repair, replacement, and rehabilitation of the project, except that, in the sole discretion of the Secretary of the Army, the United States may

perform utility and facility alterations and relocations on Federal lands, using funds provided by non-Federal interests;

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

d. Provide for adjudication of all water right's claims resulting from construction, operation, maintenance, repair, replacement, and rehabilitation of the project, and hold and save the United States free from damages due to such claims;

e. Bear 35 percent of the total cost of project construction;

f. Operate, maintain, repair, replace, and rehabilitate as necessary all features of the project, at no cost to the Government, in accordance with regulations prescribed by the Secretary of the Army, including levees, floodwalls, floodgates and approach channels, drainage structures, drainage ditches or canals, and all mitigation features;

g. Publicize floodplain information in the areas concerned and provide this information to zoning and other regulatory agencies for their guidance and leadership in preventing unwise development in the floodplain and in adopting such regulations as may be necessary to prevent unwise future development and to ensure compatibility between future development and protection levels provided by the project;

h. Within 1 year after the date of signing a project cooperation agreement, prepare a floodplain management plan designed to reduce the impact of future flood events in the project area. This plan shall be prepared in accordance with guidelines developed by the Government. The plan must be implemented no later than 1 year after completion of construction of the project.

i. Prescribe and enforce regulations to prevent obstruction of or encroachment on the project that would reduce the level of protection it affords or that would hinder operation and maintenance of the project.

j. Assure that construction, operation, maintenance, repair, replacement, and rehabilitation of any non-Federally constructed flood features do not diminish the hurricane protection provided by or jeopardize the structural integrity of the project;

k. Assure compliance with applicable Federal floodplain management and flood insurance programs;

l. Inform affected interests, at least annually, regarding the limitations of the protection afforded by the project;

m. Perform, at the time of initiation of construction and thereafter, any environmental investigations as determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675 on lands necessary for project construction, operation, maintenance, repair, replacement, and rehabilitation;

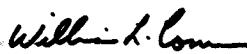
n. Assume complete financial responsibility for the cleanup of any hazardous materials located on project lands and regulated under CERCLA and be responsible for operating, maintaining, repairing, replacing, and rehabilitating the project in a manner that will not cause liability to arise under CERCLA;

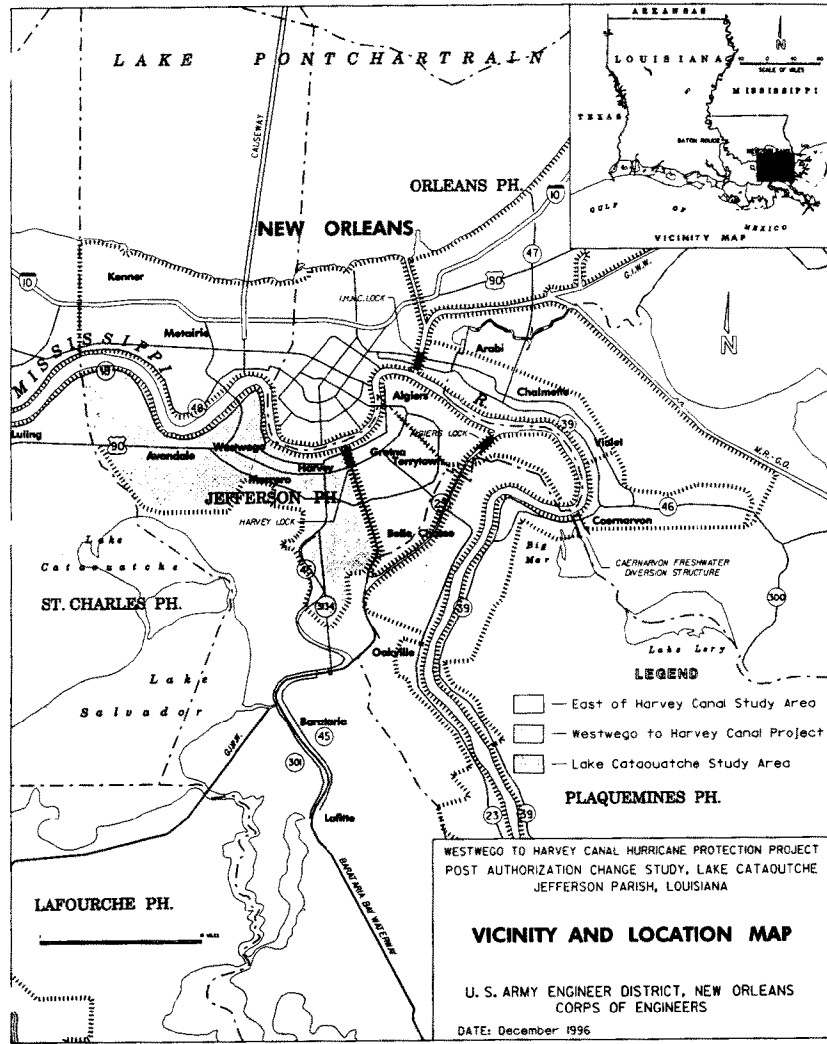
o. Comply with the applicable provisions of the Uniform Relocations and Real Property Acquisition Policies Act of 1970 (PL 91-646), as amended by Title IV of the Surface Transportation and Uniform Relocations Assistance Act of 1987 (PL 100-17);

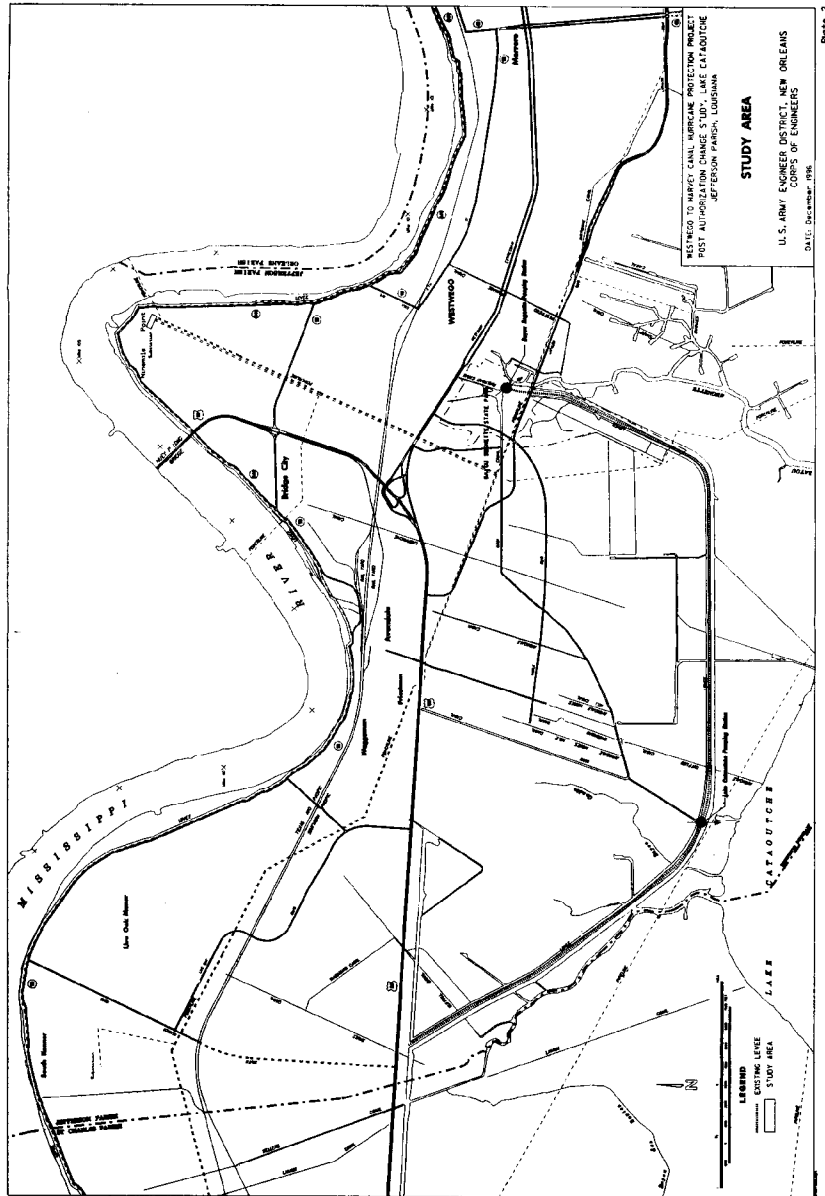
p. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, approved December 31, 1970 which provides that the construction of any water resource project by the Corps of Engineers shall not be started until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project; and

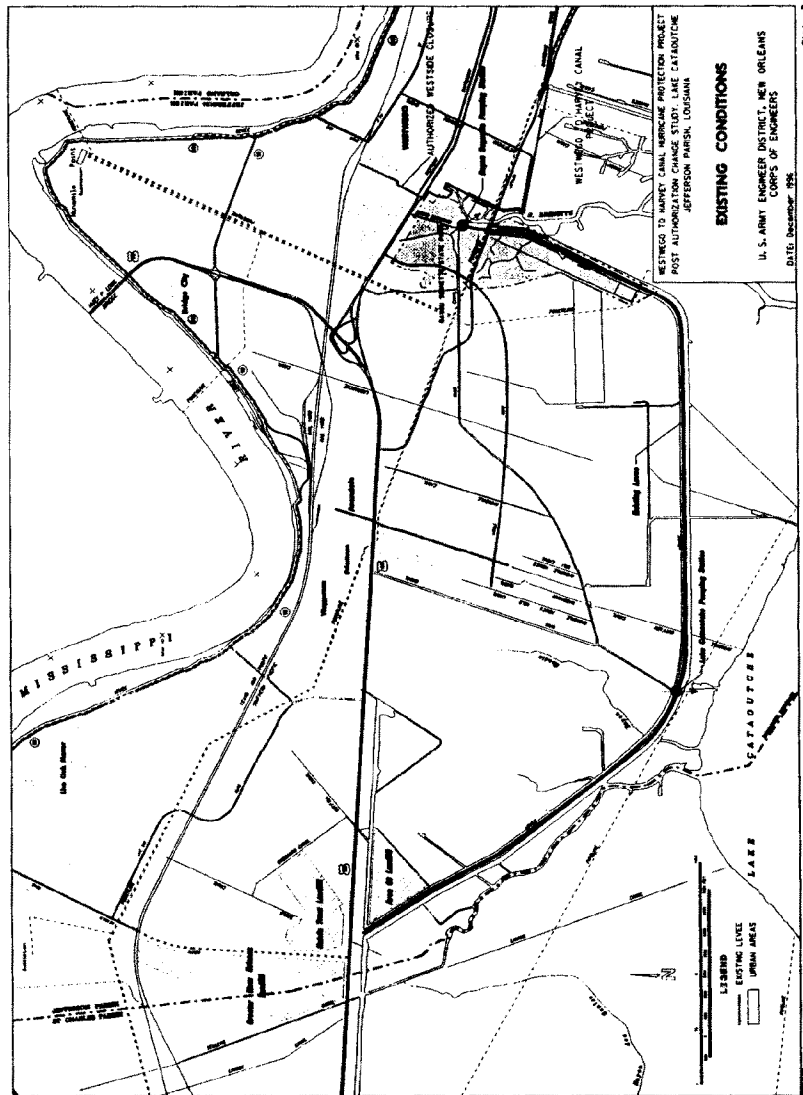
q. Comply with Section 601 of Title VI of the Civil Rights Act of 1964 (PL 88-352) that no person shall be excluded from participation in, denied the benefits of, or subjected to discrimination in connection with the project on the grounds of race, creed, or national origin.

