COMPREHENSIVE PLAN REPORT ON THE MISSISSIPPI COASTAL IMPROVEMENTS PROGRAM (MsCIP)

COMMUNICATION

FROM

THE ASSISTANT SECRETARY OF THE ARMY, THE DEPARTMENT OF DEFENSE

TRANSMITTING

RECOMMENDATION FOR THE AUTHORIZATION OF THE COMPREHENSIVE PLAN REPORT ON THE MISSISSIPPI COASTAL IMPROVEMENTS PROGRAM (MsCIP)

PART 1 OF 3

JANUARY 26, 2010.—Referred to the Committee on Transportation and Infrastructure and ordered to be printed

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DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
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WASHINGTON DC 20310-0108

JAN 13 2010

Honorable Nancy Pelosi
Speaker of the House
of Representatives
U.S. Capitol Building, Room H-232
Washington, D.C. 20515-0001

Dear Madam Speaker:

In final response to the authorizing legislation contained in the Department of Defense Appropriations Act of 2006 (Public Law (P.L.) 109-148), dated December 30, 2005, the Secretary of the Army recommends authorization of the Mississippi Coastal Improvements Program (MsCIP), Hancock, Harrison and Jackson Counties, Mississippi. The proposal is described in the report of the Chief of Engineers, dated September 15, 2009, which includes other pertinent reports and comments. The views of the Department of the Interior and the Environmental Protection Agency, as well as those of the State of Mississippi are set forth in the enclosed communications.

The Comprehensive Plan was developed using a multiple lines-of-defense approach which focused on reducing hurricane and storm damages through barrier islands restoration, beachfront protection, wetland restoration, and floodplain evacuation. In addition to a "no action" plan, numerous structural alternatives were evaluated including long linear levee systems of various heights and alignments with surge barriers across the inland bays. A wide range of non-structural alternatives were also considered. Because of the constraints imposed by P.L. 109-148 which limited the use of traditional water resources plan selection techniques, the Army Corps of Engineers did not select the recommended project elements based on traditional benefit-cost analysis or by examining net economic development benefits alone. Instead, the Corps evaluated each project element on the basis of its quantitative and qualitative contribution to the system of four accounts defined in the *Economic and Environmental Principles for Water and Related Land Resources Implementation Studies.* These four accounts include national economic development, environmental quality, regional economic development, and other social effects. On the basis of the assessments of the near-term project contributions to the 4 accounts, the Corps found each of the 12 project elements to be a cost-effective improvement in accordance with the directives of P.L. 109-148.

The recommended plan includes 12 elements for coastal Mississippi which are all consistent with the direction provided in P.L. 109-148 to aid recovery of coastal Mississippi that was severely damaged by the hurricanes of 2005. Each of the 12 elements is cost-effective, technically sound, and environmentally and socially acceptable. The recommended plan includes one structural and two non-structural hurricane and storm damage risk reduction elements; seven ecosystem restoration elements; and two coastal ecosystem restoration elements. Structural elements include restoring protective beach and dune systems, restoring native habitats, and raising an existing levee. Non-structural elements include removing structures from floodplains or raising structures that are highly vulnerable to storm damage. The recommended non-structural plan to remove over 2,000 tracts from the high hazard floodway is the largest non-structural plan ever to be recommended by the Corps of Engineers. Implementation of the 12 elements would provide approximately 30 miles of beach and dune restoration, floodproofing or acquisition of approximately 2,100 tracts within the 100-year floodplain, and the restoration of over 3,000 acres of coastal forest and wetlands that would provide additional storm surge reduction.

The recommended plan also includes a request for authorization of five additional studies. If authorized and implemented, the additional studies could provide further improvements in the coastal area of Mississippi. The additional recommended studies would address the longer term needs over the next 30 to 40 years. These studies would evaluate the restoration of over 30,000 acres of coastal forest, wetlands, beaches and dunes; sustainable restoration of the barrier islands; structural measures; and floodproofing or acquisition of over 58,000 tracts within the 100-year floodplain.

In accordance with Section 2034 of the Water Resources Development Act of 2007, an Independent External Peer Review (IEPR) was conducted under the direction of the Battelle Memorial Institute by an expert panel selected from a broad spectrum of engineering and scientific disciplines. The IEPR was completed during the normal study timeframe and it resulted in improvements to, and strengthening of the report's conclusions and recommendations. The report of the Chief of Engineers describes the IEPR process and the actions taken by the Corps to address the review comments. The Corps has posted the complete IEPR report and the written responses of the Chief of Engineers to the IEPR recommendations on the internet and provided both documents to the Committee on Environment and Public Works of the Senate and the Committee on Transportation and Infrastructure of the House of Representatives. The IEPR report and the Corps' responses are an enclosure to the report of the Chief of Engineers.

Based on the October 2009 price levels, the total first cost of the recommended plan is estimated at $1,182,600,000. Of this total first cost, about $437,500,000 is allocated to hurricane and storm damage risk reduction, about $599,000,000 is allocated to ecosystem restoration, and about $146,100,000 would fund the five additional studies. In accordance with provisions of the Water Resources Development Act (WRDA) of 1986, as amended, cost sharing for the ecosystem restoration features and the hurricane and storm damage risk reduction features, respectively will be 65 percent Federal and 35 percent non-Federal. Of the estimated $1,036,500,000 first cost for construction items, $673,700,000 would be Federal and $362,800,000 would be non-Federal. The first cost of the recommended feasibility studies would be cost shared 50 percent Federal and 50 percent non-Federal. The State of Mississippi is legally capable of fulfilling the requirements for being the non-Federal sponsor.

One or more of the MsCIP Comprehensive Plan elements may be implemented pursuant to the Flood Control and Coastal Emergencies section of Title IV of the Supplemental Appropriations Act, 2009 (P.L. 111-32) which provided $439,000,000 and directed the Secretary to use those funds for barrier island restoration and ecosystem restoration to restore historic levels of storm damage reduction to the Mississippi Gulf Coast. Construction of project elements implemented pursuant to this authority will be at full Federal expense. Operation, maintenance, repair, rehabilitation, and replacement required for such elements would be a non-Federal responsibility.

The recommendations in the Chief's report would work in concert with the 15 interim projects that were reported to the Congress in December 2006 and authorized in the Emergency Supplemental Appropriations Act of 2007 (P.L. 110-28). The implementation of these interim projects is the first step towards a comprehensive solution and will greatly assist with the recovery of coastal communities and natural resources and provide a significant boost to the overall recovery of the coast. The 15 previously authorized interim projects and the 12 elements recommended herein provide a fully integrated systems approach to partially addressing the hurricane damage in Mississippi from the storms of 2005, and were developed in concert with the ongoing Louisiana Coastal Protection and Restoration study. Furthermore, the activities of other Federal, state and local agencies that are responsible for public education, storm warning, evacuation planning, floodplain management, building codes and local zoning are integral components of efforts to reduce the hurricane risks associated with living in or visiting coastal Mississippi.

The Office of Management and Budget (OMB) advises that there is no objection to the submission of the report to Congress with the recommended 65 percent Federal and 35 percent non-Federal cost sharing for both the hurricane and storm damage risk reduction and the aquatic ecosystem restoration construction activities. A copy of its letter is enclosed. I am providing a copy of this transmittal and the OMB letter dated January 6, 2010 to the House Subcommittees on Energy and Water Development, and Water Resources and Environment.

Very truly yours,

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

Enclosures

7 Enclosures

1. Report of the Chief of Engineers w/IEPR Report and Responses, Sep 15, 2009
2. State of Mississippi Letter Aug 25, 2009
3. DOI Letter, Jul 30, 2009
4. EPA Letter, Jul 27, 2009
5. NEPA Record of Decision, Jan 13, 2010
6. OMB Letter, Jan 6, 2010
7. Mississippi Coastal Improvements Program (MsCIP) – Hancock, Harrison, and Jackson Counties, Mississippi - June 2009

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, DC 20314-1000

REPLY TO ATTENTION OF
CECW-SAD

15 SEP 20[illegible]

SUBJECT: Mississippi Coastal Improvements Program, Hancock, Harrison, and Jackson Counties, Mississippi, Comprehensive Plan Report

THE SECRETARY OF THE ARMY

1. I submit for transmission to Congress my final report on water resources improvements associated with hurricane and storm damage risk reduction and ecosystem restoration in the coastal counties of Hancock, Harrison, and Jackson, Mississippi. It is accompanied by the report of the district and division engineers. These reports are a final response to authorizing legislation contained in the Department of Defense Appropriation Act of 2006 (P.L. 109-148), dated 30 December 2005. The study authorization states, in part, the following:

> *"... the Secretary shall conduct an analysis and design for comprehensive improvements or modifications to existing improvements in the coastal area of Mississippi in the interest of hurricane and storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resource purposes at full Federal expense; Provided further, that the Secretary shall recommend a cost-effective project, but shall not perform an incremental benefit-cost analysis to identify the recommended project, and shall not make project recommendations based upon maximizing net national economic development benefits; Provided further, that interim recommendations for near term improvements shall be provided within 6 months of enactment of this act with final recommendations within 24 months of this enactment."*

Pre-construction engineering and design and additional studies will be initiated upon Congressional authorization.

2. The Mississippi Coastal Improvements Program Comprehensive Plan, hereinafter referred to as the MsCIP Comprehensive Plan, is a systemwide approach linking structural and nonstructural hurricane and storm damage risk reduction elements with ecosystem restoration elements, all with the goal of providing for a coastal community that is more resilient to hurricanes and storms. The MsCIP Comprehensive Plan for hurricane and storm damage risk reduction in coastal Mississippi was developed using a multiple lines-of-defense approach focusing on reducing hurricane and storm damages through barrier islands restoration, and employing beachfront protection, wetland restoration, and floodplain evacuation concepts of the MsCIP Comprehensive Plan. The reporting officers identify 12 elements to aid recovery of coastal Mississippi that was severely damaged by the hurricanes of 2005. Structural elements include restoring protective beaches and systems, restoring native habitats, and raising an

existing levee. Non-structural elements include removing structures from floodplains or raising structures that are highly vulnerable to storm damage. The hurricanes of 2005 severely taxed the resources of local governments and institutions, making it unlikely that those resources could be employed to implement these proposed recovery actions without Federal assistance. Thus, this package of 12 elements and the identified further feasibility studies will help the people of coastal Mississippi in their recovery. Implementation of the 12 elements would provide for the restoration of over 3,000 acres of coastal forest and wetlands, approximately 30 miles of beach and dune restoration, and floodproofing or acquisition of approximately 2,000 tracts within the 100-year floodplain.

3. The MsCIP Comprehensive Plan also includes recommendations for additional studies to address the longer term needs over the next 30-40 years. These studies would evaluate the restoration of over 30,000 acres of coastal forest, wetlands, beaches and dunes; sustainable restoration of the barrier islands; structural measures; and floodproofing or acquisition of over 58,000 tracts within the 100-year floodplain.

4. The reporting officers developed the recommended 12 elements for coastal Mississippi consistent with the direction provided in the Department of Defense Appropriations Act of 2006 (P.L. 109-148), dated 30 December 2005. In accordance with P.L. 109-148, the reporting officers found each of the 12 elements to be cost-effective, technically sound, and environmentally and socially acceptable. These 12 elements are described below and include two non-structural hurricane storm risk reduction elements, one structural hurricane and storm damage risk reduction element, seven ecosystem restoration elements, and two coastal ecosystem restoration elements. The additional studies that are part of the MsCIP Comprehensive Plan could provide further improvements in the coastal area of Mississippi if implemented. Discussion of these studies is included in paragraphs 5 and 6.

a. <u>High Hazard Area Risk Reduction Program (HARP)</u>. This project element consists of acquisition of approximately 2,000 tracts which are at the highest risk of being damaged by storm surge, demolition of existing structures, and retention of acquired tracts in an open space condition. The number of tracts was based on an estimate of what could be acquired during a five year period following the execution of the Project Partnership Agreement for implementation of this element. To the extent practicable, acquisition would be on a willing seller basis, but eminent domain could be utilized when determined to be warranted. As described in the report, acquisition will be in compliance with the provisions of the Uniform Relocations Assistance and Real Property Acquisition Policies Act (P.L. 91-646), as amended, and the uniform regulations contained in 49 CFR, Part 24 including the provision of payment of relocation assistance benefits to eligible recipients. The tracts would include residential, commercial and unimproved tracts. In addition, buildings owned by the City of Moss Point that are used for municipal purposes will be replaced with buildings out of the Federal Emergency Management Agency (FEMA) designated Velocity Zone. Benefits of the HARP include approximately $22,000,000 – $33,000,000 in average annual hurricane and storm damage risk

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reduction benefits, depending on the specific tracts acquired. At October 2008 price levels, the estimated first cost of this element is $407,860,000. The cost of this non-structural project element is allocated to hurricane and storm damage risk reduction. In accordance with the provisions of the Water Resources Development Act of 1986 (WRDA 1986), as amended, cost sharing would be 65-percent Federal and 35-percent non-Federal. The Federal share of the estimated first cost of this element would be $265,110,000 and the non-Federal share would be $142,750,000. The estimated annual cost for operation, maintenance, repair, replacement and rehabilitation of this project element is $75,000 and is a 100-percent non-Federal responsibility.

b. Waveland Floodproofing. This project element consists of elevating approximately 25 residential structures in the City of Waveland, Mississippi that are determined to be eligible for floodproofing by elevation out of the 1-percent chance storm event inundation level. Benefits of the Waveland Floodproofing include $224,000 in average annual hurricane and storm damage risk reduction benefits. At October 2008 price levels, the estimated first cost of this element is $4,450,000. The cost of this element is allocated to hurricane and storm damage risk reduction. In accordance with the provisions of WRDA 1986, as amended, cost sharing would be 65-percent Federal and 35-percent non-Federal. The Federal share of the estimated first cost of this project element is $2,890,000 and the non-Federal share is $1,560,000. Due to the non-structural nature of this element, the estimated annual costs for operation, maintenance, repair, replacement and rehabilitation are expected to be nominal. However any operation, maintenance, repair, replacement and rehabilitation that would be needed is a 100-percent non-Federal responsibility.

c. Forrest (Forest) Heights Levee. This project element for the Forrest Heights community in the Turkey Creek watershed of Gulfport, Mississippi consists of raising approximately 6,500 linear feet of an existing non-Federal levee to a levee crest elevation of 21 feet North Atlantic Vertical Datum of 1988 (NAVD-88). An existing publicly owned park with a surface elevation of 12 to 14 feet NAVD-88 would be included in the plan to serve as a water detention area for temporary containment of rainfall during storm events. This recommended project element will require the acquisition of two residential properties within the existing community. Unavoidable adverse environmental impacts have been identified and the cost of acquisition and restoration of approximately 3 acres of mitigation is included in total estimated cost of this element. Hurricane and storm damage risk reduction benefits are estimated at $101,000 to a historically significant minority community. In addition to these benefits, the levee would maintain cohesiveness of the historically significant community, and preserve the culture and heritage of its predominantly minority residential population. At October 2008 price levels, the estimated first cost of this element is $14,070,000. The cost of this element is allocated to hurricane and storm damage risk reduction. In accordance with the provisions of WRDA 1986, as amended, cost sharing would be 65-percent Federal and 35-percent non-Federal. The Federal share of the estimated first cost of this project element is $9,150,000 and the non-Federal share is $4,920,000. The estimated annual cost for operation, maintenance, repair, replacement, and rehabilitation of this project element is $114,000 and is a 100-percent non-Federal responsibility.

d. Turkey Creek Ecosystem Restoration. This project element consists of the restoration of 689 acres of an undeveloped site of degraded wet pine savannah habitat. Restoration of this area would provide an increase of 1,565 average annual functional habitat units. These habitats have been identified by the U.S. Fish and Wildlife Service as habitats of high value for native species and as relatively scarce or becoming scarce on a national basis or in the ecoregion. Measures required to restore hydrology and natural vegetation on the site include filling drainage ditches, road removal, and controlled burning. Rare and threatened and endangered birds that are expected to utilize the areas following burning and regrowth include Henslow's sparrow, Bachman's sparrow, red-cockaded woodpecker, and Mississippi Sandhill Crane. This restored ecosystem also may benefit the Mississippi Gopher frog and, in drier areas along ridges, the black pine snake and the gopher tortoise. At October 2008 price levels, the estimated first cost of this element is $6,840,000. The cost of this project is allocated to ecosystem restoration. In accordance with the provisions of WRDA 1986, as amended, cost sharing would be 65-percent Federal and 35-percent non-Federal. The Federal share of the estimated first cost of this project element is $4,450,000 and the non-Federal share is $2,390,000. The estimated annual cost for operation, maintenance, repair, replacement, and rehabilitation of this project element is $47,000 and is a 100-percent non-Federal responsibility. Post-implementation monitoring of this ecosystem restoration element is projected to be conducted for no more than five years at a cost of less than 1-percent of the total first cost of the ecosystem restoration elements. Adaptive management of ecosystem restoration element is expected to cost no more than 3-percent of the total first cost of the ecosystem restoration element. The cost of monitoring and adaptive management is included in the total estimated first cost of this element.

e. Dantzler Ecosystem Restoration. This project element consists of restoration of 385 acres of severely degraded wet pine savannah owned by the State of Mississippi. Measures required to restore hydrology and natural vegetative habitat to the site include removal of existing hurricane debris and sedimentation, filling drainage ditches, road removal, control of non-native species, and controlled burning. The proposed element would provide an increase of 1,244 average annual functional habitat units and restore the natural hydrologic character of the area. The site's location in proximity to the Pascagoula River delta, a Gulf Ecological Management Site, increases the value of this restoration element by minimizing the fracturing of biodiversity. At October 2008 price levels, the estimated first cost of this element is $2,210,000. The cost of this project is allocated to ecosystem restoration. In accordance with the provisions of WRDA 1986, as amended, cost sharing would be 65-percent Federal and 35-percent non-Federal. The Federal share of the estimated first cost of this project element is $1,440,000 and the non-Federal share is $770,000. The estimated annual cost for operation, maintenance, repair, replacement, and rehabilitation of this project element is $26,000 and is a 100-percent non-Federal responsibility. Post-implementation monitoring of this ecosystem restoration element is projected to be conducted for no more than five years at a cost of less than 1-percent of the total first cost of the ecosystem restoration elements. Adaptive management of ecosystem restoration element is expected to cost no more than 3-percent of the total first cost of the ecosystem restoration element. The cost of monitoring and adaptive management is included in the total estimated first cost of this element.

f. Franklin Creek Ecosystem Restoration. This project element includes restoration of hydrology and native habitats by removing ditches, excavating and removing existing roadbeds, installing culverts under U.S. Highway 90, control of non-native species, and controlled burning to restore 149 acres located north and south of U.S. Highway 90 with critical wet pine savannah habitat. This area routinely floods with only a slight rainfall; thus, this would also provide additional flood storage capacity by restoring the natural habitat. Pine savannah wetlands provide floodwater retention, groundwater recharge, and water purification. This habitat is becoming fragmented and with the increased development, fire maintenance is increasingly harder to perform. The proposed element would provide an increase of 516 average annual functional habitat units and restore the natural hydrology of the area. In addition, restoration of this area would provide for additional flood storage capacity within the Grand Bay area reducing flooding severity within the adjacent communities of Orange Grove and Pecan in Jackson County. The site's location in proximity to the Grand Bay National Wildlife Refuge (NWR) and the Grand Bay National Estuarine Research Reserve (NERR) increases the value of this restoration element by minimizing the fracturing of biodiversity. Incidental hurricane and storm damage risk reduction benefits would be realized from the removal of approximately 30 residential structures from the floodplain. At October 2008 price levels, the estimated first cost of this element is $1,860,000. The cost of this project is allocated to ecosystem restoration. In accordance with the provisions of WRDA 1986, as amended, cost sharing would be 65-percent Federal and 35-percent non Federal. The Federal share of the estimated first cost of this project element is $1,210,000 and the non-Federal share is $650,000. The estimated annual cost for operation, maintenance, repair, replacement, and rehabilitation of this project element is $11,000 and is a 100-percent non-Federal responsibility. Post-implementation monitoring of this ecosystem restoration element is projected to be conducted for no more than five years at a cost of less than 1-percent of the total first cost of the ecosystem restoration elements. Adaptive management of ecosystem restoration element is expected to cost no more than 3-percent of the total first cost of the ecosystem restoration element. The cost of monitoring and adaptive management is included in the total estimated first cost of this element.

g. Bayou Cumbest Ecosystem Restoration. This project element includes the acquisition of approximately 61 tracts, removal of 19 structures, excavation and removal of fill material from former home sites and adjacent lands, filling drainage ditches, control of non-native species, and planting with native emergent wetland species. Following acquisition of these tracts, 148 acres would be restored to emergent wetland (110 acres) and coastal scrub shrub habitat (38 acres). The estuarine wetland habitats provide nursery and foraging habitat that supports various species including economically-important marine fishery species, such as black drum, spotted seatrout, southern flounder, Gulf menhaden, bluefish, croaker, mullet, and blue crab. The proposed element would provide an increase of 637 average annual functional habitat units. The site's proximity to Franklin Creek, Grand Bay NWR and Grand Bay NERR increases the value of this project element by minimizing the fracturing of biodiversity. At October 2008 price levels, the estimated first cost of this element is $25,530,000. The cost of this project is allocated to ecosystem restoration. In accordance with the provisions of WRDA 1986, as amended, cost sharing would be 65-percent Federal and 35-percent non-Federal. The Federal share of the estimated first cost of this project element is $16,590,000 and the non-Federal share is $8,940,000. The current estimated annual cost for operation, maintenance, repair, replacement, and rehabilitation of this project element is $114,000 and is a 100-percent non-Federal responsibility. Post-implementation monitoring of this ecosystem restoration element is projected to be conducted for no more than five years at a cost of less than 1-percent of the total first cost of the ecosystem restoration elements. Adaptive management of ecosystem restoration element is expected to cost no more than 3-percent of the total first cost of the ecosystem restoration element. The cost of monitoring and adaptive management is included in the total estimated first cost of this element.

h. Admiral Island Ecosystem Restoration. This project element consists of restoration of a severely degraded 123-acre tidal wetland area owned by the State of Mississippi. Measures required to restore hydrology and native habitat to the area include excavating fill material, filling ditches, control of non-native species and planting native tidal emergent species. The proposed element would provide an increase of 108 average annual functional habitat units. At October 2008 price levels, the estimated first cost of this element is $21,810,000. The cost of this project is allocated to ecosystem restoration. In accordance with the provisions of WRDA 1986, as amended, cost sharing would be 65-percent Federal and 35-percent non-Federal. The Federal share of the estimated first cost of this project element is $14,180,000 and the non-Federal share is $7,630,000. The current estimated annual cost for operation, maintenance, repair, replacement, and rehabilitation of this project element is $58,000 and is a 100-percent non-Federal responsibility. Post-implementation monitoring of this ecosystem restoration element is projected to be conducted for no more than five years at a cost of less than 1-percent of the total first cost of the ecosystem restoration elements. Adaptive management of ecosystem restoration element is expected to cost no more than 3-percent of the total first cost of the ecosystem restoration element. The cost of monitoring and adaptive management is included in the total estimated first cost of this element.

i. Deer Island Ecosystem Restoration. This project element includes actions that will complement existing Federal restoration projects by minimizing the fracturing of biodiversity. Measures include restoration of a portion of the northern and southern shorelines of the island, and new stone training dikes to prevent future erosion. The proposed element would provide an additional 400 acres of highly productive estuarine wetlands, restore beach and dune habitat, create hard bottom habitat, reduce coastal erosion, and restore the coastal maritime forest. This element would produce an increase of 2,125 average annual functional habitat units. In addition, the restoration of Deer Island provides incidental hurricane and storm damage risk reduction benefits to the developed mainland Biloxi area. At October 2008 price levels, the estimated first cost of this element is $21,520,000. The cost of this project is allocated to ecosystem restoration. In accordance with the provisions of WRDA 1986, as amended, cost sharing would be 65-percent Federal and 35-percent non-Federal. The Federal share of the estimated first cost of this project element is $13,990,000 and the non-Federal share is $7,530,000. All costs for operation, maintenance, repair, replacement and rehabilitation are a 100-percent non-Federal responsibility. Post-implementation monitoring of this ecosystem restoration element is projected to be conducted for no more than five years at a cost of less than 1-percent of the total first cost of the ecosystem restoration elements. Adaptive management of ecosystem restoration element is expected to cost no more than 3-percent of the total first cost of the ecosystem restoration element. The cost of monitoring and adaptive management is included in the total estimated first cost of this element.

j. Submerged Aquatic Vegetation Element. This element consists of measures designed to evaluate techniques for restoring submerged aquatic vegetation (SAV), an essential component of an estuarine ecosystem. Specifically, five acres of SAVs in the Grand Bay National Estuarine Research Reserve (NERR) area that were destroyed by Hurricane Katrina will be restored using different techniques. The results will be used to guide and develop other SAV restoration projects that would be undertaken as future authorized elements of the overall Comprehensive Plan. At October 2008 price levels, the estimated first cost of this element is $900,000. Cost sharing would be 65-percent Federal and 35-percent non-Federal. The Federal share of the estimated first cost of this measure is $590,000 and the non-Federal share is $310,000.

k. Coast-wide Beach and Dune Ecosystem Restoration. This project element consists of beach and dune improvements to approximately 30 miles of the 60 miles of existing beaches on the mainland coast. These improvements would include construction of 60-foot wide vegetated dune fields approximately 50 feet seaward of the existing seawalls. The element would provide 248 average annual functional habitat units. These beach and dune areas are critical to nesting and resting shorebirds such as the State listed least tern and the threatened piping plover. In addition to the ecological benefits, the dunes would provide incidental hurricane and storm damage risk reduction benefits particularly during smaller storm events, tropical storms, and lower energy hurricanes. At October 2008 price levels, the estimated first cost of this element is $23,320,000. The cost of this project is allocated to ecosystem restoration. In accordance with the provisions of WRDA 1986, as amended, cost sharing would be 65-percent Federal and 35-percent non-Federal. The Federal share of the estimated first cost of this project element is $15,160,000 and the non-Federal share is $8,160,000. All costs for operation, maintenance, repair, replacement and rehabilitation are a 100-percent non-Federal responsibility. Post-implementation monitoring of this ecosystem restoration element is projected to be conducted for no more than five years at a cost of less than 1-percent of the total first cost of the ecosystem restoration elements. Adaptive management of ecosystem restoration element is expected to cost no more than 3-percent of the total first cost of the ecosystem restoration element. The cost of monitoring and adaptive management is included in the total estimated first cost of this element.

l. Barrier Island Restoration. This project element consists of the placement of approximately 22 million cubic yards of sand within the National Park Service's Gulf Islands National Seashore, Mississippi unit. Approximately 13 million cubic yards of sand would be used to close a gap between East Ship Island and West Ship Island, originally opened by Hurricane Camille, through the construction of a low level dune system. The remaining 9 million cubic yards of sand would be placed in the littoral zones at the eastern ends of Ship and Petit Bois Islands. This would result in the restoration of 1,150 acres of critical coastal zone habitats. In accordance with the requests of the National Park Service, the closure of the Ship Island gap and placement of sand into the littoral zones would be undertaken only once, and would not be nourished or otherwise maintained in the future. The restoration of Ship Island would provide over 400 average annual functional habitat units and help to ensure the sustainability of the Mississippi Sound ecosystem by maintaining salinity inflows from the Gulf of Mexico. The estuarine habitats provide nursery and foraging habitat that supports various species including economically-important marine fishery species, such as black drum, spotted seatrout, southern flounder, Gulf menhaden, bluefish, croaker, mullet, and blue crab. These estuarine-dependent organisms serve as prey for other important fisheries, such as mackerels, snappers, and groupers, and highly migratory species, such as billfishes and sharks. Incidental benefits associated with this element include average annual hurricane and storm damage risk reduction benefits of $20,000,000 to mainland Mississippi, $470,000 in average annual recreation benefits, and $43,000,000 in average annual fishery benefits to Mississippi Sound. The placement of sand would also provide incidental protection to two cultural sites listed on the National Register of Historic Places. At October 2008 price levels, the estimated cost of this element is $479,710,000. The cost of this element is allocated to ecosystem restoration. Cost sharing would be 65-percent Federal and 35-percent non-Federal. The Federal share of the estimated cost of this project element is $311,810,000 and the non-Federal share is $167,900,000.

5. Further Detailed Investigations of Remaining Elements of the Comprehensive Plan. The MsCIP Comprehensive Plan describes a number of additional components that could provide further improvements in the coastal area of Mississippi if implemented. However, these components are not recommended for authorization for construction at this time because further feasibility level analysis under additional study authority would be required to support a recommendation for construction authorization. Consequently, the reporting officers recommended additional feasibility level studies as part of the MsCIP Comprehensive Plan. These follow-on feasibility studies would evaluate the potential for restoration of over 30,000 acres of coastal forest, wetlands, beaches and dunes; restoration of barrier islands; structural measures; and floodproofing of structures on, or acquisition of, over 58,000 tracts within the 100 year floodplain. The reporting officers worked closely with other Federal agencies, the State of Mississippi, environmental groups, stakeholders, and interested parties to ensure that the program recommended for implementation best meets the goals and objectives of the MsCIP Comprehensive Plan consistent with the Congressional authorization. The total study cost of the recommended follow-on feasibility level studies is estimated to be $143,200,000, which would be cost shared on a 50-percent Federal and 50-percent non-Federal basis consistent with cost sharing provisions of Section 105 of WRDA 86, as amended. Follow-on analysis would include:

- 6 additional ecosystem restoration studies to restore the hydrology and native habitat on undeveloped state owned property.
- Long-term High Hazard Area Risk Reduction Program element to evaluate the further acquisition of high risk properties.
- Escatawpa River Freshwater Diversion to evaluate a variety of freshwater diversion scenarios to restore wet pine savannah habitat and reduce salinities in Grand Bay.

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- 30 long-term ecosystem restoration and hurricane and storm damage risk reduction studies to restore the hydrology and natural habitat and reduce storm damages in developed residential areas.
- 7 hurricane and storm damage risk reduction studies to evaluate additional hurricane and storm damage risk reduction opportunities in high density land use areas.

6. At October 2008 price levels, the estimated first cost of the 12 elements of the MsCIP Comprehensive Plan recommended for authorization is $1,010,080,000, of which $656,550,000 would be Federal and $353,530,000 would be non-Federal. The estimated first cost of the individual elements recommended for authorization is summarized below in Table 1. The first cost of the recommended feasibility studies is estimated at $143,200,000. The estimated first cost of the individual studies recommended are summarized below in Table 2.