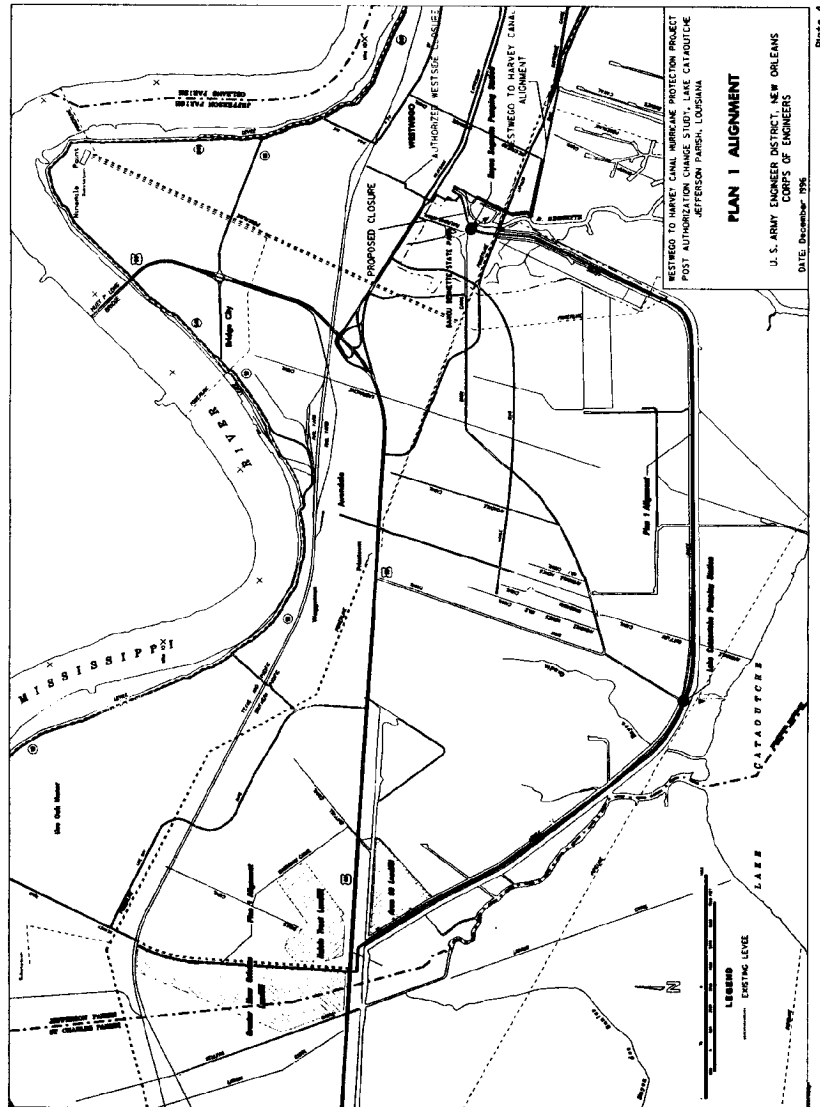
The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective 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 State of Louisiana, the West Jefferson Levee District, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

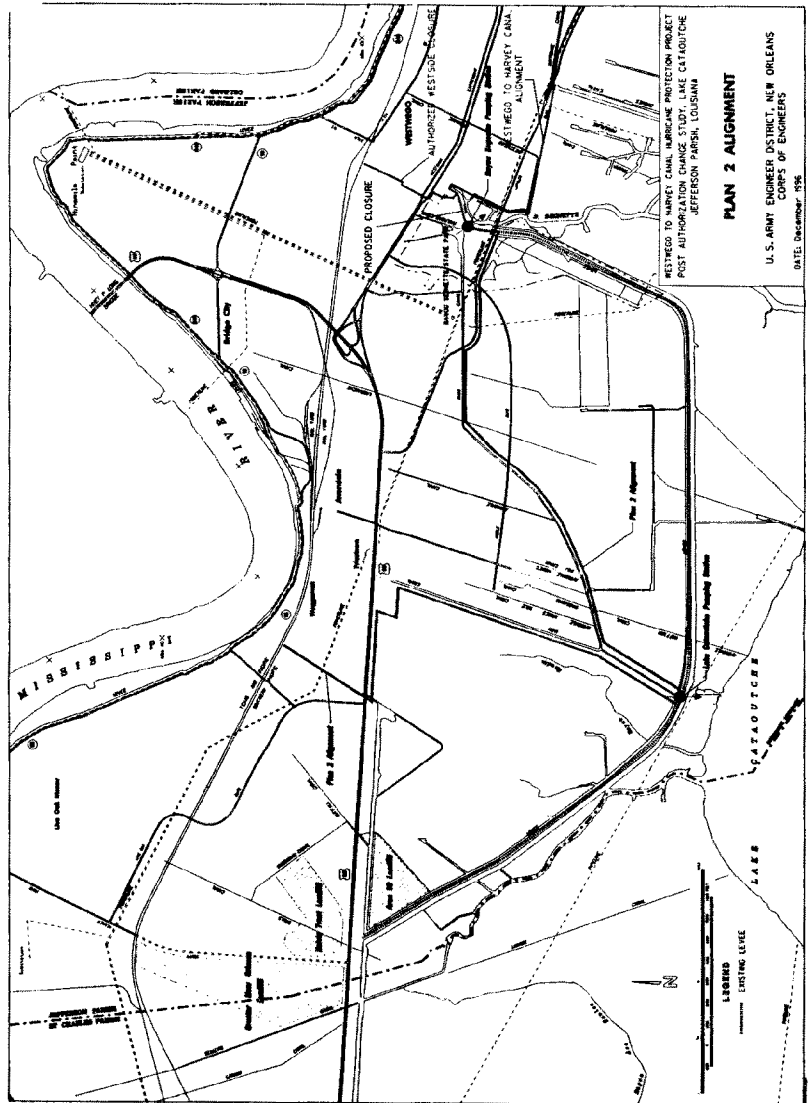

 WILLIAM L. CONNER
 Colonel, U. S. Army
 District Engineer

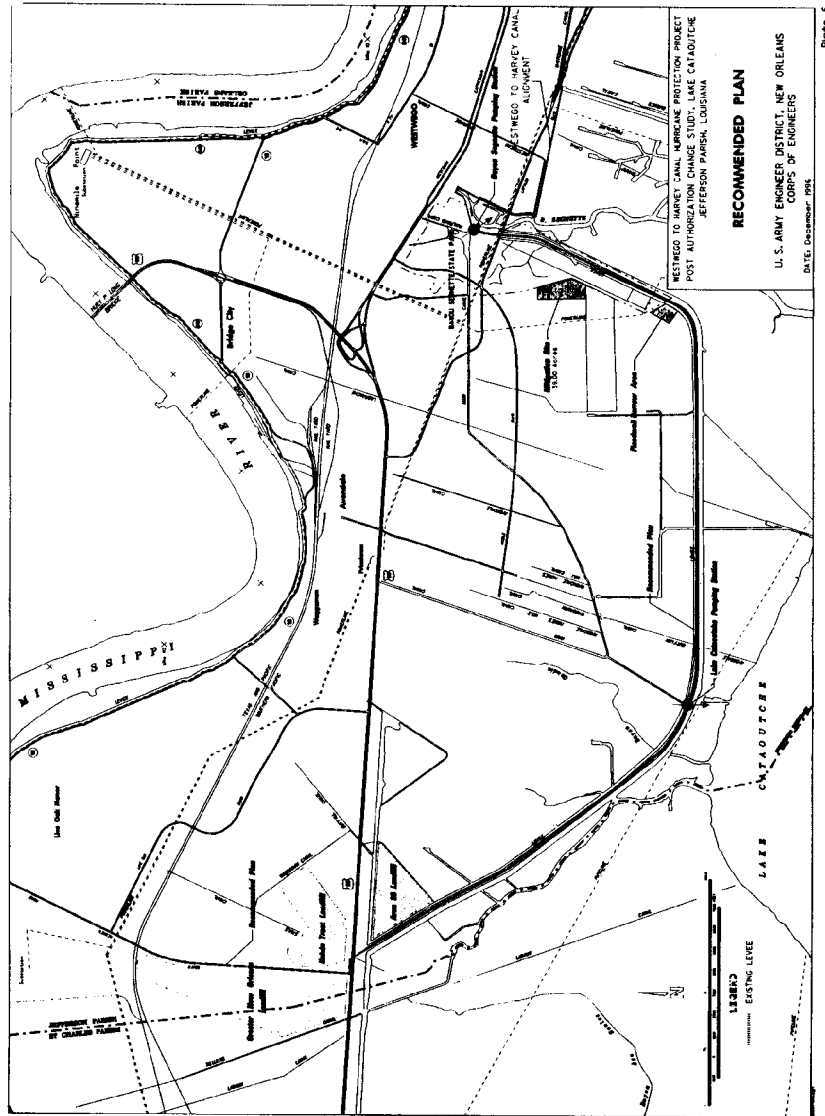












APPENDIX A**ENGINEERING INVESTIGATIONS****SECTION 2 - FOUNDATIONS****GEOLOGY**

2-01. Geology. The study area is located in Jefferson Parish, Louisiana between the Mississippi River and Lake Cataouatche. Surface elevations in the study area range from +10 feet NGVD along the natural levees of the Mississippi River to near 0 feet NGVD in the marshes bordering Lake Cataouatche. The surface and shallow subsurface in the study area is composed of natural levee, marsh, swamp, interdistributary, and prodelta deposits. Specifically, the borings show that the entire area is overlain by 8 to 22 feet of swamp deposits generally consisting of organic clays, wood, peat, with occasional sand and silt layers. Underlying swamp deposits are interdistributary deposits located between elevations +2 and -22 feet NGVD and are up to 40 feet thick. Interdistributary deposits generally consist of very soft, fat clay with occasional lenses of lean clay, silt, and silty sand. Prodelta deposits underlie interdistributary deposits between stations 149+50 and 455+00. Prodelta deposits are found between elevations -30 and -55 feet NGVD and extend to an unknown depth. Prodelta deposits generally consist of homogeneous, medium clays with occasional lenses of silt, and silty sand. Nearshore gulf deposits underlie interdistributary deposits between stations 485+00 and 570+00. Nearshore gulf deposits are found at approximately -50 feet NGVD and extend to an unknown depth. These deposits generally consist of silty sand and sand with shell fragments and occasional lenses of silt and clay. Geologic profiles for the study area are presented on plates F-16 thru F-18.

SOILS

2-02. General. This report addresses design assumptions and parameters for new levees, enlargement of existing levees and floodwalls. The project consist of four (4) design reaches for approximately 10,000 feet of floodwall and 50,000 feet of levee.

2-03. Foundation Conditions. The foundation soils are predominantly fat clays (CH) varying in consistency from very soft to medium, with occasional layers of silt (ML) and lean clays (CL). Layers of organic clays, which typically display high moisture contents, exist in many areas from the original ground surface down to approximate elevation -20.

2-04. Field Exploration and Laboratory Investigation.

a. Soil Borings. Twelve general type borings were made along parts of the proposed alignment between Mar 91 and Apr 93. Location of these borings can be found on plates 2 thru 13 in the Engineering Appendix. The boring logs are presented on plate F-10. Four

undisturbed type borings were made along parts of the proposed alignment during Apr 93. Location of these borings can be found on plates 2 thru 13. The undisturbed boring logs are presented on plates F-11 thru F-14.

b. Laboratory Tests. Visual classifications were made on all boring samples and water content determinations were performed on all cohesive samples. Standard Penetration Resistance blow counts were recorded when sampling in granular strata. Unconfined compression (UC) shear tests and grain size analyses were made on selected samples of cohesive and granular soils, respectively.

Unconsolidated-undrained (Q), consolidated-undrained (R), triaxial compression shear tests and consolidation (C) tests were performed on selected undisturbed samples and included Atterberg limits. All laboratory tests results are included in Annex 1 of the Engineering Appendix.

c. Design Parameters. For all reaches, the shear strength and wet density test results from all the borings were used to determine design parameters. Shear strength and density results are based on (UC) and (Q) tests on samples taken from the four undisturbed borings and (UC) tests on samples from some of the general type borings. A density and shear strength plot for the levee and floodwall alignment is presented on Plate F-1.

2-05. Design Reaches. The job was divided into four design reaches based on hydraulics considerations and boring data. The reaches are as follows:

Reach I	- Sta. 0+00 to Sta. 109+00	(Levee)
Reach II	- Sta. 109+00 to Sta. 250+00	(Levee)
Reach III	- Sta. 250+00 to Sta. 518+00	(Levee/with wave berm)
Reach IV	- Sta. 518+00 to Sta. 602+00	(Levee/I-wall)

The highest still water level (SWL) used for this project was elev. 7.5 (N.G.V.D.). Low water level used was elev. -2.0.

2-06. Stability of Levees. Existing conditions along the proposed alignment were estimated and the slopes and berm distances for the proposed levee were designed for the (Q) construction case. A "Factor of Safety" (F.S.) of 1.3 is required for the levee stability. Typical levee sections and floodwall sections are presented on Plates F-2 and F-5.

2-07. Cantilever I-Wall. I-wall stability and required penetration were determined by the "Method of Planes". A "Factor of Safety" was applied to the soil parameters. For the friction angle, the F.S. was applied as follows:

$$\theta_d = \tan^{-1} \frac{\tan \theta_a}{\text{factor of safety}}$$

where θ_a = available friction angle
 θ_d = developed friction angle

The developed friction angle was used in determining lateral earth pressure coefficients.

Using the resulting shear strengths, net horizontal water and earth pressure diagrams were determined for movement toward each side of the sheet pile. From the earth pressure diagrams, the summation of horizontal forces were equated to zero and the summation of overturning moments were determined for various tip penetrations. The depth of necessary penetration is the point of zero summation of moments.

Two I-wall designs were analyzed for this project. The first was for an existing sheetpile wall adjacent on either side of the Lake Cataouatche Pumping Stations 1 and 2 between approximate stations 307+00 to 310+00. Since this reach is subject to wave loads, the sheetpile was analyzed for the following design cases.

Note: There is a significant wave load on the sheetpile wall:

Q-Case

F.S. = 1.5 with static water at still water level (SWL)

F.S. = 1.25 with static water at SWL plus waveload

F.S. = 1.0 with static water at SWL plus 2 feet

S-Case

F.S. = 1.2 with static water at SWL plus waveload

General: If the penetration to head ratio is less than 3:1, then increase it to 3:1.

The S-case was the governing design case for the pumping station sheetpile walls. For design results, see Plate F-6.

The other design reach runs from approximate Sta. 518+00 B/L to the Bayou Segnette floodwall. In this reach, the top of sheetpile will range from elevation 10.5 (near sta. 518+00 B/L) to 9.5 (near Bayou Segnette pump station). The crown of the levee will range from elevation 5.5 (near sta. 518+00 B/L) down to 5.0. (near Bayou Segnette pump station).

The following design cases were analyzed for determining required penetration for the levee/I-wall in this reach.

Note: There is no significant wave load on I-wall:

Q-Case

F.S. = 1.5 with static water at still water level
(SWL)

F.S. = 1.0 with static water at SWL plus 2 feet

General: If the penetration to head ratio is less
than 3:1, then increase it to 3:1.

The 3 to 1 penetration to head ratio was the governing design case for the proposed levee/I-wall. However, to compensate for future flood conditions (general land subsidence and sea level changes), additional sheetpile penetration has been incorporated into the design. See Plate F-7.

2-08. Pile Curves. Pile capacity curves are presented on Plates F-8 and F-9 for a 12-inch square concrete pile and a Class B timber pile, respectively.

2-09. Borrow Material. The proposed floodside borrow pit will be bored in the future to ascertain its suitability for use in the levee enlargement. Due to the expected high moisture content of the pit material, substantial drying of the material will probably be required before semicompaction is possible.

2-10. Settlement. Based on historical data, shrinkage and settlement of levee fill should be in the range of 15 to 25 percent over the 3 or 4 years between the first and second enlargements. The final enlargement will compensate for the expected lifetime settlement of the levee. The Lake Cataouatche levee should experience minimal settlement since the centerline of the levee will remain unchanged and the existing levee is to be raised approximately 3 to 4 feet.

SECTION 3 - DESIGN

GENERAL

3-01. Surveys and Mapping. The design for the recommended plan was developed using detailed alignment, cross sectional and topographic surveys obtained in 1993. Aerial maps were prepared from aerial photographs taken in July 1994.

3-02. Future Surveys and Mapping Required. Additional surveys will be taken during the preparation of Plans and Specifications for the project including a detailed topographic survey at U.S. Highway 90. The existing aerial mapping is adequate for any future work.

LEVEE DESIGN

3-03. Levee Design. The general location and alignment of the Lake Cataouatche Levee is shown on plate 1. A detailed alignment and profile of the levees and features are shown on plates 2 through 8. Approximately 10 miles of levee will be constructed or improved. Typical levee sections are shown on plates 24 and 25.

The levee north of U.S. Highway 90 will be built over the existing South Kenner Road. It will be built to a height of 6.5 feet and have a 3-foot crown. The flood side of this levee will have a 1 vertical on 3 horizontal slope and will be fertilized and seeded. The protected side of the levee will have a 1 on 10 slope and will be surfaced with 7-inches of crushed stone to handle vehicular traffic as a replacement of the existing road. The 3-foot crown will also have a 7-inch crushed stone surface. Borrow for this small levee will be trucked from the Davis Pond Project.

Approaching U.S. Highway 90, the levee will turn eastward and parallel the north right-of-way of the highway until reaching natural grade of 6.5 feet at the shoulder of the westbound lanes. The protected side levee slope will transition into a 1 on 3 slope and the entire levee will be simply fertilized and seeded once the levee alignment diverges from the South Kenner Road alignment. South Kenner Road will ramp over the levee to the floodside of the hurricane protection to intersect U.S. Highway 90. Five 18-inch culverts under South Kenner Road (in the area where the levee is being built over the road) will be removed. The removal of these culverts is consistent with EPA's requirement for closure of the adjacent landfill. A new 24-inch RCP culvert is to be installed under South Kenner Road at the intersection with U.S. Highway 90 (on the floodside of the levee alignment). Existing buried utilities and pipelines will be simply covered by this small levee.

Both shoulders of U.S. Highway 90 will require rework to accept the incoming levee at elevation 6.5 feet and provide transitions that are acceptable to LADOTD. Details of the levee - highway tie-in are shown on plate 32. The U.S. Highway 90 median and traffic lanes are above elevation 6.5 feet and will provide a line of protection.

Upon crossing to the south side of U.S. Highway 90, the levee immediately transitions from a height of 6.5 feet to 9.5 feet. This new section, as detailed on plate 24, is carried to Sta 250+00. This levee section is to have a 7-foot crown and 1 on 3 side slopes. The levee is to be fertilized and seeded. A future second lift will increase the crown width to 10-feet while maintaining 1 on 3 side slopes. The alignment of the levee will encapsulate the existing levee. Borrow for the levee and stability berm adjacent to the land fill will come from degrading the existing levee at isolated locations where it is above the elevation 9.5 feet grade and section and will be trucked

from the Davis Pond Project. The borrow for the remainder of this reach of levee will come from the interior drainage canal adjacent to the fill area. This canal will be relocated landward as required to maintain stability of the levee.

From Sta 250+00 to Sta. 510+00 the levee height will be increased to 10.5 feet while maintaining a 7-foot crown and 1 on 3 side slopes. The levee will be fertilized and seeded. The second lift of this project will increase the crown width to 10-feet and maintain 1 on 3 side slopes. A wave berm will be constructed on the flood side. The toe of this berm terminates just beyond the bankline of the floodside borrow canal. It will be riprapped to armor it against scour generated by wind and recreational boat waves. This section is detailed on plate 25 and the armorment detail is shown on plate 32. Borrow for the protected side stability berm of the levee will come from the interior drainage canal which will be relocated landward to achieve stability. Borrow for the levee and flood side berm of the levee and second enlargement stockpile will come from bucket dredge excavation in the flood side canal. Extra borrow will be stock piled in a protected side berm for the future upgrade of the levee.

At Sta 509+50 the levee wave berm will be phased out. The levee will maintain a 7-foot crown until the ultimate lift. The 1 on 3 side slopes will be fertilized and seeded. This section is detailed on plate 25. At station 518+05 the levee will transition into a smaller levee section with an I-wall driven in the crown. Borrow for the floodwall reach of levee will be excavated from a 13.6 acre borrow area adjacent to the Bayou Segnette State Park.

The second lift 10-foot levee crown will provide inspection and maintenance access. The semicompacted roadway sections between Sta 509+50 and 518+05 will be used for second lift borrow. The waveberm roadway will not be restored. Fill requirements on the waveberm during this second lift construction will be uncompacted fill. Borrow will come from a widening of the interior drainage canal.

FLOODWALLS

3-04. Floodwalls. Design considerations and cost estimates for the structural features of the study included I-walls, I-wall/levee combinations, vehicular gates, pile supported inverted T-walls, and modifications of existing pumping stations discharges (front-end protection). These structures assure a continuity of protection between full earthen levee sections and pumping stations, and allow economical protection through congested areas while minimizing adverse effects. T-wall, I-wall and/or I-wall/earthen levee sections are proposed through the Segnette State Park and in the vicinity of the Segnette Pumping Station. The existing floodwall at the Cataouatche Pumping Station will be incorporated into the project. The floodwall sections are necessary to reduce down drag forces and improve stability in the sections near

the pumping stations. The plan depicting the proposed floodwall alignment is shown on Plates 9 through 14. The plan of the existing protection at the Lake Cataouatche Pumping Station is shown on Plate 33. Typical T-wall, I-wall and I-wall/earthen levee sections and details are shown on Plates 26 through 31, and 34 through 40. The exposed areas of the floodwalls will be provided with architectural finishes for aesthetic reasons. An example of a typical architectural wall treatment, a fractured fin finish, is shown on Plate 41.

Vehicular and pedestrian access is provided at existing roads and walkways by gates in the floodwalls. Swing type gates are considered advantageous at these crossing due to their ease of operation and low construction and maintenance costs. Typical gate details are shown on Plates 42 through 50.

PUMPING STATIONS

3-05. Pumping Stations. The Cataouatche Pumping Stations 1 and 2, located between Sta. 307+22 B/L and Sta. 310+31 B/L, were constructed by Jefferson Parish during the early 1980's. Pumping Station No. 2 included front-end protection which satisfies the standard Project Hurricane criteria, and only minor revisions are required along the transition floodwalls. Plates 33 through 34 show details of the pumping station plan and front end protection, as well as details of the discharge pipes of Pumping Station No. 1 crossing over the levee. No work-in-kind credits are required for this work.

The discharge pipes of the Segnette State Park Pumping Station, located at approximately Sta. 603+30 W/L, two 18 inch diameter pipes, will be passed through the floodwall using standard details for utility crossings, as shown on Plate 51.

The Segnette Pumping Station, located in the vicinity of Sta. 101+75 W/L, will be modified by replacing the existing steel sheet pile bulkhead fronting protection with a pile supported T-wall constructed on a granular fill embankment in the discharge canal, extending the existing discharge pipes through the floodwall, and installing butterfly type valves on the discharge pipes for positive cut-off. The existing tie rod anchor piles, required for stability of existing sheet pile cells supporting the pumping station, will be removed and the tie rods will be anchored to the new T-wall base. These modifications will have negligible effects on the existing discharge capacity of the pumping station. A typical section of this work is shown on Plate 36.

STRUCTURAL DESIGN

3-06. Criteria For Structural Design. The structural design to be used in preparing the final plans for construction of the structural features presented herein will comply with standard engineering practice and criteria set forth in Engineering Manuals and Engineering Technical

Letters for civil works construction published by the Office, Chief of Engineers, subject to modifications indicated by engineering judgement and experience to meet local conditions. The design is similar to the design presented in the Westwego to Harvey Canal, Louisiana, Hurricane Protection Project, Design Memorandum No. 1, General Design, Supplement No. 2, dated February 1990.

3-07. Basic Data. Basic data relevant to the design of the protective works are described above, in paragraphs titled "FLOODWALLS" and "PUMPING STATIONS".

3-08. Design Methods.

a. Structural steel. The design of steel structures is in accordance with the requirements of the allowable working stresses recommended in "Working Stresses for Structural Design", EM 1110-1-2101, dated 1 November 1963 and amendment No. 2, dated 17 January 1972. The basic working stress for ASTM a-36 steel is 18,000 psi. Steel for steel sheet piling will meet the requirements of ASTM 328, "Standard Specifications for Steel Sheet Piling".

b. Reinforced Concrete. The design of reinforced concrete structures is in accordance with the requirements of the strength design method of the current ACI Building Code, as modified by the guidelines of EM 1110-2-2104 "Strength Design Criteria for Reinforced Concrete Hydraulic Structures", dated January 1990. The basic minimum compressive strength concrete will be 3,000 psi, except for prestressed concrete piling where the minimum will be 5,000 psi. For convenient reference, pertinent stresses are tabulated below:

PERTINENT STRESSES FOR REINFORCED CONCRETE DESIGN

f 'c	3,000 psi
Maximum Flexural Reinforcement	48,000 psi
Minimum Flexural Reinforcement	0.25 x Balance Ratio
f 'c (For Prestressed Concrete Piles)	5,000 psi
fu (Prestressing Strands, Gr. 250)	250,000 psi
(Prestressing Strands, Gr. 270)	270,000 psi

3-09. I-Type Floodwall.

a. General. The I-walls consist of steel sheet piling driven into the reshaped existing earthen embankment. The upper portion of the sheet piling will be capped with concrete. The sheet piling will be driven to the required depth with 9 inches of the sheet piling extending above the finished ground elevation. The concrete portion of the floodwall will extend from 2 feet below the finished ground elevation

to the required protection height plus 6 inches to account for settlement. A typical I-wall section is shown on Plate 37.

b. Loading Cases. In the design of the I-walls, the loading cases to be considered will be as follows:

- Case I. Q-Case, F.S. = 1.5 with water to SWL
- Case II. Q-Case, F.S. = 1.0 with water to SWL + 2 ft

c. Joints. Expansion joints in the I-wall will be spaced approximately 30 feet apart, adjusted to fall at the steel sheet piling interlocks. To compensate for expansion, contraction, or displacement, three-bulb waterstops and premolded expansion joint fillers will be provided. Where the I-wall joins the T-wall, the deflection of the I-wall will produce a lateral displacement. To compensate for this displacement, a special sheet pile connection detail and a waterstop seal located in a notch in the I-wall have been designed to prevent water from flowing through this joint. Details of these joints are shown on Plates 38 through 40.

3-10. T-Type Floodwall.

a. General. The T-wall will consist of a reinforced concrete stem on a monolithic concrete base of varying width supported on prestressed concrete piles, except for the Fronting Protection T-wall at the Segnette Pumping Station which will be founded on steel H-piles. The base of the T-wall will be constructed on a four inch concrete stabilization slab. A continuous steel sheet pile wall will be provided beneath the base for seepage cutoff purposes. A typical T-wall at the Segnette Pumping Station discharge is shown on Plate 36. A typical T-wall section is shown on Plate 37.

b. Loading Cases. The T-walls will be designed for the following load conditions:

Case I. Static water pressure with water to SWL, no wind, impervious sheet pile cutoff, no dynamic wave force

Case II. Static water pressure with water to SWL, no wind, pervious sheet pile cutoff, no dynamic wave force

Case III. Static water pressure with water two feet above SWL, no wind, impervious sheet pile cutoff, no dynamic wave force (75% forces used).

Case IV. Static water pressure with water two feet above SWL, no wind, pervious sheet pile cutoff, no dynamic wave force (75% forces used).

Case V. No water, no wind.

Case VI. No water, wind from protected side (75% forces used).

Case VII. No water, wind from flood side (75% forces used).

Additionally, at the Segnette Pumping Station Front End Protection T-wall, the tension loads from the existing tie rods will be included in the above load cases.

c. Joints. Expansion joints in the T-wall will be spaced approximately forty feet apart, except at gate monoliths and at the pumping stations front-end protection. To compensate for expansion, contraction, or displacement, three-bulb waterstops and premolded expansion joint fillers will be provided.

3-11. Swing Gates and Gate Monoliths.

a. General. Gate monoliths will be constructed for street crossings in lieu of I-walls. Each gate monolith will include a steel swing gate which will be closed by local interests when a hurricane approaches. To assure a proper seal, the gates will be constructed so that they can be adjusted in either the horizontal or vertical direction. The side and bottom seals can also be adjusted as alternate or supplemental means to assure that a proper seal is obtained. Typical details of swing gates and gate monoliths are shown on Plates 42 through 47.

b. Loading Cases. The gate structures will be designed for the following load conditions:

Case I. Gate closed, static water pressure with water to SWL, no wind, impervious sheet pile cutoff, no dynamic wave force

Case II. Gate closed, static water pressure with water to SWL, no wind, pervious sheet pile cutoff, no dynamic wave force

Case III. Gate closed, static water pressure with water two feet above SWL, no wind, impervious sheet pile cutoff, no dynamic wave force (75% forces used).