Table 1
Mississippi Coastal Improvements Program
Cost Sharing (October 2008 Price Level)

Phase I Recommended Plan Element	Total First Cost	Federal Cost	Non-Federal Cost
Phase I High Hazard Area Risk Reduction Plan	$407,860,000	$265,110,000	$142,750,000
Waveland Floodproofing	$4,450,000	$2,890,000	$1,560,000
Forrest Heights Levee	$14,070,000	$9,150,000	$4,920,000
Turkey Creek Ecosystem Restoration	$6,840,000	$4,450,000	$2,390,000
Dantzler Ecosystem Restoration	$2,210,000	$1,440,000	$770,000
Franklin Creek Ecosystem Restoration	$1,860,000	$1,210,000	$650,000
Bayou Cumbest Ecosystem Restoration & Hurricane & Storm Damage Reduction	$25,530,000	$16,590,000	$8,940,000
Admiral Island Ecosystem Restoration	$21,810,000	$14,180,000	$7,630,000
Deer Island Ecosystem Restoration	$21,520,000	$13,990,000	$7,530,000
Submerged Aquatic Vegetation Pilot Program	$900,000	$590,000	$310,000
Coast-wide Beach and Dune Ecosystem Restoration	$23,320,000	$15,160,000	$8,160,000
Comprehensive Barrier Island Restoration	$479,710,000	$311,810,000	$167,900,000
Total MsCIP Authorization Request	$1,010,080,000	$656,550,000	$353,530,000

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Table 2
Mississippi Coastal Improvements Program
Cost Sharing (October 2008 Price Level)

Feasibility Studies	Estimated Study Cost	Federal Cost	Non-Federal Cost
Long-term High Hazard Area Risk Reduction	$5,000,000	$2,500,000	$2,500,000
Escatawpa River Freshwater Diversion	$3,000,000	$1,500,000	$1,500,000
Ecosystem Restoration Studies	$1,700,000	$850,000	$850,000
Long-term Ecosystem Restoration and Hurricane and Storm Damage Risk Reduction	$48,500,000	$24,250,000	$24,250,000
Structural Hurricane and Storm Damage Risk Reduction	$85,000,000	$42,500,000	$42,500,000
Total First Cost of MsCIP Recommended Investigations	$143,200,000	$71,600,000	$71,600,000

7. In concert with the Corps Campaign Plan, the MsCIP Comprehensive Plan was developed utilizing a systematic and regional approach in formulating solutions and in evaluating the impacts and benefits of those solutions. All potential impacts, both adverse and beneficial, have been considered without regard to geographic boundaries. The MsCIP and Louisiana Coastal Protection and Restoration (LACPR) study teams collaborated fully their efforts on a systems scale to ensure consistency. A regional salinity and water quality model has been developed covering an area from west of Lake Pontchartrain to east of Mobile Bay and south beyond the Chandeleur Islands in the Gulf. Regional storm surge modeling has been applied to examine regional-scale changes to storm surge levels associated with several of the proposed project alternatives. A multi-disciplinary risk assessment team was assembled by the Corps to characterize the probabilities of different hurricanes that can impact the northern Gulf of Mexico region. The risk assessment team supported both the MsCIP and LACPR work and FEMA's remapping efforts, and developed a unified general coastal flooding methodology that is being applied by U.S. Army Corps of Engineers (Corps) and FEMA.

8. Independent External Peer Review (IEPR) of the MsCIP Comprehensive Plan was managed by Battelle Memorial Institute, a non-profit science and technology organization with experience in establishing and administering peer review panels for the Corps. The IEPR panel consisted of seven individuals selected by Battelle with technical expertise in engineering (civil and geotechnical); geology/geomorphology; hydrology; hydraulics; coastal environmental science, water quality/resource management; floodplain management; meteorology/hurricanes; socioeconomics; real estate; risk assessment; and modeling. The Final Report from the IEPR panel was issued November 7, 2008 and included 14 final comments. Overall, the IEPR panel found the MsCIP Comprehensive Plan is an impressive body of work that is wide-ranging in the scope of research used to inform plan selection and recommendations. However, they felt that the plan could be improved by inclusion of a concise statement of the project's long-term vision for the future coastal landscape and a figure illustrating the project in the Executive Summary. The panel also acknowledged that there has been extensive outreach and community engagement

in the scoping process. The panel encouraged continued Corps collaboration with the public, local and Federal agencies, and the inclusion of universities and research institutions to continue to inform this plan. Support of local communities and states should be fostered as it is also a critical component to project success. Of the 14 IEPR comments identified by the panel, four were classified as high significance by the panel. This first comment recommended including a refined analysis in certain areas before design and build is conducted. In response, additional clarification was added to the report to indicate that a refined analysis would be undertaken in the ensuing project phases. The second comment requested providing additional explanations on the preliminary evaluations of hurricane storm damage risk reduction, erosion control, and ecosystem restoration. In response, with assistance from recommendations in the IEPR report, the Comprehensive Plan was revised to provide further clarification in these areas. The third comment recommended that the redevelopment scenarios should include a range of possible outcomes for the economy. In response, the team provided further explanations on the preliminary analysis and possible outcomes for the redevelopment scenarios. The fourth comment recommended that adaptive management processes should be a more integral part of the Comprehensive Plan and must include a strong monitoring and feedback mechanism. In response, the adaptive management process was further integrated into the Comprehensive Plan, along with recognition that adaptive management will be developed more extensively in collaboration with others in the ensuing project phases. Eight of the IEPR panel comments were classified as medium significance by the panel. They included clarifying the extent of inclusion of public and agency engagement into plan selection; including additional information on future impacts to municipal and industrial waste facilities; including additional detail on human adaptation, as it relates to economic activities; including additional explanations on sea level rise; including a clearer description on how relative sea level rise is incorporated; providing a clearer explanation on the physics-based models; providing further descriptions on the factors in model selection; and providing further explanation on why oysters were used as an indicator species. As a result of these comments, additional discussions were added to the report to clarify these areas, including why decisions were made through the study process respective to these comments. The report was also revised to provide further explanation on the use of oysters as one of several indicator species that assisted in the identification of feasible alternatives. The final two comments from the IEPR panel were classified as low significance. They included reevaluating the goal to reduce loss of life by 100% as it is unrealistic for the project; and to clarify the process for weighting metrics, both of which were addressed with modifications to the report. While the goal to reduce loss of life by 100% remained in the study, additional discussion was added to the report to state that residual risk will remain with any type of plan in place, and to emphasize the roles of all partners in addressing and communicating residual risk, including the need for a well coordinated hurricane evacuation plan.

9. Washington level review indicated that the project is technically sound, environmentally acceptable, and cost effective. The plan 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

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legislative policies and guidelines. Also, the views of interested parties, including Federal, State and local agencies have been considered.

10. One or more of the 12 elements of the MsCIP Comprehensive Plan recommended in this report to be authorized for implementation may be implementable pursuant to statutory language included in Title IV of the Supplemental Appropriations Act, 2009 (Public Law 111-32) under the heading "Flood Control and Coastal Emergencies" that was enacted on June 24, 2009 (*see* 123 Stat. 1875-1876). Analysis as to which element or elements may be implemented pursuant to that language is ongoing.

11. I find that the reporting officers have addressed the provisions of P.L. 109-148, and I generally concur in their findings, conclusions, and recommendations. Accordingly, I recommend that the 12 elements described herein be authorized for implementation in accordance with the reporting officers' plan, with such modifications as in the discretion of the Chief of Engineers may be advisable. I further recommend that the additional studies as described herein be authorized subject to cost sharing, financing, and other applicable requirements of Federal and State laws and policies, including WRDA 1986, as amended. This recommendation of authorization for implementation of the 12 elements is subject to cost sharing, financing, and other applicable requirements of Federal and State laws and policies, including WRDA 1986, as amended, and with the non-Federal sponsor agreeing to comply with applicable Federal law and policies, and with the following requirements:

a. Provide 35 percent of total project costs allocated to hurricane and storm damage risk reduction, as further specified below:

(1) Provide 25 percent of design costs allocated to hurricane and storm damage risk reduction in accordance with the terms of a design agreement entered into prior to commencement of design work for a project element for hurricane and storm damage risk reduction;

(2) Provide, during the first year of construction of a project element for hurricane and storm damage risk reduction, any additional funds necessary to pay the full non-Federal share of design costs allocated to hurricane and storm damage reduction;

(3) Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of a project element for hurricane and storm damage risk reduction;

(4) Provide, during construction of a project element for hurricane and storm damage risk reduction, any additional funds necessary to make its total contribution for hurricane and storm damage risk reduction equal to 35 percent of total project costs allocated to hurricane and storm damage risk reduction:

b. Provide 35 percent of total project costs allocated to ecosystem restoration, as further specified below:

(1) Provide 25 percent of design costs allocated to ecosystem restoration in accordance with the terms of a design agreement entered into prior to commencement of design work for a project element for ecosystem restoration;

(2) Provide, during the first year of construction of a project element for ecosystem restoration, any additional funds necessary to pay the full non-Federal share of design costs allocated to ecosystem restoration;

(3) Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of a project element for ecosystem restoration;

(4) Provide, during construction of a project element for ecosystem restoration, any additional funds necessary to make its total contribution for ecosystem restoration equal to 35 percent of total project costs allocated to ecosystem restoration;

c. Shall not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefore, to meet any of the non-Federal obligations for a project element unless the Federal agency providing the Federal portion of such funds verifies in writing that expenditure of such funds for such purpose is authorized;

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

e. Not less than once each year, inform affected interests of the extent of protection afforded by the project elements for hurricane and storm damage risk reduction;

f. Agree to participate in and comply with applicable Federal floodplain management and flood insurance programs for project elements for hurricane and storm damage risk reduction;

g. Comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12), which requires a non-Federal interest to prepare a floodplain management plan within one year after the date of signing a project partnership agreement, and to implement such plan not later than one year after completion of construction of a project element for hurricane and storm damage risk reduction;

h. Publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with protection levels provided by a project element for hurricane and storm damage risk reduction;

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

j. Comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. 4601-4655), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way required for construction, operation, and maintenance of a project element, including those necessary for relocations, the borrowing of materials, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;

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

l. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to a project element for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project element;

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

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n. Keep and maintain books, records, documents, or other evidence pertaining to costs and expenses incurred pursuant to a project element, for a minimum of three years after completion of the accounting for which such books, records, documents, or other evidence are required, to the extent and in such detail as will properly reflect total project costs, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20;

o. 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; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141- 3148 and 40 U.S.C. 3701 – 3708 (revising, codifying and enacting without substantial change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a *et seq.*), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 *et seq.*) and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c *et seq.*);

p. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended (42 U.S.C. 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of a project element. 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;

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

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

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s. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. 1962d-5b), and Section 103(j) of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2213(j)), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project or separable element.

12. The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and implementation funding. However, prior to transmittal to the Congress, the non-Federal sponsor, the State, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

R. L. VAN ANTWERP
Lieutenant General, US Army
Chief of Engineers

Battelle
The Business of Innovation

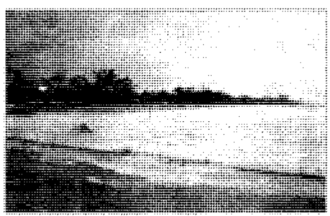
Final Independent External Peer Review Report for the Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan

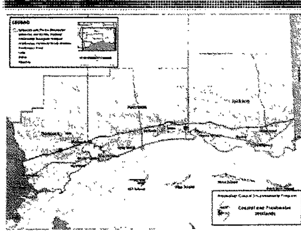
Prepared by
Battelle Memorial Institute

Prepared for
Department of the Army
U.S. Army Corps of Engineers
Coastal Storm Damage Reduction
Planning Center of Expertise
Baltimore District

Contract No. DACW33-03-D-0004
Delivery Order No. DA02

November 7, 2008





FINAL

INDEPENDENT EXTERNAL PEER REVIEW REPORT

for the

Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan

Prepared by

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for

Department of the Army
U.S. Army Corps of Engineers
Coastal Storm Damage Reduction Planning Center of Expertise
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November 7, 2008

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FINAL
INDEPENDENT EXTERNAL PEER REVIEW REPORT

for the
Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan

EXECUTIVE SUMMARY

In the Third Emergency Supplemental to the Defense Appropriations Act, 2006, Congress directed the U.S. Army Corps of Engineers (USACE) to conduct an analysis and design for comprehensive improvements or modifications to existing improvements for the coastal Mississippi region. This analysis and design is required to address hurricane and storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resource purposes. The Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan contains final recommendations on these topics from USACE. The report consists of an integrated main report/environmental impact statement (EIS) and supporting appendices that describe an integrated system of structural, nonstructural, and environmental measures.

Because of the importance of this project, USACE conducted an unbiased independent external peer review (IEPR) of the MsCIP Comprehensive Plan. Independent, objective peer review is regarded as a critical element in ensuring the reliability of scientific analyses. Battelle, as a non-profit science and technology organization with experience in establishing and administering peer review panels for USACE, was engaged to coordinate the IEPR of the MsCIP Comprehensive Plan. The IEPR was conducted following guidance described in the Department of the Army, USACE, guidance *Peer Review of Decision Documents* (EC 1105-2-410) dated August 22, 2008, CECW-CP Memorandum dated March 30, 2007, and the Office of Management and Budget's *Final Information Quality Bulletin for Peer Review* released December 16, 2004.

This final report describes the IEPR process, summarizes final comments of the IEPR panel, and describes the panel members and their selection. The results of this IEPR report will be taken into consideration in preparation of the final MsCIP Comprehensive Report.

Seven panel members (all from academe) were selected for the IEPR from nearly 20 identified candidates. Corresponding to the technical content of the MsCIP Comprehensive Plan, the areas of technical expertise of the 7 selected peer reviewers included: engineering (civil and geotechnical); geology/geomorphology; hydrology; hydraulics; coastal environmental science; water quality/resource management; floodplain management; meteorology/hurricanes; socio-economics; real estate; risk assessment; and modeling.

The peer reviewers were provided an electronic version of the MsCIP Comprehensive Plan documents, along with a charge that solicited their comments on specific sections of the documents that were to be reviewed. More than 400 individual comments were received from the IEPR panel in response to the charge questions. There was no communication between the IEPR panel and the authors of the MsCIP Comprehensive Plan during the peer review process.

Following the individual reviews of the MsCIP Comprehensive Plan documents by the IEPR panel members, a consensus discussion was conducted to review key technical comments, discuss charge questions for which there were conflicting responses, and reach consensus on the final comments to be provided to USACE. The final comments were documented according to a five-part format that included description of: (1) the nature of the comment, (2) the basis for the comment, (3) significance of the comment (high, medium, and low), (4) comment cross-referencing if related to other comments, and (5) recommendations on how to resolve the comment. Overall, 14 final IEPR comments were identified and documented. Of the final 14 comments, four were identified as having high significance (including one, comment 12, that was designated as "High/Medium"), eight were identified as having medium significance, and two comments were identified as having a low level of significance. Table ES-1 summarizes the final comments by level of significance. Detailed information on each comment is contained in Appendix A of this report.

Table ES-1. Overview of 14 Final Comments Identified by the MsCIP Comprehensive Plan IEPR Panel.

Significance – High	
1	More refined analysis is recommended in certain areas before design and build can be conducted.
2	The preliminary evaluations of the Hurricane Storm Damage Reduction, erosion control, and ecosystem restoration need more explanation. For example it is unclear if dynamic habitat models and geomorphic evolution are considered.
3	The redevelopment scenarios should include a range of possible outcomes for the economy.
4	Adaptive management processes should be a more integral part of the Comprehensive Plan and must include a strong monitoring and feedback mechanism.
Significance – Medium	
5	The extent of inclusion of recommendations from the public and agency engagement process into the plan, and whether major controversies regarding the program plan exist, is unclear.
6	There needs to be a more in-depth discussion of the municipal and industrial waste and the future impact to the treatment facilities.
7	Human adaptation, as it relates to economic activities, needs more detail.
8	The effects of relative sea level rise need to be explained more explicitly, taking into account local effects in addition to global effects and incorporating recent studies.
9	It is unclear how relative sea level rise (RSL) is incorporated.
10	All of the physics-based models used need a better explanation, including inputs, outputs and assumptions.
11	The decision factors involved in using the models selected needs to be described. In some cases, updated modeling tools should be used.
12	Need to explain the rationale for selecting the oyster as a surrogate for other species.
Significance – Low	
13	The stated goal of the project to reduce loss of life by 100% is unrealistic.
14	The process for weighting metrics is unclear.

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1. INTRODUCTION

1.1 Background of Report Reviewed

In the Third Emergency Supplemental to the Defense Appropriations Act, 2006, Congress directed the U.S. Army of Engineers (USACE) "to conduct an analysis and design for comprehensive improvements or modifications to existing improvements" for the coastal Mississippi region. This analysis and design is required to address "hurricane and storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resource purposes..." In addition, USACE was directed to "recommend a cost-effective project, but ... not perform an incremental benefit-cost analysis to identify the recommended project." In particular, project recommendations were not to be "based upon maximizing net national economic development benefits." Based on this directive from Congress, the Mississippi Coastal Improvements Program (MsCIP) was initiated in January 2006, and the MsCIP Comprehensive Plan was developed.

The MsCIP project involves a multi-discipline team including members from the USACE Mobile District, Savannah District, South Atlantic Division, Environmental Research and Development Center, USACE Nonstructural Floodproofing Committee, Headquarters (HQUSACE), and Planning Centers of Expertise. The team extends to multiple Mississippi agencies, particularly the Mississippi Department of Marine Resources and Department of Environmental Quality, multiple academic groups and nongovernmental organizations, and several Federal agencies including the National Oceanic and Atmospheric Administration, U.S. Environmental Protection Agency, National Marine Fisheries Service, Federal Emergency Management Agency, U.S. Fish and Wildlife Service, National Park Service, U.S. Geological Survey, and the Natural Resources Conservation Service. Outside engineering and environmental firms are also involved in the MsCIP project. A feature of the study was the early engagement of the State of Mississippi, agencies, the public and other interest groups.

The MsCIP Comprehensive Plan report consists of an integrated main report/environmental impact statement (EIS) and supporting appendices that describe an integrated system of structural, nonstructural, and environmental measures. Specifically, the report includes: study area description; description of public and agency involvement; summary of the plan formulation activities including the application of a risk-informed decision framework; environmental impact statement; description of recommended plans; documentation of compliance with environmental requirements; and appendices on cost, engineering, environment, economic analysis, adaptive risk informed decision framework, plan formulation, and real estate.

1.2 Purpose of Independent External Peer Review

To help ensure that USACE documents are supported by the best scientific and technical information, a peer review process has been implemented by USACE that utilizes Independent External Peer Review (IEPR) to complement the Agency Technical Review (ATR), as described in the Department of the Army, U.S. Army Corps of Engineers, guidance *Peer Review of*

Decision Documents (EC 1105-2-410) dated August 22, 2008; and CECW-CP Memorandum dated March 30, 2007.

The purpose of peer review, in general, is to strengthen USACE's quality control processes for the development of decision documents in support of its Civil Works program. Independent external peer review provides an independent assessment of the technical analyses and recommendations included in a plan. In particular, the IEPR addresses the overall adequacy of the scope and structure of the report; the technical soundness of the report's assumptions, analyses, and calculations; and the need for additional data or analyses to make a good decision regarding implementation of alternatives and recommendations.

In this case, the IEPR of the MsCIP Comprehensive Plan was conducted and managed using contract support from an independent 501(c)(3) science and technology organization (Battelle Memorial Institute; hereafter Battelle) to ensure independent objectivity, along with a high degree of flexibility and responsiveness, which was essential for USACE to meet deadlines.

This final report describes the IEPR process, summarizes final comments of the IEPR panel, and describes the panel members and their selection. The results of this IEPR report will be taken into consideration in preparation of the final MsCIP Comprehensive Plan. Detailed information on the final comments of the panel is provided in Appendix A.

2. METHODS

This section describes the methodology followed in selecting independent external peer reviewers (hereafter: peer reviewers), and in planning and conducting the IEPR. The IEPR was conducted following procedures described in USACE's guidance as cited in Section 1.2 of this report and in accordance with the Office of Management and Budget's *Final Information Quality Bulletin for Peer Review*, released December 16, 2004. Supplemental guidance on evaluation for conflicts of interest used the National Academies' *Policy on Committee Composition and Balance and Conflicts of Interest for Committees Used in the Development of Reports*, dated May 12, 2003.

2.1 Planning and Schedule

Table 1 defines the schedule followed in execution of the IEPR.

Table 1. Schedule.

Task	Action	Due Date
Task 1	Identification of ~20 potential peer reviewers (including expertise/conflict of interest assessment and recruitment)	December 5, 2007
Task 2	Draft charge developed based on preliminary draft MsCIP comprehensive report	December 7, 2007
	Revised MsCIP report documents received and draft charge revised	September 8, 2008*
	Final charge approved by USACE	September 18, 2008
Task 3	Peer reviewers selected	December 5, 2007
	Subcontracts for peer reviewers completed	January 2008 (initial contracts)/ September 2008 (modified contracts)
Task 4	MsCIP documents for IEPR received	September 19, 2008*
	Kick-off meeting with IEPR Panel	September 24, 2008
	IEPR Panel members review MsCIP Comprehensive Plan and submit individual comments in response to charge	September 24 - October 15, 2008
Task 5	Battelle identifies list of strawman key issues (based on individual comments) and distributes to IEPR Panel	October 20, 2008
	Consensus teleconference – facilitated IEPR Panel discussion of key issues; agreement on consensus issues	October 22, 2008
	IEPR Panel prepares final consensus comments using formatted structure and submits to Battelle	October 30, 2008
	IEPR Panel reviews the Final IEPR Report (prepared by Battelle and incorporating the final consensus comments)	November 3-5, 2008
	Battelle submits the Final IEPR Report to USACE	November 7, 2008
Task 6	Final consensus comments from IEPR Panel are posted to DrChecks (Design Review and Checking System) web-based design review tool	November 7, 2008
	MsCIP authors provide responses to final consensus comments using DrChecks	November 12, 2008
	Peer reviewer provide feedback (i.e., BackChecks) on MsCIP author responses to consensus comments	November 18, 2008

* The release of the MsCIP Comprehensive Plan was delayed by approximately nine months from the initial expected release date, delaying the preparation of the final charge and conduct of the peer review process.

2.2 Identification and Selection of Peer Reviewers

In the formation of the MsCIP Comprehensive Plan IEPR Panel, Battelle sought to recruit highly qualified reviewers according to the following general criteria:

- Scientific and technical stature – Evidence of stature in the broad scientific and technical community (invited contributions to workshops, conferences or panels; evidence of scientific and technical leadership; awards, membership, or important committee assignments in prestigious organizations).
- Advisory experience – Experience advising top managers and promoting constructive uses of science and technology, especially in arenas relevant to water and sediment management and/or ecosystem restoration.
- Technical publications – A strong record of publication in peer-reviewed scientific literature or other appropriate venues in an area of expertise relevant to the issues at hand.
- Relevant knowledge – Evidence of extensive and/or intensive working knowledge of a scientific or technical field related to the specific issues of concern.
- Reputation for achieving balance – Evidence of ability to weigh issues in a balanced manner when in an advisory capacity.
- Interdisciplinary skills – Evidence of ability to work and think across disciplines, and/or experience in working with and advising on complex issues that integrate multiple disciplines.

In addition, the technical credentials of the peer reviewers were evaluated according to the overall scope of the MsCIP Comprehensive Plan, with the goal of comprising an IEPR panel of multiple technical disciplines covering a broad area of study, including the following disciplines and experiences:

- Engineering – including but not limited to structural, cost, mechanical, and geotechnical engineering expertise;
- Hydrology and hydraulics;
- Geology and geomorphology;
- Coastal environmental science/wetland ecology;
- Meteorology and hurricane expertise;
- Water resources decision-making and decision analyses
- Water quality;
- Floodplain management;
- Nonstructural flood damage reduction alternatives;
- Socio-economics;`
- Real estate;
- Risk assessment; and
- Modeling.

The peer reviewers were also screened for the following *potential* exclusion criteria or conflicts of interest.

Exclusion Criteria
- Current USACE employee;
- Involvement in developing or contributing to the development of the MsCIP Comprehensive Plan;
- A significant portion (i.e., greater than 50 percent) of personal or company revenues within the last three years came from USACE contracts;
- Current work or arrangements concerning future work in support of industries or other parties that could potentially be affected by developments or material presented in the MsCIP Comprehensive Plan;
- Any personal benefit or financial interest held by the reviewer (or employer, spouse or dependent child) that could be affected by participation in this matter; or
- Any publicly documented statement made by the reviewer or the reviewer's firm advocating for or against the MsCIP Comprehensive Plan.

Other Potential Conflicts of Interest
- Former USACE employee;
- Repeatedly served as USACE technical reviewer; or
- Other USACE affiliation, including research grants or cooperative agreements [Scientist employed by the USACE (except as described in NAS criteria, see EC 1105-2-4 Section 9d)][a].

Battelle initially identified approximately 20 highly qualified potential MsCIP peer reviewers with a broad range of technical expertise. Of those initially contacted, 9 IEPR candidates confirmed their interest and availability, and 11 candidates declined either due to the schedule and anticipated level of effort, disclosed conflicts of interest, or because they did not possess the technical expertise being sought.

In selecting final peer reviewers from the list of potential peer review candidates, an effort was made to select experts who best fit the criteria and factors described above. Based on these considerations, 7 reviewers, all from academe, were selected for the final peer review panel. (See Section 3 of this report for names and biographical information on the selected peer reviewers.) Battelle established subcontracts with the peer reviewers indicating their willingness to participate and documented the absence of conflicts of interest (through a signed conflict of interest form).

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[a] Note: Battelle will be evaluating whether scientists in universities and consulting firms that are receiving USACE-funding have sufficient independence from USACE to be appropriate peer reviewers. See the OMB memo p. 18, "....when a scientist is awarded a government research grant through an investigator-initiated, peer-reviewed competition, there generally should be no question as to that scientist's ability to offer independent scientific advice to the agency on other projects. This contrasts, for example, to a situation in which a scientist has a consulting or contractual arrangement with the agency or office sponsoring a peer review. Likewise, when the agency and a researcher work together (e.g., through a cooperative agreement) to design or implement a study, there is less independence from the agency. Furthermore, if a scientist has repeatedly served as a reviewer for the same agency, some may question whether that scientist is sufficiently independent from the agency to be employed as a peer reviewer on agency-sponsored projects."

2.3 Preparation of the Charge and Conduct of the Peer Review

A charge for peer review, which contained specific questions regarding the MsCIP Comprehensive Plan, was developed to assist the IEPR panel. The draft charge was prepared by Battelle with input from USACE and guidance provided in USACE's guidance *Peer Review of Decision Documents* (EC1105-2-410) and the Office of Management and Budget's *Final Information Quality Bulletin for Peer Review*. A draft charge was submitted to the USACE for consideration and evaluation, and finalized by Battelle after minor clarifications were incorporated. The final charge included general guidance for the reviewers on conduct of peer review, as well as 61 questions/discussion points on specific sections of the Comprehensive Plan for the IEPR panel to respond to, as shown in Appendix B of this report.

The peer reviewers were provided an electronic version of the MsCIP Comprehensive Plan documents and the charge for review. A full list of the MsCIP Comprehensive Plan documents that were reviewed by the IEPR panel is provided in the charge in Appendix B of this report. Peer reviewers were instructed to submit responses to the charge questions. More than 400 comments were received from the individual IEPR panel members in response to the charge questions. There was no communication between the IEPR panel and the authors of the MsCIP Comprehensive Plan during the peer review process, but communication between Battelle and the reviewers, and among the reviewers, was conducted as needed.

2.4 Review of Individual Peer Review Comments

Battelle reviewed the more than 400 comments received from the individual IEPR panel members to identify overall recurring themes, potential areas of conflict, and other panel impressions of the report. As a result of this review, Battelle developed a preliminary list of 33 overall comments and talking points that emerged from the IEPR panelists' verbatim comments, including 23 negative comments, 6 positive comments, and 4 comments that were possibly conflicting among the various reviewers. Each reviewer's verbatim comments were shared with the full IEPR panel.

2.5 Peer Review Panel Consensus Discussion

Battelle facilitated a consensus discussion conference call with the IEPR panel. The purpose of the consensus discussion was to allow the exchange of technical information among the panel experts, many of whom are from diverse scientific backgrounds. This information exchange ensured that the IEPR report represents the consensus of the panel and avoided isolated or conflicting information and analyses. The main goal of the consensus discussion was to review the overall comments identified by Battelle and ascertain and confirm their importance to the IEPR panel, remove points having a lack of consensus, identify and add any missing issues of high-level importance to the IEPR panel, and finally, reach consensus on the final comments to be provided to USACE.

The panel discussion resulted in 14 overall consensus comments. Following the discussion, a summary memorandum documenting each consensus comment identified by the panel (and organized by level of significance) was prepared by Battelle and distributed to the IEPR panel.

The memorandum provided detailed guidance on the approach and format to be used in the development of the final IEPR comments for the MsCIP Comprehensive Plan.

In addition to reaching consensus on the final comments to be provided to USACE, the IEPR panel discussed responses to 4 specific charge questions where there appeared to be disagreement among the reviewers. The conflicting comments were resolved based on professional judgment of the panel members and the comment was either incorporated into the final comments or determined to be a non-significant issue (i.e., either a true disagreement did not exist, or the issue was not important enough to include as a final comment).

2.6 Preparation of Final Comments

The IEPR panel used the 14 overall consensus comments as a basis for preparing the final comments. A memorandum was distributed to the IEPR panel providing detailed guidance on the approach and format to be used in the development of the final comments. A summary of the directive is provided below:

- Lead Responsibility: A lead reviewer who was responsible for coordinating the development of the final comment and submitting it to Battelle was assigned for each consensus comment. Lead assignments were modified by Battelle at the direction of the IEPR panel. To assist each lead in the development of the final comments, Battelle distributed individual verbatim comments in the comment-response table format, a summary detailing each consensus comment (in the memorandum), an example final comment following the five-part structure (described below), and a template for the preparation of the final comments.

- Directive to the Lead: Each lead was encouraged to communicate directly with other reviewers, as needed, to contribute to a particular consensus comment. If a significant comment was identified that was not covered by one of the original 14 overall consensus comments, the appropriate lead was instructed to draft a new consensus comment. If a consensus comment was related to another consensus comment, the lead was to cross-reference them.

- Format for Final Comments: Each final comment was presented as part of a five-part structure, including:
  1. Nature of comment (i.e., succinct summary statement of concern)
  2. Basis for comment (i.e., details regarding the concern)
  3. Significance (high, medium, low; see description below)
  4. Comment cross-referencing
  5. Recommendation (see description below).

- Criteria for Significance: The following were used as criteria for assigning a significance level to each final comment:
  - High — Describes a fundamental problem with the project that could affect the recommendation or justification of the project
  - Medium — Affects the completeness or understanding of the reports/project

- Low	Affects the technical quality of the reports but will not affect the recommendation of the project.

- Guidance for Developing the Recommendation: The recommendation was to include specific actions that the USACE should consider to resolve the comment (e.g., suggestions on how and where to incorporate data into the analysis, how and where to address insufficiencies, areas where additional documentation is needed, etc.).

As a result of this process 14 final comments were prepared by the peer review panel. Battelle reviewed and edited (with concurrence from the IEPR panel) all final comments for clarity and adherence to the requested final comment template format. There was no communication between the IEPR panel and the authors of the MsCIP Comprehensive Plan during the preparation of the final comments. The final IEPR comments were assembled and are presented in Appendix A.

3. BIOGRAPHICAL INFORMATION ON PEER REVIEWERS

Potential peer review candidates were identified through Battelle's Peer Reviewer Database, targeted internet searches using key words (e.g., technical area, geographic region), search of websites of universities or other compiled expert sites, and through referrals from candidates who declined. A draft list of screened (for availability, technical background, conflict) potential reviewers was prepared by Battelle and provided to USACE. The final list of peer reviewers was determined by Battelle.

An overview of the credentials of the three reviewers selected for the IEPR panel and their qualifications in relation to the technical evaluation criteria is presented in Table 2. More detailed biographical information regarding each candidate and his or her technical areas of expertise is presented following Table 2.

Table 2. MsCIP Comprehensive Plan IEPR Panel: Technical Criteria and Areas of Expertise.

Name	Affiliation	Primary Areas of Expertise									
		Engineering (civil, structural, cost, mechanical, geotechnical)	Hydrology/hydraulics	Geology/geomorphology	Meteorology/hurricanes/storm surge modeling	Coastal environmental science/wetland ecology/ water quality	Socio-economics	Real estate	Water resources decision-making/ Floodplain management	Risk Assessment	Modeling
	Totals →	3	2	2	2	3	2	1	3	2	4
Charles Aubeny	Texas A&M University	x		(x)							
Shuyi Chen	University of Miami				x						x
Peter Goodwin	University of Idaho	x	x			x			(x)		x
Scott Hagen	University of Central Florida	x	x		x	x					x
Jamie Kruse	East Carolina University						x	x	x	x	x
Douglass Shaw	Texas A&M University						x		x	x	
L. Donelson Wright	College of William and Mary			x		x					

Note: (x) in parentheses indicates this reviewer is not the primary expert recruited for this category, but has expertise in this area.

Charles Aubeny, Ph.D.
Role: This reviewer was chosen primarily for his expertise in geotechnical and civil engineering.
Affiliation: Texas A&M University, College Station, Texas

Dr. Aubeny is an Associate Professor in Civil Engineering in the Zachry Department of Civil Engineering at Texas A&M University. He teaches soil mechanics, geotechnical design, geotechnical testing, and numerical methods in geomechanics. His current research interests involve geotechnics of offshore foundations, anchors, and pipelines. Experience prior to his current academic position includes 8 years with the Embankment Dams Branch at the U.S. Bureau of Reclamation Engineering and Research Center in Denver, and 7 years in private consulting in geotechnical engineering, dam engineering, levees, flood control, and geo-environmental engineering. Much of his consulting work centered on levee systems in the Sacramento-San Joaquin River Delta in central California. His experience includes geotechnical field investigations, laboratory testing, analysis, design, construction observations, and monitoring performance of structures during operation. Dr. Aubeny holds a Ph.D. in Civil Engineering from Massachusetts Institute of Technology. He is a licensed Professional Engineer, States of Texas and Colorado, and a Registered Civil Engineer, State of California.

Shuyi Chen, Ph.D.
Role: This reviewer was chosen primarily for her expertise in the areas of tropical meteorology (hurricanes and storm surge) research and modeling.
Affiliation: University of Miami, Miami, Florida

Dr. Chen is a Professor of Meteorology and Physical Oceanography at the Rosenthal School of Marine and Atmospheric Science (RSMAS) of the University of Miami. Dr. Chen is a widely published author whose research interests include mesoscale and tropical meteorology, coastal meteorology, air-sea interactions, high-resolution coupled atmosphere-wave-ocean modeling of tropical cyclones, and numerical weather prediction. Dr. Chen leads a research group at RSMAS/UM that has developed a high-resolution, fully coupled atmosphere-wave-ocean, vortex-following, nested-grids model for hurricane research and prediction. She is currently the principal investigator/chief scientist for the National Science Foundation funded Hurricane Rainbands and Intensity Change Experiment (RAINEX) using three Doppler radar aircraft collected unprecedented in-situ data in Hurricanes Katrina, Rita, and Ophelia during the 2005 Hurricane Season. She also served as principal investigator for the Coupled Boundary Layer Air-Sea Transfer (CBLAST)-Hurricane modeling team sponsored by the Office of Naval Research. In 2006, Dr. Chen was awarded the NASA Group Achievement Award. Most recently, Dr. Chen was the invited speaker on a panel of experts for the Congressional Briefing on the National Hurricane Initiative at the U.S. House and Senate in July 2007, and testified as a witness at the Joint Hearing on: *The State of Hurricane Research and the National Hurricane Research Initiative Act of 2007*, before the Subcommittee on Energy and Environment and the Subcommittee on Research and Science Education, Committee on Science and Technology of United States House of Representatives in June 2008. She served as an Editor for *Weather and Forecasting* Journal of the American Meteorological Society. Dr. Chen holds a Ph.D. in Meteorology from the Pennsylvania State University.

Peter Goodwin, Ph.D., P.E.
Role: This reviewer was chosen primarily for his expertise in the areas of wetland ecology, ecohydraulics, civil engineering, and modeling. He also has expertise in floodplain management.
Affiliation: University of Idaho, Boise, Idaho

Dr. Goodwin is the DeVlieg Presidential Professor of Ecohydraulics and Professor in the Department of Civil Engineering at the University of Idaho. He serves as the Director of the Center for Ecohydraulics Research, an interdisciplinary program researching the linkages between ecological response to management actions or changes in physical processes of rivers, lakes, estuaries and wetlands. His expertise also includes modeling physical processes in natural and disturbed systems and quantifying benefits of restoration activities. He has co-authored numerous books, refereed journal publications, and conference proceedings related to flood management, restoration ecology, wetland management, and hydraulic and environmental modeling of coastal, estuarine and river waters. He has been invited to speak both nationally and abroad on topics such as ecohydraulics, habitat restoration, flood management, and ecology, and serves on several national and international committees. Most recently, he was elected Vice President, International Association for Hydraulic Research and Engineering since 2007, and serves on the Science Board, Louisiana Coastal Action Plan (rebuilding the ecosystem and wetlands of coastal Louisiana post- Hurricane Katrina) since 2006. Dr. Goodwin holds a Ph.D. in Hydraulic Engineering from the University of California, Berkeley. He is a Registered Engineer, States of California and Idaho and a Chartered Engineer, United Kingdom.

Scott Hagen, Ph.D., P.E.

Role: This reviewer was chosen primarily for his expertise in the areas of modeling, hydrology, civil engineering, coastal environmental science. He also has some expertise in water quality.
Affiliation: University of Central Florida, Orlando, Florida

Dr. Hagen is an Associate Professor in the Civil and Environmental Engineering Department at the University of Central Florida. He is also the Director of the Coastal Hydroscience Analysis, Modeling & Predictive Simulations (CHAMPS) Laboratory, a nationally- and internationally-recognized laboratory whose primary research goal is to use computer modeling and simulation to better analyze and understand coastal hydroscience. Dr. Hagen's current research includes astronomic and meteorologic tidal modeling, including hurricane storm surge simulations and tidal flow analyses. He was the principal investigator of a simulation of tidal hydrodynamics on the continental shelf and within the multiple inlet/barrier island coastline of northeast Florida as well as model simulations of tidal boundary conditions for coastal water models. He has co-authored numerous refereed journal articles, conference publications, and technical reports focusing on oceanic and coastal tidal models. He has been invited to speak both nationally and abroad on the topic of modeling. Dr. Hagen serves on several committees and was recently named the Chair of Tidal Hydraulics, a national committee for the American Society of Civil Engineers (ASCE) Coasts, Oceans, Ports and Rivers Institute. Dr. Hagen holds a Ph.D. in Civil Engineering from the University of Notre Dame. He is a registered Professional Engineer, State of Florida.

Jamie Brown Kruse, Ph.D.

Role: This reviewer was chosen primarily for her expertise in the areas of real estate, risk assessment, economics, modeling, and non-structural flood damage reduction alternatives.
Affiliation: East Carolina University, Greenville, North Carolina

Dr. Kruse is a Professor in the Department of Economics at East Carolina University. She also is the Director for the Center for Natural Hazards Research. Her research interests include economics, risk, health, wind hazard economics, disaster management, and response to hazards. She has co-authored numerous journal articles, conference publications, and technical reports on areas such as hurricanes and economic research and real estate responses to flood hazards. She was the Guest Editor, Hurricane Katrina Symposium, Southern Economic Journal in October

2007. She has been invited to speak both nationally and abroad. She is a member of the American Economic Association, Economic Science Association, Southern Economic Association, Society for Risk Analysis, Society of Behavioral Economics, and American Association for Wind Engineering and is on the Advisory Panel, National Science Foundation, Decision, Risk and Management Sciences Program, 2007-2009. Dr. Kruse holds a Ph.D. in Economics from the University of Arizona.

Douglass Shaw, Ph.D.
Role: This reviewer was chosen primarily for his expertise in economics and risk assessment.
Affiliation: Texas A&M University, College Station, Texas

Dr. Shaw is a Professor in the Department of Agricultural Economics at Texas A&M University, with a joint appointment in the Department of Recreation, Parks and Tourism Sciences. He is also a research fellow at the Hazards Reduction and Recovery Center, an internationally known disaster research group, and is a participating member of the Graduate Program in Water Management and Hydrologic Science at A&M. His research specialties are environmental and water resource economics, with emphasis on valuing environmental amenities and changes in health risks associated with contamination and degradation of resources. He has published over seventy peer-reviewed articles, book chapters, or books. His current research focuses most on the connections between the role of perceived risks in environmental economics and non-market valuation under uncertainty. He has also written about climate change, the risks from consuming contaminated fish, the risks of nuclear waste transport, risks of drinking water contaminated with arsenic, risks of damage from hurricanes, and air pollution's affect on asthma patients. Dr. Shaw has given over 30 papers or talks at professional conferences, university and college seminars, and at government workshops. He has frequently presented work at annual meetings of the American Agricultural Economics Association, the Association of Environmental and Resource Economics, and the American Economic Association, and he has presented papers both nationally and internationally. He has served as Associate Editor for the journals *Water Resources Research* and the *Journal of Leisure Research* and as a member of the editorial council for the Journal of Agricultural and Resource Economics. Dr. Shaw holds a Ph.D. in Economics from the University of Colorado.

L. Donelson Wright, Ph.D.
Role: This reviewer was chosen primarily for his expertise in the areas of coastal environmental science and geomorphology.
Affiliation: School of Marine Science, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Virginia

Dr. Wright is a Chancellor Professor Emeritus of Marine Science, College of William and Mary Fellow for Coastal Research, Southeastern University Research Association. His research is largely focused on bottom boundary layer and sediment transport processes operating in the coastal ocean and adjoining estuaries, the cross-shelf flux of particles, the morphodynamics of the inner continental shelf, river-mouth and estuarine processes including the roles of positive and negative buoyancy, and on the complex interrelationships among numerous physical and biological processes near the sea floor. His research is interdisciplinary and involves elements of physical, geological, and biological oceanography and has direct engineering and environmental applications. Field investigations have been conducted in the coastal waters of the Atlantic, Pacific, Arctic and Indian Oceans, Gulf of Mexico, Chesapeake Bay, Baltic Sea, Timor Sea, and Yellow Sea. He is currently coordinating a multi-institutional effort to establish a comprehensive coastal ocean-observing program in the southeastern region of the U.S. Dr. Wright has authored dozens of journal publications, books, and conference proceedings and given papers or talks at professional conferences, university and college seminars, and at government workshops, both nationally and abroad. Dr. Wright holds a Ph.D. through the Coastal Studies Institute, Louisiana State University (Coastal and alluvial morphology and nearshore dynamics specializations).

4. RESULTS – SUMMARY OF PEER REVIEW COMMENTS

As a result of the consensus discussion process, the IEPR panel identified 14 final comments, segmented into rankings of high, medium, and low significance. In total, as shown in Table 3, four were identified as having high significance, eight were identified as having medium significance (including one, comment 12, that was designated as "High/Medium"), and two were identified as having a low level of significance.

As indicated in Table 3, the majority of the comments focused on areas viewed by the reviewers as needing improvement or additional discussion, or that were omitted. The final IEPR comments in their entirety are included in Appendix A.

Overall, the IEPR panel agreed that the MsCIP Comprehensive Plan is an impressive body of work that is wide-ranging in the scope of research used to inform plan recommendations. However, they felt that the plan could be improved by inclusion of a concise statement of the project's long-term vision for the future coastal landscape and a figure illustrating the project in the Executive Summary. The panel also acknowledged that there has been extensive outreach and community engagement in the scoping process. The panel encouraged continued USACE collaboration with the public, local and federal governments, and the inclusion of universities and research institutions to help steer this plan towards a successful outcome. Support of local communities and States should be fostered as it is also a critical component to project success.

Because the MsCIP Comprehensive plan is a large scale and long-term project, it will take a long time to implement, and it will be an incremental process that will involve adjustments along the way. Thus, the panel emphasized that on-going monitoring to calibrate assumptions against observable evidence coupled with adaptive management that adjusts to new information is absolutely essential. Further, as identified in panel comments, they recommended that for a number of analyses the assumptions should be re-examined, the models should be refined, and a new series of simulations conducted before the USACE proceeds to the design and build phases of this project. Most importantly, the panel recommended that recent evidence of accelerated relative sea level rise should be considered in the final design, and how that relative sea level rise is incorporated must be reconsidered.

Table 3. Overview of 14 Final Comments Identified by the MsCIP Comprehensive Plan IEPR Panel.

Significance – High	
1	More refined analysis is recommended in certain areas before design and build can be conducted.
2	The preliminary evaluations of the Hurricane Storm Damage Reduction, erosion control, and ecosystem restoration need more explanation. For example it is unclear if dynamic habitat models and geomorphic evolution are considered.
3	The redevelopment scenarios should include a range of possible outcomes for the economy.
4	Adaptive management processes should be a more integral part of the Comprehensive Plan and must include a strong monitoring and feedback mechanism.
Significance – Medium	
5	The extent of inclusion of recommendations from the public and agency engagement process into the plan, and whether major controversies regarding the program plan exist, is unclear.
6	There needs to be a more in-depth discussion of the municipal and industrial waste and the future impact to the treatment facilities.
7	Human adaptation, as it relates to economic activities, needs more detail.
8	The effects of relative sea level rise need to be explained more explicitly, taking into account local effects in addition to global effects and incorporating recent studies.
9	It is unclear how relative sea level rise (RSL) is incorporated.
10	All of the physics-based models used need a better explanation, including inputs, outputs and assumptions.
11	The decision factors involved in using the models selected needs to be described. In some cases, updated modeling tools should be used.
12	Need to explain the rationale for selecting the oyster as a surrogate for other species.
Significance – Low	
13	The stated goal of the project to reduce loss of life by 100% is unrealistic.
14	The process for weighting metrics is unclear.

Appendix A

Final IEPR Comments on the MsCIP Comprehensive Plan

Comment 1:
More refined analysis is recommended in certain areas before design and build can be conducted.
Basis for Comment:
Missing or incomplete analyses supporting the comprehensive plan were identified in a number of areas. Intertwined with this issue is a general uncertainty among the reviewers as to what the USACE plans to do from this point forward. Specifically, it is not clear whether the USACE considers that it is ready to proceed directly to the levee design stage, or if the study to date is considered as a starting point and the USACE intends to do more extensive analyses. Areas considered by the panel to be in need of more refined analysis include the following: ▪ No explicit levee height is recommended, so clearly more work is needed regarding this critical design issue. ▪ Rainfall and runoff should be considered in the analysis. While storm surge is recognized as the primary focus of this project, rainfall and flooding preceding, during, and after a storm surge could have a combined disastrous effect and should be considered as an important factor affecting the results of the analysis. ▪ The justification for selecting a 50-year planning horizon is unclear. This issue affects critical aspects of the project such as sustainability of measures, and State and Federal funding. Examples of other aspects of the study that can be affected by the selection of the planning horizon include subsidence, sea level rise, and storm intensity related to climate change. ▪ Maps of inundation and frequency of exceedance for present conditions and projections of future scenarios would assist in better evaluating mitigation strategies. ▪ The physical process effects are not fully addressed in the Comprehensive Plan and the physical alterations to the Mississippi coastal environment need to be more fully described. Certain physical parameters used in the analysis do not appear in the report. In addition, certain physical processes (e.g., regional scale influence including landscape and coastline alternations on the local analysis in the Comprehensive Plan) were not reflected in the report; these processes involve a chain of physical processes affecting flows, salinity, vegetation, and erosion. ▪ The storm surge and transport models should include the effects of all lines of defense (LODs). ▪ No analysis is provided supporting the feasibility of the proposed surge gates closing off the bays; since the effectiveness of LODs 3 and 4 rely on blocking off the bays with surge gates, the feasibility of this component of the plan should be firmly established.
Significance – High:
Issues relating to any of the issues listed above could significantly change the outcome of the analyses, thereby potentially affect the recommended course of action or the justification for the project.
Comment Cross-referencing:
Also see related comments:

(4) Adaptive management processes should be a more integral part of the Comprehensive Plan and must include a strong monitoring and feedback mechanism. (8) The effects of relative sea level rise (RSL) need to be explained more explicitly, taking into account local effects in addition to global effects. (9) It is unclear how relative sea level rise (RSL) is incorporated. (10) All of the physics-based models used need a better explanation, including inputs, outputs and assumptions.
Recommendations for Resolution:
To resolve these concerns, the report would need to be expanded to include: ▪ A specific recommended levee height. ▪ Inclusion of rainfall and runoff in the analysis. ▪ A justification for a 50-year planning horizon and what is expected to occur after the 50 years. ▪ Inclusion of inundation maps for present conditions and for projections of future scenarios. ▪ Include all data on physical parameters used in the analyses and ensure that the physical models simulate all relevant physical processes on both regional and local scales. ▪ The storm surge and transport models should include the effects of all lines of defense (LODs). ▪ Provide an analysis of the proposed surge gates closing off the bays to more fully demonstrate their feasibility.

Comment 2:
The preliminary evaluations of the Hurricane Storm Damage Reduction, erosion control, and ecosystem restoration need more explanation. For example it is unclear if dynamic habitat models and geomorphic evolution are considered.
Basis for Comment:
The evaluation of storm damage reduction, erosion control and ecosystem restoration over a 50-year period must be made in the context of a dynamic and changing system, not on the assumption of static conditions. Following initial implementations, it is to be expected that progressive changes in coastal energy regime and sea level will lead to corresponding evolution of coastal configuration and nearshore/inner shelf profiles. The coastal ecosystem will also likely undergo changes which may further contribute to morphologic changes. These changes will modify storm surges, currents and waves. The altered energy regime will then feed back into the continued evolution of habitat and coastal shape. The morphologic and habitat changes, combined with sea level rise, would probably be accompanied by changes in inundation frequency and height. Because of these changes, maps of inundation vulnerability projected some decades into the future may be very different from those of the present day. It is not clear if model runs designed to predict these changes and their consequences have been carried out. If they have, then the results need to be more explicitly described. If they have not, then the need for such runs should be acknowledged and a plan for carrying out the necessary analyses and modeling in the future as part of the adaptive management plan needs to be laid out.
Significance – High:
Failure to take account of dynamic feedbacks, such as morphology-induced storm surge amplification or attenuation, could lead to first order errors in evaluating the efficacy of the long-range program. For that reason, the panel ranks the significance of this concern as high.
Comment Cross-referencing:
Also see related comments: (1) More refined analysis is recommended in certain areas before design and build can be conducted. (4) Adaptive management processes should be a more integral part of the Comprehensive Plan and must include a strong monitoring and feedback mechanism. (8) The effects of relative sea level rise need to be explained more explicitly, taking into account local effects in addition to global effects and incorporating recent studies. (9) It is unclear how relative sea level rise (RSL) is incorporated.
Recommendations for Resolution:
To resolve these concerns, the report would need to be expanded to include: ▪ If the possible effects of morphological and ecologic change over time have been considered by USACE, then this needs to be explicitly pointed out in the plan. ▪ If the effects listed above have not been considered and plans are underpinned by assumptions of a static coastal regime, then the possible consequences of coastal evolution over time need to be clearly acknowledged but not necessarily addressed prior to initial implementation provided that the condition below is met.

- A more explicit description of how sediment and freshwater diversion actions interact between the Mississippi and Louisiana programs. Will actions in one state preclude options in another?
- An Adaptive Management Plan that includes routine monitoring and modeling of temporal changes in coastal habitat and configuration along with accompanying observed and predicted changes in storm surge and erosive waves should be articulated in detail.

Comment 3:

The redevelopment scenarios should include a range of possible outcomes for the economy.

Basis for Comment:

There are two redevelopment assumptions used to develop future scenarios for the without project conditions: a) Simple replacement of "like-kind" structures that were destroyed by Hurricane Katrina and b) Replacement of structures with condos and casinos on the water front (planning units 1 and 2). These two possibilities seem to have been selected with no real justification. There is no discussion of reasoning behind selecting these two scenarios.

Full replacement of all like-kind structures (a) is unlikely and probably impossible given that Katrina eroded a portion of the previously available land parcels. While erosion of parcels is a distinct possibility under assumption (b) as well, a single change in the redevelopment pattern is considered. There is no economic forecast or explanation for this choice of redevelopment pattern.

The panel realizes that the initial phases of redevelopment in the region might favor a pattern similar to (b) but we do not find any solid justification for either of the redevelopment scenarios that was assumed. Further current volatility in the financial and energy sectors will certainly influence the redevelopment pattern for the region. The report does not offer the two scenarios as either the minimum or maximum within a range of potential outcomes and does not provide justification for either scenario as a prediction based on a probability distribution. Whereas the method used to address uncertainty was explained in other parts of the analysis, no such attempt was made here.

Tables 7 and 8 of Appendix B provide a projected inventory of structures. There are a couple of questions that arise. Under what assumption does planning unit 2 reverse from residential to manufactured homes under redevelopment scenario (b)? The panel also noted that the parcel count is exactly the same under the two scenarios. Is there actually a 1 for 1 replacement of a single family home with a condo or casino?

The matrix of six future scenarios is created by integrating or crossing the two redevelopment scenarios (a and b) with three possibilities for relative sea level rise (RSL), none, a max of 2.4 feet RSL over 100 years, and a max of 3.4 feet of RSL over 100 years. Would the inventory of structures really be the same under these three possibilities for RSL? An owner of a parcel will adapt to different levels of flooding/storm surge risk when he/she chooses whether to rebuild. As discussed in Comment #7 individuals will optimally substitute/adapt to relevant conditions. They will not rebuild a structure identical to what existed before the storm, rather, they will choose different mitigation measures in the rebuilt structure or retrofit it based on observable evidence of RSL. In fact they could conceivably choose a "disposable structure" meant to provide benefits for only 5 or 10 years, fully expecting that it will be condemned due to encroachment by the sea.

In summary, the six scenarios have been created as if individuals and businesses will reflexively

replace what was lost with no thought given to the fact that some parcels are not rebuildable and that there is greater future risk, given mounting evidence on sea level rise. This is not a justifiable assumption.
Significance – High:
Given that the numbers generated here influence cost effectiveness analysis and ultimately project selection, significance is high.
Comment Cross-referencing:
Also see related comments: (7) Human adaptation, as it relates to economic activities, needs more detail.
Recommendations for Resolution:
To resolve these concerns, the report would need to be expanded to include: ▪ Add rebuilding scenarios that describe a broader range of outcomes and are based on rational behavior or provide better justification for the two rebuilding scenarios that were chosen. ▪ Explain the assumptions behind the stock of structures in Tables 7 and 8 of Appendix B. ▪ Use assumptions on economic growth that include a recession scenario.

Comment 4:

Adaptive management processes should be a more integral part of the Comprehensive Plan and must include a strong monitoring and feedback mechanism.

Basis for Comment:

Monitoring and performance criteria are often underfunded and it is difficult to assess whether the intended outcomes are achieved. Adaptive management is a defensible, scientifically-based approach for ensuring that the goals of the project are achieved and is frequently used in large-scale complex projects such as MsCIP.

It is recommended that a strong on-going monitoring and feedback mechanism feeds into an adaptive management process. Adaptive management receives a cursory mention in Section 5.5, but there are some very significant uncertainties in the proposed plan and the implementation process would benefit from a continuous assessment and feedback between field data and management decisions. This requires adequate funding, formal assessment and review and decisions made periodically about whether the desired outcomes expressed by the vision are being achieved. A description of an adaptive management approach with performance measures is surprisingly absent.

Considerable expertise has been generated within the USACE in the past decade with adaptive management, particularly at ERDC. There are many examples of similar plans include:

- Louisiana Coastal Action Plan,
- Chesapeake Bay,
- Everglades (http://www.evergladesplan.org/pm/landing_program.aspx),
- CALFED (http://198.31.87.66/monitoring/monitoring_framework.shtml),
- Columbia River (www.icbemp.gov/html/icbstrat.pdf).

Significance – High/Medium:

This management approach is the best way to ensure that the project objectives are achieved and helps minimize risks and uncertainties associated with the design process. If, however the USACE includes an Adaptive Management Plan (AMP) before the design and build this comment would be rated medium.

Comment Cross-referencing:

Also see related comments:
(1) More refined analysis is recommended in certain areas before design and build can be conducted.

Recommendations for Resolution:

To resolve these concerns, the report would need to be expanded to include:

- A separate Adaptive Management Plan (AMP) that describes how adaptive management is integrated with the design, implementation, and post-implementation management.
- The AMP should include details of the performance measures, monitoring program, statistical design of sampling protocols where appropriate, and duration of monitoring program.

- Details of how the monitoring data will be assimilated into the computer models and analysis procedures.
- Details of data archiving, periodic updating of models and future expansion of new model capabilities should be considered an integrated part of AMP.
- Details of how information related to adaptive management will be made available to local communities and other agencies. This will build on the strong outreach and engagement process already initiated by the State of Mississippi and the USACE.
- Information regarding contingency plans, thresholds that may initiate alternative management actions and a general description of what these revised actions may entail.

Comment 5:
The extent of inclusion of recommendations from the public and agency engagement process into the plan, and whether major controversies regarding the program plan exist, is unclear.
Basis for Comment:
The prevailing opinion amongst the reviewers was that a significant effort was clearly made to involve the public and numerous agencies. The panel recognizes that this component of the project must have been very difficult to manage within the very tight time schedule set by Congress. Having stated this, the panel raised the following issues regarding the public engagement component of the project: ▪ The Comprehensive Plan does not fully quantify the number of public participants, who they were, and it is not entirely clear as to the quality of the public feedback. ▪ The Comprehensive Plan is unclear as to the degree of actual public "buy-in" to the project. ▪ With regard to input from other government agencies, the report does not fully explain the role of the other agencies (e.g., NOAA). ▪ One passage of the Comprehensive Plan raises a question as to whether all affected parties were engaged in the process. In particular, in the first public meeting it was noted that people in areas not affected attended, but it was difficult for people directly affected to participate. ▪ The extent to which public input was incorporated into the program plan is unclear. For example, a comment in the report states that large structural measures did not garner much local support, but the proposed LODs 3 and 4 involve some relatively large-scale structural measures. ▪ Some statements regarding public preferences should be better documented. For example, the Real Estate Appendix states that the public prefers a "natural" looking beach. The comment noted in the bullet item above describing lack of local support for structural measures is another example. As these public preferences can affect design decisions, their sources should be well documented.
Significance – Medium:
The comments above largely pertain to documenting the public involvement efforts and demonstrating that public preferences were considered in the decision making process; this affects the completeness of the report and is therefore considered to be medium significance.
Comment Cross-referencing:
Also see related comments: (14) The process of weighting metrics is unclear.

Recommendations for Resolution:
To resolve these concerns, the report would need to be expanded to: ▪ Include specific data on the number of public participants, who they were, and be specific as to the quality of the public feedback. ▪ Address the issue of public acceptance for the project. ▪ Better explain the role of the other governmental agencies in the public engagement process. ▪ Verify that affected parties were adequately represented in the public engagement process. ▪ Provide a clearer description regarding the extent to which public input was incorporated into the program plan. ▪ Document any mention of public preferences made throughout the report.

Comment 6:
There needs to be a more in-depth discussion of the municipal and industrial waste and the future impact to the treatment facilities.
Basis for Comment:
The release of contaminants from municipal and industrial waste facilities during a storm surge is a potentially serious issue. The facilities are described, but the MsCIP Comprehensive Plan does not indicate whether or not they are protected and gives no mention of the impact of Hurricane Katrina on these facilities. If the facilities have not been protected, the Comprehensive Plan needs to address how to prevent municipal and industrial wastes from being carried with the storm surge. Major issues that should be addressed in the MsCIP Comprehensive Plan include: (1) how did the storm water management infrastructure perform after the storm surge of Hurricane Katrina receded, (2) are there major needs to enable the storm water management infrastructure to perform better in the future, and (3) will the proposed measures prevent municipal and industrial waste from being carried with the storm surge? In addition to the above focus on the three-county region of Mississippi, the report should address this problem from a comprehensive perspective with respect to "fallout" from Louisiana, where the municipal and industrial contamination of the surge waters was extensive. The Comprehensive Plan should address the possibility of contaminants transported out of the New Orleans area impacting the Mississippi Gulf coast. The MsCIP and LACPR (Louisiana Coastal Protection and Restoration) plans should therefore be considered comprehensively with respect to wastewater and industrial contamination.
Significance – Medium:
This issue will not likely affect the overall recommendations and justification for the project. However, the issue of release of contaminants into the environment during a storm surge is a serious concern, so addressing this issue is considered important from the standpoint of completeness of the report.
Comment Cross-referencing:
Also see related comments: (1) More refined analysis is recommended in certain areas before design and build can be conducted.
Recommendations for Resolution:
To resolve these concerns, the report would need to be expanded to include: ▪ A description of the existing measures for protecting against release of contaminants from municipal and industrial waste facilities during a storm surge. ▪ A description of the performance of these facilities during Hurricane Katrina. ▪ Demonstrate that the proposed measures will prevent municipal and industrial wastes from being carried with the storm surge. ▪ Consideration of the MsCIP and LACPR comprehensively with respect to wastewater and industrial contamination.