Case IV. Gate closed, static water pressure with water two feet above SWL, no wind, pervious sheet pile cutoff, no dynamic wave force (75% forces used).

Case V. Gate open, no water, no wind, truck on protected side edge of base slab.

Case VI. Gate open, no water, no wind, truck on flood side edge of base slab.

Case VII. Gate open, no water, wind from protected side, truck on flood side edge of base slab (75% forces used).

Case VIII. Gate open, no water, wind from flood side, truck on protected side edge of base slab (75% forces used).

3-12. Cathodic Protection and Corrosion Control.

a. Cathodic Protection For Steel Sheet Piling. All steel sheet piling will be bonded together to obtain electrical continuity and no corrosion protection measures will be provided. Cathodic protection can be installed in the future if the need arises. The sheet piles will be bonded together with a No. 6 reinforcing bar welded to the top of each pile. Flexible wire jumpers insulated with cross-linked polyethylene will be welded or brazed to adjacent sheet piles at the monolith joints, 3 to 12 inches below the bottom of the concrete.

b. Corrosion Control. The steel gates, corner plates, and all ferrous metal components which are not galvanized or stainless steel will be coated with a 7-coat vinyl paint system as required for corrosion control.

RELOCATIONS

3-13. Relocations. There are several relocations, consisting of gas and oil pipelines; waterlines; and telephone, electrical, water and sewer service to the Segnette State Park cabins that will be impacted by the project. These utilities will be relocated to cross the project in accordance with the existing hurricane protection standards. Disruptions to existing facilities will be kept to a minimum. Typical details of utility crossings through the floodwall are shown on Plate 51.

SECTION 4 - COST ESTIMATE

4-01. Basis Of Cost Estimate. The cost estimate for the Lake Cataouatche Hurricane Protection Levee Project were prepared utilizing the MCACES computer system. However, all data for equipment, labor, and materials were manually entered in lieu of referencing the MCACES unit price book and data base. Thus, the cost estimate reflects current and applicable pricing and addresses specific construction procedures for the various line items in the estimate.

The estimated costs were based upon an analysis of each line item evaluating quantity, production rate, and time, together with the appropriate equipment, labor, and material costs. In addition, these costs were based on actual in-house knowledge and experience by NOD

cost engineers who either personally designed or estimated similar projects.

The construction site, located in Jefferson Parish but still in the metropolitan New Orleans area, is accessible from both land and water. By land, access is easily provided from U.S. Highway 90 and nearby I-310. From water, access is available via the GIWW to the Bayou Segnette Waterway.

All construction work (e.g., levees, floodwalls, pipelines) is common to NOD. In addition, all major construction materials - including structural steel and concrete, steel sheet piling and pipe, and steel and concrete piling are available locally. All earthen fill is obtained from Government-furnished borrow (either truck-hauled or adjacent borrow). The riprap and bedding material can be barged to the site, off-loaded, and truck-hauled for placement.

4-02. Contingencies. In obtaining contingencies, the cost estimate was subjected to a risk analysis to determine the degree of uncertainty associated with each line item in the estimate. The Range Estimating computer program, which incorporates risk analysis by varying both quantities and costs, was performed on the cost estimate yielding the contingency values in the cost estimate.

Contingencies for Engineering and Design are based on uncertainties involved in the preparation of P&S and in engineering during construction. These include cost of field data collection; unanticipated design problems; change in design based on the review of the report, due to information from surveys and soil borings and changes in design criteria; and changes in overhead rates.

The 20% contingencies for Construction Management are based on using a historical average of time growth for similar type contracts in the area. The time growth includes additional duration for unusually severe weather and unknown changes to the contracts.

4-03. Detailed Estimate. The total estimated first cost at October 1994 price levels is \$13,850,000. The detailed estimate of first cost is shown in Annex 2. When indexed to October 1996 price levels, the estimated first cost increased to \$14,806,000.

SECTION 5 - CONSTRUCTION SCHEDULE

5-01. General.

a. Contract 1. A separate contract will be awarded for construction of the levee from Sta. 0+00 B/L to Sta. 518+00 B/L. This

contract will include the levee over South Kenner Road and the U.S. Hwy 90 interface.

b. Contract 2. A separate contract will be awarded for construction of the floodwall from Sta. 518+00 B/L to Sta. 596+06.72 B/L.

c. Contract 3. A separate contract will be awarded for construction of the floodwall at the Segnette Pumping Station.

d. Contract 4. A separate contract will be awarded for second lift construction of the levee between Sta. 250+00 B/L to Sta. 518+05 B/L.

5-02. Schedule For Design And Construction. The schedule for design and construction is shown below.

Schedule For Design And Construction

	Design		Construction			Estimated
	Start	Complete	Advertise	Award	Complete	Cost ¹
Contract 1	May 97	Apr 98	May 98	Jun 98	Dec 01	\$4,390,000
Contract 2	May 97	Dec 97	Jan 98	Feb 98	Nov 98	\$3,249,000
Contract 3	Jul 97	Mar 98	Apr 98	May 98	Feb 99	\$2,089,000
Contract 4	Apr 06	Dec 06	Jan 07	Feb 07	Sep 07	\$800,000

¹This cost includes contingencies and Federal and non-Federal construction cost but not E&D and Construction Management costs. October 1995 price levels.

APPENDIX B**ECONOMICS****SECTION 9. RISK-BASED ANALYSIS**

GENERAL. Even though every attempt is made to ensure accuracy, a degree of uncertainty is implicit in many areas of planning for water resource projects. The uncertainty arises due to error in the data being measured or errors inherent in the methods used to estimate the values of certain critical variables. The potential for error exists throughout the traditional analysis because each of the variables has been assigned a single point value rather than a range of values. In order to compensate for possible error, risk-based analysis can be applied to the planning and design of water resource projects. This approach, which quantifies the extent of systematic risk, provides the decision-maker with a broader range of information. Thus, a decision can be made that reflects the explicit tradeoff between risks and costs.

In the following sections of this report, a summary of the results of the traditional NED analysis will be provided, and the results of the risk and uncertainty analysis for the Lake Cataouatche PAC study will be presented. The risk-based analysis was prepared in accordance with the procedures described in EC 1105-2-205, dated February 1994.

TRADITIONAL NED ANALYSIS. The traditional approach was used to formulate alignment alternatives that would provide hurricane protection for the Lake Cataouatche study area. Both an exterior alignment and an interior alignment were analyzed as part of the study. An analysis of the floodplain damage potential, the damages prevented, and the cost of five (5) alternative alignments was prepared. Each of the alternative alignments was found to provide a similar level of benefits at all levels of protection, including inundation reduction benefits ranging from \$8,362,000 at the 100-year level to \$8,534,000 at the SPH-level. The interior alignment alternatives (Plans 2A and 2B) were eliminated from further consideration due to their higher costs relative to the other plans, their lower net benefits, and their greater environmental impacts. Plan 1A, which requires backfilling the interior canal that runs parallel to the existing levee, was also eliminated early in the analysis due to its excessive cost relative to the other two exterior alignment alternatives, and their lower net benefits. Plan 1C was found to yield the greatest net benefits at all levels of protection relative to Plan 1B. Thus, Plan 1B was eliminated from further consideration, and Plan 1C was carried forward into the risk-based analysis in order to determine the optimal level of protection.

OVERVIEW OF RISK-BASED ANALYSIS. Risk-based analysis was used to determine the NED level of protection for Plan 1C. Also, the inherent uncertainty associated with each of the key hydrologic/hydraulic and economic variables in the analysis was quantified.

The analysis considered a range of possible values, with a maximum and a minimum value, for each economic variable used to calculate the elevation- or stage-damage curves, and for each hydrologic/hydraulic variable used to calculate the stage-frequency curves. It also considered a probability distribution for the likely occurrence of any given outcome within the specified range. The @Risk program used Monte Carlo simulation to derive the possible occurrences of each variable. Randomly generated numbers were used to simulate the occurrences of selected variables from within the established ranges and distributions. In a normal distribution, 68 percent of the possible outcomes occur within one standard deviation on either side of the mean (expected value), 95 percent occur within two standard deviations on either side of the mean, and 99.7 percent occur within three standard deviations.

For each variable, the computerized Latin Hypercube sampling technique was used to sample from within the range of possible values. With each sample, or iteration, a different value was selected. The number of iterations performed affects the simulation execution time and the quality and accuracy of the results. In most cases, 1,000 iterations were run. However, in the project-sizing template spreadsheet that selects from all the economic and hydrologic/hydraulic variables, 10,000 iterations were run. The sum of all sampled values divided by the number of samples yielded the expected value, or mean. This process was conducted simultaneously for each economic variable associated with each structure inventoried. The resulting mean value and probability distributions formed a comprehensive picture of all possible outcomes. In order to show the sensitivity of the results to changes in the number of iterations, New Orleans District conducted a test run of the economic uncertainty and reliability spreadsheets. It was determined that as the number of iterations was increased past 100, there was less than a 1 percent change in the mean or expected value. Also, there was considerably less than a 1 percent difference in the mean or expected value as the number of iterations was increased from 500 to 10,000.

Four @RISK simulation spreadsheets were used in the risk-based analysis for the Lake Cataouatche PAC. The first spreadsheet, which was developed in cooperation with Vicksburg District and Division, was used to calculate structural elevation-damage (or stage-damage) relationships in the risk analysis framework. The second spreadsheet, known as the project-sizing template, was developed by Hydrologic Engineering Center (HEC) and recently adapted for use in the Lake Cataouatche study by the Institute for Water Resources (IWR). This spreadsheet was used to integrate the results of the economic uncertainty analysis (elevation-damage curve with error) with the results of the hydrologic/hydraulic uncertainty analysis (stage-frequency curve with error) to produce the existing and future without-project and with-project expected annual damages under each of the three (3) levels of protection. The project-

sizing template was also used to determine the reliability of the various levee heights being considered to contain a specific flood event. The third spreadsheet was used to compare the existing and future without-project damages to the existing and future with-project damages, in order to produce the existing and future conditions benefits under each of the three (3) levels of protection. The fourth spreadsheet was used to convert the existing and future benefits in the risk analysis framework to an equivalent value, and finally, to perform the basic NED analysis.

ECONOMIC UNCERTAINTY. In the Lake Cataouatche PAC study, risk-based analysis was performed on four (4) key economic variables: structure values, contents-to-structure value ratios, first floor elevations, and depth-damage relationships. Each of these variables was analyzed for its impact on the elevation-damage curve. It should be noted that non-residential contents were not evaluated for risk-based analysis in the development of the elevation-damage curve. Only 1 percent of the total inundation reduction damages involved non-residential contents, and the error associated with this variable was not expected to materially affect net benefit estimates.

Structure Values. The surveyed value of each residential property in the structure inventory file, that was compiled during field surveys and valued by the Marshall and Swift Valuation Service, was assumed to have an error of plus or minus 10 percent based on professional judgment. Non-residential structures were assumed to have an error of plus or minus 20 percent based on professional judgment. These error percentages reflect possible miscalculations in the square footage of the structure, and/or inaccurate judgments regarding the age and quality of the structure. Vehicular damages were also assumed to have an error of plus or minus 10 percent based on professional judgment.

A TNORMAL probability density function, which is a normal distribution that is truncated at each end of the distribution by the limits of the range of possible values established, was used along with the surveyed value to calculate the mean and the standard normal deviation. The minimum value for residential structures and automobiles was assumed to be 10 percent below the mean, while the maximum value was assumed to be 10 percent above the mean. Non-residential structures had a minimum and maximum value based on a 20 percent estimated error.

Contents-to-Structure Value Ratios. A contents-to-structure value ratio of 51.2 percent was used in the Lake Cataouatche PAC. This percentage was based on the mean contents-to-structure value ratio (CSVr) for all the residential structures in Jefferson Parish on which an

FIA flood insurance claim was filed between the years 1978 and 1991. The range for the CSVr of residential structures was based on the standard deviation of 25.3 percent from all the national flood claims filed between 1978 and 1991, as calculated by the Institute for Water Resources (IWR). Research conducted by IWR and cited in EC 1105-2-205 (discussed below) determined that a TLOGNORMAL probability density function most closely fits the national and local data on structure and contents values. According to IWR, structure and contents values are not normally distributed and a lognormal distribution could be superimposed on the data to provide a closer fit. Thus, the TLOGNORMAL probability density function was used to describe the uncertainty associated with the contents-to-structure value ratio.

First Floor Elevations. The risk associated with first floor elevations was based on the existing estimates of error that were reported in EC 1105-2-205, Risk Analysis Framework for Evaluation of Hydrology/Hydraulics and Economics in Flood Damage Reduction Studies, dated 25 February 1994. According to EC 1105-2-205, first floor elevations for structures within the study area, which were derived using hand levels, should be assigned a standard deviation of 0.1 feet. Ground elevations, which were determined using aerial photographs with 1-foot contours, should be assigned a standard deviation of 0.3 feet. A TNORMAL probability density function was used to describe the uncertainty associated with this variable because it was assumed that the errors would be randomly distributed within the truncated range.

Depth-Damage Relationships. The range of the depth-damage relationships was based on a comparison of three depth-damage curves, which included the depth-damage relationships developed as part of the LPHPP, the depth-damage relationships from Huntington District, and the depth-damage relationships developed by the Tennessee Valley Authority. The average standard deviation of this relationship was found by Vicksburg District to be 25 percent. This was based on a comparison of the average standard deviations for each specific depth on the three curves. A TNORMAL probability density function was used to describe the uncertainty associated with this variable because it was assumed that the errors would be randomly distributed within the truncated range.

ECONOMIC UNCERTAINTY RESULTS. As discussed above, risk-based analysis was performed on four (4) key economic variables: structure values, CSVrs, first floor elevations, and depth-damage relationships. Each of these variables was analyzed for its impact on the elevation-damage relationships.

A range of interior elevations was established for each reach. The beginning damage elevation, as determined by the SID program in the traditional analysis, was used as the lowest elevation in the range. The SPH stage from the probable non-failure point (PNP) for the future without-project condition was used as the highest elevation in the range. Eight (8) possible elevations within the established range were selected to generate one generic interior elevation-damage with error relationship for each reach within the existing levee system. In order to account for apparent subsidence and future development, elevation-damage with error relationships were developed for both existing conditions (1994) and future conditions (2049).

Within the @Risk program, 1,000 iterations from the Latin Hypercube sampling were run for each of the eight selected elevations to determine a mean (expected value) damage and a standard deviation of the error for the interior reaches. Each iteration used a randomly selected value for each of the four economic variables. As the results of each iteration were compiled for each elevation, an elevation-damage with error curve was developed for each interior reach for the years 1994 and 2049.

A Lotus 1-2-3 spreadsheet was used to interpolate the elevations and standard deviations of the error and to produce an interior elevation-damage curve with error for each 0.1 foot increment in elevation for each reach. These curves were then combined with the interior stages associated with each frequency storm event and aggregated to develop an interior frequency-damage relationship with error for the entire study area. These relationships were developed for the without-project PFP and PNP scenarios, for both the existing (1994) and future (2049) conditions.

In accordance with PGL 26, the PFP and PNP frequency-damage with error curves were combined to produce one without-project frequency-damage with error curve under existing and future conditions for the entire study area. An 85 percent probability of occurrence was used for the PFP, while a 15 percent probability of occurrence was used for the PNP. (See Section 7 of the Economic Appendix for a more complete discussion of PGL 26.) Table 29A and 29B show the combined without-project frequency-damage with error curves.

Similar procedures as discussed above, with the exception of the PFP and PNP scenarios, were used to produce an interior frequency-damage with error curve for each of the three with-project conditions. Tables 30A and 30B show these curves for the existing and future with-project conditions for the 100-year, 200-year, and SPH levels of protection.

TABLE 20A
LAKE CATAGUATCHIE
WITHOUT PROJECT CONDITIONS
PFP AND PMP SCENARIOS
FREQUENCY-DAMAGE WITH ERROR
YEAR 1994

RETURN INTERVAL (YEAR)	FREQUENCY	EXTERIOR ELEVATION 1	PROBABILITY OF FAILURE	NON-FAILURE DAMAGES	FAILURE DAMAGES	FAILURE ERROR	WITHOUT PROJECT DAMAGES	WITHOUT PROJECT ERROR
1	1.0000	1.72		\$0	\$0	\$0	\$0	\$0
2	0.5000	2.90		\$2,130,782	\$463,381	\$2,130,782	\$2,130,782	\$463,381
5	0.2000	3.10		\$4,236,301	\$556,442	\$4,236,301	\$4,236,301	\$556,442
10	0.1000	3.90	0.150	\$6,649,641	\$696,835	\$6,649,641	\$13,246,369	\$1,226,870
25	0.0400	4.80	0.450	\$8,632,210	\$716,755	\$7,915,455	\$34,331,147	\$2,862,250
50	0.0200	5.40	0.650	\$10,063,942	\$2,343,401	\$7,720,541	\$59,967,342	\$4,267,098
100	0.0100	6.00	0.850	\$90,816,500	\$5,642,444	\$85,174,056	\$99,433,856	\$8,115,862
200	0.0050	6.70	1.000	\$111,081,634	\$4,451,509	\$106,630,125	\$126,475,654	\$7,059,314
500	0.0020	7.50	1.000	\$143,634,137	\$7,194,136	\$136,440,001	\$151,612,956	\$7,362,700

TABLE 20B
LAKE CATAGUATCHIE
WITHOUT PROJECT CONDITIONS
PFP AND PMP SCENARIOS
FREQUENCY-DAMAGE WITH ERROR
YEAR 2049

RETURN INTERVAL (YEAR)	FREQUENCY	EXTERIOR ELEVATION 1	PROBABILITY OF FAILURE	NON-FAILURE DAMAGES	FAILURE DAMAGES	FAILURE ERROR	WITHOUT PROJECT DAMAGES	WITHOUT PROJECT ERROR
1	1.0000	2.02		\$0	\$0	\$0	\$0	\$0
2	0.5000	2.90		\$1,693,093	\$492,528	\$1,693,093	\$1,693,093	\$492,528
5	0.2000	3.40		\$4,123,544	\$566,862	\$4,123,544	\$4,123,544	\$566,862
10	0.1000	4.15	0.190	\$4,236,184	\$776,485	\$3,459,699	\$22,874,463	\$1,964,969
25	0.0400	5.40	0.447	\$112,264,981	\$7,539,640	\$104,725,341	\$136,605,954	\$9,273,102
50	0.0200	6.20	0.636	\$186,397,831	\$11,586,126	\$174,811,705	\$271,037,098	\$14,209,665
100	0.0100	7.10	0.836	\$209,775,161	\$14,675,161	\$195,100,000	\$305,496,942	\$15,292,558
200	0.0050	7.80	1.000	\$204,462,500	\$15,291,142	\$189,171,358	\$337,053,777	\$17,334,786
500	0.0020	8.00	1.000	\$337,451,465	\$17,334,536	\$320,116,929	\$337,053,777	\$17,334,786

1/ Elevations are based on the exterior still water elevation associated with a given frequency event. The associated crest elevation of the with-project conditions will vary from 2 to 3 feet above the still water level based on susceptibility to wave run-up.

TABLE 30A
LAKE CATAQUATCHE
WITH-PROJECT CONDITIONS
FREQUENCY-DAMAGE WITH ERROR
YEAR 1994

RETURN INTERVAL	100-YEAR PROTECTION EXTERIOR ALIGNMENT		200-YEAR PROTECTION EXTERIOR ALIGNMENT		500-YEAR PROTECTION EXTERIOR ALIGNMENT	
	DAMAGE	STANDARD DEVIATION OF THE ERROR	DAMAGE	STANDARD DEVIATION OF THE ERROR	DAMAGE	STANDARD DEVIATION OF THE ERROR
2	\$2,130,782	\$463,381	\$2,130,782	\$463,381	\$2,130,782	\$463,381
5	\$4,236,301	\$556,442	\$4,236,301	\$556,442	\$4,236,301	\$556,442
10	\$6,649,641	\$695,835	\$6,649,641	\$695,835	\$6,649,641	\$695,835
25	\$6,649,641	\$695,835	\$6,649,641	\$695,835	\$6,649,641	\$695,835
50	\$6,649,641	\$695,835	\$6,649,641	\$695,835	\$6,649,641	\$695,835
100	\$6,649,641	\$695,835	\$6,649,641	\$695,835	\$6,649,641	\$695,835
200	\$12,327,877	\$1,369,206	\$6,649,641	\$695,835	\$6,649,641	\$695,835
500	\$48,921,863	\$3,939,631	\$13,044,885	\$1,482,578	\$6,649,641	\$695,835

TABLE 30B
LAKE CATAQUATCHE
WITH-PROJECT CONDITIONS
FREQUENCY-DAMAGE WITH ERROR
YEAR 2049

RETURN INTERVAL	100-YEAR PROTECTION EXTERIOR ALIGNMENT		200-YEAR PROTECTION EXTERIOR ALIGNMENT		500-YEAR PROTECTION EXTERIOR ALIGNMENT	
	DAMAGE	STANDARD DEVIATION OF THE ERROR	DAMAGE	STANDARD DEVIATION OF THE ERROR	DAMAGE	STANDARD DEVIATION OF THE ERROR
2	\$1,693,093	\$492,928	\$1,693,093	\$492,928	\$1,693,093	\$492,928
5	\$4,125,096	\$586,953	\$4,125,096	\$586,953	\$4,125,096	\$586,953
10	\$6,242,288	\$776,618	\$6,242,288	\$776,618	\$6,242,288	\$776,618
25	\$6,242,288	\$776,618	\$6,242,288	\$776,618	\$6,242,288	\$776,618
50	\$6,242,288	\$776,618	\$6,242,288	\$776,618	\$6,242,288	\$776,618
100	\$6,242,288	\$776,618	\$6,242,288	\$776,618	\$6,242,288	\$776,618
200	\$9,967,943	\$1,337,006	\$6,242,288	\$776,618	\$6,242,288	\$776,618
500	\$42,014,646	\$3,850,154	\$8,689,119	\$1,103,387	\$6,242,288	\$776,618

Exterior stage-frequency curves for existing and future without-project conditions were provided by the H&H Branch. These curves include stages for eight (8) frequency storms (2, 5, 10, 25, 50, 100, 200, and 500-year events). A direct relationship between exterior stage and interior damage was assumed (i.e., an exterior stage of 6.0 feet results in a given interior damage value regardless of the event frequency). An exterior elevation/interior damage relationship with error was derived by combining the exterior stage-frequency relationships with the corresponding interior frequency-damage relationships. These relationships, which were developed for the without-project conditions, and for the 100-year, 200-year, and SPH-levels of protection under existing (1994) conditions and future (2049) conditions, are shown in Tables 31A and 31B. These curves, which take into account the economic uncertainty, were then put into the project-sizing template that also addresses the inherent hydrologic/hydraulic uncertainty.

HYDROLOGIC/HYDRAULIC UNCERTAINTY. Risk and uncertainty analysis was performed on the exterior stage-frequency curves provided by the H&H Branch. Of the five (5) gages located in the Barataria Basin, of which the Lake Cataouatche study area is a part, the Harvey Canal gage and the Lafitte gage were used most extensively to model the study area. For the more frequent storm events (50-year or less), stages recorded by the Harvey Canal gage at the Intracoastal Waterway were used, while stages recorded by the Bayou Barataria gage at Lafitte were used for the less frequent (100-year or higher) events. The elevation or stage-damage function for the interior reaches was fixed relative to the exterior stages and the confidence limits for each particular frequency. The computer program "LIMIT", which was developed by HEC for non-analytical frequency curves, was used in the computation of confidence limits for each stage. The program extrapolated the stage-frequency curves for the existing and future conditions from the 99.9 percent chance of exceedance (1-year storm) to the 0.01 percent chance of exceedance (10,000-year storm). The confidence level was found to be higher for the more frequent storm events, and lower for the less frequent storm events. For example, the computed error increases from 0.123 feet at the 50 percent chance of exceedance to over 2 feet at the 0.01 percent chance of exceedance. (See the Hydrologic/Hydraulic Appendix for a more complete discussion of this type of uncertainty).

PROJECT-SIZING DAMAGE RESULTS. The second spreadsheet used in the risk-based analysis was the project-sizing template that was developed by HEC and recently modified by IWR for stage-frequency data. It was used to integrate the results of the economic uncertainty analysis (elevation-damage with error) with the results of the hydrologic/hydraulic uncertainty

TABLE 31A
LAKE CATLAQUATCHE
ELEVATION DAMAGE WITH ERROR
WITHOUT AND WITH-PROJECT CONDITIONS
YEAR 1994

RETURN PERIOD (YEAR)	EXTREMITY ELEVATION ^{1/}	WITHOUT-PROJECT			100-YEAR			500-YEAR		
		DAMAGE	STANDARD DEVIATION OF THE ERROR	STANDARD DEVIATION OF THE ERROR	DAMAGE	STANDARD DEVIATION OF THE ERROR	STANDARD DEVIATION OF THE ERROR	DAMAGE	STANDARD DEVIATION OF THE ERROR	STANDARD DEVIATION OF THE ERROR
1	1.72	00	00	00	00	00	00	00	00	00
2	2.00	\$2,125,702	\$462,291	\$462,291	\$2,125,702	\$462,291	\$462,291	\$2,125,702	\$462,291	\$462,291
5	3.10	\$4,258,301	\$694,442	\$694,442	\$4,258,301	\$694,442	\$694,442	\$4,258,301	\$694,442	\$694,442
10	3.80	\$12,946,399	\$1,238,870	\$1,238,870	\$12,946,399	\$1,238,870	\$1,238,870	\$12,946,399	\$1,238,870	\$1,238,870
25	4.80	\$24,251,147	\$2,298,289	\$2,298,289	\$24,251,147	\$2,298,289	\$2,298,289	\$24,251,147	\$2,298,289	\$2,298,289
50	5.40	\$46,877,242	\$4,257,289	\$4,257,289	\$46,877,242	\$4,257,289	\$4,257,289	\$46,877,242	\$4,257,289	\$4,257,289
100	6.00	\$86,476,486	\$7,125,702	\$7,125,702	\$86,476,486	\$7,125,702	\$7,125,702	\$86,476,486	\$7,125,702	\$7,125,702
200	6.70	\$126,476,486	\$11,238,870	\$11,238,870	\$126,476,486	\$11,238,870	\$11,238,870	\$126,476,486	\$11,238,870	\$11,238,870
500	7.80	\$181,412,000	\$17,298,289	\$17,298,289	\$181,412,000	\$17,298,289	\$17,298,289	\$181,412,000	\$17,298,289	\$17,298,289