Comment 7:
Human adaptation, as it relates to economic activities, needs more detail.
Basis for Comment:
When prices, quantities, and qualities of goods that people consume change, economic theory predicts that people will change behavior in response. People can switch (substitute) goods or activities when conditions are worse, but there is nothing that requires them to do so. For example, if the price of gasoline increases, people are made worse off and might switch temporarily or permanently to a different form of transportation, but they may not. Similarly, if the quality of a particular beach deteriorates, a person may take fewer recreational trips to that beach, preferring to go to a different beach, or they may reduce or stop taking beach trips altogether. Adaptive behavior is also important in considering housing and labor market changes. Of high importance here is the adaptation to risk associated with living and working in a given region. An adaptive response by people and businesses to higher storm surge/flooding risk could be to leave or choose not to locate new businesses in the area. Evaluation that assumes no adjustment will introduce bias. If hurricanes damage one's home, it is possible that the occupants consider moving elsewhere, or essentially rebuild the same house at the same location, or rebuild a very different structure at the same location. All economic analysis depends therefore on the assumptions made with regard to adaptation or, in the economic jargon, substitution. In general, in cases where there are many close substitutes and adaptation is relatively easy, the benefits from a program to reduce negative conditions will be smaller. In contrast, in situations where impacted resources or goods have few substitutes, the benefits from preventing or reducing negative aspects will be larger. The report uses existing models to develop the economic analyses, such as the Hydrologic Engineering Center's Flood Damage Analysis (HEC-FDA) software package, for which these assumptions are not provided. The report states that these models are consistent with the guidelines provided in 1983 by the U.S. Water Resources Council. However, some of the principles and guidelines in this document have been questioned in the leading environmental economics journal, and thus may be outdated. For example, see Morey, Edward R. 1994. "What is consumer's surplus per day of use, when is it a constant, independent of the number of days of use, and what does it tell us about consumer's surplus?" *J. of Environmental Economics and Management* 27: 257-70. This paper argues that the often used "value per day" is not appropriate for use in benefits calculations, in many situations.
Significance – Medium:
The assumptions about what people do in response to changes in conjunction with the project are fundamental in predicting the likely benefits and costs of the project.

Comment Cross-referencing:
Also see related comments: (3) The redevelopment scenarios should include a range of possible outcomes for the economy.
Recommendations for Resolution:
To resolve this concern, the report authors could do the following: ▪ Add supporting information about adaptation assumptions for each of the key economic models used in the analyses. State in simple terms what is being assumed about how people will respond to future changes in conjunction with the project. ▪ Provide a technical appendix on the economic models that provides a knowledgeable economist with the details needed to clarify these assumptions.

Comment 8:

The effects of relative sea level rise need to be explained more explicitly, taking into account local effects in addition to global effects and incorporating recent studies.

Basis for Comment:

Sea level changes are crucial to planning for future inundation scenarios. The relative changes in sea level taking account of local, regional and global contributions are the most important aspect to consider. For example in neighboring Louisiana, rapid subsidence is a major contributor to relative sea level rise there. While this is less of an issue in coastal Mississippi, subsidence and related effects such as compaction under the weight of new engineering works cannot be ignored. (The argument made as to why the RSL for the Mississippi coast is dramatically less than that of Louisiana is very weak. The values for Mississippi RSL rise are 1/3 to 1/5 of those for Louisiana. This is an area where a comprehensive approach for MsCIP and LACPR appears to be lacking.) Estimates of these effects are probably available in long-term tide gauge records. If they have been incorporated, this needs to be clearly stated. If not, then the omission must be corrected or justified.

With respect to global changes, Section 1.6.2.3 cites climate change and rates of sea level rise from NRC (1987) and IPCC (2001). Since this is such a critical parameter in the design process, recognition should be given to more recent findings. The authors state that the 2007 4th IPCC Assessment was not used as it arrived too late for this process. Since this 2007 IPCC report, evidence has been mounting that the changes are occurring at a much faster rate than originally anticipated.

Significance – Medium:

Because the report does not ignore the issue of sea level rise and allows for a rise of as much as 0.5 meter over a 50-year period, the panel does not view the shortcomings as a fatal flaw of high significance. However, they feel that estimates need to be better explained and justified. Therefore, significance is medium.

Comment Cross-referencing:

Also see related comments:

(1) More refined analysis is recommended in certain areas before design and build can be conducted.

(2) The preliminary evaluations of the Hurricane Storm Damage Reduction, erosion control, and ecosystem restoration need more explanation. For example it is unclear if dynamic habitat models and geomorphic evolution are considered. [Future scenarios of geomorphic evolution and the impacts on storm surge amplification are strongly dependent on sea level change.]

(3) The redevelopment scenarios should include a range of possible outcomes for the economy.

(9) It is unclear how relative sea level rise (RSL) is incorporated.

Recommendations for Resolution:

To resolve these concerns, the report would need to be expanded to include:

- The decision to disregard the 2007 IPCC report should be revisited since several other major coastal planning programs are also using the 4th Assessment along with more current information.
- Access can be made at: http://www.ipcc.ch/ipccreports/ar4-wg1.htm. Since the release of the 2007 IPCC report, evidence has been mounting that the changes are occurring at a much faster rate than originally anticipated.
- One recent reference is: E. J. Rohling, K. Grant, Ch. Hemleben, M. Siddall, B. A. A. Hoogakker, M.Bolshaw & M. Kucera, 2008. High rates of sea-level rise during the last interglacial period. *Nature Geoscience* 1, 38-42.
- Provide a more substantive justification as to why the RSL for the Mississippi coast is dramatically less than that of Louisiana.

Comment 9:
It is unclear how relative sea level rise (RSL) is incorporated.
Basis for Comment:
On page 2-6 of the MsCIP Comprehensive Plan it states: "Project performance in this study effort was evaluated for both an extrapolation of the observed historic rate plus subsidence…" Unfortunately, there is no specification here or in the subsequent report or its appendices defining exact how the RSL was used to evaluate project performance. Table 4-1 implies that RSL rise will simply be linearly added. One cannot take the storm surge results from no-RSL calculations and add on the RSL rise. The physics are more complicated than that. The IPET report (by the USACE) clearly demonstrated that a one-foot rise in RSL can lead to an increase in inland storm surge of more than double, possibly a factor of four increase. Certainly the change in the physics brought on by an RSL rise (an ever wider continental shelf, short waves evolving and breaking in new locations and possibly being reconstituted further inland) does not permit a linear supposition.
Significance – Medium:
The significance of how RSL is incorporated can be deemed medium provided the panel is correct in assuming that any design and build of the LODs will not be done without readdressing RSL in all surge-related simulations.
Comment Cross-referencing:
Also see related comments: (1) More refined analysis is recommended in certain areas before design and build can be conducted. (8) The effects of relative sea level rise need to be explained more explicitly, taking into account local effects in addition to global effects.
Recommendations for Resolution:
To resolve these concerns, the report would need to be expanded to include: ▪ Clarify exactly how the RSL rise was used to evaluate project performance. ▪ A strong recommendation to that RSL rise will be included in coupled short- and long-wave simulations before any future design and build of LODs.

Comment 10:
All of the physics-based models used need a better explanation, including inputs, outputs and assumptions.
Basis for Comment:
Good science is based in the ability to define an experiment, conduct it, and produce an outcome that can then be reproduced by other scientists. The same holds true for a thorough numerical simulation. While the authors of the MsCIP Comprehensive Plan and its appendices are to be commended for their use of Public Domain models currently available, and there is no doubt that the physics-based modeling performed was done expertly, the application of the physics-based models is not always fully explained such that another modeler could follow the lead provided. This is not to say that the Comprehensive Plan needs to provide all input/output files; rather, there simply needs to be a better explanation of what assumptions were made in the model simulations, how the input data were used, and how the outputs were diagnosed. Further, often the appendices (e.g., Engineering Appendix) are cited in the main report, when sample output and discussion would serve better if it were included in the main body of the Comprehensive Plan. For an example of the latter, see lines 7-11 on page 3-38, which tell us that LOD-1 was modeled, but all results/discussion are relegated to the Engineering Appendix. Those results and a brief discussion belong in the main report. Section 2.8 (Storm Surge Modeling) of Appendix E (Engineering) serves as an example for how all physics-based models need further discussion of inputs. The appendix indicates that the SL15 mesh was used for all storm surge modeling, but no information is provided as to how the mesh was modified to permit an examination of the lines of defense. A reader does not know if the elements of the mesh were reconfigured in order to describe various LODs or if topographic elevations were simply raised at the nodes. How the SL15 mesh was modified to include any of the LODs should be described. (Note that the same commentary can be made with respect to the other physics-based models.) In addition, what effect this had on how bottom friction was characterized is not revealed. There is no discussion of the wind-reduction factors and how the mesh modifications may influence a change in the factors. Again, as noted above, the authors do not need to provide all input files, but they should discuss all parameters and what was done to accommodate those parameters with the inclusion of LODs into SL15. In addition, on page 129, lines 21 & 22 it is noted that the grid (SL15) was used to ensure consistency with the LACPR study. What is not clear is if the SL15 was modified with both LACPR recommendations and MsCIP LODs to ensure that one modification did not impact the other. When results are displayed to show the impact of LOD-3, for example, the graphics do not identify LOD-3 (see Figure 2.8-3). One can see that the output presented in Figure 2.8-2 differs from that of Figure 2.8-3; however, it is not clear from the figure what caused the varied envelope of maximum water level. And at least one set of figures like these should be included in the main report body.

Another example is that wind input to a surge model is extremely important for both waves and surges. There is a large uncertainty in the wind input used in the model simulations for MsCIP. However, there is no information and discussion given in the Comprehensive Plan, which is a major weakness in terms of application of the modeling results.

All physics-based model inputs/outputs and assumptions should be reviewed and provide further discussion using the above points as example.

Significance – Medium:

This comment is classified as medium since it is a point of clarification and no major re-work of any modeling exercise is required.

Comment Cross-referencing:

Also see related comments:
(1) More refined analysis is recommended in certain areas before design and build can be conducted.

Recommendations for Resolution:

To resolve these concerns, the report would need to be expanded to include:

- Review all physics-based model documentation and make sure that another modeler would be able to repeat the documented simulation.
- Provide an estimate of uncertainty due to the limitation of current computer model physics, model errors, and input data such as wind, waves, and currents
- Incorporate, at a minimum, sample output in the main report to emphasize why the various conclusions from the model results can be drawn.
- These are particularly important when addressing the question of effectiveness of the Barrier Island restoration in reducing storm surge along the coastline. This restoration component is a major financial investment and recent concerns have been raised over the exact reduction in storm surge height. The analyses and modeling details should be transparent and defensible.

Comment 11:

The decision factors involved in using the models selected needs to be described. In some cases, updated modeling tools should be used.

Basis for Comment:

In some instances the reviewers felt that either the USACE did not use the most up-to-date models and/or they did not provide a strong justification for the model and inputs that they used. Some specific instances are listed below:

- A more in-depth discussion should be given for the inputs into the ADCIRC (ADvanced CIRCulation) and Storm Surge Model for Oceanic, Coastal and Estuarine Waters. It is also not clear how the effects of LOD-3 and LOD-4 were input into the model. It also appears that LODs 1 and 2 were included in the model. If they were omitted, justification should be provided.
- The wind and atmospheric pressure model TC96 is a parametric model that does not represent the highly variable dynamic structure of a hurricane. It provides a simplified symmetric vortex with the maximum wind radius and relatively smooth wind field. In reality, hurricane winds are highly asymmetric around the storm center, especially near landfall. The surface wind field is rather gusty with wind speed and directions vary in much smaller scale than the vortex itself. Ocean waves and storm surge are very sensitive to the gustiness of the wind. The results of coupled wave-surge model (ADCIRC-STWAVE) using TC96 forcing may not be adequate for assessments used in MsCIP. In the past, TC96 provided a good proxy to a realistic storm forcing. However, that has changed over the last 5 years or so. High-resolution models are running at ~1 km resolution, which can provide a much more accurate forcing for surge model. These high-resolution models (e.g., Weather Research and Forecast (WRF) model and MM5) are available in the public domain.
- Regarding Appendix B of the economic analysis (ES-2, line 26) – the report should justify why SLoSH was used for this portion of the study when ADCIRC was used elsewhere.
- Much of the analysis in the Economics Appendix relies on the HEC-FDA model. Little documentation is provided on this in this Appendix, so it is impossible to tell whether the models are adequate because all models depend on their underlying assumptions. If the reader could see the detailed assumptions about substitution for business and residential and recreation substitution, it would alleviate possible concerns about the calculations.
- Newer physical models (e.g., wind surge) are operational and available as open source and are being used by other agencies like NOAA.
- Issues raised with regard to the Risk Informed Decision Framework (RIDF) model: (1) there were no measures of intensity of the preference for the metric, and (2) the MAX and MIN functions are not defined.

The panel recognizes that the USACE may have deemed it preferable to use open source or existing operational models rather than more recent models in a research mode. The panel does not consider this unreasonable. However, it is important that the MsCIP Comprehensive Plan state the limitations of any models used in the study as well as recognize the potential need for more up-to-date models in the final design and adaptive management stages.

Significance – Medium:
The general sense among the reviewers was that, while the USACE selection of models was reasonable, the understanding and completeness of the report would be greatly enhanced by more complete descriptions of the models used and the input parameters selected.
Comment Cross-referencing:
Also see related comments: (1) More refined analysis is recommended in certain areas before design and build can be conducted. (10) All of the physics-based models used need a better explanation, including inputs, outputs and assumptions.
Recommendations for Resolution:
To resolve these concerns, the report would need to be expanded to include: ▪ Provide more complete descriptions of the models used in the study, particularly with regard to the fundamental assumptions on which the model is based. ▪ More thoroughly describe and justify the input parameters used in the models and reference associated calibration and uncertainty analyses. ▪ In cases where a more up to date model could have been used, the USACE should demonstrate that a more refined analysis would not affect the current decision making or, as appropriate, identify future studies using more refined models to be used in the final design. This strategy may include running one or more models in parallel in some stages of the plan implementation.

Comment 12:

Need to explain the rationale for selecting the oyster as a surrogate for other species.

Basis for Comment:

Oysters are of importance to the State of Mississippi and local communities as evidenced by the Mississippi Department of Marine Resources (MDMR) emphasis on oyster bed restoration where feasible. (Environmental Appendix, Section ES 3.1.10, Section 3.1.9). The system-wide objectives of the study include seasonal salinities within the Western Mississippi Sound. A target of 15ppt is selected on the basis of optimal growth of oysters with the oyster selected as a surrogate for other aquatic resources Section 3.3. Oysters may also be useful as an indicator of salinities for zones within the general ecosystem, although the Comprehensive Plan lacks any scientific justification for the selection of the Oyster and 15ppt (p3.20 Main Report). For example, there could be a conflict between oysters and other species (i.e., shrimp or intertidal wetland vegetation).

The report continuously emphasizes the importance of a systems approach from both the physical processes and biological perspective. This is a very positive aspect of the report and reflects recent management approaches by the USACE (NRC: 'River Basins and Coastal Systems planning within the U.S. Army Corps of Engineers' (2004)). These are linked in parts of the report (for example through the Wetland restoration DSS and the water quality model (Environmental Appendix, Section 4.1 and Section 4.2 respectively). The Environmental Appendix also provides a detailed qualitative description of Threatened and Endangered Species and their preferred habitats which is followed by a detailed spatial description of potential sites for restoration or environmental enhancement.

However, a detailed description of the landscape ecology and the cumulative benefits/impacts that might transpire from the plan implementation is lacking. It is suggested that some discussion is presented about the importance of a mosaic of habitats to ensure the overall health of the regional ecosystem. What are the limiting biological factors for the key endangered species, particularly related to minimum areas or habitat, water quality and resilience of physical habitat? Ecosystems evolve over centuries and care to avoid the collapse of certain habitats/species at the end of the 50 year horizon should be considered. ERDC has extensive experience in these issues and it is suggested that a preliminary analysis/description of a conceptual model of key species (including oysters) is prepared for this report. Of course, this is an immensely complex problem, but identification of key indicators (in addition to oysters) and processes could be identified. This information could then be used to shape the performance measures and monitoring described in Comment 4. Further, the water quality model was developed in a short-time frame with limited functionality. As described in the report, the model is useful for comparing different options and ascertaining trends, but the recommended integrated modeling and monitoring (Comment 4) will allow improved, more reliable and more defensible results. This modeling will then allow the mosaic of habitats and their trends to be assessed throughout the project implementation and beyond.

Significance – Medium:
There has been extensive interaction between NGOs, state and federal agencies to develop the priorities of habitats. This recommendation will provide a preliminary description of how the proposed project would relate to the ecosystem dynamics.
Comment Cross-referencing:
Also see related comments: (3) Adaptive management processes should be a more integral part of the Comprehensive Plan and must include a strong monitoring and feedback mechanism.
Recommendations for Resolution:
To resolve these concerns, the report would need to be expanded to include: ▪ A description of the ecosystem dynamics and how the landscape is expect to change. This description will include a range of key indicators, a description of why they are important and what they are representative of and how they may change as a result of the project, climate change and sea-level rise. Are there any scenarios that could result in a catastrophic collapse of part of the ecosystem and what factors can be include to improve the resilience?

Comment 13:
The stated goal of the project to reduce loss of life by 100% is unrealistic.
Basis for Comment:
The 100% goal is of concern here. Although life safety is of supreme importance, no project can completely eliminate the future loss of life related to hurricanes in the region, which is what this 100% goal implies. Also, the level of investment required to achieve the stated goal ignores the opportunity cost in terms of other life saving public investments. Realistically, there is no amount of planning that can eliminate accidents from happening, or prevent people from choosing to ignore all warnings and staying when an event happens, as some Galveston residents did when Hurricane Ike hit in September. The project involves a finite amount of resources and future hurricane protection efforts also involve a limited amount of human resources (labor, and effective risk communication). In economic analysis, when such constraints are involved, a realistic objective is stated that recognizes these constraints. In other words, we might say that society can strive to minimize the loss of life, subject to those constraints. Put another way, probabilistically, reducing the risk of death to zero when human activities that relate to natural hazards are involved, is infeasible. This is regularly recognized in policy and regulation in the United States, which is often set so that the acceptable mortality rate is 1 in one million, or lower.
Significance – Low:
The original "100%" statement is likely an editorial/semantic problem.
Comment Cross-referencing:
None
Recommendations for Resolution:
To resolve this concern, the report authors could do one of the following: • Reword the goal to state that the project hopes to achieve the lowest possible loss of life in the future as is possible, given the constraints on human resources that can be devoted to protection as part of the project, and as events happen in the future. • Reword the 100% goal as "ideal" or "desirable" in a world with no cost-constraints or constraints on resources in dealing with hurricanes. Then note that the project involves a fixed amount of resources, so the ideal cannot realistically be achieved.

Comment 14:
The process for weighting metrics is unclear.
Basis for Comment:
Evaluation metrics were created to help rank potential projects but the process by which the 15 evaluation metrics were selected and how the weights were determined are not described with sufficient detail in the Comprehensive Plan to be understandable. By the very criteria described in Section 3.19.5 of the plan, the panel does not have enough information to determine whether the metrics are *scientifically verifiable*, *credible*, *scalable* or *relevant*. The description of use and development in the text was certainly not *transparent*. In some places the authors refer to evaluation metrics however, they describe risk weighting workshops to determine the appropriate weights to place on the 15 criteria only three of which are referred to as Risk Metrics (#13, #14, #15 sec. 3.19.5.5). The 15 weighted evaluation criteria are supposed to be an input into the Risk Informed Decision Framework (RIDF) but the definition of risk seems very narrow. Risk is a term that has many interpretations. The reader is familiar with the notion that for a given mean outcome, greater statistical variance can be viewed as increased risk. But alternatively, the probability of exceeding design requirements as a measure of risk could be viewed. More generally, many people tend to view risk as the likelihood of an undesirable outcome of some stochastic process. The risk-related action points seem to incorporate several broader definitions than the one offered. The report should be much clearer in its use of the terms risk and uncertainty. A fairly clean definition allows that risk is used for the case where probability distributions are known or knowable and the range of outcomes is known. Uncertainty (Knightian uncertainty) describes the case where there is missing information about the probability distribution or the range of outcomes. At times the discussion goes off into areas that are more appropriately called measurement error or model specification error. The purpose of the cluster analysis is not well articulated. The weights were constructed using the input of 45 individuals. How vulnerable is the process to strategic behavior on the part of a few participants? These 45 individuals are representative of what population? The two largest stakeholder groups, homeowners and local business owners seem not to have contributed to the weighting process. Is it possible that sample might be biased towards environmental restoration measures? Table 3-35 in the main report and also shown in the Risk Appendix is unclear on what the point allocation means. It would be interesting to see how the final ranking of projects would change if each of the five groups of metrics had simply received equal weight.
Significance – Low:
This comment was given a low significance in that the main requirement is revision for clarity.
Comment Cross-referencing:
Also see related comments:

(5) It is unclear if the recommendations from the public engagement process (i.e., public input) were included in the process or incorporated into the program plan.
Recommendations for Resolution:
To resolve these concerns, the report would need to be expanded to include: ▪ A very specific statement on the context in which the term risk is used. Stakeholder Risk Score is a misnomer. ▪ A clearer description of the weight construction process and discussion of the sensitivity of the final recommendations to the weights chosen. ▪ The 15 evaluation criteria are listed in a different order in Table 3-35 than they are in the text of the main report; a correction is needed for consistency.

Appendix B

Charge to the MsCIP Comprehensive Plan Independent External Peer Review Panel

Independent External Peer Review of the Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan

Charge to the Independent External Peer Review Panel

September 2008

BACKGROUND

In the Third Emergency Supplemental to the Defense Appropriations Act, 2006, Congress directed the U.S. Army Corps of Engineers (USACE) to conduct an analysis and design for comprehensive improvements or modifications to existing improvements for the coastal Mississippi region. This analysis and design is required to address hurricane and storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resource purposes. In addition, USACE was directed to recommend a cost-effective project(s), but perform neither an incremental cost-benefit analysis nor maximization of net economic benefits analysis as the basis to select the recommended project(s). Based on this congressional language, the Mississippi Coastal Improvements Program (MsCIP) was initiated in January 2006. More information on the MsCIP project can be found at http://mscip.usace.army.mil/downloads.asp.

An interim report (IR) with recommendations for near-term improvements was completed in August 2006. This Comprehensive Plan contains final recommendations and will be submitted to Congress upon completion of independent external peer review and pubic review. The Comprehensive Plan consists of an integrated main report/environmental impact statement (EIS) and supporting appendices. The main report/EIS summarizes the plan formulation activities undertaken during development of the Comprehensive Plan, including the incorporation of risk as a decision criterion in the overall selection of plans. The Comprehensive Plan encompasses a system-wide framework of measures, which either alone or in combination, will achieve the goals and objectives of MsCIP. The framework is an integrated system of structural, nonstructural, and environmental measures.

Because of the national importance of this project, it has been directed that an Independent External Peer Review (IEPR) be conducted. The IEPR will follow the procedures described in the Department of the Army, USACE *Peer Review of Decision Documents* (EC1105-2-410) and the Office of Management and Budget's *Final Information Quality Bulletin for Peer Review*, released December 16, 2004. Thus specific charge schedule, questions, and instructions listed below pertain only to the Comprehensive Plan.

SCHEDULE

1.	Comprehensive Plan distributed to IEPR Panel with charge for review	9/18/2008
2.	IEPR Panel reviews Comprehensive Plan document	9/24/2008-10/15/2008
3.	IEPR Panel submits technical review comments to Battelle	COB 10/15/2008
4.	Battelle merges comments, prepared draft list of key issues, and Distributed to the IEPR Panel	10/20/2008
5.	Consensus conference call	10/22/2008
6.	IEPR panel prepares and submits final consensus comments	10/30/2008
7.	Battelle delivers draft IEPR report to USACE	11/7/2008
8.	Comprehensive Plan authors provide responses to IEPR Panel comments via DrChecks	11/12/2008
9.	IEPR Panel submits any final comments or clarifications via DrChecks	11/17/2008

CHARGE FOR PEER REVIEW

Members of this peer review are asked to determine whether the technical approach and scientific rationale presented in the MsCIP Comprehensive Plan are credible and whether the conclusions are valid. The reviewers are asked to determine whether the technical work is technically adequate, competently performed, properly documented, satisfies established quality requirements, and yields scientifically credible conclusions. The peer reviewers are not being asked whether they would have conducted the work in a similar manner. In addition, the reviewers are asked to determine whether the findings are appropriate to support the USACE in its decision-making process for the project. General guidance for the peer reviewers, followed by specific questions by report section, is provided below.

__General Charge Guidance__

1. Please answer the scientific and technical questions listed below and conduct a broad overview of the Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan (including appendices). Please focus on your areas of expertise and technical knowledge.
2. Identify, explain, and comment on assumptions that underlie economic, engineering, or environmental analyses.
3. Evaluate the soundness of models and planning methods as applicable and relevant to your area of expertise. Comment on whether models explain past events and how models will be evaluated and validated.
4. Evaluate whether the interpretations of analysis and conclusions are reasonable.
5. Please focus the review on scientific information, including factual inputs, data, the use and soundness of models, analyses, assumptions, and other scientific and engineering matters that inform decision makers.
6. If appropriate, you can offer opinions as to whether there are sufficient analyses upon which to base a recommendation for construction, authorization, or funding.
7. Please **do not** make recommendations on whether a particular alternative should be implemented, or whether you would have conducted the work in a similar manner. Also

please **do not** comment on or make recommendations on policy issues and decision making.

8. If desired, IEPR panel members can contact each other. However, IEPR panel members **should not** contact anyone who is or was involved in the project, preparing the subject documents or that were part of the Internal Technical Review.
9. Please contact the Battelle Assistant Project Manager (Maureen Wooton wootonm@battelle.org 614-646-4890) for requests or additional information.
10. In case of media contact, notify the Battelle project manager immediately.
11. Your name and bio will appear as one of the panelists in the peer review. Your comments will be included in the Final IEPR Report, but will remain anonymous.

Please submit your comments in electronic form via the project Sharepoint site (see URL and instructions below) or directly to Maureen Wooton (wootonm@battelle.org) no later than October 15, 2008, 8 pm Eastern Time.

SharePoint Instructions:

- Navigate to http://websps1.battelle.org/usace-epr/home/MsCIP/default.aspx.
- Enter your individual user name and password provided by Battelle to access the site.
- Click on "New Document" to open the Comment Response Form Template.
- When you have completed the form, select "Save As " and save the file using the following convention: AuthorLastName_MsCIP_EPR_CRF.doc
- Alternatively, you can save the template to your computer and Upload the final document to the site. (Note: once a file is uploaded, its contents cannot be changed or deleted; if you need to make revisions to your form, please upload the document again.)

Specific Charge Questions

Executive Summary

(No questions)

Chapter 1. Introduction

1. Comment on the completeness and clarity of the purpose and the scope of the study.

2. Comment on whether the agency and public involvement process was inclusive and sufficient to solicit technical input from the state and Federal agencies, general public, and any other stakeholders and/or interested party.

Chapter 2. Study Area Description (Affected Environment)

3. Comment on whether you agree with the general analysis of the affected environment within the study area. Is the description of the affected environment sufficient to support

the analysis of environmental effects in Chapter 4? For your particular area of expertise, provide an in-depth review of the adequacy of the analysis. (see also Appendix A)

Chapter 3. Plan Formulation (Alternatives and Plans)

4. Is the 50 year planning horizon sufficient to meet the study objectives and goals? Why or why not?

5. Is the plan formulation process discernable and sound? Can one logically understand how the tentatively selected plans fit into the overall comprehensive plan?

6. Is the discussion of problems and opportunities complete? Comment on whether the opportunities adequately describe structural, non-structural and environmentally-focused solutions and plans.

7. Please comment on the adequacy of the planning goals, objectives and constraints. What additional information, if any, should be included?

8. Was the process used to conduct a preliminary evaluation of Hurricane Storm Damage Reduction, erosion reduction, ecosystem restoration and saltwater intrusion adequate? What additional information should be considered?

9. Are the assumptions and methodology used to develop the lines of defense concept reasonable and well justified? Why or why not?

10. Is the methodology for the development, evaluation and comparison of preliminary and final alternatives adequately described? What additional information or approaches should be considered?

11. Please comment on the criteria used for the evaluation metrics. Are the metrics developed for environmental quality, national economic development, other social effects, regional economic development, and risk adequate and weighted appropriately? Why or why not?

Chapter 4. Environmental Effects

12. Are the effects to the socio-economic, physical and biological environment adequately described for the comprehensive plan? What additional information, if any, should be included?

13. Are the effects to the physical and biological environment adequately described for the Homeowner Assistance and Relocation Program? What additional information, if any, should be included?

14. Are cumulative impacts adequately addressed for all proposed actions? What information, if any, is lacking?

15. Have the no action alternative and potential impacts been adequately described for Beach and Dune Restoration, Admirals Island, Dantzler, Turkey Creek, Bayou Cumbest, Franklin Creek, the SAV Pilot, Deer Island Restoration Moss Point Relocation, Waveland Floodproofing, and Forrest Heights levee? What additional information, if any, should be included?

Chapter 5. Description of Tentatively Selected Comprehensive Plan Components.

16. Please comment on the discussion of the projects being implemented by agencies other than the USACE. In your professional opinion, is inclusion of these projects beneficial to the overall goals and objectives of the Mississippi Coastal Improvements Program? Why or why not?

17. Are there key issues pertaining to the proposed USACE implementation projects that have not been adequately addressed? Please describe.

Chapter 6. Implementation Requirements

(No questions)

Appendices

A: Environmental Appendix

18. Is the Section 404(b)(1) Evaluation Report complete with respect to engineering and environmental considerations? Why or why not?

19. Are the restoration objectives and assumptions stated for each of the proposed restoration projects complete and adequate? Why or why not? What additional information should be included?

20. Is the conclusion that the MsCIP "will be in attainment" with Mississippi's Air Quality Standards reasonable?

21. Was the Spatial Decision Support Model used appropriately for this project? Why or why not?

B: Economic Appendix

22. Is the economic analysis based on accepted economic methodologies and is it sound and appropriate for this project? Why or why not?

23. Comment on the selection and adequacy of the models used to perform the economic analysis.

24. Comment on the adequacy and appropriateness of the method used to calculate the value of the structures and contents.

25. Are the assumptions used in the analysis reasonable? Why or why not?

26. Are the six future without project scenarios reasonable? Why or why not?

27. Are the assumptions underlying the redevelopment scenarios explicit, justified and/or realistic? Are the most likely re-development scenarios included in the analysis?

C: Real Estate Appendix

28. Does this appendix adequately address all real estate interests and requirements?

29. Are the real estate cost estimates reasonable?

D: Nonstructural Formulation Appendix

30. Provide an assessment of the overall nonstructural alternative analysis, including an assessment of its quality, completeness, and feasibility.

E: Engineering Appendix

31. Provide an assessment of the overall engineering analysis, including an assessment of its quality, completeness, and feasibility.

32. Comment on the completeness and accuracy of the General section as a basis for the engineering analysis.

33. Comment on the Lines of Defense (beginning with offshore barrier islands and progressing inland) planning concept. Are the components and options within each Line of Defense appropriate?

34. Comment on the described model applications and engineering analysis appropriate to your areas of expertise: hydrodynamic and coastal process, statistical, wind and atmospheric pressure, offshore wave, nearshore wave, storm surge, stage frequency curves, barrier islands, wetlands, regional sediment budget, flood damage analysis, and geotechnical issues?

35. Do the schedules for design and construction, and operation and maintenance requirements, seem reasonable?

F: Cost Estimating Appendix

36. Is the basis for estimate and rationale provided complete and reasonable? What additional information should be considered?.

G: Risk Appendix

37. Comment on the methodology for integrating risk and uncertainty and conducting trade-offs.

38. Is the application of the Risk Informed Decision Framework (RIDF) for evaluating the benefits and consequences of the measures appropriate?

H: Barrier Islands Appendix

Please address whether the information presented is adequate to support the recommendation of Barrier Island creation and restoration.

I: Modeling Appendix

Were the models used for the MsCIP the appropriate models? In your professional opinion, are there others that should have been considered? If so, which ones and why?

J: Internal Technical/External Peer Review

(No questions)

K: Plan Formulation Appendix

39. Is the information presented in the appendix sufficient to describe the overall planning process that was described in Chapter 3 of the Environmental Impact Statement?

40. Please comment on whether the MsCIP Planning Process is complete with respect to the Traditional Planning Process.

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
441 G STREET, NW
WASHINGTON, DC 20314-1000

REPLY TO
ATTENTION OF

OCT 14 2009

CECW-MVD

MEMORANDUM FOR ASSISTANT SECRETARY OF THE ARMY (CIVIL WORKS)

SUBJECT: Mississippi Coastal Improvements Program - Final USACE Response to Independent External Peer Review

1. Independent External Peer Review (IEPR) was conducted for the subject project in accordance with Section 2034 of WRDA 2007, EC 1105-2-410, and the Office of Management and Budget's Final Information Quality Bulletin for Peer Review (2004).

2. The IEPR was conducted by the Battelle Memorial Institute through their contract with the Army Research Office. The IEPR panel consisted of seven individuals selected by Battelle with technical expertise in engineering (civil and geotechnical); geology/geomorphology; hydrology; hydraulics; coastal environmental science, water quality/resource management; floodplain management; meteorology/hurricanes; socioeconomics; real estate; risk assessment; and modeling.

3. The final written responses to the IEPR report are hereby approved. The enclosed document contains the final written responses of the Chief of Engineers to the issues raised and recommendations contained in the IEPR report. The IEPR report and USACE responses have been coordinated with the vertical team and will be posted on the Internet, as required in EC 1105-2-410.

4. If you have any questions on this matter, please contact Joseph Redican, MVD-RIT Planner at 202-761-4523.

FOR THE COMMANDER:

Encl

STEVEN L. STOCKTON, P.E.
Director of Civil Works

Mississippi Costal Improvements Program (MsCIP) Hancock, Harrison, and Jackson Counties, Mississippi Comprehensive Plan and Integrated Programmatic Environmental Impact Statement

USACE Response to Independent External Peer Review September 2009

Independent External Peer Review (IEPR) was conducted for the subject project in accordance with Department of the Army, USACE, guidance *Peer Review of Decision Documents* (EC 1105-2-410) dated August 22, 2008, CECW-CP Memorandum dated March 30, 2007, and the Office of Management and Budget's *Final Information Quality Bulletin for Peer Review* released December 16, 2004.

In the Third Emergency Supplemental to the Defense Appropriations Act, 2006 (Dec 2005), Congress directed the U.S. Army Corps of Engineers (USACE) to conduct an analysis and design for comprehensive improvements or modifications to existing improvements for the coastal Mississippi region. This analysis and design is required to address hurricane and storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resource purposes. The MsCIP Comprehensive Plan contains final recommendations on these topics. The report consists of an integrated main report/environmental impact statement and supporting appendices that describe an integrated system of structural, nonstructural, and environmental measures.

Battelle Memorial Institute, a non-profit science and technology organization with experience in establishing and administering peer review panels for USACE, was engaged to coordinate the IEPR of the MsCIP Comprehensive Plan. The IEPR panel consisted of seven individuals selected by Battelle with technical expertise in engineering (civil and geotechnical); geology/geomorphology; hydrology; hydraulics; coastal environmental science, water quality/resource management; floodplain management; meteorology/hurricanes; socioeconomics; real estate; risk assessment; and modeling.

The Final Report from the IEPR was issued by Battelle on November 7, 2008. Overall, the report contained 14 comments. The report presented the 14 comments in categories with four identified as having high significance, eight identified as having medium significance, and two identified as having low significance. Further details on each comment, such as the basis for the comment and comments cross-reference were also included.

The following discussions present the USACE Final Response to the 14 IEPR comments.

1. IEPR Comment - High Significance: More refined analysis is recommended in certain areas before design and build can be conducted.

USACE Response: Adopted.

A refined analysis including specific levee height and rainfall and runoff analysis has been conducted for improvements to the existing Forrest Heights Levee, the only structural option recommended for construction at this point. These analyses are included in the Final MsCIP Comprehensive Report. All other structural options, i.e. new levee systems around specific populated areas, were evaluated at a reconnaissance level. The new levees are recommended for further feasibility level study.

USACE regulations (ER-1105-2-100) specifically require that, "the period of analysis shall be the same for each alternative plan. The period of analysis shall be the time required for implementation plus the lesser of: (1) the period of time over which any alternative plan would have significant beneficial or adverse effects, (2) a period not to exceed 50-years except for major multiple purpose reservoir projects, or, (3) a period not to exceed 100 years for major multiple purpose reservoir projects". In addition to following the guidance, the performance of measures, their reliability and resilience, and sensitivity to change in regards to longer term factors such as potential sea level rise and redevelopment was considered utilizing scenario testing as described in Section 5.3.1 of the Economic appendix.

A 'risk' framework was utilized in which higher to lower levels of risk were assigned to the range of inundation footprints, and relating those in public forums to the probability of inundation during, for example, the length of one's mortgage payout. We believe this to be consistent with the intent of inundation maps but builds upon them to communicate the risk associated with specific areas along the coast and to deal with the misconceptions associated with the use of inundation maps.

Modeling results summarized the data utilized in the modeling effort necessary to support the recommendation. Specific information is included in the Engineering, Environmental, and Economic Appendices and is available in the open source literature.

The use of surge gates as part of long linear levee systems was eliminated from further study due to cost and lack of local support. All other structural options, i.e. levee systems around specific populated areas, which were evaluated at a reconnaissance level, are recommended for further feasibility level study. As studies are initiated on these structural options the more refined analysis discussed including evaluation of risk reduction with different levee heights or nonstructural options, rainfall and runoff analysis and storm surge and transport modeling would be undertaken in detail.

2. IEPR Comment - High Significance: The preliminary evaluations of the Hurricane Storm Damage Reduction, erosion control, and ecosystem restoration need more explanation. For example it is unclear if dynamic habitat models and geomorphic evolution are considered.

USACE Response: Adopted

USACE has designed the environmental restoration efforts based on a holistic framework of the changes which have occurred in the past to natural landscapes in coastal Mississippi over the past 50 years, plus an estimation of what the landscape will look in the future with and without the implementation of the MsCIP or other ongoing programs. Damage to the Mississippi natural landscape has been caused in large part by man's development within the fragile coastal ecosystems and by the extensive introduction of exotic species following storm events. In developing this framework, the USACE incorporated the work by A. D. Manning, et al. (2006), Landscape Fluidity, specifically anticipatory restoration concepts. This concept focuses on change, landscape trajectories and climate adaptation, highlighting the need to anticipate the future requirements of organisms. In addition to conventional restoration activities, 'anticipatory restoration' efforts may seek to create certain conditions in anticipation of further changes in the future. The report has been modified in numerous areas to further discuss the anthropogenic and geomorphic processes which are shaping the Mississippi coast (e.g. Barrier Island Appendix Chapters 3 and 6).

USACE also recognizes the importance of sea level change and the resultant gradual shifts in community composition within the natural landscape features of coastal Mississippi. The goal of the restoration program is not to create static habitat types but to assist in the recovery of naturally functioning landscape units that will be most able to adapt to climate change and sea level rise.

A systemwide and regional approach has been taken in investigating water resources issues along the northern Gulf coast, including freshwater diversion and sedimentation issues. The MsCIP Comprehensive Plan is designed such that all features will complement each other and there would be no conflict as elements are added at a later date.

USACE concurs with the value and need for an adaptive management plan and has included the concepts of monitoring and adaptive management in the Final Report. A specific plan will be developed in the ensuing phases as the Comprehensive Plan is further developed. The adaptive management plan will be a living document that would be revised as implementation proceeds and we learn from the initial projects implemented. This plan will include all of the above information, as necessary, and will be jointly developed by all the partners in the MsCIP including State and Federal agencies and interested local stakeholders.

3. IEPR Comment - High Significance: The redevelopment scenarios should include a range of possible outcomes for the economy.

USACE Response: Adopted in Part

The range of redevelopment scenarios utilized in the MsCIP are consistent with the actual redevelopment that has occurred along the northern Gulf coast following major disasters beginning with Hurricane Frederic in 1979 and continuing through Hurricane Ivan in 2004. In addition, the scenarios were developed with a consideration of local politics and land use restrictions. USACE has modified the report to better document the assumptions utilized in developing the 6 scenarios that were utilized. Specific revisions have been made in the Economic Appendix, Section 5.3.2 and Section 5.3.3. As additional studies are undertaken to further define the Comprehensive Plan, additional scenarios will be developed specific to the areas under study.

USACE believes this approach to be realistic in nature and does not believe that the evaluation of additional scenarios such as lack of full development appropriately considers the future risk to the area.

4. IEPR Comment - High Significance: Adaptive management processes should be a more integral part of the Comprehensive Plan and must include a strong monitoring and feedback mechanism.

USACE Response: Adopted

USACE concurs with the value and need for an adaptive management plan and has included the concepts of monitoring and adaptive management in the Final Report. The plan will be developed further during the ensuing phases of implementation of the MsCIP Comprehensive Plan. Hence, the adaptive management plan will be a living document that would be revised as implementation proceeds and we learn from the initial projects implemented. This plan will be jointly developed by all the partners in the MsCIP including State and Federal agencies and interested local stakeholders.

5. IEPR Comment - Medium Significance: The extent of inclusion of recommendations from the public and agency engagement process into the plan, and whether major controversies regarding the program plan exist, is unclear.

USACE Response: Adopted.

USACE has summarized the public and agency participation associated with the development of the Comprehensive Plan. This is due to the extent of participation, which included over 50 public involvement events. The events included public meetings, workshops, on-line auditoria and website-based activities. Also summarized was the close coordination among the government agencies (e.g. Federal Emergency Management Agency, National Park Service, US Geological Survey etc.) in developing the comprehensive plan. It is not practicable to include specific data on all of these events or to gauge the quality of the public feedback.

USACE made every effort to ensure that all affected parties were invited to participate. Event advertisements were provided in print, television, radio and internet media. Multiple meetings were held on different dates and in different locations. Additionally, the opportunity for on-line participation was made to accommodate those parties relocated by the storm. Presentations were made to church groups, garden clubs, civic organizations and other non-governmental organizations.

Public acceptance of the program has been formally solicited through the public review process as part of the National Environmental Policy Act compliance activities. The majority of the comments received during the recently completed public review of the draft document were in favor of implementation of the Plan. These comments and USACE responses are included in Appendix L of the Final Report.

Public input and preference are mentioned throughout the document and were utilized extensively in the plan formulation process (e.g. problem identification, alternative evaluation), as discussed in the Plan Formulation Appendix and Main Report. USACE has documented public preferences in the System of Accounts tables included in the Main Report.

6. IEPR Comment - Medium Significance: There needs to be a more in-depth discussion of the municipal and industrial waste and the future impact to the treatment facilities.

USACE Response: Adopted.

Issues related to the release of contaminants from municipal and industrial waste facilities in coastal Mississippi from the Hurricane Katrina surge were not significant as compared to Louisiana. With the exception of central Jackson County coastal Mississippi is predominately residential and light commercial. The major concerns dealt with public water and wastewater facilities and these are being considered, for the six-county coastal area, by a state-commissioned consortium formed from existing utility boards in the wake of the hurricane. USACE did specifically evaluate the future siting of these facilities in developing what was called Line of Defense 5 or the "maximum probable intensity" storm surge line (i.e., maximum probable surge-plain). In addition, the acquisition of lands within the high hazard area (low elevations) will reduce the need for public water and wastewater facilities near the coast and possibly contribute to the regionalization of facilities outside the floodplain. The existing industrial facilities fared rather well during Katrina with only minor discharges from one facility.

The U.S. Environmental Protection Agency is utilizing data and mapping generated by the MsCIP study effort to support re-location and/or permitting of facilities in the future along the coastline, as a spill risk minimization measure. As the Comprehensive Plan is further developed additional consideration of risk reduction for municipal and industrial waste facilities will be included.

7. IEPR Comment - Medium Significance: Human adaptation, as it relates to economic activities, needs more detail.

USACE Response: Adopted in Part.

USACE has modified the report to better document the assumptions put forth in developing the 6 scenarios that were utilized. Specific revisions have been made in the Economic Appendix, Section 5.3.2 and Section 5.3.3. It is also assumed that redevelopment will occur as per the criteria associated with the National Flood Insurance Program (NFIP). It is conceded that at some point, the NFIP premiums could increase to a point that would cause a shift in the typical consumers' inclination to rebuild. However past precedent in other areas of the Northern Gulf Coast shows, the effects of major hurricanes (i.e. cost, time to rebuild, risk, etc.) has not appeared to impact the utility of water front and near-water living. Rather than speculating on what may occur, USACE used a range of redevelopment scenarios that are reflective of the actual occurrences along the northern Gulf coast following major disasters. This time period begins with Hurricane Frederic in 1979 and continues through Hurricane Ivan in 2004. As additional studies are undertaken to further define the Comprehensive Plan, additional scenarios will be developed specific to the areas under study.

Further modifications have been made in Chapter 3 of the Economic Appendix to clarify the assumptions and data utilized in the Hydrologic Engineering Center Flood Damage Analysis (HEC-FDA) modeling effort.

USACE did not calculate damages for recreation losses except on the barrier islands. These recreational damages were not related to the redevelopment scenario, but were based on pre-storm recreation visits to the National Park Service facilities on the barrier islands. Damage curves were not used to calculate these recreation losses. Instead they are based on a comparison of the future with and future without scenarios.

USACE does not agree that an additional technical appendix would improve or change the recommendations made in the report.

8. IEPR Comment - Medium Significance: The effects of relative sea level rise need to be explained more explicitly, taking into account local effects in addition to global effects and incorporating recent studies.

USACE Response: Adopted

USACE has modified the report to include a discussion of why the Mississippi inferred subsidence rates are much lower than those in Louisiana. This is due mainly to differing geology but another overlooked and under-evaluated reason is perhaps the long-term, large-scale oil extraction off of the Louisiana and Texas coasts. This observation applies not only to Mississippi, but also the entire gulf coasts of Alabama, and Florida. This is can be readily inferred from the long term tide gage records in these states. Long term Mississippi gage data (a continuous record of over 225 years at Biloxi, MS) were used for the Mississippi relative sea level rise analysis.

USACE did not disregard the 2007 IPCC (Intergovernmental Panel on Climate Change) report but considered all appropriate information in determining the role of potential sea level rise. This included local and global effects, in development of the Comprehensive Plan. Unlike the 1987 NRC (National Research Council) and 2001 IPCC reports, the 2007 IPCC report provides a discrete prediction for eustatic sea level rise for a vaguely defined time period (not quite 100 years), as opposed to continuous predictions over time into the future. The magnitude of future sea level rise given in the 2007 IPCC report varies according to scenarios but in general are substantially less than reported in the NRC and 2001 reports over the same time period, except at the low-end of the predicted range, which in any case was not considered for MsCIP purposes. Nonetheless, in the analysis of sea level rise on various alternatives considered in the MsCIP study, a rate of sea level rise similar to that proposed by IPCC 2007 was used to evaluate impacts on long-term performance, reliability, and resilience

USACE is presently revising its internal sea level rise guidance. Sea level rise analysis and predictive methods may be refined for future work. As additional studies are undertaken to further define the Comprehensive Plan, local subsidence and compaction due to weight of structures will be considered in more detail.

9. IEPR Comment - Medium Significance: It is unclear how relative sea level rise (RSL) is incorporated.

USACE Response: Adopted.

USACE has modified the report to better describe how scenario testing was utilized to evaluate relative sea level rise (RSL) on project performance in HEC-FDA (Hydrologic Engineering Center – Flood Damage Analysis) (see Scenario Testing Methodology Section 5.3.3, Economic Appendix). The potential effects of sea level rise are also displayed for each of the final array of alternatives, in the System of Accounts tables (Factor F.1.d), in Table 3-11 of Chapter 3 of the Main Report (Vol.1). Future relative sea level rise was employed in the economic flood damage analysis exercise. These exercises were conducted using HEC-FDA (inundation damage) and BEACH-FX (Life Cycle Risk Analysis of Shore Protection Projects) (shoreline erosion related damage).

While it is granted that wave characteristics vary according to a number of factors (proximity to coast, local slope, roughness elements, water depth, etc.), the flood damage problem in this context is simplified to one of the still water elevation. Accordingly, in consultation with the Corps' Hydrologic Engineering Center and Engineering Research and Design Center, it was stated that it would indeed be reasonable to shift the stage-frequency curve by the amount of predicted sea level rise over the period of analysis in order to obtain an estimate of expected annual damage due to sea level rise when employing the HEC-FDA inundation tool, and the effects of sea level rise on the order of one meter are appropriately captured for present purposes.

The recommended plans provide for adaptive management to respond to changes in time due to relative sea level rise. USACE is leading the collaborative research effort on the effect of relative sea level rise (RSLR) referred to by the reviewers. The results of this work and the inclusion of the knowledge from this research effort will be considered in adaptive management during the implementation of the Comprehensive Plan.

10. IEPR Comment - Medium Significance: All of the physics-based models used need a better explanation, including inputs, outputs and assumptions.

USACE Response: Adopted in Part

The report and supporting appendices provide summary information documenting the methodology and models applied. The Engineering Appendix includes descriptions of the physics-based models, including model inputs and output, and application methodology. Citations are also given where the reader can go to get more information on the models and their application.

USACE has modified the Engineering Appendix to provide additional details on how barriers such as levees and road systems are incorporated in the ADCIRC (Advanced Circulation Model) mesh and the STWAVE (Steady-State Spectral Wave Model) and COULWAVE (Cornell University Long and Intermediate Wave Model) grids (Sec 2.8.2). The appendix has also been modified to discuss the level of uncertainty that is inherent in any modeling exercise due to model errors and uncertainty in model inputs (Sec 2.4.1). Additional references have been added to Section 2.4.1.1 of the appendix.

The purpose of the comprehensive barrier island restoration is to enhance the sustainability of the Mississippi Sound estuary and the critical ecosystem functions that it provides through the restoration of the sediment budget of the islands. There is a detailed evaluation of the environmental benefits which would accrue from the restoration and future sustainability of the island/estuarine system. The report clearly states that there are incidental benefits to the mainland shoreline, primarily in the reduction of wave climate that is provided via the sheltering effect the barrier islands provide. Should the islands continue to erode, there would be increased wave energy on the mainland shoreline which would increase damages to existing infrastructure. Additional documentation of the wave reduction benefits of the barrier islands will be generated as part of the additional studies described in the Barrier Island Appendix.

11. IEPR Comment - Medium Significance: The decision factors involved in using the models selected needs to be described. In some cases, updated modeling tools should be used.

USACE Response: Adopted in Part

Summary information on the models utilized in the development of the comprehensive plan is presented in the Main Report. The technical appendices include detailed descriptions of the models including the governing equations, inputs, and sample output from the models.

USACE has modified the report and appendices to include additional information with respect to the incorporation of Lines of Defense (LOD) 3 and 4 and uncertainty (Engineering Appendix Sections 2.5 – 2.8) and the use of the SLOSH (Sea, Lake and Overland Surges from Hurricanes) model for delineating the study area into sub-units and the use of ADCIRC and HEC-FDA for analysis of economic risk (Economic Appendix Section 1.3.3 and Chapter 3). Additional references with details on model validation have been added to the Engineering Appendix.

The review seems to specifically be concerned with the application of the parametric TC96 PBL model. USACE understands the comments pertaining to the atmospheric model selection, but in the confines of the project, the value added through the use of atmospheric models with increased resolution is limited because these models:

- do not have verification/validation history in the estimation of tropical systems;
- require boundary condition information from global atmospheric models requiring additional (potentially erroneous) assumptions;
- require an increase in computational resources that are at the minimum two to three orders of magnitude larger.

USACE concurs that wind input is an important factor contributing to the uncertainty in storm surge models and performed a comprehensive analysis to assess the implication of applying the PBL in the work conducted following Hurricane Katrina. The analysis performed showed only slight variations in the resulting surge and wave fields, based on inter-comparisons of "best-wind" applications (i.e. H-Winds as the construct for the tropical system core) versus the use of the PBL TC96. See *Interagency Performance Evaluation Task Force, 2007, "Performance Evaluation of the New Orleans and Southeast Louisiana Hurricane Protection System, Volume VIII – Engineering and Operational Risk and Reliability Analysis, Appendix 8" U.S. Army Corps of Engineers, Washington, D.C., https://ipet.wes.army.mil/* for details on limited impact on surge. The wave field analysis is included in a yet-unpublished FEMA report. Information from that report including plots measuring wave data with wave model estimates using "best-winds" from OWI and winds from the PBL for Hurricane Katrina shows that good estimates are obtained with the PBL wind fields. The results for Katrina are similar to those obtained for Hurricanes Betsy, Rita, Camille, Ivan, and Andrew. USACE has included reference to this work as well as to the uncertainty associated with the PBL model in the Final Report Engineering Appendix Section 2.4.1).

12. IEPR Comment - Medium Significance: Need to explain the rationale for selecting the oyster as a surrogate for other species.

USACE Response: Adopted

The USACE view is guided by an environmental framework built upon knowledge of the dynamic and changing ecosystem of the coast and the need for restoration of habitats in such a manner as to be adaptive to future environmental influences. Many of the coastal habitats, such as submerged aquatic vegetation, emergent tidal marsh and wet pine savannah, have been heavily influenced by development (direct and indirect) in the last 50 to 100 years. Although the geomorphic process is impacted by large catastrophic storm events causing drastic and dramatic changes on the local ecosystems, such as erosion of islands/mainland and colonization by exotic species, developmental pressures on these ecosystems were noted as a primary concern.

Specifically, it is recognized that as sea level changes there will be gradual shifts in community compositions within the natural landscape features of coastal Mississippi. USACE has utilized the oysters as the surrogate species only for the freshwater diversion of Mississippi River water into western Mississippi Sound. This is appropriate, since the primary purpose of the diversion project is to introduce historic freshwater flows from spring flood events into this area of Mississippi Sound that have been lost due to levees being constructed along the Mississippi River outflow into the Gulf of Mexico. Other surrogate species or communities were utilized in the design of the tidally emergent and wet pine savannah restoration projects. As additional efforts are initiated as part of this comprehensive effort other species or communities may be identified as appropriate keystone species to guide habitat restoration in other community types.

13. IEPR Comment - Low Significance: The stated goal of the project to reduce loss of life by 100% is unrealistic.

USACE Response: Adopted In Part.

The stated goal of the MsCIP Comprehensive Plan is the development of a resilient Mississippi coast which would have the goal of no loss of life in the future. While USACE recognizes that this goal may not be achievable, all efforts are being made in the Comprehensive Plan to reduce residual risk to the maximum. The focus on risk reduction through nonstructural means, ecosystem restoration and risk communication stressing floodplain management, evacuation planning, and building codes are examples contained in the plan to clearly identify the residual risks to the coastal population. Communication of that risk to Federal, State, and local decision makers and the general public through the use of the system of accounts tables and other educational awareness programs, will continue to be an factor during the implementation of the Comprehensive Plan and as additional studies are undertaken with the overall goal of further reduction in risk in the coastal area.

14. IEPR Comment - Low Significance: The process for weighting metrics is unclear.

USACE Response: Adopted.

USACE has modified the Final Report to include a discussion of risk and how the information gained through the Risk Informed Decision Framework was utilized in the development of the Comprehensive Plan. USACE is acutely aware as to the problems posed by the use of MCDA (Multi-Criteria Decision Analysis) and agrees that methods of eliciting weights, framing, ordering, and choice of metrics all had an effect on outcomes. Different stakeholder sessions were meant to refine and improve this process; however, the methodology in actual application for civil works planning remains flawed. USACE chose, therefore, to use MCDA as an information tool rather than a selection tool, for the same reasons the IEPR team found the application problematic. Additional effort in developing the proper tools of risk evaluation for use in Corps Planning Studies is being undertaken.

STATE OF MISSISSIPPI
OFFICE OF THE GOVERNOR

HALEY BARBOUR
GOVERNOR

August 25, 2009

Mr. Theodore A. Brown, P.E.
Chief, Planning and Policy Division
Directorate of Civil Works
U.S. Army Corps of Engineers
441 G Street NW
Washington, D.C. 20314-1000

Dear Mr. Brown:

Reference is made to my letter of July 31, 2009 expressing the full support of the State of Mississippi for the implementation of the Mississippi Costal Improvements Program (MsCIP) Comprehensive Plan. I am providing this letter to clarify that support.

The State is legally capable of fulfilling the requirement for being the local sponsor for this program in accordance with Section 21 of the Flood Control Act of 1970, as amended (Public Law 91-661). This letter, while not legally binding on the State in any way and not an obligation of future funds appropriated by the State Legislature, voices and demonstrates our strong support for the implementation of the Mississippi Coastal Improvements Program Comprehensive Plan as described in the report of the District Engineer dated June 2009 and the draft Report of the Chief of Engineers, as provided by your letter of June 29, 2009, with cost sharing as required in the Water Resources Development Act of 1986. However it is our intent to request of Congress that the cost share for the implementation of the comprehensive plan be in line with other Federal disaster relief (100% Federal share or at least 90% Federal share), due to the unprecedented nature of the disaster and the continuing impact it has had of the economic base of these communities and the State.

If you have any questions, please do not hesitate to contact me.

Sincerely,

Haley Barbour

Haley Barbour

HB/mb

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STATE OF MISSISSIPPI
OFFICE OF THE GOVERNOR

IALEY BARBOUR
GOVERNOR

July 31, 2009

Mr. Theodore A. Brown, P.E.
Chief, Planning and Policy Division
Directorate of Civil Works
U. S. Army Corps of Engineers
441 G Street NW
Washington, D.C. 20314-1000

Dear Mr. Brown:

Reference is made to your letter of June 29, 2009, requesting the position of the State of Mississippi with regards to the Mississippi Coastal Improvements Program, Hancock, Harrison, and Jackson Counties, Mississippi and specifically to the proposed report of the Chief of Engineers. The State of Mississippi (State) fully supports the implementation of the Comprehensive Plan as developed by the District's Mississippi Coastal Improvements Program (MsCIP) team over the past three years. In particular, we support the thirteen comprehensive plan features recommended for construction as described in Chapter 5 of the final report dated June 2009. In addition, the State strongly supports the need to include freshwater diversion from the Mississippi River as authorized by the Water Resources Development Act of 2007 as an integral part of the comprehensive plan. Secondly, the State supports the continued evaluation of those features that are recommended for additional feasibility level studies; particularly the six environmental restoration projects identified properties within the Mississippi Coastal Preserves Program. All appropriate agencies of the State have reviewed the report and found that the recommendations are consistent with State laws and policies and are in full agreement with the State's comprehensive restoration goals.

As confirmed in the Comprehensive Plan, the physical and economic destruction to the State of Mississippi brought by Hurricane Katrina was on a scale unmatched by any natural disaster in U.S. history. The natural landscape of Mississippi suffered severe damage and nearly all our coastal communities along the Gulf of Mexico were completely devastated or seriously damaged. The impact of this disaster is still being felt by these communities and the entire northern Gulf of Mexico region today, almost four years after the hurricane. The activities recommended by the Corps in the Mississippi Coastal Improvements Program Interim Report (June 2006) and authorized by Congress have begun and will provide a basis for our continued redevelopment towards a resilient coastal Mississippi. I appreciate the efforts of the Army Corps of Engineers to expeditiously develop this comprehensive plan and express the strong support of the State toward the implementation of this plan.

Page 2

July 31, 2009

The State is legally capable of fulfilling the requirement for being the local sponsor for this program in accordance with Section 21 of the Flood Control Act of 1070, as amended (Public Law 91-611). This letter, while not legally binding on the State in any way and not an obligation of future funds appropriated by the State Legislature, voices and demonstrates our support for the Mississippi Coastal Improvements Program Comprehensive Plan. However, we believe there is a need for further discussions and modifications related to the standard cost sharing requirements as described in the report. Hurricane Katrina was not a standard event and the devastation was unmatched. It is our intent to request of Congress that the cost share for the implementation of the comprehensive plan features by the Corps of Engineers be in line with other Federal disaster relief (100% Federal share), due to the unprecedented nature of the disaster and the continuing impact it has had on the economic base of these communities and the State.

We look forward to our continued working relationship with the U.S. Army Corps of Engineers on this unprecedented effort towards making coastal Mississippi more resilient to future hurricane related events.

If you have any questions, please do not hesitate to contact me.

Sincerely,

Haley Barbour

Haley Barbour

HB/mb

United States Department of the Interior

OFFICE OF THE SECRETARY
Washington, D.C. 20240

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Mr. Theodore A. Brown, P.E.
Chief, Planning and Policy Division
Directorate of Civil Works
Headquarters
U.S. Army Corps of Engineers
CECW-P (SA)
7701 Telegraph Road
Alexandria, VA 22315-3860

RE: Thirty-Day Review of the Chief of Engineers Proposed Report, On The Mississippi Coastal Improvements Program (MsCIP), Hancock, Harrison, and Jackson Counties, MS

Dear Mr. Brown:

The U.S. Department of the Interior (Department) has reviewed the U.S. Army Corps of Engineers (USACE), Chief of Engineers Proposed Report and supporting documents on the Mississippi Coastal Improvements Program (MsCIP).

Our U.S. Fish and Wildlife Service (Service) has been a full and cooperating member of the McCIP planning team. We appreciate your consideration of their comments and recommendations during the advanced planning stages of the program. The Service believes that three of the recommended program features for ecosystem restoration, Dantzler, Franklin Creek, and Bayou Cumbest would potentially complement refuge goals at the Mississippi Sandhill Crane National Wildlife Refuge (NWR) and Grand Bay NWR.

The Department does not object to the Chief of Engineers Proposed Report. However, we do wish to provide the following comments developed by our National Park Service (NPS) for your consideration.

General Comments

Development of a Supplemental Environmental Impact Statement (SEIS) Prior to Barrier Island Restoration

In a discussion that took place on July 24, 2009, between the USACE (MsCIP Program Manager, Dr. Susan Rees) and the NPS, both agreed to proceed with the preparation of a SEIS that would tier from the Programmatic Environmental Impact Statement (EIS) to provide a more detailed evaluation of the environmental impacts with regard to the barrier island restoration component of the MsCIP. The NPS proposes to work closely with the USACE, through its status as a cooperating agency (as requested in its previous comments on the Draft Programmatic EIS), to expedite the development of the SEIS.