TABLE 31B
LAKE CATLAQUATCHE
ELEVATION DAMAGE WITH ERROR
WITHOUT AND WITH-PROJECT CONDITIONS
YEAR 2048

RETURN PERIOD (YEAR)	EXTREMITY ELEVATION ^{1/}	WITHOUT-PROJECT			100-YEAR			500-YEAR		
		DAMAGE	STANDARD DEVIATION OF THE ERROR	STANDARD DEVIATION OF THE ERROR	DAMAGE	STANDARD DEVIATION OF THE ERROR	STANDARD DEVIATION OF THE ERROR	DAMAGE	STANDARD DEVIATION OF THE ERROR	STANDARD DEVIATION OF THE ERROR
1	2.02	00	00	00	00	00	00	00	00	00
2	2.50	\$1,089,688	\$462,290	\$462,290	\$1,089,688	\$462,290	\$462,290	\$1,089,688	\$462,290	\$462,290
5	3.40	\$4,125,044	\$694,442	\$694,442	\$4,125,044	\$694,442	\$694,442	\$4,125,044	\$694,442	\$694,442
10	4.15	\$12,974,466	\$1,238,870	\$1,238,870	\$12,974,466	\$1,238,870	\$1,238,870	\$12,974,466	\$1,238,870	\$1,238,870
25	5.40	\$24,251,147	\$2,298,289	\$2,298,289	\$24,251,147	\$2,298,289	\$2,298,289	\$24,251,147	\$2,298,289	\$2,298,289
50	6.00	\$46,877,242	\$4,257,289	\$4,257,289	\$46,877,242	\$4,257,289	\$4,257,289	\$46,877,242	\$4,257,289	\$4,257,289
100	6.70	\$86,476,486	\$7,125,702	\$7,125,702	\$86,476,486	\$7,125,702	\$7,125,702	\$86,476,486	\$7,125,702	\$7,125,702
200	7.40	\$126,476,486	\$11,238,870	\$11,238,870	\$126,476,486	\$11,238,870	\$11,238,870	\$126,476,486	\$11,238,870	\$11,238,870
500	8.00	\$181,412,000	\$17,298,289	\$17,298,289	\$181,412,000	\$17,298,289	\$17,298,289	\$181,412,000	\$17,298,289	\$17,298,289

^{1/} Elevations are based on the exterior sill water elevation associated with a given frequency event. The associated crest elevation of the protection for the sub-project conditions will vary from 2 to 3 feet above the sill water level based on susceptibility to wave run-up.

analysis (stage-frequency with error) to produce the existing and future without-project and with-project expected annual damages in a risk-based framework. Within the @Risk program, 10,000 iterations from the Latin Hypercube sampling were run for the existing and future without-project conditions, and for the existing and future with-project conditions under each of the three (3) levels of protection. This process was used to determine a mean (expected value) damage and a standard deviation of the error. With each sample, or iteration, a different flood event was selected from the range of possible events. The sum of all sampled values divided by the number of samples yielded the expected value, or mean damage with error, which together with the probability distributions, formed a comprehensive picture of all possible outcomes. Table 32A shows the mean damage, standard deviation of the error, and the minimum and maximum damage values for the existing without-project conditions, and for the with-project conditions under the three levels of protection. Table 32B displays the same data for the future without-project and with-project conditions.

PROJECT-SIZING EXPECTED ANNUAL BENEFIT RESULTS. Project benefits with error are defined as the difference between the without-project and with-project damages with error. In order to calculate these benefits with a mean, or expected value, and a probability distribution, a third @Risk spreadsheet was developed using the histogram function from the statistical reports produced by the project-sizing template. The histogram function contains the range of damages and their associated probabilities for each existing and future without-project and with-project condition. Within this @Risk spreadsheet, 10,000 iterations from the Latin Hypercube sampling were run for the existing and future without-project conditions and for each of the existing and future with-project conditions under the three (3) levels of protection to determine a mean (expected value) benefit and a standard deviation of the error. With each sample, or iteration, a different level of damage was selected from the range of possible without-project and with-project damages. Since there is a correlation between without-project and with-project conditions, a correlation factor was used in the program to ensure that with each iteration, the without-project and with-project damages selected from the range would have a similar set of underlying assumptions. For example, if a structure value below the mean within the probability distribution was randomly selected by the program under without-project conditions, then the program would also randomly select a structure value below the mean under with-project conditions. Thus, if a value representing low without-project damages was selected, a similar low with-project damage value would be selected from the probability distribution. The sum of all sampled values divided by the number of samples yielded the expected values, or mean without-project damages and mean with-project damages. Finally, the program took the difference between the mean without-

TABLE 32A
LAKE CATAOUATCHE
EXPECTED ANNUAL DAMAGES WITH ERROR
WITHOUT AND WITH-PROJECT
EXISTING CONDITIONS (1994)
(\$1,000's)

	Without-Project	Levels of Protection		
		100-Year	200-Year	SPH
Expected Damages	\$7,115	\$3,147	\$2,966	\$2,939
Standard Deviation	\$2,584	\$694	\$582	\$564
Minimum Damages	\$1,331	\$744	\$974	\$1,027
Maximum Damages	\$20,877	\$5,933	\$5,303	\$5,172

TABLE 32B
LAKE CATAOUATCHE
EXPECTED ANNUAL DAMAGES WITH ERROR
WITHOUT AND WITH-PROJECT
FUTURE CONDITIONS (2049)
(\$1,000's)

	Without-Project	Levels of Protection		
		100-Year	200-Year	SPH
Expected Damages	\$16,565	\$2,790	\$2,629	\$2,617
Standard Deviation	\$6,546	\$714	\$610	\$602
Minimum Damages	\$1,443	\$464	\$740	\$472
Maximum Damages	\$46,787	\$5,709	\$4,900	\$5,116

project damages and the mean with-project damages and produced the mean expected annual benefits and probability distributions for both existing (1999) and future (2049) conditions.

Table 33A shows the expected benefits, standard deviation of the error, and the minimum and maximum benefit values for the existing with-project conditions under the three levels of protection. Table 33B displays the same data for the future with-project conditions.

PROJECT-SIZING EQUIVALENT ANNUAL BENEFIT RESULTS. The fourth @Risk spreadsheet, which was developed by New Orleans District, was used to convert the existing and future expected (or mean) benefits with error to equivalent annual benefits with error for each of the three (3) levels of protection. The histogram function from the statistical reports produced by the third @Risk spreadsheet was used to convert the benefits with error to an equivalent annual value.

The histogram function contains the range of benefits and their associated probabilities for the existing (1994) and future (2049) with-project conditions. Within this @Risk spreadsheet, 10,000 iterations from the Latin Hypercube sampling were run for the existing and future conditions under each of the three (3) levels of protection to determine an equivalent mean, or expected, benefit and a standard deviation of the error. With each sample, or iteration, a different level of existing and future project benefits was selected from the range of possible existing and future with-project benefits. Since there is a correlation between existing and future benefits, a correlation factor was used in the program to ensure that with each iteration, the existing and future benefits selected from the range would have a similar set of underlying assumptions. Thus, if a value representing low benefits was selected under the existing 1994 conditions, a similar low benefit value would be selected from the probability distribution for the future 2049 conditions. Each selected sample of existing and future benefits was converted within the spreadsheet to an equivalent time frame by using the Federal discount rate of 7-3/4 percent and a project life of 100 years. The base year for this conversion is the year 2000, when the project becomes operational. Straight line interpolation was used to calculate expected annual benefits between the years 1994 and 2049, while the level of expected annual benefits was held constant during the following 50-year period ending in the year 2099. The sum of all sampled values divided by the number of samples yielded the equivalent annual mean benefit with error. The resulting mean value and probability distributions formed a comprehensive picture of all possible benefit outcomes for each of the three (3) levels of protection.

TABLE 33A
LAKE CATAOUATCHE
EXPECTED ANNUAL BENEFITS WITH ERROR
EXISTING CONDITIONS (1994)
(\$1,000's)

	Levels of Protection		
	100-Year	200-Year	SPH
Expected Benefits	\$3,968	\$4,149	\$4,176
Standard Deviation	\$1,894	\$2,008	\$2,027
Minimum Benefits	\$505	\$356	\$307
Maximum Benefits	\$14,944	\$15,629	\$15,742

TABLE 33B
LAKE CATAOUATCHE
EXPECTED ANNUAL BENEFITS WITH ERROR
FUTURE CONDITIONS (2049)
(\$1,000's)

	Levels of Protection		
	100-Year	200-Year	SPH
Expected Benefits	\$13,775	\$13,936	\$13,948
Standard Deviation	\$5,835	\$5,940	\$5,951
Minimum Benefits	\$979	\$728	\$695
Maximum Benefits	\$41,078	\$41,736	\$41,598

Table 34 shows the mean equivalent annual benefits, the standard deviation of the error, and the minimum and maximum benefit values under each of the three (3) levels of protection. It also shows the effectiveness of each level of protection in reducing the without-project equivalent annual damages, which were estimated to be \$10,302,299.

Figures 2, 3, and 4 graphically depict the range of equivalent annual benefits at the 95 percent confidence level for each of the three (3) levels of protection. As shown in the figures, there is a 95 per cent chance that the equivalent annual benefits will be greater than \$1.97 million but less than \$14.29 million for the 100-year level of protection. There is a 95 per cent chance that the equivalent annual benefits will be greater than \$2 million but less than \$14.77 million for the 200-year level, and greater than \$1.97 million but less than \$14.83 million for the SPH-level.

COMPARISON OF PROJECT-SIZING EQUIVALENT ANNUAL BENEFITS AND COSTS.

The equivalent annual benefits with error for each of the three (3) levels of protection were then compared to the equivalent annual costs for Plan 1C, which was derived from the traditional analysis. Table 28C on page 65 of this Appendix provides a detailed summary of the equivalent annual costs for Plan 1C at each level of protection, including interest during construction, gross investment, operation and maintenance costs, future protection costs, and mitigation costs.

Table 35 shows the first costs, the equivalent annual costs, mean equivalent annual benefits from the project-sizing template, the net benefits derived from the implementation of Plan 1C under each of the three (3) levels of protection, and the benefit-cost ratios. The project-sizing equivalent annual benefits were found to be approximately \$1 million lower than those derived using traditional analysis. However, a consistent relationship exists between the benefits and the three (3) levels of protection under both the traditional and risk-based approaches. In spite of being reduced, the project-sizing benefits remained considerably higher than the costs of the three (3) levels of protection.

Table 35 also shows the results of the project-sizing template. The median exceedance probability, which is the computed frequency curve without the expected probability adjustment, has been provided for each level of protection. The simulation exceedance probabilities, developed through the 10,000 iterations of the Monte Carlo simulation model, have also been provided for each of the design stages. The simulation exceedances occur more frequently than the median frequencies for all three levels of protection. This indicates

TABLE 34
LAKE CATAQUATCHE
EQUIVALENT ANNUAL BENEFITS WITH ERROR
(\$1,000's)

	Levels of Protection		
	100-Year	200-Year	SPH
Expected Benefits	\$7,277	\$7,447	\$7,467
Standard Deviation	\$3,246	\$3,360	\$3,383
Minimum Benefits	\$668	\$485	\$542
Maximum Benefits	\$23,747	\$24,423	\$24,452
% Damages Prevented	71%	72%	72%

*Without project equivalent annual damages were estimated to be \$10,302,299.