Cat Island

The NPS finds that the USACE responded favorably to the vast majority of comments and recommendations submitted by the NPS on the Draft MsCIP Comprehensive Plan and Integrated Programmatic EIS. However, the NPS notes that the Final MsCIP Comprehensive Plan and Integrated Programmatic EIS now includes several figures (see pg. S-9, Figure 4.1, Figure 5-1 and Figure 7-3) which show a littoral zone sand deposition area near Cat Island under the Comprehensive Barrier Island Restoration Alternative H. Littoral zone placement of sand near Cat Island was not a component of Alternative H due to the paucity of scientific information supporting such placement. As stated on pg. 5-32 of the Main Report:

> This alternative includes the direct placement of sandy sediments to fill the breach in Ship Island and thereby reconnect West and East Ship Islands to their historic condition and to place sandy sediments within the littoral zones of Ship, Horn and Petit Bois Islands to ensure that the sediment budget of the islands is sufficient to maintain the islands in the future. This littoral zone placement would also benefit from the modification of dredging and disposal practices of the federally maintained Gulfport and Pascagoula Harbor navigation projects. These coupled efforts would begin the long-term process of barrier island repair and sustainability. Another consideration that still must be addressed is the best alternative for dealing with the erosion of Cat Island. This island is geomorphically different from the other three barrier islands and our understanding of the processes controlling Cat Island is not well developed. Additional effort would be required to add this island into an overall comprehensive barrier island restoration plan.

The NPS suggests that it is premature to include a littoral zone deposition area near Cat Island in the absence of supporting scientific data.

Environmental Effects to Geology

The NPS also notes that Table S-2 (pg. S-14), Environmental Effects of Recommended Alternatives, continues to show "no impact" to geology under the Comprehensive Barrier Island Restoration Alternative H. While we understand that the USACE narrowly defines "geology" as pertaining to geologic formations on the mainland, restoration of the barrier island sand budget and transport system would likely benefit coastal geologic processes. The NPS recommends that this important beneficial impact issue be raised in the SEIS process.

Specific Comments

Main report

1. Table 6-1 shows a non-Federal cost share of $180 million for barrier island restoration. Is this non-Federal cost share an accurate number, and what non-Federal entities will be participating in such cost sharing?

Appendix E: Engineering

1. p. 226, line 17 – change "George" to "Georges"
2. p. 230, line 5 and p. 264, line 24 – change "8 million cubic yards" to "13 million cubic yards"
3. p. 234, line 17 – change ""Isalnd" to "Island"
4. p. 235, line 12 -- states that islands have lost 20-25% of their land masses since pre-Camille times, this seems to be an underestimate.

Appendix H: Barrier Islands

1. p. 34, line 2 – recommends using sand dredged from Ship Island Pass for filling Camille Cut and littoral zone placement
2. p. 35, line 4 – states that "inland sources of sand exist that will be used for … restoration."
3. p. 52, line 9 – "The source of these sands may be from inland sources or offshore borrow areas"
4. p. 56, line 14 – states that islands have lost 20-25% of their land masses since pre-Camille times, this seems to be an underestimate
5. p. 40, line 3 – change "week" to "weak"
6. p. 40, line 5 – when describing an experiment, says "I used …" but does not identify the narrator.
7. p. 44, line 12 – change "past" to "passed"
8. p. 44, line 17 and p. 56, line 16 – change "George" to "Georges"
9. p. 47, line 22 and p. 48, line 13 – change "Camille Pass" to "Camille Cut"
10. p. 52, line 13 – change "affect" to "effect"
11. p. 62, line 32 – change "tracts" to "tracks"

We appreciate the opportunity to review the Chief's Proposed Report and supporting documents. We look forward to working with the USACE in the preparation of a SEIS, and any subsequent activities including detailed planning and implementation phases of the NWR areas mentioned above, including long-term management. If you have any questions regarding these comments please contact Mr. Jerry Ziewitz, Fish and Wildlife Service, Southeast Region Conservation Planning Assistance Coordinator, at 850-769-0552x223 or Mr. Steven Wright, National Park Service, Southeast Regional Office, Planning and Compliance, at 404-507-5710.

Sincerely,

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

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

July 27, 2009

Dr. Susan I. Rees
Project Manager
U.S. Army Corps of Engineers
Mobile District
P.O. Box 2288
Mobile, AL 36628-0001

Subject: EPA's NEPA Review of the COE's Final Integrated Programmatic Environmental Impact Statement (FPEIS) for the "Mississippi Coastal Improvements Program (MsCIP)"; Recommended Comprehensive Plan; June 2009; Hancock, Harrison, and Jackson Co, MS; CEQ# 20090216; ERP# COE-E39075-MS

Dear Dr. Rees:

Pursuant to Section 102(2)(C) of the National Environmental Policy Act (NEPA) and Section 309 of the Clean Air Act, the U.S. Environmental Protection Agency (EPA) Region 4 has reviewed the U.S. Army Corps of Engineers' (COE: Mobile District) Final Comprehensive Plan and Integrated Programmatic Environmental Impact Statement (FPEIS = Recommended Comprehensive Plan). The FPEIS consists of a main document and ten appendices (A-L). As a Cooperating Agency, EPA has participated in various meetings and site visits preceding the issuance of this FPEIS. These included Regional Coordination Meetings for scoping in 2006, Risk Analysis Workshops in 2007, a web-based feedback and participation forum in 2007, and wetland field reconnaissance site visits and interagency project deliberations. These meetings and site visits were attended by representatives of our Water Protection Division (WPD) and NEPA Program Office (NPO). We also provided NEPA comments on the Draft PEIS (DPEIS) in a letter dated March 27, 2009.

As we indicated in our DPEIS comment letter, we commend the COE for their extensive scoping, planning and coordination of this project with federal, state and local agencies as well as non-governmental organizations (NGOs), universities, stakeholders and the general public. Moreover, we also appreciate the project status briefings presented by the COE's South Atlantic Division (SAD) and the coordination provided by EPA's Office of Water in Washington, DC and our Gulf of Mexico Program (GMP) in Mississippi.

Project Overview

The Recommended Comprehensive Plan addresses recent (2005-2006) hurricane and storm damage (Katrina, Rita and Cindy) in Hancock, Harrison, and Jackson Counties through the implementation of several projects and the further study and NEPA review of others. Specifically, we note the study of ecosystem restoration of wetlands, fish and wildlife preservation, eroded coastlines and saltwater intrusion; the purchase or flood-proofing of properties in high hazard zones to change their land use; and the policy that reduction measures for hurricane/storm damage were provided "...without encouraging re-development in high-risk areas" (pg. S-5 of Main Document/hard copy). EPA supports the restoration goals of the MsCIP and the overall approach to achieve them taken by the Mobile District. We concur with the MsCIP objective to recommend solutions that "...are intended to render the region more resilient and less susceptible to the recurrence of damages from future coastal storm events" (pg. S-5).

COE Responses to EPA's DPEIS Comments

The Mobile District's responses to EPA's NEPA comments on the DPEIS are found in Appendix L. We appreciate that the COE's direct response to our comments as opposed to bundling similar public comments together for response. On the compact disc (CD) provided for Appendix L, we note that our letter is located on page 32 of 222, and the COE's responses to that letter on page 50 of 222.

Overall, we agree with most of the Mobile District's responses, although they included a few non-concurrences. These areas of non-concurrence involved saltwater intrusion and Section 404 permitting decisions in COE and Federal Emergency Management Agency (FEMA) designated high-risk areas along the Mississippi Gulf Coast. We offer the following final comments on selected COE responses for consideration in the COE's Record of Decision (ROD):

* Comment Responses 2 & 16 (*Emphasis on Restoration Projects*) – The Mobile District does not concur with our comment to emphasize post-hurricane restoration for the Mississippi coastline more so than other regional ecosystem projects that are not the direct result of hurricane damage. While EPA is aware of the Congressional authorization to study saltwater intrusion (and clearly expects the COE to be responsive to such mandates), we believe that hurricane-induced saltwater intrusion issues are less pronounced for the Mississippi coastal mainland relative to other storm-affected regions such as neighboring Louisiana (also see Comment Responses 10 & 18 for *Saltwater Intrusion* below). Although we continue to maintain that the emphasis should be placed on post-hurricane restoration, we understand that the referenced freshwater diversion study originating in Violet, Louisiana could be beneficial to diluting the elevated salinities of the Mississippi Sound (that were increased by hurricane erosion of the barrier islands) to the more ambient, lower salinities more characteristic of the Sound.

* Comment Response 3 (*Non-Structural Alternatives*) – EPA's DPEIS comments supporting non-structural alternatives to restore the Mississippi coast where appropriate resulted in a "comment noted" response. Although discretionary, this comment provided an excellent opportunity for the District to underscore the COE's intent to implement non-structural alternatives within MsCIP where appropriate. Nevertheless, we are pleased to note from the Main Document (pg. 5-3) that the non-structural features listed

in the DPEIS (Draft Comprehensive Plan) is consistent with the Recommended Comprehensive Plan in the FPEIS. However, we also note that this COE response does not address our suggestion to establish coastal greenspace (greenways/parks) as an additional non-structural alternative for high-risk areas vacated by relocations. We recommend that the ROD further address this, even though implementation of such changes in land use would ultimately be a local decision (also see Comment Response 14 on *Coastal Greenspace* below).

* Comment Response 4 (*Ring Levees*) – EPA agrees with the COE's response that: "In some cases, ring levees structures may be acceptable means of reducing risk." The COE's example of Forrest Heights may be reasonable since an "uncertified" levee structure already exists there that could be modified to be compatible with Flood Control Insurance Program. However, to reiterate our DPEIS comments, we find that ring levees are not preferable in most cases. Overall, they are expensive to build and maintain (i.e., rainwater must be pumped out of the levee enclosure), must be serviced by an access road that is elevated to levee height, and do not necessarily eliminate the evacuation need of the residents within the levee-enclosed area. In addition, ring levees may also require wetland fill and exacerbate flooding issues for surrounding communities (also see Comment Response 22 below for the *Forrest Heights Levee*). In cases where it is determined ring levees are necessary to protect coastal communities, EPA looks forward to working with you closely to identify environmentally acceptable levee alignments, and to ensure that potential adverse impacts to aquatic resources are avoided and minimized.

* Comment Response 6 (*Section 404 Permitting*) – We are pleased to understand that the COE deems the approach to hurricane/storm recovery is "closely coordinated" between its MsCIP team (COE Planning Branch) and Section 404 permitting (COE Regulatory Branch). EPA recommends and supports such consistency, and continues to encourage stronger collaboration among the COE's Section 404 permitting program and planning program, including linking permitting decisions with the recovery conclusions reached in the FPEIS, namely, avoiding development and re-development in designated high-risk areas along the Mississippi coast. Moreover, we encourage the broad application of this coordinated coastal planning and permitting approach along other vulnerable coastal areas on the Gulf of Mexico.

* Comment Responses 9 & 21 (*Turkey Creek*) – EPA appreciates the COE's efforts to coordinate the MsCIP restoration efforts with the Mississippi Department of Transportation's (MDOT) mitigation efforts in the Turkey Creek watershed. This watershed is classified as a priority watershed by both the State of Mississippi and EPA. Consequently, EPA met with the COE following the submittal of our MsCIP comment letter on the DPEIS to reiterate our interest in ensuring that every effort is made to restore water quality and maximize future hurricane and storm damage reduction with the area. We will continue to work jointly with the Mobile District, MDOT, Mississippi Department of Marine Resources (MDMR), the Land Trust for the Mississippi Coastal Plain (Land Trust), and the communities of Turkey Creek to maximize the restoration efforts within the watershed.

* <u>Comment Responses 10 & 18 (*Saltwater Intrusion*)</u> – As suggested in Comment Response 2 above, our view that less saltwater intrusion problems exist in Mississippi than in Louisiana primarily refers to the Mississippi coastal mainland, i.e., what EPA considers traditional saltwater intrusion of coastal mainland rivers and groundwater. We agree that the nearshore salinities of the Mississippi Sound are now elevated after the hurricane events and that reasonable efforts could be used to restore the lower salinities that are optimal for the Sound's commercial (e.g., oysters) and other natural flora and fauna. The proposed beach renourishment of the Gulf side of the Mississippi barrier islands should also help minimize future salinity elevations of Mississippi Sound (i.e., "saltwater intrusion" of the Sound) by providing more of a barrier to storm surges and island overwashes.

* <u>Comment Response 12 (*Expedited Implementation*)</u> – Although the COE's "comment noted" response to our recommendation for expedited project implementation may imply concurrence, EPA wishes to re-emphasize that projects ready for implementation pursuant to this PEIS and its ROD should be rapidly implemented in anticipation of future storm events, so that impacts to the Mississippi coast can be reduced. Likewise, for projects requiring additional NEPA tiering from the PEIS, we recommend that these documents and data gathering efforts be initiated as soon as feasible for public review and prospective implementation.

* <u>Comment Response 13 (*Gulf Application*)</u> – We wish to reiterate the importance of broadly applying the non-structural alternatives approach where appropriate – both by the COE and the stakeholders seeking to locate along the coast – to the entire Gulf of Mexico because EPA concurs with the Mobile District's innovative approach to restoration.

* <u>Comment Response 14 (*Coastal Greenspace*)</u> – Our recommendation to include coastal greenspace (parks and greenways) is not addressed. As suggested above, the COE should address this recommendation in its pending ROD for high-risk areas vacated by relocations, even though implementation of such changes in land use would be a local decision.

* <u>Comment Response 17 (*New Section 5.17.8*)</u> – Although this response refers the reader to Comment Response 6, and although we understand from that response that the COE deems the coordination between the COE's Planning and Regulatory Branches to be good, the addition of our recommended Section 5.17.8 would have better confirmed and disclosed consistency between these branches (i.e., consistency between the conclusions of this FPEIS document and the Section 404 permit decisions made for applications to develop or re-develop in high-risk areas).

* <u>Comment Response 22 (*Forrest Heights Levee*)</u> – As suggested above in our comments on Comment Response 4, the proposed elevation of the existing levee at Forrest Heights has some merit since a structure already exists and the residents would like it to remain in place. We appreciate the COE's reassessment efforts that notably reduced the wetland footprint for such elevation from 19.85 acres (17-ft levee) and 23 acres (23-ft levee) to

1.47 acres and 3.62 acres of non-tidal wetlands, respectively. We also concur that wetland mitigation is proposed to be located within the same watershed and assume that mitigation will be in-kind as well. However, we wish to reiterate that such a levee, even when improved ("certifiable" per the COE's Comment Response 4) and compatible with the Flood Control Insurance Program, is not health protective even though it does reduce the risk of flooding for the enclosed community. As previously noted, EPA typically prefers the use of non-structural alternatives where appropriate, such as the proposed High Hazard Area Risk Reduction Plan (HARP) that provides residents the opportunity to move from high-risk to lower-risk areas

* Comment Response 23 (*Near Term HARP*) – The intent of the COE's response to our comments on HARP projects is unclear: "The high hazard area is defined by FEMA flood insurance". Therefore, these follow-up EPA comments are being provided:

> Although EPA typically prefers non-structural alternatives that relocate residents out of high-risk areas, we note that one disadvantage to such relocation is the potential for societal effects on all demographics being moved, including environmental justice (EJ) communities. It remains unclear from this response as to what outreach communication and actions was/would be provided to the HARP communities that would be considered for relocation in the near term (2,000 structures). The ROD should better address the outreach planned for these communities, and Long Term HARP projects should be similarly treated. Additional tiered NEPA documents on Long Term HARP projects should include EJ demographic data/maps.

* Comment Response 27 (*Disposition of Dredged Material*) – We appreciate the COE's reuse of suitable new work dredged material in nearshore littoral areas to keep clean sands in the littoral system.

RECOMMENDED COMPREHENSIVE PLAN

MsCIP restoration projects "presented in support of a Record of Decision for construction" are listed in the FPEIS on pages S-9 and S-10 of the Main Document. We note that this list is consistent with that of the DPEIS. In fact, it appears that additional projects may have been confirmed for construction in the FPEIS, although some additional NEPA documentation may still be needed following specific implementation plans for certain projects. The listed projects (components) that are essentially ready for construction in the Recommended Comprehensive Plan are:

1) Turkey Creek Ecosystem Restoration
2) Bayou Cumbest Ecosystem Restoration
3) Dantzler Ecosystem Restoration
4) Admiral Island Ecosystem Restoration;
5) Franklin Creek Ecosystem Restoration
6) Deer Island Ecosystem Restoration
7) Submerged Aquatic Vegetation [SAV] Ecosystem Restoration

8) Coast-wide Beach and Dune Restoration
9) Waveland Flood Proofing Pilot Project
10) Forrest (Forest) Heights Hurricane and Storm Damage Reduction
11) High Hazard Area Risk Reduction (HARP) including the Moss Point Municipal Structure Relocation; and
12) Comprehensive Barrier Islands Restoration Plan[1].

These projects are primarily ecosystem restoration projects, although non-structural community relocation and flood-proofing studies (e.g., Waveland flood-proofing) were also included. We note that other non-structural features offered in the Recommended Comprehensive Plan were also consistent with the Draft Comprehensive Plan. In the FPEIS (pg. 5-3), these features included:

- Hurricane Risk Reduction Education
- Hurricane and Storm Warning Systems;
- Hurricane Evacuation Planning;
- Floodplain Management;
- Building Codes;
- Zoning Codes; and
- Relocation of Critical Infrastructure and Services (Line of Defense 5).

Relative to floodplain management, the "coastal Mississippi risk zones" relative to hurricane and storm damage are shown in Figure 5-2 and depicted as high-risk and various lower risk areas. In addition to these non-structural features, we also recommend that the ROD also address the possibility of establishing coastal greenspace – such as parks and greenways – in areas vacated by high-risk area relocations, even though implementation of such changes in land use would ultimately be a local decision.

Therefore, EPA is pleased to note that the non-structural components and features of the Recommended Comprehensive Plan in the FPEIS are consistent (if not expanded) with the Draft Comprehensive Plan in the DPEIS. We recommend that the ROD remain consistent with the Recommended Comprehensive Plan in the FPEIS. Furthermore, we also recommend that the Comprehensive Plan be implemented in an expedited manner following COE approval to more rapidly produce a more resilient coastline and reduce the possibility of additional hurricane coastal damage to infrastructure and ecosystems.

Conclusions and Recommendations

EPA continues to support the progressive restoration approach used by the Mobile District to restore the Mississippi coastline following the infrastructural and ecological destruction by Hurricanes Katrina, Rita and Cindy. We particularly support the proposed use of non-structural alternatives where appropriate to complement structural alternatives

[1] We note that this Barrier Island project is listed differently on page 5-1 (*Barrier Island Risk Reduction Plan*). Also, the SAV and Waveland projects are termed as "Pilot Projects" on page S-10 but as "Ecosystem Restoration" projects on page 5-1. The ROD should clarify.

that may be needed. Non-structural alternatives would relocate residents out of designated high-risk areas, raise hurricane awareness through education and rezoning, and minimize flooding for any re-developments through structural elevations and better construction codes. Use of coastal greenspace – such as parks and greenways – in high-risk areas vacated by relocations should also be discussed in the ROD, even though implementation of such changes in land use would ultimately be a local decision.

EPA recommends that implementation of projects ready for construction after issuance of the ROD for this PEIS should be reasonably expedited to more rapidly minimize future coastal storm damage. Similarly, additional NEPA documentation for planned future projects tiering from this PEIS, such as Long Term HARP and barrier island renourishment, should also be feasibly expedited. COE Section 404 permitting decisions should be consistent with COE coastal planning activities. This would help ensure that the re-development or development of high-risk areas is avoided, that the non-structural alternatives devised by the MsCIP team are implemented, and that activities which would conflict with coastal restoration efforts are not authorized. We further recommend that the lessons learned for the Mississippi coastline should be broadly applied – both by the COE and stakeholders seeking to locate along the coast – to the Gulf coastline in general.

EPA appreciates the opportunity to review the FPEIS and the Mobile COE's coordination with us. Where appropriate, we wish to offer our assistance for the expeditious implementation and application of the Recommended Comprehensive Plan. Should you have any questions, feel free to contact Ntale Kajumba at 404/562-9620 (kajumba.ntale@epa.gov) or Chris Hoberg at 404/562-9619 (hoberg.Chris@epa.gov) of my staff, and Duncan Powell at 404/562-9258 (powell.duncan@epa.gov) in the Region 4 Water Protection Division for specific waters-of-the-US issues.

Sincerely,

Heinz J. Mueller, Chief
NEPA Program Office
Office of Policy and Management

cc: Mr. Claiborne Barnwell – MDOT: Jackson, MS
Mr. Jeff Clark – MDMR: Biloxi, MS
Mr. David Felder – USFWS: Daphne, AL
Brig. General Todd Semonite – COE/SAD: Atlanta, GA
Ms. Judy Steckler – Land Trust: Biloxi, MS
Mr. Dickie Walters – FHWA: Jackson, MS

RECORD OF DECISION

MISSISSIPPI COASTAL IMPROVEMENTS PROGRAM
HANCOCK, HARRISON, and JACKSON COUNTIES, MISSISSIPPI

The Final Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan Report, which includes an Integrated Programmatic Environmental Impact Statement (EIS), dated June, 2009, describes a Comprehensive Plan to support of the long-term recovery of Hancock, Harrision and Jackson Counties, Mississippi from the devastation caused by the hurricanes of 2005. Based on the report, the reviews of other Federal, State, and local agencies, input from the public, and the review of my staff, I find the Comprehensive Plan to be technically feasible, cost-effective, in compliance with applicable environmental statutes, and in the public interest.

The MsCIP study was conducted under the authority of the Department of Defense Appropriations Act of 2006 (P.L. 109-148), dated December 30, 2005. The U.S. Army Corps of Engineers, along with the State of Mississippi acting as the non-Federal sponsor, developed the MsCIP Comprehensive Plan to address cost-effective solutions for hurricane and storm damage risk reduction, salt water intrusion, shoreline erosion, and preservation of fish and wildlife. The MsCIP Comprehensive Plan utilized a multiple lines-of-defense approach through barrier islands restoration, and employing shoreline damage reduction, wetland restoration, and floodplain evacuation. The report identifies 12 elements to aid recovery of coastal Mississippi. Structural elements include restoring protective beaches, restoring native habitats, and raising an existing levee. Non-structural elements include removing structures from floodplains or raising structures that are highly vulnerable to storm damage. The following elements are recommended for construction:

- <u>High Hazard Area Risk Reduction Program (HARP)</u> consists of acquisition of approximately 2,000 tracts which are at the highest risk of being damaged by storm surge, demolition of existing structures, and retention of acquired tracts in an open space condition. The number of tracts was based on an estimate of what could be acquired during a five-year period following the execution of the Project Partnership Agreement for implementation of this element. To the extent practicable, acquisition would be on a willing seller basis, but eminent domain could be utilized when determined to be warranted. The tracts would include residential, commercial and unimproved tracts. In addition, buildings owned by the City of Moss Point that are used for municipal purposes will be replaced with buildings out of the Federal Emergency Management Agency (FEMA) designated Velocity Zone.

- <u>Waveland Floodproofing</u> consists of elevating approximately 25 residential structures in the City of Waveland, Hancock County that are determined to be eligible for floodproofing by elevation out of the 1-percent chance storm event inundation level.

- Forrest Heights Levee consists of modification of an existing locally built levee around the Forrest Heights community, Gulfport, Harrison County, consistent with levee certification guidelines for a 0.2-percent probability storm occurrence. Approximately 6,500 linear feet of an existing non-Federal levee would be raised to a levee crest elevation of 21 feet North Atlantic Vertical Datum of 1988 (NAVD-88). An existing publicly owned park with a surface elevation of 12 to 14 feet NAVD-88 would be included in the plan to serve as a water detention area for temporary containment of rainfall during storm events. This element will require the acquisition of two residential properties within the existing community. Unavoidable adverse environmental impacts have been identified and mitigation would include the acquisition and restoration of approximately three acres of non-tidal wetlands.

- Turkey Creek Ecosystem Restoration consists of the restoration of 689 acres of an undeveloped site of degraded wet pine savannah habitat. Measures required to restore hydrology and natural vegetation on the site include filling drainage ditches, road removal, and controlled burning.

- Dantzler Ecosystem Restoration consists of restoration of 385 acres of severely degraded wet pine savannah. Measures required to restore hydrology and natural vegetative habitat to the site include removal of existing hurricane debris and sedimentation, filling drainage ditches, road removal, control of non-native species, and controlled burning.

- Franklin Creek Ecosystem Restoration consists of restoration of hydrology and native habitats by removing ditches, excavating and removing existing roadbeds, installing culverts under U.S. Highway 90, control of non-native species, and controlled burning to restore 149 acres located north and south of U.S. Highway 90 with critical wet pine savannah habitat.

- Bayou Cumbest Ecosystem Restoration consists of the acquisition of approximately 61 tracts, removal of 19 structures, excavation and removal of fill material from former home sites and adjacent lands, filling drainage ditches, control of non-native species, and planting with native emergent wetland species. Following acquisition of these tracts, 148 acres would be restored to emergent wetland (110 acres) and coastal scrub shrub habitat (38 acres).

- Admiral Island Ecosystem Restoration consists of restoration of a severely degraded 123-acre tidal wetland area. Measures required to restore hydrology and native habitat to the area include excavating fill material, filling ditches, control of non-native species and planting native tidal emergent species.

- Deer Island Ecosystem Restoration consists of actions that will complement existing Federal restoration projects by minimizing the fracturing of biodiversity. Measures include restoration of a portion of the northern and southern shorelines of the island, and new stone training dikes to prevent future erosion.

- Submerged Aquatic Vegetation element consists of measures designed to evaluate techniques for restoring submerged aquatic vegetation (SAV), an essential component of an estuarine ecosystem. Specifically, five acres of SAVs in the Grand Bay National Estuary Research Reserve area that were destroyed by Hurricane Katrina will be restored using different techniques. The results will be used to guide and develop other SAV restoration projects that would be undertaken as future authorized elements of the overall Comprehensive Plan.

- Coast-wide Beach and Dune Ecosystem Restoration consists of beach and dune improvements to approximately 30 miles of the 60 miles of existing beaches on the mainland coast. These improvements would include construction of 60-foot wide vegetated dune fields approximately 50 feet seaward of the existing seawalls.

- Barrier Island Restoration consists of the placement of approximately 22 million cubic yards of sand within the National Park Service's Gulf Islands National Seashore, Mississippi unit. Approximately 13 million cubic yards of sand would be used to close a gap between East Ship Island and West Ship Island, originally opened by Hurricane Camille, through the construction of a low level dune system. The remaining 9 million cubic yards of sand would be placed in the littoral zones at the eastern ends of Ship and Petit Bois Islands. In accordance with the requests of the National Park Service, the closure of the Ship Island gap and placement of sand into the littoral zones would be undertaken only once, and would not be nourished or otherwise maintained in the future.

With the exception of the mitigation that may be required as a result of the improvements to the Forrest Heights levee as described above, there are no other separable mitigation requirements associated with the construction of these elements. The MsCIP Comprehensive Plan will result in significant environmental benefits to coastal Mississippi and the northern Gulf of Mexico region.

In addition to these construction elements, the MsCIP Comprehensive Plan also identifies the need for feasibility studies of additional elements that could provide further improvements in the coastal area of Mississippi if implemented. Further study would consist of a feasibility level analysis to identify cost-effective solutions for hurricane and storm damage risk reduction, salt water intrusion, shoreline erosion, and preservation of fish and wildlife. These follow-on feasibility studies would evaluate the potential for restoration of over 30,000 acres of coastal forest, wetlands, beaches and dunes; structural measures; and floodproofing of structures on, or acquisition of, over 58,000 tracts within the 100-year floodplain. Additional National Environmental Policy Act compliance documentation would be completed as part of these additional studies.

A broad array of alternatives were evaluated in the development of the MsCIP Comprehensive Plan, and those alternatives are hereby incorporated into this Record of Decision by reference. In addition to a "no action" plan, numerous structural alternatives were evaluated for hurricane and storm risk reduction including long linear levee systems of various heights and alignments including surge barriers across the inland bays. Alternatives to the purchase of approximately 2,000 tracts, including acquisition of a larger number of tracts, were evaluated to determine social and economic impacts. A nonstructural option and a 17-foot levee were also evaluated at Forrest Heights.

Over 1,000 potential environmental restoration areas were screened as possible alternatives. From these, 43 alternative restoration sites were identified as likely to provide the desired environmental and hurricane and storm damage risk reduction benefits. These 43 alternatives were further screened to identify those high priority sites which would provide significant benefits in a relative short period of time. The other alternative sites are retained for future study. At each of the five specific ecosystem restoration sites, alternative restoration methods were evaluated including various means of restoring natural hydrologic characteristics and natural vegetation.

A number of alternative options were considered singly or in combination for the Deer Island restoration including southern shoreline restoration, expansion of the created wetland site and breakwater protection. Large submerged aquatic vegetation restoration projects were evaluated as alternatives to the recommended pilot project. Alternatives evaluated for the restoration of beach and dune included various heights, widths, and alignment of the mainland dunes.

Alternatives to the comprehensive barrier island restoration element included different methods of placement of sand within the system, i.e. direct placement vs. littoral zone placement, restoration of only the Ship Island breach, different configurations for the restoration of the breach, restoration of the islands to an early 20th century footprint, and only restoration of submerged aquatics associated with the existing island footprints.

The Draft MsCIP Comprehensive Plan was circulated for public review for 45 days on February 13, 2009. Public meetings were held on March 16, 18, and 19, 2009 in each of the three coastal counties. All comments submitted were responded to in the Final MsCIP report. Additional comment letters were received on the Final Plan. Strong support for the comprehensive plan was expressed by the U.S. Environmental Protection Agency, Region 4 U.S. Fish and Wildlife Service, National Park Service, and the State of Mississippi. No objections to the program were expressed.

The recommended MsCIP Comprehensive Plan represents a cost-effective and environmentally beneficial solution for a more resilient Mississippi Coast. All practicable means were employed to avoid or minimize the environmental and socioeconomic harm from implementing the Comprehensive Plan. Environmental monitoring and adaptive management will be performed to ensure regulatory compliance, to document the creation of beneficial habitat, to confirm the expected findings of no significant negative impacts, and to provide operational input on the success of habitat creation and potential changes which will increase the value and utilization. The Comprehensive Plan will reduce hurricane and storm damage risk to over 2,000 parcels located within the high velocity zone of the 100-year floodplain of the three coastal counties, improve flood storage capacity in approximately 1,900 acres of degraded habitat, restore approximately 1,900 acres of mainland wet pine savannah, emergent wetland, submerged aquatic, and island habitat; restore approximately 1,150 acres of offshore barrier island habitat, restore over 30 miles of beach and dune habitat, and reduce coastal erosion. The Comprehensive Plan is consistent with the authorizing legislation and is identified as the environmentally preferable alternative.

The 15 previously authorized interim projects which are nearing completion of construction along with the 12 elements recommended herein provide a fully integrated systems approach to partially addressing the hurricane damage in Mississippi from the storms of 2005, and were developed in concert with the Louisiana Coastal Protection and Restoration study. Furthermore, the activities of other Federal, state and local agencies that are responsible for public education, storm warning, evacuation planning, floodplain management, building codes and local zoning are integral components of efforts to reduce the hurricane risks associated with living in or visiting coastal Mississippi.

Technical, environmental, economic, and risk criteria used in the formulation of alternative plans were those specified in the Water Resource Council's <u>Economic and Environmental Principles for Water and Related Land Resources Implementation Studies</u>, except for deviations specifically directed in the authorizing language. All applicable laws, Executive Orders, regulations and local government plans were considered in the evaluation of the alternatives. Based on review of these evaluations, I find that the public interest would be best served by implementing the recommended Comprehensive Plan. This Record of Decision completes the National Environmental Policy Act process.

Jan. 14, 2010
Date

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

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

January 6, 2010

The Honorable Jo-Ellen Darcy
Assistant Secretary of the Army for Civil Works
108 Army Pentagon
Washington D.C. 20310-0108

Dear Ms. Darcy:

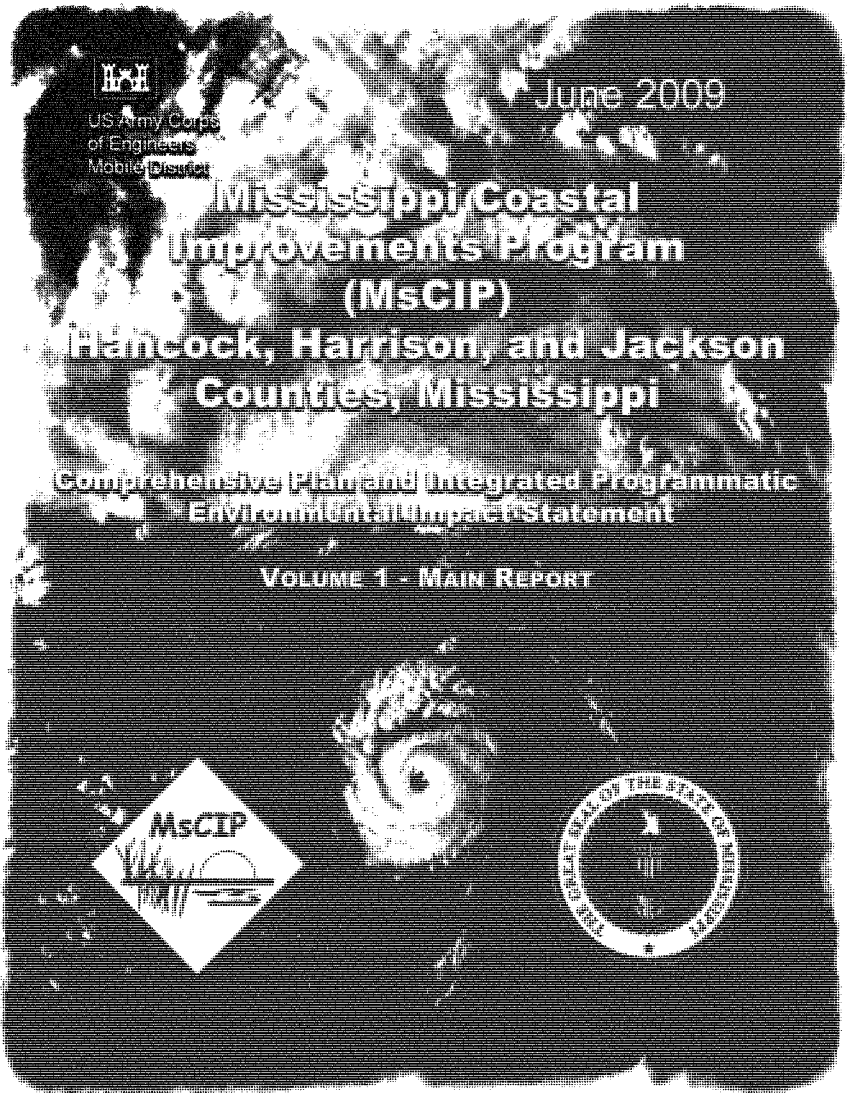
As required by Executive Order 12322, the Office of Management and Budget (OMB) has completed its review of your recommendation concerning the Comprehensive Report for the Mississippi Coastal Improvements Program (MsCIP) – Hancock, Harrison, and Jackson Counties, Mississippi.

We concur with your recommendation that the standard 65 percent Federal and 35 percent non-Federal cost-share be applied to both the hurricane and storm damage risk reduction and ecosystem restoration construction activities as proposed in the comprehensive MSCIP program. In addition, the future storm damage reduction studies that the report recommends the Corps undertake as a follow-on to this effort should assure adequate consideration of both ecosystem values and the evaluation of non-structural solutions, as opposed to strictly structural alternatives. It is also important that the Corps continue to coordinate its planning efforts in the MsCIP program with the Louisiana Coastal Restoration and Protection study to assure the hydrological and ecological compatibility of these two efforts.

We do not object to you forwarding this report to Congress for authorization. Please share your draft transmittal letter with OMB prior to transmittal to the Congress.

Sincerely,

Richard A. Mertens
Deputy Associate Director
Energy, Science and Water


US Army Corps
of Engineers
Mobile District
June 2009
Mississippi Coastal
Improvements Program
(MsCIP)
Hancock, Harrison, and Jackson
Counties, Mississippi
Comprehensive Plan and Integrated Programmatic
Environmental Impact Statement
VOLUME 1 - MAIN REPORT
MsCIP

Mississippi Coastal Improvements Program (MsCIP)
Hancock, Harrison, Jackson Counties, Mississippi
Comprehensive Plan and Integrated Programmatic
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ERRATA SHEET
16 October 2009

Volume 1 - Main Report, Executive Summary Table S-1 (Page S-11)
Waveland Floodproofing Pilot Project – Project Benefits changed to read:
$223,505 annual damages avoided
Forrest Heights Levee – Project Benefits changed to read:
$101,000 annual damages avoided
Submerged Aquatic Vegetation (SAV) Pilot Project – Project Benefits changed to read:
5 acres of seagrass restoration
Improved knowledge of SAV restoration techniques

Volume 1 – Main Report, Section 6, Table 6-1 (Page 6-4 thru 6-6)
Table has been revised as shown in this Errata Sheet

Volume 4 – Appendix C: Real Estate, Exhibit C

Real Estate Summary (page RES-2) – Last paragraph changed to read:

It is likely that costs can be refined during the Pre-Construction, Engineering and Design Phase when plans and specifications are available for a recommended plan. *If there are substantial changes to a component, a* Real Estate Supplement (RES) will be prepared for each authorized component once the real estate requirements have been sufficiently identified during PED. *If a RES is required it will be coordinated and submitted through appropriate review authorities for final approval.* The RES will provide updated information as to final real estate requirements for a particular component and will include updated data on the real estate values and costs since the majority of the costs and values contained herein should not be relied upon beyond calendar year 2008. A Real Estate Relocation Plan should also be prepared during PED for each authorized component requiring relocations or displacement of individuals and/or businesses. The Relocation Plan will investigate the availability of replacement housing within a specified radius and any unique or unusual problems that should be considered.

Table 1 (page C-4) – Table Title changed to read:
Estimated Real Estate Costs

Table 2 (page C-5) – Footnote changed to read:

In accordance with the provisions of WRDA 1986, as amended, cost sharing would be 65-percent Federal and 35-percent non Federal. Based on these provisions the estimated Federal share of the total cost of this project feature is *$258,050,000* and the current estimated non Federal share is *$142,948,400.*

Table 6-1
Mississippi Coastal Improvements Program
Cost Sharing (October 2008 Price Level)

Phase I Recommended Plan Element	**Total Project Cost**	**Federal Cost***	**Non Federal Cost ***
Phase I High Hazard Area Risk Reduction Plan	$407,860,000	$265,110,00	$142,750,00
Waveland Floodproofing	$4,450,000	$2,890,000	$1,560,000
Forrest Heights Levee	$14,070,000	$9,150,000	$4,920,000
Turkey Creek Ecosystem Restoration	$6,840,000	$4,450,000	$2,390,000
Dantzler Ecosystem Restoration	$2,210,000	$1,440,000	$770,000
Franklin Creek Ecosystem Restoration	$1,860,000	$1,210,000	$650,000
Bayou Cumbest Ecosystem Restoration & Hurricane Storm Damage Reduction	$25,530,000	$16,590,000	$8,940,000
Admiral Island Ecosystem Restoration	$21,810,000	$14,180,000	$7,630,000
Deer Island Ecosystem Restoration	$21,520,000	$13,990,000	$7,530,000
Submerged Aquatic Vegetation Pilot Program	$900,000	$590,000	$310,000
Coast-wide Beach and Dune Ecosystem Restoration	$23,320,000	$15,160,000	$8,160,000
Comprehensive Barrier Island Restoration	$479,710,000	$311,810,000	$167,900,000
Total MsCIP Authorization Request	**$1,010,080,000**	**$656,550,000**	**$353,530,000**

Feasibility Studies******	**Total Study Cost**	**Federal Cost ***	**Non Federal Cost ***
Ecosystem Restoration Studies	$1,700,000	$850,000	$850,000
Long-term High Hazard Risk Reduction Plan	$5,000,000	$2,500,000	$2,500,000
Escatawpa River Freshwater Diversion	$3,000,000	$1,500,000	$1,500,000
Long-term Ecosystem Restoration and Hurricane and Storm Damage Risk Reduction	$48,500,000	$24,250,000	$24,250,000
Structural Hurricane Storm Damage Reduction	$85,000,000	$42,500,000	$42,500,000
Subtotal of MsCIP Recommended Investigations	**$143,200,000**	**$71,600,000**	**$71,600,000**

* Indicated cost sharing is consistent with law and Corps policy.

COVER SHEET

Responsible Agency and Lead Federal Agency: U.S. Army Corps of Engineers

Title: Comprehensive Plan and Integrated Programmatic Environmental Impact Statement, Mississippi Coastal Improvements Program (MsCIP) Hancock, Harrison, and Jackson Counties, Mississippi

Contact: *For information on the* final *Programmatic Environmental Impact Statement (EIS).*

Dr. Susan Ivester Rees
Army Engineer District, Mobile
P.O. Box 2288
Mobile, AL 36628-0001
Phone (251) 694-4141
Via E-mail to: Susan.I.Rees@usace.army.mil

The Comprehensive Plan and Integrated Programmatic EIS is available at:
http://www.mscip.usace.army.mil/

Abstract:
This Final Programmatic EIS analyzes the potential environmental consequences of implementing the recommended features of the Comprehensive Plan in the interests of hurricane / storm damage reduction, ecosystem restoration, erosion control, and saltwater intrusion prevention. A Notice of Intent (NOI) was published in the Federal Register on August 9, 2006, to inform the public of the Corps' intent to prepare an EIS for the MsCIP Comprehensive Plan. A Draft EIS was circulated for a 45-day public review on February 13, 2009. A total of 51 comments were received from Federal and State agencies and the interested public. All comments have been considered and included in the final EIS as appropriate. All comments and responses are included in Appendix L of the Final Comprehensive Plan and Integrated Programmatic EIS.

The recommended plan consists of system-wide and site specific structural, non-structural, and environmental solutions to the problem areas identified in the Department of Defense Appropriations Act, 2006 (P.L. 109-148) 30 December 2005. Other alternatives which were developed as part of the planning process were considered less effective or efficient solutions to the problems identified in the study. The No Action alternative is also evaluated, per the requirements of the National Environmental Policy Act (NEPA) and Corps planning regulations. Implementation of the recommended actions would aid in the recovery of coastal Mississippi from the damages caused by the Hurricanes of 2005. The solutions recommended in this report are intended to render the region more resilient and less susceptible to damages resulting from future coastal storm events.

Public Comments:
Prior to preparation of the Final Programmatic EIS, public involvement was conducted through the publishing of the NOI and a public scoping meeting on December 19, 2006. Additionally, meetings and workshops with resource agencies and the public were held throughout the study process. Formal public hearings on the Draft EIS were held on March 16, 18, and 19, 2009 in each of the three coastal counties. The Corps of Engineers considered all comments received throughout this public involvement process in preparing the final recommended comprehensive plan elements.

A 30-day comment period on this Final Programmatic EIS begins with the publication of the U.S. Environmental Protection Agency Notice of Availability in the Federal Register. Individuals and agencies may present written comments relevant to the Final Programmatic EIS or request a public hearing by sending the information to the address above. The comments received during the comment period will be considered in the preparation of the Record of Decision.

SUMMARY

STUDY INFORMATION

Study Authority

The following report recommends comprehensive water resources improvements associated with hurricane and storm damage reduction, flood damage reduction, and ecosystem restoration in the three coastal counties of Mississippi. This report is in partial response to authorizing legislation contained in the Department of Defense Appropriation Act of 2006 (P.L. 109-148), dated 30 December 2005. The study authorization states, in part, the following: "... *the Secretary shall conduct an analysis and design for comprehensive improvements or modifications to existing improvements in the coastal area of Mississippi in the interest of hurricane and storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resource purposes at full Federal expense; Provided further, that the Secretary shall recommend a cost-effective project, but shall not perform an incremental benefit-cost analysis to identify the recommended project, and shall not make project recommendations based upon maximizing net national economic development benefits; Provided further, that interim recommendations for near term improvements shall be provided within 6 months of enactment of this act with final recommendations within 24 months of this enactment.*"

Study Sponsor

The sponsor for the Mississippi Coastal Improvements Program, hereafter referred to as MsCIP, is the State of Mississippi. Acting on behalf of the State is the Mississippi Department of Marine Resources (DMR).

Study Purpose and Scope

The hurricanes of 2005 caused an unprecedented level of destruction within the Gulf Region of the United States. Homes and businesses, industry, employment, regional economies, environmental resources, and life, health and safety were negatively affected, and a life-changing blow was dealt to residents of the region that has not yet abated. These storms also resulted in significant secondary impacts to the much broader region due to the subsequent migration of the displaced population, wholesale disruption of the region's economy, disruption of the region's infrastructure, and severe impacts on the human, physical and natural resources of the area.

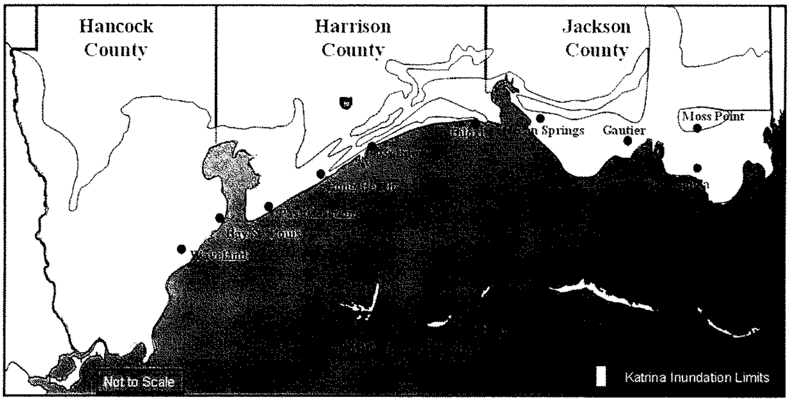
The direction provided by Congress to the Corps of Engineers established the purpose and scope for the MsCIP as "conduct an analysis and design for comprehensive improvements or modifications to existing improvements in the coastal area of Mississippi in the interest of hurricane and storm damage reduction, prevention of saltwater intrusion, preservation offish and wildlife, prevention of erosion, and other related water resource purposes."

The purpose of this report is to describe the Comprehensive Plan developed for the Mississippi Coastal Improvements Program and, following approval by the Assistant Secretary of the Army (Civil Works), to seek authorization from Congress for implementation of the recommended plan features to assist in the recovery of coastal Mississippi.

Project Location / Congressional District

The MsCIP study area consists of the three coastal counties of Mississippi: Hancock, Harrison, and Jackson. The study area resides within the 4th Mississippi Congressional District, represented by Congressman Gene Taylor (D), Senator Thad Cochran (R), and Senator Roger Wicker (R). The figure below shows the three coastal Mississippi counties, as well as the approximate areas inundated by Hurricane Katrina.

MsCIP Study Area



Prior Reports and Existing Water Projects

In response to the authorization's instruction "... *that interim recommendations for near term improvements shall be provided within 6 months of enactment of this act...*" the Chief of Engineers submitted his Interim Report on December 30, 2006. The Interim Report recommended the implementation of 15 projects across the coast at a cost of $107.7 million. These projects are currently in either the design phase, under construction or construction has been completed. In addition to the interim report, a list of 36 other reports relevant to this study, is included in the References Section of this report.

Public Involvement and Agency Coordination

The MsCIP has employed a collaborative approach toward the development of the Comprehensive Plan involving Federal, State, and local agencies, non-governmental organizations (NGOs), the scientific and education community, and local stakeholders. As a result the Comprehensive Plan represents the thoughts and opinions of all interested parties. Critical to this public involvement was the effective communication between all Federal, state, local agencies, and tribal governments, and other persons or organizations [i.e. public and NGOs] that may have an interest in the project. A NOI was published in the Federal Register on August 9, 2006, to inform the public of the Corps' intent to prepare an EIS for the MsCIP Comprehensive Plan. The public has been invited to over 60 meetings to obtain public input during the plan formulation process and ensure compliance with NEPA. Methods employed by the MsCIP study team to reach the general public and interested stakeholders included on site meetings and workshops, on-line meetings, brochures, news releases to local print and broadcast news media, and a web site. Further public communications included maintaining contact with public officials and agency representatives, ensuring that calls and letters from the public are addressed in a timely manner, and contacting stakeholders through placement of notices of public meetings in stakeholder newsletters. In addition, the draft EIS has been widely circulated and comments received. Revisions to the report have been made in response to many of the comments.

The MsCIP Comprehensive Report and Integrated Programmatic EIS effort has been coordinated with all other agencies tasked with addressing the damages resulting from the hurricanes of 2005. Agencies, educational institutions and interested individuals have been contacted via phone, e-mail, or public notice, to solicit ideas and input to the plan formulation process. Those entities that have chosen to participate have availed themselves of several opportunities to involve themselves in the MsCIP planning process, including the Federal Principals Group, Regional Principals Group, local Coordination and Public Workshop meetings, interactive problem area identification sessions, and development of measures sessions, via open forums, web-based feedback and participation forums, and less formalized discussions.

Per the Council on Environmental Quality regulations on implementing the NEPA, the Corps, Mobile District requested that a number of State and Federal Agencies accept the status of Cooperating Agency on the Integrated Report and Programmatic Environmental Impact Statement. In response to this request, dated October 30, 2006, the following entities are participating as cooperating agencies:

State:

- Mississippi Department of Archives and History
- Mississippi Department of Environmental Quality, Office of Pollution Control
- Mississippi Department of Marine Resources
- Mississippi Department Of Transportation
- Mississippi Emergency Management Agency
- Mississippi Museum of Natural Science
- Mississippi Secretary of State, Public Lands Division

Federal:

- Federal Emergency Management Agency, Region 4
- Minerals Management Service, Gulf of Mexico Region
- National Oceanic and Atmospheric Administration, National Marine Fisheries Service Southeast Region, , Protected Resources and Habitat Conservation Divisions
- National Park Service
- U.S. Department of Agriculture , Natural Resources Conservation Service
- U.S. Department of Transportation, Federal Highway Administration
- U.S. Environmental Protection Agency, Region 4
- U.S. Fish and Wildlife Service
- U.S. Geological Survey

Local:

- Gulf Regional Planning Commission

In addition, this study effort was accomplished with the active participation of the following additional Federal and state agencies, local governments, and stakeholders in the planning and NEPA impact evaluation process:

- National Aeronautics and Space Agency
- National Weather Service
- Hancock, Harrison and Jackson Counties
- Communities of Bay St. Louis, Biloxi, D'Iberville, Gautier, Gulfport, Long Beach, Moss Point, Ocean Springs, Pascagoula, Pass Christian, and Waveland

- University of Southern Mississippi
- University of New Orleans
- Coastal Restoration Network
- The Nature Conservancy (TNC)
- The Audubon Society
- Sierra Club

The MsCIP team has placed a high value on incorporating public input and active stakeholder listening into the planning process and intends to continue this thread throughout the implementation of the Comprehensive Plan. A listing of the public involvement opportunities during the planning process is included in the report.

STUDY OBJECTIVES

Problems and Opportunities

A number of system-wide problems were discussed during the study process that can be combined into these four categories:

- Significant damage to structures and infrastructure within the three-county (Hancock, Harrison, and Jackson) MsCIP study area due to hurricane-induced storm surge;
- Significant damage to coastal ecosystems and fish and wildlife resources due to hurricane-induced storm surge and subsequent coastal erosion and saltwater intrusion;
- Saltwater intrusion to the Mississippi Sound ecosystem and associated coastal environments was increased through the hurricane storm surge as well as erosion of the coastal landscape surrounding the estuary; and
- Significant erosion of the coastal landscape with subsequent damage to coastal ecosystems and man-made infrastructure.

An overall theme of Comprehensive Plan opportunities is not merely to reverse the harm done by the hurricanes of 2005, but as importantly to promote the long-term future sustainability of physical, human, and environmental resources within the study area. The comprehensive, system-wide opportunities include:

- Assist in sustainable redevelopment of hurricane damaged physical, environmental, and human resources within the MsCIP study area;
- Reduce the susceptibility of residential, commercial, and public structures and infrastructure to hurricane induced storm damages within the three-county (Hancock, Harrison, and Jackson) MsCIP study area;
- Assist in the recovery and long-term sustainability of coastal wetlands that support important fish and wildlife resources within the study area;
- Accelerate the recovery and assist in the long-term sustainability of maritime forest environments that suffered hurricane induced damages;
- Restore barrier island environments that suffered hurricane induced storm damages in a manner that promotes long-term sustainability of the Mississippi Sound estuary;
- Reduce saltwater intrusion to the Mississippi Sound landscape; and
- Assist in the recovery of coastal ecosystems and infrastructure damaged by erosion during the hurricane events of 2005 and support programs that promote long-term erosion reduction and limit erosion potential during future hurricane events.

Planning Vision, Goals, Objectives and Constraints

The Comprehensive Vision for the MsCIP is a coastal Mississippi that is more resilient and less susceptible to risk from hurricane and storm surge. Consistent with this Comprehensive Vision and the Federal Goal specified by Congress, this Comprehensive Plan has sought to identify solutions to the hurricane and storm damage, saltwater intrusion, fish and wildlife, erosion, and other related water resource problems of coastal Mississippi. The solutions recommended in this report are intended to render the region more resilient and less susceptible to the recurrence of damages from future coastal storm events. Resiliency (i.e., ability to withstand / survive) to storm events equaling or exceeding the 2005 hurricanes was also an evaluation criteria that was applied to the formulation of projects recommended as part of the Comprehensive Plan.

The system-wide goals established for this study were developed in clear recognition of the linkages between structural and nonstructural storm damage reduction and ecosystem restoration opportunities. System-wide goals are intended to address the coastal landscape of the entire Gulf Region, including the adjacent area specifically evaluated in the LaCPR program. MsCIP system-wide goals identified in the Comprehensive Plan effort include the following:

- Identify measures to minimize risk to loss of life and safety caused by hurricane and storm surge;
- Recommend cost-effective measures for restoration of nationally and regionally significant environmental resources within a context of long-term sustainability;
- Recommend cost-effective measures to reduce damages from hurricanes and storms without encouraging re-development in high-risk areas;
- Recommend cost-effective measures to mitigate damages caused by saltwater intrusion into nationally significant ecosystems;
- Recommend cost-effective measures to restore eroded coastal resources as part of a system-wide approach to develop a resilient coastline;
- Identify other water resource related programs and activities integral to the development of a comprehensive system-wide plan.

System-wide objectives for the MsCIP are:

- Reduce loss of life caused by hurricane and storm surge by 100%;
- Reduce damages caused by hurricane and storm surge by $150M-$200M annually, per coordination with state and local interests based on knowledge of damages from previous hurricane
- Restore 10,000 acres of fish and wildlife habitat including coastal forests, coastal wetlands, wet pine savannah, submerged aquatic sea grasses, oyster reefs, and beaches and dunes by the year 2040;
- Manage seasonal salinities within the western Mississippi Sound such that optimal conditions for oyster growth (surrogate for other aquatic resources, 15 ppt during summer months) are achieved on an annual basis by 2015;
- Reduce erosion to barrier islands, mainland, and interior bay shorelines by 50%;
- Create opportunities for collaboration with local, state, and Federal agencies to facilitate implementation of programs and activities that maximize the use of resources in achieving the comprehensive goal.

System-wide constraints identified by the study team, State, County, and City officials, residents, and agency staff, included:

- Measures developed must not negatively impact the resources within the NPS's Gulf Islands National Seashore, particularly with respect to the agency's 2006 Management Policies as well as from those constraints created by inclusion of Horn and Petit Bois Islands as Wilderness Areas;

- Measures developed must avoid, minimize, or mitigate any negative impacts to T&E species identified as residing within areas potentially impacted by study recommendations;
- Measures developed must comply, to the maximum extent practicable, with State of Mississippi Coastal Management Plan;
- Measures developed must meet the guidelines for maintenance of State Water Quality standards;
- Development of measures must be consistent with the Regulations Implementing NEPA and other applicable environmental laws and regulations.

Plan Formulation

The Corps has taken a system wide approach in formulating the MsCIP Comprehensive Plan to ensure that this plan and a similarly congressionally authorized study in Louisiana, Louisiana Coastal Protection and Restoration (LaCPR), are fully coordinated and develop complementary plans for the restoration of the two state portion of the northern Gulf coastal region as an integrated system. In addition, the MsCIP comprehensive plan is formulated to ensure that no adverse impacts would occur in the Alabama coastal region to the east.

The MsCIP follows the Corps' 6 step planning process in addressing the overall water resources problems and opportunities of coastal Mississippi. Following the comprehensive identification of problems and opportunities, site specific solutions were developed that contribute to accomplishing the Comprehensive Vision for the restoration and protection of the Mississippi Gulf Coast. The results of this effort are presented in this report and include a comprehensive plan addressing hurricane and storm damage reduction and environmental restoration needs. The Comprehensive Plan is a phased approach to occur over the next 30 – 40 years and includes plan features recommended immediate implementation (Phase I), plan features recommended for detailed study of site specific environmental restoration (Phase II) and additional investigations of areas which could result in both significant hurricane and storm damage reduction and environmental restoration throughout the 100-year floodplain of coastal Mississippi (Phase III).

Multiple assumptions that were used during the planning process in the development of alternatives included:

- The demands for waterfront and near-waterfront living will not decrease in the future as a result of hurricanes (i.e. people will always want to live by the water).
- Only destruction of property occupied prior to Hurricane Katrina will be accounted for in forecasting (i.e. there will be no projection of previously undeveloped land).
- Full redevelopment of previously occupied structures will occur by the base year 2012.
- Communities will adopt and adhere to FEMA guidelines under the National Flood Insurance Program (NFIP).
- Redevelopment of the study area could take the form of residential redevelopment (exactly the way it was pre-Hurricane Katrina) or a mixture of commercial/condominium and residential redevelopment, as has been observed following other significant hurricane events along the northern Gulf Coast.
- An increase in relative sea level rise will probably occur over the period of analysis
- The barrier islands, particularly Ship Island, will continue to diminish over the planning horizon.

Many potential problem-solving measures were identified during the study. Measures are defined simply as "a feature or activity across the system or at a particular site". The initial measures were developed independently within the structural, environmental, and nonstructural sub-teams, and then later evaluated to determine their role within a comprehensive framework. The measures were then further developed at a series of regional coordination meetings, inter-agency meetings, and public workshops. Examples of measures are described below:

- storm damage reduction - levees, seawalls, or embankments; surge gates, berms, and breakwaters; elevating and/or acquisition of structures; zoning and building code modification, and floodplain management.
- saltwater intrusion (seawater encroachment into a freshwater and or estuarine body) reduction - re-allocation of freshwater supply by re-regulation of reservoirs, and diversion of freshwater sources into areas of critical need.
- erosion reduction - placement of additional sand, shell materials, construction debris, rubble, stone, and/or geo-textiles; supply of additional sand to littoral zone / island sediment budget; and reduction of sand-robbing activities in the near-shore or barrier island zones.
- ecosystem restoration and fish and wildlife preservation - acquiring and restoring currently undeveloped lands; restoring previously degraded wetlands; removal of sediment and/or debris choking streams and estuaries; re-grading to historic conditions and topography; preserving habitats to reduce fragmentation; removal of invasive species; removal of dead vegetation, deadfalls, and other vegetation that interferes with natural functions; planting of native species in areas in which those species were killed by the hurricanes; and filling of drainage channels that interfere with natural hydrologic functions.

Each problem area or site and its associated measures were evaluated to determine the level of effort required for more detailed development of site specific solutions, the need for additional data and more rigorous technical analyses (such as detailed modeling), the need for more site specific environmental analysis in order to project potential positive and negative environmental impacts, and other factors which are required for informed decision making.

After the measures were developed and evaluated, they were screened based on the inter-disciplinary study team's understanding of each site's potential to meet a variety of criteria and its contribution to the comprehensive plan. Each measure/problem area combination had to meet the following criteria:

- Technical feasibility (i.e., will a given measure provide a sound technical solution to the identified problem(s));
- Environmental feasibility (i.e., will a given measure provide a sound solution to the identified problem(s), without creating environmental resource problem of its own);
- Potentially cost-effective (for the identified problem area);
- Does not induce development (e.g., building a levee around undeveloped land);
- Does not induce flooding (e.g., creating a barrier that moves more water into another area, thereby increasing flood damages.

In addition, for ecosystem restoration or saltwater intrusion reduction, the problem addressed had to be identified as having: no ability to heal on its own, national and/or regional significance, and other factors relating to restoring ecosystems damaged by the storms of 2005.

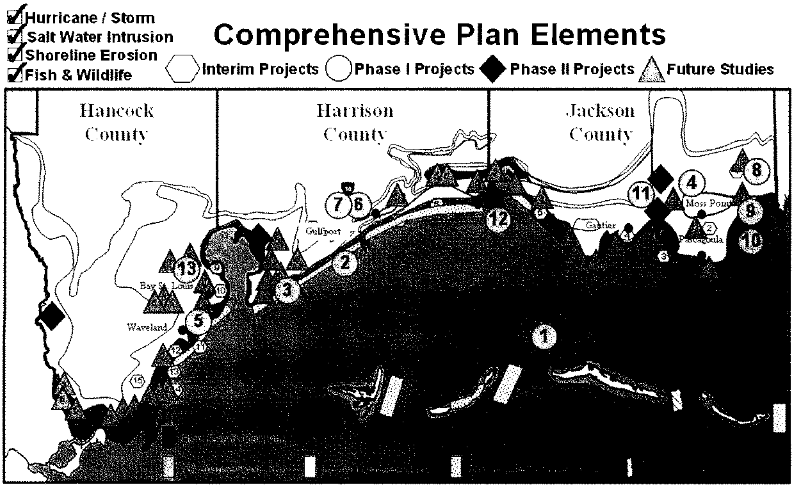
After the list measures were screened, they were further developed and combined to form a set of comprehensive altenatives. These preliminary alternatives were formed in close coordination with the public and local, state, and federal agencies. Several of these alternatives were screened out due to a lack of technical or environmental feasibility such as inflatable barriers, concrete sidewalks or roadways that could be rotated upwards to form a seawall, sliding panel gates, offshore breakwaters, a contiguous barrier island 'Wall', and large "Galveston type" seawalls.