FIGURE 2
LAKE CATAQUATCHE
PROBABILITY DISTRIBUTION
EQUIVALENT ANNUAL BENEFITS
95 PERCENT CONFIDENCE INTERVAL

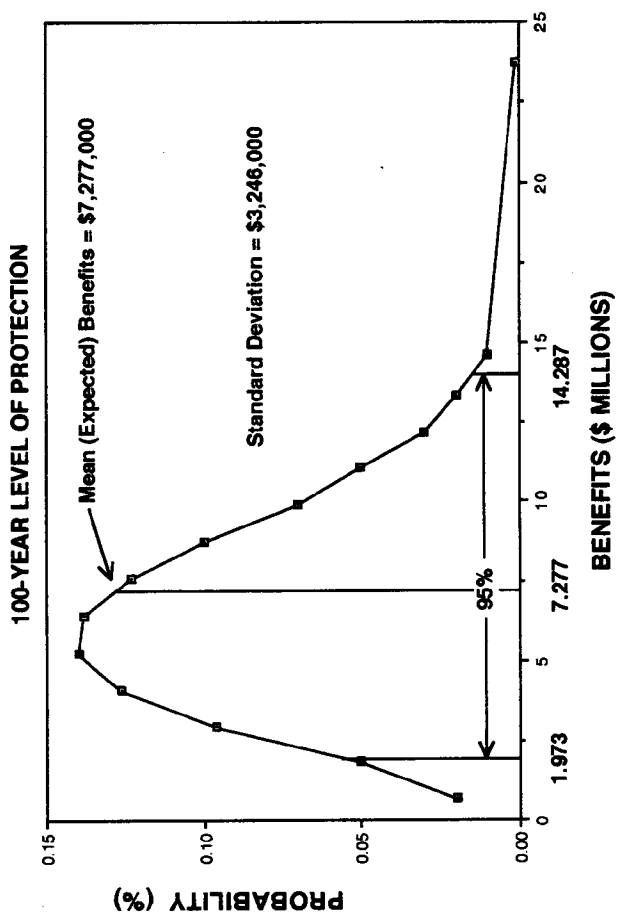


FIGURE 3
LAKE CATAQUATCHE
PROBABILITY DISTRIBUTION
EQUIVALENT ANNUAL BENEFITS
95 PERCENT CONFIDENCE INTERVAL

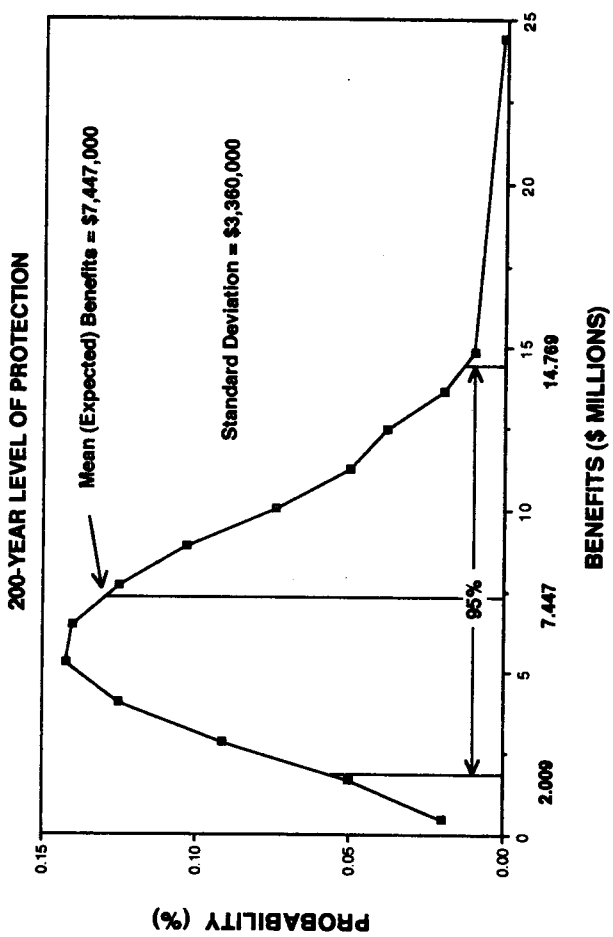


FIGURE 4
LAKE CATAOUATCHÉ
PROBABILITY DISTRIBUTION
EQUIVALENT ANNUAL BENEFITS
95 PERCENT CONFIDENCE INTERVAL

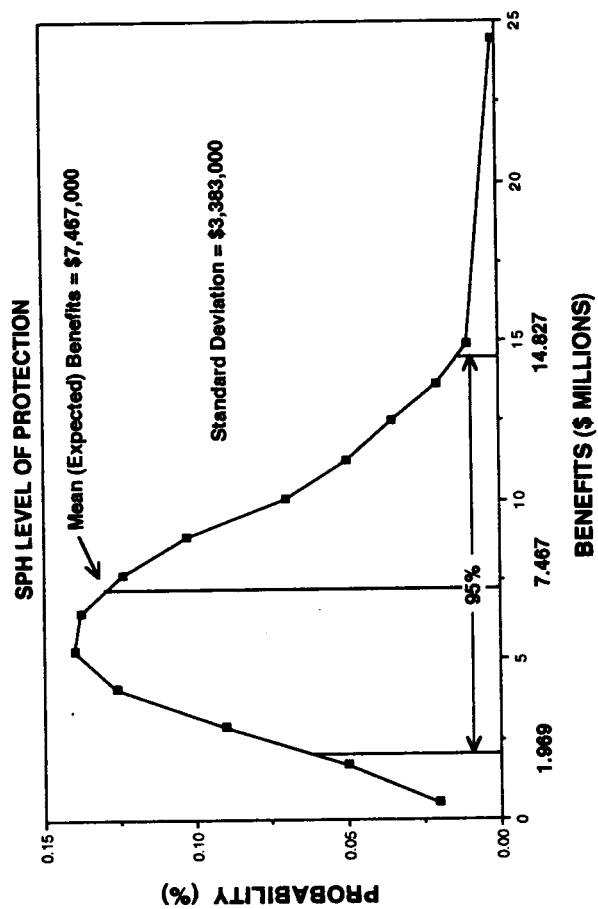


TABLE 35
LAKE CATAGUATCHIE
SUMMARY OF EQUIVALENT ANNUAL COSTS AND BENEFITS
AND RESULT OF
THE PROJECT-SIZING TEMPLATE
(\$1,000's)

DESIGN STAGE	FIRST COSTS	EQUIVALENT ANNUAL BENEFITS	ANNUAL COSTS	NET BENEFITS	B/C RATIO	MEDIAN EXCEEDANCE PROBABILITY	SIMULATION EXCEEDANCE PROBABILITY
6.0 ft (100-yr)	8,003	7,277	731	6,546	9.95	0.01	0.0114
6.7 ft (200-yr)	9,238	7,447	836	6,611	8.91	0.005	0.0066
7.5 ft (SPH)	10,101	7,467	903	6,564	8.27	0.002	0.0027

for example, that a 200-year project design may in fact only provide a 150-year level of protection. The simulation exceedances reflect the uncertainties in the stage-frequency curve, and thus provide the more accurate estimate of project exceedances.

The probabilities of possible benefit-cost ratios can be determined by dividing the mean equivalent annual benefits by the annual cost under the three (3) levels of protection. The equivalent annual benefit probability curve can then be converted to a benefit-cost ratio probability curve. Figures 5, 6, and 7 display the project-sizing benefits for each level of protection and the corresponding probabilities derived from the risk-based analysis. As shown in the figures, there is better than a 99 percent chance that there will be a benefit-cost ratio greater than 1.0 under each of the three (3) levels of protection. There is better than a 97 percent chance that the benefit-cost ratio will be greater than 2.0.

PROJECT RELIABILITY. The project-sizing template can also be used to determine the reliability of the various design stages for the Lake Cataouatche levee. Within the project-sizing template, 1,000 iterations from the Latin Hypercube sampling were run using the existing condition exterior stage-frequency curve with error. With each sample, or iteration, a different stage value was selected from the range of possible stages for a given frequency storm event. The sum of all the sampled values divided by the number of samples yielded the expected value, or mean stage with error. The mean stage with error, together with its probability distribution, formed a comprehensive picture of all possible outcomes for the selected storm event. The result of this process yielded the reliability of a particular project size to contain a specific frequency flood event. The reliabilities for the various design stages for the Lake Cataouatche levee are presented in Table 36. For example, a design stage of 6.0 feet NGVD (100-year event stage with a 1 percent probability of exceedance) has a 98.6 percent chance of containing the 25-year storm, a 82.0 percent chance of containing the 50-year storm, a 50 percent chance of containing the 100-year storm, an 22.5 percent chance of containing the 200-year storm, and a 8.4 percent chance of containing the 500-year storm.

FIGURE 5
LAKE CATAQUATCHE
EQUIVALENT ANNUAL BENEFITS PROBABILITY CURVE
100-YEAR LEVEL OF PROTECTION

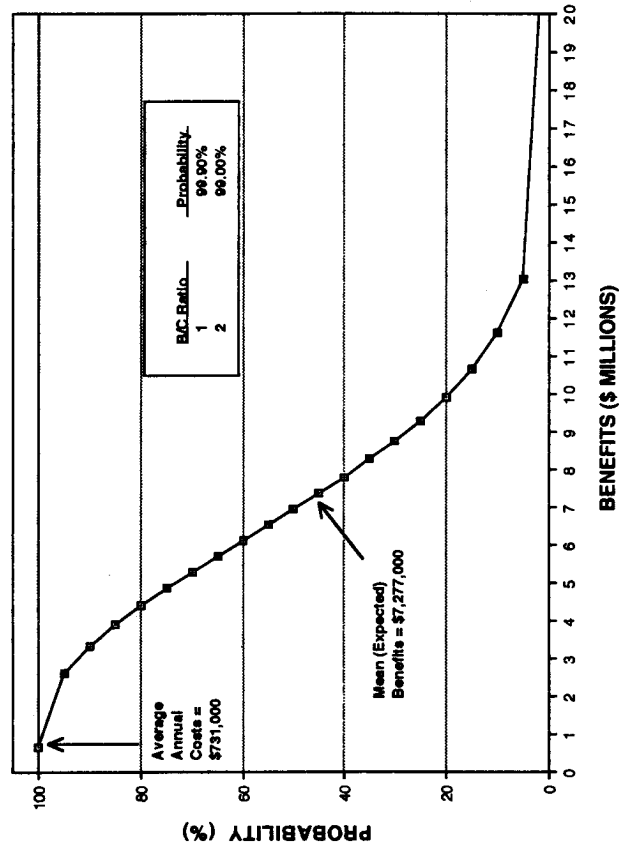


FIGURE 6
LAKE CATAQUATCHE
EQUIVALENT ANNUAL BENEFITS PROBABILITY CURVE
200-YEAR LEVEL OF PROTECTION

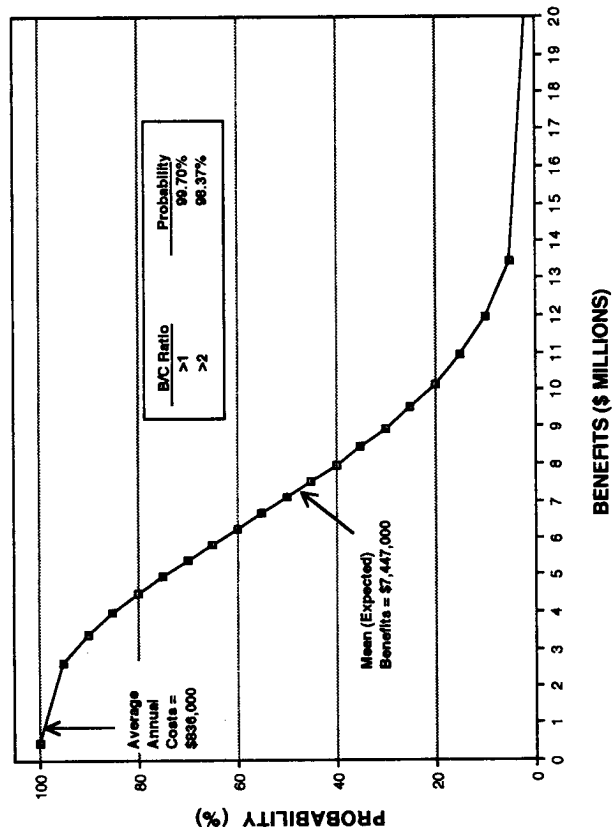


FIGURE 7
LAKE CATAQUATCHE
EQUIVALENT ANNUAL BENEFITS PROBABILITY CURVE
SPH LEVEL OF PROTECTION

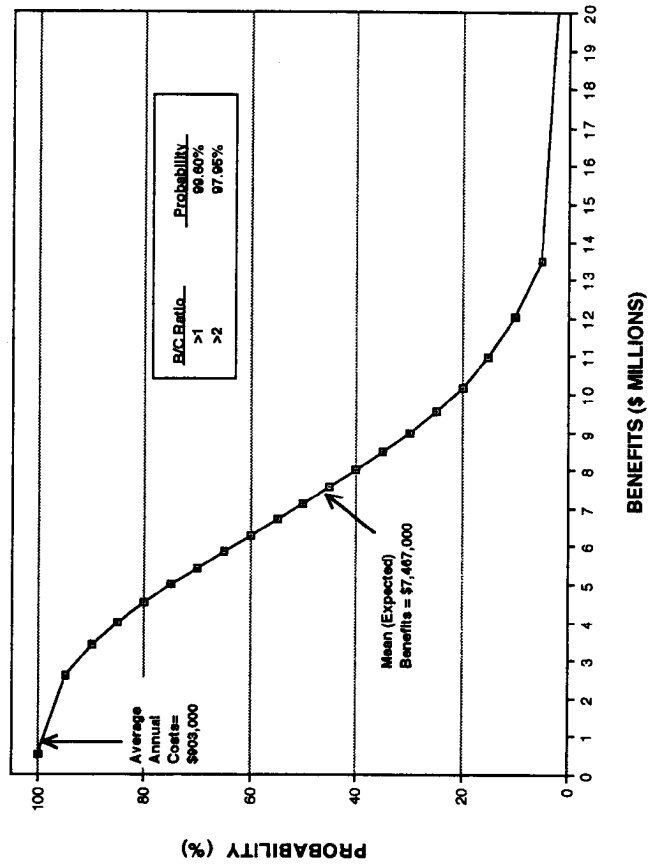


TABLE 36
LAKE CATAQUATCHI
RELIABILITY OF DESIGN STAGE
FOR VARIOUS FREQUENCY EVENTS

Design Stage	Percent Chance of of Non-Exceedance ¹				
	25-Year Event	50-Year Event	100-Year Event	200-Year Event	SPH Event
5.0	64.7	27.1	10.0	3.3	1.2
6.0 (100-yr)	98.6	82.0	50.0	22.5	8.4
6.5	100.0	95.4	74.0	41.4	17.9
6.7 (200-yr)	100.0	97.7	81.6	50.0	23.1
7.0	100.0	99.3	91.1	62.7	32.3
7.5 (SPH)	100.0	100.0	97.3	80.8	50.0
8.0	100.0	100.0	99.5	92.2	67.8

¹ Probability that the selected event would be contained within the specified design stage.

NED LEVEL OF PROTECTION. The NED level of protection is the one that most reasonably maximizes net tangible economic development benefits consistent with Federal regulations. Benefits are maximized at the point where the excess benefits over costs is the greatest, and marginal costs equal marginal benefits. The net benefits of the project begin to decrease at any level of protection past this point. The NED level of protection for Plan 1C was determined by comparing the equivalent annual costs to the mean equivalent annual benefits with error under each of the three (3) levels of protection.

As previously shown in Table 35, the 200-year level of protection yielded the highest net benefits and is the NED level. It should be noted that the 200-year level was also found to yield the highest net benefits in the traditional analysis. As shown previously in Figure 6, which displays the equivalent annual benefit-probability curve for the 200-year level of protection, there is a 99.7 percent chance that there will be a benefit-cost ratio greater than 1.0, and a 98.4 percent chance that there will be a benefit-cost ratio greater than 2.0.

SECTION 10. RECOMMENDED PLAN

GENERAL. Even though the 200-year level of protection for Plan 1C yields the highest net benefits, the SPH level of protection was selected as the recommended plan. The analysis leading to this decision included a comprehensive review of all the economic, social, hydraulic, environmental, and public interest factors relating to the project. SPH protection provides an additional \$20,000 in mean equivalent annual benefits. The difference in first cost between the 200-year level of protection (\$9,238,000) and the SPH level of protection (\$10,101,000) is \$863,000. This results in an increase of \$67,000 in the average annual cost. The resulting incremental B/C ratio is 0.30.

There are three major factors that led to the selection of SPH protection for the Lake Cataouatche area. First, the SPH level of protection is consistent with the existing protection in the adjacent areas of the New Orleans metropolitan area. The residents of this community would expect equal protection with other nearby areas. Without this consistency, the required evacuation of only the residents in the Lake Cataouatche area could become ineffective. Residents may not have a clear understanding as to the degree of protection provided by the project, thus endangering their lives.

Second, the expected damages under existing without-project conditions for the 500-year event total approximately \$165,000,000. With the 200-level of protection, these damages are reduced to approximately \$13,000,000. SPH protection reduces these damages by an additional \$5,000,000.

The probability of the protection functioning as designed is the third factor that was considered. The 200-year level of protection would have a 97.7 percent chance of containing the 50-year event, an 81.6 percent chance of containing the 100-year event, a 50 percent chance of containing the 200-year event, and only a 23.1 percent chance of containing the 500-year event. The recommended plan would have a 100 percent chance of containing the 50-year event, a 97.3 percent chance of containing the 100-year event, an 80.8 percent chance of containing the 200-year event, and a 50.0 percent chance of containing the 500-year event. Constructing a Federal project with only a 50 percent chance of containing the 200-year event and a 23.1 percent of containing the 500-year event does not seem adequate given the projections for continued development within the area. Providing the area with SPH protection increases the probability of containment by over 30 percent for the 200-year storm and over 25 percent for the 500-year storm.

M-CACES COST ESTIMATE, GROSS APPRAISAL, AND REAL ESTATE COST ESTIMATE. Upon selection of the recommended plan, an M-CACES Cost Estimate, a Gross Appraisal, and a Real Estate Supplement were prepared for Plan 1C under the SPH level of protection. Because a considerable amount of time and cost is associated with the development of these additional data, it is cost prohibitive to generate these data for each of the other levels of protection. The cost presented for the recommended plan cannot be compared to the cost for the alternative plans because it contains a different level of detail. If these data were also generated for the other alternative plans, similar cost increases would be expected.

The costs and benefits reflect October 1996 price levels. It should be noted that the base year used in the M-CACES Cost Estimate is the year 2001, rather than the year 2000 which was used in all preceding portions of the economic analysis. The current Federal discount rate of 7-3/8 percent was used to convert these values to an equivalent time frame. Table 37 displays the first cost, the equivalent annual cost, the equivalent annual benefits, the net benefits, and the B/C ratio for the recommended plan.

Figure 8 displays the equivalent annual benefit-probability curve for the recommended plan. As shown in the figure, there is a 99.2 percent chance that there will be a benefit-cost ratio greater than 1.0, and a 95.2 percent chance that there will be a benefit-cost ratio greater than 2.0. An existing conditions expected annual benefit-probability curve was produced and converted to a benefit-cost ratio probability curve for the recommended plan. Figure 9 displays the benefit-probability curve for the SPH level of protection under existing conditions. As shown in the figure, there is a 95.1 percent chance that there will be a benefit-cost ratio greater than 1.0 under the existing condition scenario, which does not include changing future hydraulics and/or future development. Also, there is a 75.5 percent chance that the benefit-cost ratio will be greater than 2.0.

RELATIONSHIP TO WESTWEGO TO HARVEY CANAL PROJECT. The recommended plan for the Lake Cataouatche study area extends to a common tie-in point with the authorized Westwego to Harvey Canal project. (See Plate 6 of the Main Report.) This proposed tie-in would eliminate the need to construct a portion of levee (the westside closure) for Westwego to Harvey Canal project and reduce the construction costs of the authorized project by \$5,286,000. However, the full \$5,286,000 can only be claimed as a cost-savings if the benefits to the Westwego to Harvey Canal project are not delayed by the construction of the Lake Cataouatche project.

TABLE 37
LAKE CATAOUATCHÉ
MCACES COST ESTIMATE
CALCULATION OF EQUIVALENT ANNUAL COSTS AND BENEFITS
RECOMMENDED PLAN

...LEVEL OF PROTECTION...			
YEAR	PRESENT VALUE FACTOR	SPH	PRESENT VALUE SPH
1997	1.32927	\$1,073,000	\$1,428,305
1998	1.23797	\$6,840,000	\$8,467,703
1999	1.15294	\$2,294,000	\$2,644,842
2000	1.07375	\$1,663,000	\$1,785,646
2001	1.00000	\$1,611,000	\$1,611,000
2002	0.93132	\$0	\$0
2003	0.86735	\$0	\$0
2004	0.80778	\$0	\$0
2005	0.75229	\$0	\$0
2006	0.70062	\$255,000	\$178,659
2007	0.65250	\$1,070,000	\$698,176
2008	0.60768	\$0	\$0
TOTALS		\$14,806,000	\$16,812,331

	SPH	
FIRST COST EXTERIOR LEVEE		\$14,806,000
INTEREST DURING CONSTRUCTION		\$2,006,331
GROSS INVESTMENT COST AT END OF INSTALLATION PERIOD		\$16,812,331
PROJECT ANNUAL COSTS		
INTEREST	0.07375	\$1,239,909
AMORTIZATION	0.00006	\$1,009
O&M		\$108,990
FUTURE PROTECTION	0.34	\$40,556
PROJECT AVERAGE ANNUAL COST		\$1,390,464
MITIGATION AVERAGE ANNUAL COST		\$12,000
TOTAL AVERAGE ANNUAL COST		\$1,402,464
TOTAL EQUIVALENT ANNUAL BENEFITS		\$8,056,733
BENEFIT/COST RATIO		5.74
NET BENEFITS		\$6,654,269

FIGURE 8
LAKE CATAQUATCHIE
EQUIVALENT ANNUAL BENEFITS PROBABILITY CURVE
RECOMMENDED PLAN
M-CACES COST ESTIMATE

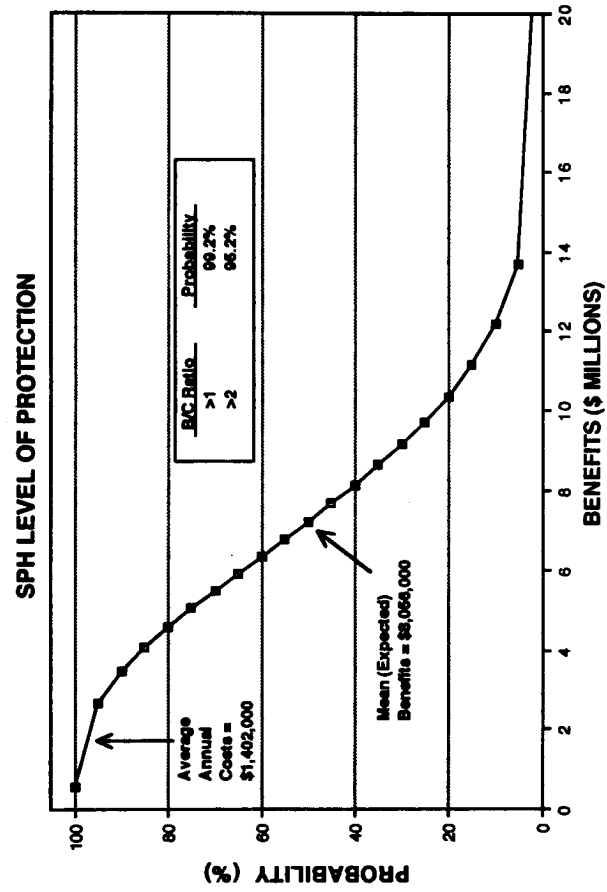
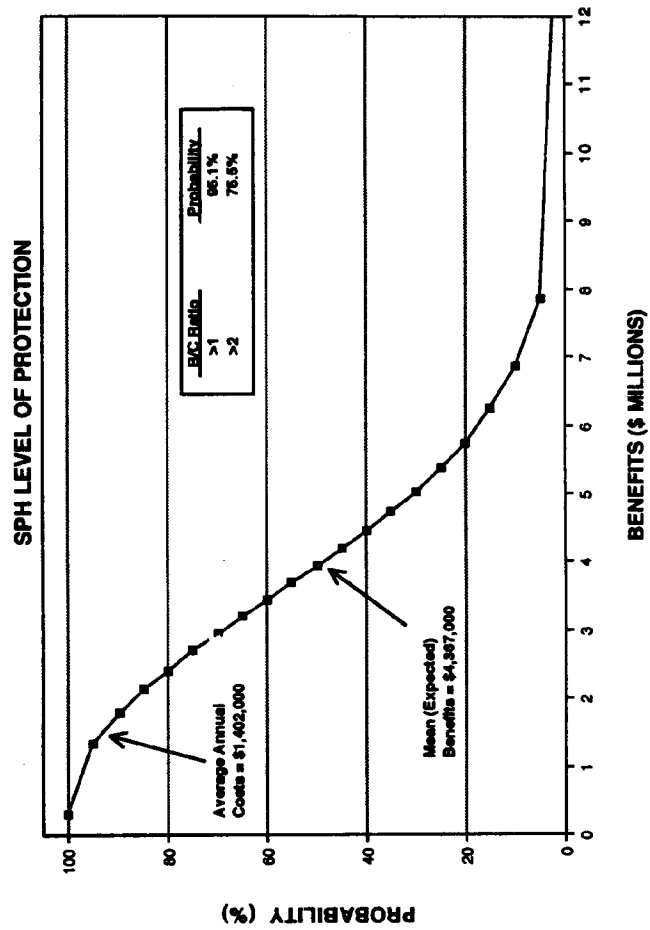


FIGURE 9
LAKE CATAQUATCHIE
EXPECTED ANNUAL BENEFITS PROBABILITY CURVE
RECOMMENDED PLAN
EXISTING CONDITIONS ONLY



The current construction schedule for the Westwego to Harvey Canal project provides for the westside closure to be completed in the year 2001. Beneficial completion of the recommended plan for the Lake Cataouatche project, which would be obtained upon completion of all first lifts, is scheduled for the year 2001. With the Lake Cataouatche project scheduled for completion at the same time as the westside closure, there would be no delay in benefits to the authorized project. Thus, the \$5,286,000 can be claimed as a reduction in the first cost of the currently authorized project. When interest during construction (\$930,000) is also considered, the total decrease in the gross investment cost for the Westwego project is \$6,216,000. The 7-3/8 percent discount rate was then used to amortize the cost savings over the life of the project (100 years). Thus, the average annual cost of the Westwego project was reduced by \$459,000. A display of this calculation is shown in Table 38. Table 39 shows that the combination of the Westwego to the Harvey Canal project and the recommended plan for the Lake Cataouatche area provides greater net benefits than the Westwego to Harvey Canal project alone.

TABLE 38

**LAKE CATAOUATCHE
CALCULATION OF COST SAVINGS FOR
WESTWEGO TO HARVEY CANAL PROJECT**

..... COST SAVINGS.....			
YEAR	PRESENT VALUE FACTOR	WESTWEGO	PRESENT VALUE WESTWEGO
1997	1.32927	\$106,395	\$141,428
1998	1.23797	\$2,471,556	\$3,059,708
1999	1.15294	\$1,437,571	\$1,698,938
2000	1.07375	\$1,104,380	\$1,185,828
2001	1.00000	\$130,866	\$130,866
2002	0.93132	\$0	\$0
TOTALS		\$5,286,768	\$6,216,767
EQUIVALENT ANNUAL COST SAVINGS			\$458,860

TABLE 39
LAKE CATAOUCHE
COMBINATION OF WESTWEGO TO THE HARVEY CANAL PROJECT
AND THE RECOMMENDED PLAN
(000's)

	Westwego to Harvey ¹	Lake Cataouatche	Sum of Projects
<u>Westwego to Harvey Canal</u>			
<u>Project Alone</u> (Existing Project)			
First Cost	\$57,771	\$0	\$57,771
Gross Investment	62,258	0	62,258
Avg. Annual Costs	4,595	0	4,595
Equivalent Annual Benefits	31,779	0	31,779
Net Benefits	27,184	0	27,184
<u>Westwego to Harvey Canal Modified to</u>			
<u>Include Lake Cataouatche</u> (Recommended Plan)			
First Cost ²	\$52,485	\$14,806	\$67,291
Gross Investment ²	56,042	16,812	72,854
Avg. Annual Costs ²	4,136	1,402	5,538
Equivalent Annual Benefits	31,779	8,056	39,835
Net Benefits	27,643	6,654	34,297

¹ The remaining cost and benefit figures for the Westwego to Harvey Canal project were taken from the Draft LMV Form 23C-R, dated September 3, 1996. The benefit figures were updated from 1989 to 1996 price levels using the Marshall and Swift Estimator Program.

² The average annual costs have been decreased by \$459,000 to account for deleting the westside closure from the Westwego to Harvey Canal project (\$6,216,000) and the interest during construction (\$930,000).