The final array of alternatives were grouped into 12 elements that would compose the first phase of a comprehensive plan and would work in concert with the 15 interim projects already authorized. These elements were deemed "time critical" to the comprehensive plan and the alternatives were sufficiently developed so they could be recommended for construction. The remaining alternatives, that would require additional development, were grouped into the second and third phase of the year comprehensive plan, to be implemented over a 30-40 year timeframe.

At least three alternative methods, in addition to "do nothing" or "no action", were compared to each other to determine the most cost effective alternative for each of the 12 Phase I elements. It should be noted that a 13th critical element of Phase I, diverting water from the Mississippi River near Violet, LA into the Mississippi Sound to reduce salt water intrusion, is included in the first phase of the comprehensive plan and is already authorized by Congress for construction. In addition to these cost-effective elements identified for implementation, there are two phases of additional studies that are recommended to evaluate hurricane and storm damage reduction and ecosystem restoration opportunities.

Recommended Comprehensive Plan

The recommended plan consists of cost-effective elements that address the goals of hurricane and storm damage reduction, shoreline erosion, saltwater intrusion, and fish and wildlife preservation. The recommended plan elements will provide vital assistance in the recovery, and an insurance of provision of added safety for the residents of, visitors to, environmental resources within, and property residing on the coast of Mississippi. Justification of the cost-effectiveness, technical feasibility, environmental feasibility, and other plan accomplishments for each recommendation, are presented in detail, in the individual appendices attached to the main report. The figure below shows the relationship between the Comprehensive Plan elements.



Phase 1 Projects Shown Above: 1. Comprehensive Barrier Island Restoration Plan, 2. Coastwide Beach and Dune Restoration, 3. High Hazard Area Risk Reduction Program, 4. Moss Point Municipal Relocation 5. Waveland Residential Structure Floodproofing, 6. Forrest Heights Levee Elevation, 7.Turkey Creek Ecosystem Restoration, 8. Franklin Creek Ecosystem Restoration , 9. Bayou Cumbest Ecosystem Restoration, 10. Submerged Aquatic Vegetation (SAV) Pilot Project,11. Dantzler Ecosystem Restoration, 12. Deer Island Ecosystem Restoration, 13. Admiral Island Ecosystem Restoration

The Programmatic Environmental Impact Statement evaluates the environmental effects of the comprehensive plan elements on three different levels, based on the information available at the time. As a result of the diversity of potential projects that have come forth and the timeframe over which they may be implemented as a part of the Comprehensive Plan, further environmental considerations and analyses may be required prior to projects being implemented. Provisions for "tiering" of EISs are found in 40 CFR 1502.20 whenever a broad environmental impact statement has been prepared (such as a program or policy statement) and a subsequent statement or environmental assessment would then be prepared on an action included within the entire program or policy. This EIS will serve as the basis from which further required environmental analyses and documentation could be tiered from. During development of tiered NEPA documentation, detailed discussions of potential impacts and any mitigation of specific comprehensive plan elements, if required, will be incorporated as measures and alternatives are being developed.

The Programmatic Environmental Impact Statement evaluates the impacts associated with all the Phase I comprehensive plan elements in support of a Record of Decision per the Regulations Implementing the National Environmental Policy Act (NEPA). These projects are presented in support of a Record of Decision for construction:

- Turkey Creek Ecosystem Restoration
- Bayou Cumbest Ecosystem Restoration

- Dantzler Ecosystem Restoration
- Admiral Island Ecosystem Restoration
- Franklin Creek Ecosystem Restoration
- Deer Island Ecosystem Restoration
- Submerged Aquatic Vegetation Pilot Project
- Coast-wide Beach and Dune Restoration
- Waveland Flood Proofing Pilot Project
- Forrest (Forest) Heights Hurricane and Storm Damage Reduction
- High Hazard Area Risk Reduction Plan (HARP) including the Moss Point Municipal Structure Relocation
- Comprehensive Barrier Islands Restoration Plan

The restoration project at Deer Island also has been developed sufficiently for a construction authorization recommendation and is presented in support of a Record of Decision for construction. Should the Corps proceed with this action, additional decisions may be made with regard to additional Deer Island project components at a later date (such as a breakwater and westward expansion of the former Section 204 wetland site). Each of these future decisions will be subject to appropriate documentation to comply with NEPA.

Two other Phase I elements presented in support of construction authorization could require additional NEPA documentation following the development of the specific implementation plans. These projects include the High Hazard Area Risk Reduction Plan (HARP) and the comprehensive Barrier Islands Restoration Plan. Following the generation of site specific data, supplemental NEPA documentation would be presented as necessary to ensure compliance with the appropriate environmental laws and regulations.

Part 1 of the Cost Appendix included Rough Order of Magnitude costs that did not include escalation for all alternatives considered during the planning process. These costs were used for initial screening of options. Part 2 of the Cost Appendix includes Total Project Cost Summaries that include escalation based on proposed contract award dates for those Phase I comprehensive plan elements recommended for construction.

Project cost and benefit summaries (not including interest during construction) for the recommended Phase I plan elements are shown in Table S-1.

Table S-1
Cost and Benefit Summary for Tentative Selected Plans Elements Evaluated in Detail

Recommended Plan Element	Project Costs* (FY-09)	Annual O&M Costs	Project Benefits
Comprehensive Barrier Island Restoration Plan**	$479,710,000	$0	$17,699,600 annual damages avoided
Coastwide Beach and Dune Restoration	$23,320,000	$0	More than 30 miles of beach and dune restoration
Forrest Heights Levee	$14,070,000	$114,000	$331,500 annual damages avoided
Admiral Island Ecosystem Restoration	$21,810,000	$58,000	123 acres of ecosystem restoration
Turkey Creek Ecosystem Restoration	$6,840,000	$47,000	689 acres of ecosystem restoration
Dantzler Ecosystem Restoration	$2,210,000	$26,000	385 acres of ecosystem restoration
Bayou Cumbest Ecosystem Restoration	$25,530,000	$114,000	148 acres of ecosystem restoration
Franklin Creek Ecosystem Restoration	$1,860,000	$11,000	149 acres of ecosystem restoration
Deer Island Ecosystem Restoration	$21,520,000	$0	342 acres of ecosystem restoration
Submerged Aquatic Vegetation (SAV) Pilot Project	$900,000	$0	Ecosystem restoration benefits to be determined
High Hazard Area Risk Reduction Program	$407,860,000	$75,000	$33,000,000 annual damages avoided
Waveland Floodproofing Pilot Project	$4,450,000	$0	Annual damages avoided to be determined

*There are no known HTRW issues, but contingencies were adjusted to account for this eventuality. See Cost Appendix, Part 2 for the Total Project Cost Summaries. ** The cost for the Comprehensive Barrier Island Restoration Plan includes a contingency based on a Cost Risk Analysis.

The costs provided in Table S-1 are October 2008 price levels. For cost sharing purposes total project costs which include escalation are shown in Chapter 6. All traditional cost sharing policies have been followed.

This report also supports a recommendation for initiating studies to accomplish the intent of Section 3083 of the Water Resources Development Act of 2007 to design a freshwater diversion project to be located in the vicinity of Violet, LA. The comprehensive goal to be attained through the initiation of these studies would provide sufficient inflows to the western Mississippi Sound area to support oyster reef health and productivity in coastal Mississippi.

- Freshwater Diversion at Violet, Louisiana

There are four system-wide elements of the Comprehensive Plan which require additional investigation and evaluation prior to the recommendation of site-specific plans for construction or implementation. These system-wide elements of the Comprehensive Plan include:

- Long-term High Hazard Risk Reduction Plan (HARP) (additional acquisition of high risk properties over a 30 to 40 year period).
- Additional Damage Reduction Alternatives
- Coastal Mississippi Ecosystem Restoration Program
- Escatawpa River Freshwater Diversion.

A Record of Decision for construction is not being requested for these Comprehensive Plan components, but their potential environmental effects are presented as reasonably foreseeable actions for the consideration of cumulative effects. The environmental effects of these system-wide elements of the Comprehensive Plan are presented in Chapter 4 Environmental Effects.

Table S-2 depicts the recommended projects and a summary of their environmental effects. Detailed analysis of the environmental effects of alternatives is provided in Chapter 4.

Table S-2

Environmental Effects of Recommended Alternatives

Category of Effects	No Action	Dantzler, Turkey Creek, Franklin Creek and similar Phase II Ecosystem Restoration	Forest Heights Hurricane and Storm Damage Reduction Component	Deer Island Ecosystem Restoration	Bayou Cumbest, Admiral Island, and similar Phase II Ecosystem Restoration	SAV Pilot Project at Bayou Cumbest	Beach and Dune on Mainland and Similar Phase II Ecosystem Restoration	Barrier Island Restoration	Waveland Floodproofing, Housing Relocation Assistance Program (HARP), Moss Point Municipal Relocation Component
Benthos / Terrestrial Invertebrates	Loss of the coastal ecotone habitat, such as barrier islands and beaches	No impact due to natural recolonization with similar and/or other appropriate species	N/A.	No impact due to natural recolonization with similar and/or appropriate species	Significant positive impact due to restoration of wetland habitat	Significant positive impact due to restoration of exceptional valuable habitat	No impact	Filling Camille Cut would change the nature of the species from open water to beach habitat Littoral zone placement results in minor impact as recolonization would occur ovar time Overall significant positive impact to regional benthos with maintenance of salinities in of the Mississippi Sound estuarine conditions	N/A
Fish	Loss of coastal ecotone such as wetlands and estuarine conditions	Positive enhancement of water quality of stormwater	Some positive impact due to clearing and snagging of Turkey Creek.	Direct positive benefit via improved estuarine functions	Direct positive benefit via improved estuarine functions	Significant benefit via replacement of lost critical habitat	N/A	Overall positive benefit to fishery habitat by maintaining the nutrient-rich, protective habitat in Mississippi Sound that is necessary to sustain the vital food-chain in one of the most productive areas in the U S	N/A
Wetlands	Continued degradation of existing wetlands, continued loss of habitat due to old fill	Significant direct positive benefits via improved wetland functions and restoration of lost wetlands Approximately 4,802 acres of wet pine savannah would be restored, of which, 1265 acres are owned by the State of Mississippi in their Coastal Preserves Program	Direct loss of up to 3 5 acres of non-tidal wetlands associated with levee construction	Significant direct positive benefits via improved and restored tidal and non-tidal wetlands	Significant direct positive benefits via improved wetland functions and restoration of lost wetlands Approximately 21,640 acres of emergent tidal marsh, of which, 14,068 acres are owned by the State of Mississippi in their Coastal Preserves Program	N/A	N/A	Overall significant positive benefit to existing wetlands by ensuring future sustainability of the islands.	Potential for adverse impacts to wetlands should relocations occur in rural undeveloped land, however, potential for future wetland restoration of previously filled wetlands as properties become vacant

Category of Effects	No Action	Dantzler, Turkey Creek, Franklin Creek and similar Phase II Ecosystem Restoration	Forest Heights Hurricane and Storm Damage Reduction Component	Deer Island Ecosystem Restoration	Bayou Cumbest, Admiral Island, and similar Phase II Ecosystem Restoration	SAV Pilot Project at Bayou Cumbest	Beach and Dune on Mainland and Similar Phase II Ecosystem Restoration	Barrier Island Restoration	Waveland Floodproofing, Housing Relocation Assistance Program (HARP), Moss Point Municipal Relocation Component
Submerged Aquatic Vegetation	Continue loss to SAVs	N/A	N/A	N/A	Indirect impact associated with overall improvement water quality in areas suitable for natural establishment of SAVs.	Significant positive benefit	N/A	Restoration of Camille Cut could restore natural conditions conducive to establishment of SAVs Turbidity may adversely impact the flora	N/A
Marine Mammal Communities	Loss of coastal ecotones could negatively impact	No change	No change.	No change	Benefits community due to limited habitat in urban setting	Benefits community due to limited habitat in urban setting	No change	Benefits community due to limited vital coastal ecotone in the Gulf of Mexico	N/A
Marine & Coastal Birds	Loss of coastal ecotones could negatively impact.	Provides valuable stopover habitat within the Mississippi Flyway Corridor	No change.	Provides valuable stopover habitat within the Mississippi Flyway Corridor	Provides valuable stopover habitat within the Mississippi Flyway Corridor	N/A	Provides valuable nesting, roosting and breeding habitat	Provides the first valuable stopover habitat within the Mississippi Flyway Corridor in the Gulf of Mexico	Potential for enhancement of habitat as properties become vacant
T&E Species	Loss of coastal ecotones could negatively impact.	Habitat benefits listed species, such as Sandhill Crane, and Mississippi Gopher Frog	No change.	Habitat could benefit T&E species, such as Gulf Sturgeon and Piping plover	Habitat could benefit T&E species	No change	Habitat benefits nesting, roosting, and breeding of listed species, such as piping plovers and least terns, and is a valuable stopover in the MS Flyway Corridor.	Habitat benefits listed species, such as piping plovers sea turtles, and gulf sturgeon	No change
Geology	No impacts.	No impacts	No impacts	No impacts	No impacts	No impacts	No impacts	No impacts	No impacts
Meteorology	No impacts	No impacts	No impacts.	No impacts	No impacts	No impacts	No impacts	No impacts	No impacts.
Soils & Sediments	No impacts	Restores historical soils	Adds fill material to existing levee	Restores historical soils	N/A	Restores historical soils	Restores historical soils	N/A	Possible restoration of historical soils as properties become vacant
Water Quality	Degraded water quality could negatively impact coastal ecotones.	Improves water quality through natural filtration by wetland restoration	No impacts	Improves water quality through natural filtration by wetland restoration	Improves water quality through natural filtration by wetland restoration	SAVs enhances water quality through natural filtration	No impacts.	Improves water quality through sustaining estuarine conditions in Mississippi Sound	Enhancement of water quality as parcels are restored to green space of historical condition
Commercial & Recreational Fishing	Loss of coastal ecotones	N/A	N/A	Restores diverse habitat to juvenile	Restores diverse habitat to juvenile species	Restores SAV habitat to juvenile	N/A	Improves habitat through sustaining estuarine conditions in Mississippi	N/A

Category of Effects	No Action	Dantzler, Turkey Creek, Franklin Creek and similar Phase II Ecosystem Restoration	Forest Heights Hurricane and Storm Damage Reduction Component	Deer Island Ecosystem Restoration	Bayou Cumbest, Admiral Island, and similar Phese II Ecosystem Restoration	SAV Pilot Project at Bayou Cumbest	Beach and Dune on Mainland and Similar Phase II Ecosystem Restoration	Barrier Island Restoration	Waveland Floodproofing, Housing Relocation Assistance Program (HARP), Moss Point Municipal Relocation Component
	could negatively impact			species		species		Sound	
Essential Fish & Shellfish Habitats	Loss of coastal ecotones could negatively impact.	N/A	N/A	Restores diverse habitat to juvenile species	Restores diverse habitat to juvenile species	Restores SAV habitat to juvenile species	N/A	Restores valuable essential fish & shellfish habitats for breeding and foraging grounds of species of aquatic resources of national importance	N/A
Marine Sanctuaries	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cultural Resources	Loss of sites could occur, such as Ft Massachusetts and French Warehouse	If identified, sites would be avoided and/or impacts minimized	No impacts	Identified sites would be avoided	If identified, sites would be avoided and/or impacts minimized	No impacts	Protects sites along the mainland	Protects sites on the islands and along the mainland	If identified, sites would be avoided and/or impacts minimized.
Noise	No change	Current levels will resume following construction activities	Current levels will resume following construction activities.	Current levels will resume following construction activities	Current levels will resume following construction activities	Current levels will resume following construction activities	Current levels will resume following construction activities	Current levels will resume following construction activities.	Improvement with addition of greenspace through purchasing land
Air Quality	No change	Current levels will resume following construction activities	Current levels will resume following construction activities	Current levels will resume following construction activities	Current levels will resume following construction activities	Current levels will resume following construction activities	Current levels will resume following construction activities	Current levels will resume following construction activities	Improvement with addition of greenspace through purchasing land
Socioeconomics – Utilities	Continue degradation	Removes destroyed utilities	No impacts	No impacts	Removes destroyed utilities	No impacts	No impacts.	No impacts	Removes destroyed utilities
Socio-economics – Economy, Demographics, and Environmental Justice	Continue degradation	No impacts	Maintains integrity of historical minority community	No impacts	No impacts	N/A	No impacts	No impacts	Possible impact due to acquisition of property and subsequent loss of tax revenue, relocation of communities
Socio-economics – Vehicular, Railroad, & Marine Vessel Traffic	Continue degradation	Removes destroyed infrastructure	No impacts	No impacts.	Removes destroyed infrastructure	N/A	N/A	N/A	Removes infrastructure or protects by floodproofing
Land & Water Use	No impact.	Converts development to restored habitat	No impact	Converts development to restored emergent tidal habitat.	No impact	No impact	No impact	Restores loss habitat.	Removes and/or floodproofs developed areas

Category of Effects	No Action	Dantzler, Turkey Creek, Franklin Creek and similar Phase II Ecosystem Restoration	Forest Heights Hurricane and Storm Damage Reduction Component	Deer Island Ecosystem Restoration	Bayou Cumbest, Admiral Island, and similar Phase II Ecosystem Restoration	SAV Pilot Project at Bayou Cumbest	Beach and Dune on Mainland and Similar Phase II Ecosystem Restoration	Barrier Island Restoration	Waveland Floodproofing, Housing Relocation Assistance Program (HARP), Moss Point Municipal Relocation Component
Public Safety	Adverse impacts by future storms	Protect public	Protect public	Protect public	N/A	Protect public mainland	Protect public mainland	Protect public	The public would benefit by not be in the potential area impacted by future storm events
Cumulative Impacts	Loss of coastal ecotones, such as barrier islands and beaches	Restores valuable wet pine savannah habitat	Protect public infrastructure Maintains integrity of culturally significant minority community.	Restores coastal ecotones, protects mainland	Restores valuable marsh habitat, provides fishery & WQ benefits	Restores SAV nursery grounds	Restores coastal ecotone - nesting grounds for coastal birds, protects mainland valuable components	Restores coastal ecotone - nesting grounds for coastal birds, protects mainland valuable components, and provides fishery & WQ benefits	Protects public safety

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1 INTRODUCTION (PURPOSE AND NEED*[1])

The hurricanes of 2005 caused an unprecedented level of destruction within the Gulf Region of the United States, most notably in the states of Texas, Louisiana, and Mississippi. Significant coastal storm events impacting the Gulf Region in 2005 included:

- Hurricane Cindy, which made landfall on the 6th of July near Waveland, Mississippi;
- Hurricane Katrina, which made landfall on the 29th of August on the Louisiana-Mississippi border, and
- Hurricane Rita, which made landfall on the 24th of September between Sabine Pass, Texas and Johnsons Bayou, Louisiana.

During Hurricane Katrina coastal Mississippi was the point of impact of the greatest tidal surge that has hit the mainland of the U.S. in its recorded history. Hurricane Katrina affected over 90,000 square miles (sq. mi.) of the Gulf Coast region and caused almost complete destruction of several large coastal communities, and seriously damaged numerous others.

Each of these large storm events caused significant damage to the U.S. coast bordering the northern Gulf of Mexico. This series of tremendous storms devastated the physical, natural, and human environments of the region. The impacts of these storms were not only local, but regional, and system wide as well. Homes and businesses, industry, employment, regional economies, environmental resources, and life, health and safety were negatively affected, and a life-changing blow was dealt to residents of the region that has not yet abated. These storms also resulted in significant secondary impacts to the much broader region due to the subsequent migration of the displaced population, wholesale disruption of the region's economy, disruption of the region's infrastructure, and severe impacts on the human, physical and natural resources of the area.

The Congress of the United States authorized the U.S. Army Corps of Engineers (Corps) in 2005 to initiate two important and related comprehensive planning efforts to address the devastation caused by the coastal storms of 2005:

- the Mississippi Coastal Improvements Program (MsCIP) and
- the Louisiana Coastal Protection and Restoration (LaCPR).

Taken together, these two planning efforts are intended to develop system-wide solutions to assist the multi-state region of the U.S. Gulf Coast in:

- recovering from the devastation caused by storm events, and
- provide greater resiliency towards future storm events.

This report, the *Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan and Integrated Programmatic Environmental Impact Statement* (hereafter referred to as the Comprehensive Plan) is intended to identify near and long term strategies to reduce the vulnerability of the region to a recurrence of similar natural disasters. The purpose of this report is to describe the Comprehensive Plan developed for the Mississippi Coastal Improvements Program and, following approval by the Assistant Secretary of the Army (Civil Works), to seek authorization from Congress for implementation of its recommended plan features to assist in the recovery of coastal Mississippi (Hancock, Harrison, and Jackson counties).

[1] This document is an integrated report/environmental impact statement, sections marked with an * are required portions of the environmental impact statement

This report presents information in support of a Record of Decision for construction for a number of ecosystem restoration, storm damage reduction, and multi-purpose projects. Additionally, other projects are developed in this feasibility study which are not presented in support of a Record of Decision for construction, but are addressed as reasonably foreseeable actions for the consideration of cumulative effects. Supplemental NEPA information will be presented in the future as programmatic elements of the Comprehensive Plan are further developed.

1.1 Authorization

The MsCIP was authorized by the Department of Defense Appropriations Act, 2006 (P.L. 109-148) 30 December 2005, which states:

> *"For an additional amount for "investigations" to expedite studies of flood and storm damage reduction related to the consequences of hurricanes in the Gulf of Mexico and Atlantic Ocean in 2005, $37,300,000 to remain available until expended: Provided, that using $10,000,000 of the funds provided, the Secretary shall conduct an analysis and design for comprehensive improvements or modifications to existing improvements in the coastal area of Mississippi in the interest of* ***hurricane and storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resource purposes*** *at full Federal expense; Provided further, that the Secretary shall recommend a cost-effective project, but shall not perform an incremental benefit-cost analysis to identify the recommended project, and shall not make project recommendations based upon maximizing net national economic development benefits; Provided further, that interim recommendations for near term improvements shall be provided within 6 months of enactment of this act with final recommendations within 24 months of this enactment."*

The direction provided by Congress to Corps established the Federal (Comprehensive) Goal for the MsCIP as "**comprehensive** improvements or modifications to existing improvements". The Corps has taken a ***system wide*** approach in formulating the Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan to ensure that both the MsCIP and the Louisiana Coastal Protection and Restoration (LaCPR) efforts are fully coordinated and develop complementary plans for the restoration and future resiliency of the U.S. Gulf coastal region ***as an integrated system.***

In addition, the planning effort has taken a "top down" ***comprehensive planning*** approach, beginning with development of a Comprehensive Plan to address the overall water resources problems and opportunities of the region. Building off of the comprehensive identification of problems and opportunities, the planning effort then proceeded to develop site specific problems, opportunities and solutions that contribute to accomplishing the ***Comprehensive Vision*** for the restoration and protection of the Mississippi Gulf Coast. The results of this effort are presented in this report and include a comprehensive regional plan that addresses hurricane and storm damage reduction and environmental restoration needs distributed across all three impacted counties. The Comprehensive Plan recommends a variety of site specific projects for either for immediate implementation or for further investigation and subsequent implementation. Comprehensive plan features include non-structural, structural, and environmentally-oriented solutions and plans.

1.2 Study Purpose and Scope

The ***Comprehensive Vision*** for the Mississippi Coastal Improvements Program (MsCIP) is a coastal Mississippi that is more ***resilient*** and less susceptible to risk from hurricane and storm surge. Webster's dictionary [2]defines resilient as "*a. capable of withstanding shock without permanent deformation or rupture; b. tending to recover from or adjust easily to misfortune or change*". Ecosystem resilience is "*the capacity of a system to undergo disturbance and maintain its existing functions and controls and its capacity to adapt to future change*" (Gunderson, L.H. 2000). Consistent with this Comprehensive Vision and the Federal Goal specified by Congress, this Comprehensive Plan has sought to identify solutions to the hurricane and storm damage, saltwater intrusion, fish and wildlife, erosion, and other related water resource problems of coastal Mississippi. The solutions recommended in this report are intended to render the region more resilient and less susceptible to damages resulting from future coastal storm events. Resiliency (i.e., ability to withstand / survive) to storm events equaling or exceeding the 2005 hurricanes was also an evaluation criteria that was applied to the formulation of projects recommended as part of the Comprehensive Plan. The pursuit of resiliency for coastal Mississippi communities led to the development of the Lines of Defense concept (see Plan Formulation section), which incorporates natural and manmade features in a comprehensive storm damage reduction plan.

1.3 Study Area Location and Geographic Description

The MsCIP Comprehensive Plan study area consists of the three Mississippi coastal counties: Hancock, Harrison, and Jackson. For planning purposes, these three counties were further divided into sub-units for evaluation and are described in the appendices Also included are the offshore ecosystems of Mississippi Sound and its barrier islands. Areas in Louisiana and Alabama that could be affected by actions considered for improvement to the Mississippi coast will also be discussed, where applicable.

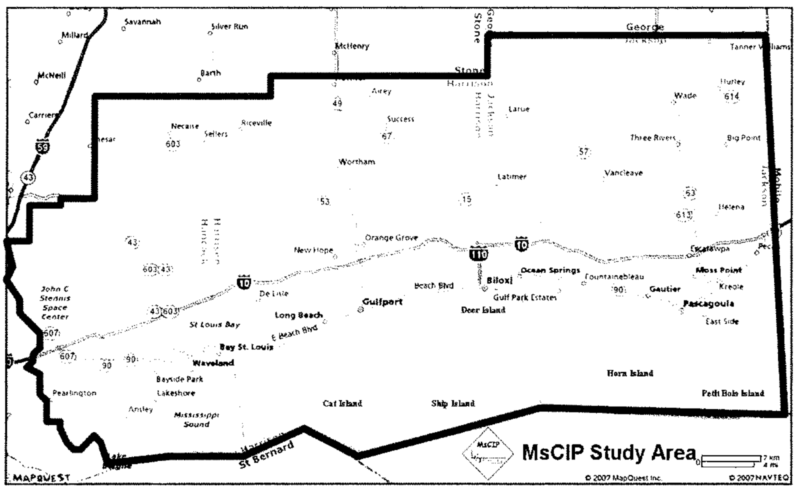


Figure 1-1
The MsCIP Study Area

[2] Webster's New Collegiate Dictionary, G. & C. Merriam Company, 1975

The 75 mile-long coastal study area is bounded on:

- the west by the Pearl River, which follows the boundary with the State of Louisiana until it reaches the Mississippi Sound,
- the east by the Alabama State line, and
- the south by the Gulf of Mexico.

Mississippi Sound is a partially protected body of water averaging 8 to 10 miles wide and separated from the Gulf of Mexico by a series of barrier islands (Cat, Ship, Horn, and Petit Bois Islands). The Gulf Intra-coastal Waterway provides a shallow draft channel (12 feet deep by 150 feet wide) for navigation within Mississippi Sound a few miles from the mainland shore. The mainland shore is broken by the entrances to St. Louis Bay between Bay St. Louis and Pass Christian, and Biloxi Bay between Biloxi and Ocean Springs.

U. S. Highway 90 traverses the area a few miles inland except in Harrison County, where it closely borders the coastline. Two major rivers empty into Mississippi Sound: the Pearl River, which enters on the west and the Pascagoula River which enters on the east,. Elevations along the coast vary from low-lying marsh reaches at elevations of 1 to 7 feet at the eastern and western extremities to the relatively high ground near shore in the central portion that rises from the beaches at elevation 4 to 6 feet up to over 16 feet within a short distance inland. Major towns along the Mississippi Gulf Coast are, from west to east, Waveland, Bay St. Louis, Pass Christian, Long Beach, Gulfport, Biloxi, Ocean Springs, and Pascagoula. This area is illustrated in Figure 1-1 above.

1.4 Prior Studies, Reports, and Programs

1.4.1 Studies and Reports

In response to the authorization's instruction ***"... that interim recommendations for near term improvements shall be provided within 6 months of enactment of this act..."*** the Chief of Engineers submitted his Interim Report on December 30 2006. The Interim Report recommended the implementation of 15 projects across the coast at a cost of $107.7 million. A brief summary of the authorized "near-term" construction projects are presented in Table 1-1. These projects are currently in design phase, under construction or complete.

Table 1-1
Authorized Interim Projects

Projects	Purpose	County
Bayou Caddy	Ecosystem Restoration	Hancock
Hancock County Beaches	Ecosystem Restoration & Hurricane & Storm Damage Reduction	Hancock
Hancock County Streams	Flood Damage Reduction & Ecosystem Restoration	Hancock
Jackson Marsh	Ecosystem Restoration	Hancock
Clermont Harbor	Hurricane & Storm Damage Reduction	Hancock
Downtown Bay St. Louis	Hurricane & Storm Damage Reduction	Hancock
Cowand Point	Hurricane & Storm Damage Reduction	Hancock
Long Beach Canals	Flood Damage Reduction	Harrison
Harrison County Beaches	Ecosystem Restoration & Hurricane & Storm Damage Reduction	Harrison
Courthouse Road	Flood Damage Reduction & Ecosystem Restoration	Harrison
Shearwater Bridge	Hurricane & Storm Damage Reduction	Jackson
Gautier Coastal Streams	Flood Damage Reduction & Ecosystem Restoration	Jackson
Pascagoula Beach Boulevard	Hurricane & Storm Damage Reduction & Ecosystem Restoration	Jackson
Upper Bayou Casotte	Flood Damage Reduction	Jackson
Franklin Creek Floodway	Hurricane & Storm Damage Reduction	Jackson

A list of 36 various studies and reports relevant to this study, which have been reviewed and by the study team, is included in the References Section of this report.

1.4.2 Federal Programs Addressing Recovery from Hurricane Katrina

Government, private, and volunteer organizations continue to work closely together to help rebuild the damaged region affected by Hurricane Katrina. The Department of Homeland Security (DHS)/ Federal Emergency Management Agency (FEMA) acts as the lead Federal agency in the relief, recovery, and rebuilding mission and has implemented various programs to help address the damages. Numerous Federal agencies have accomplished much and continue to provide much needed services in order to help not only get the region back on its feet but also to provide for a stronger and better future for the residents of the Gulf Coast.

The Housing and Urban Development Administration continues to help rebuild damaged housing and other infrastructure through its Community Development Block Grants (CDBG) Program, which is administered through the Mississippi Development Authority. The application of the CDBG

Program to the region affected by Hurricane Katrina represents the largest single housing recovery program in U.S. history. The Federal Housing Administration together with FEMA are providing mortgage and foreclosure relief and counseling for homeowners.

FEMA, Department of Transportation (DOT), U.S. Coast Guard (USCG), and US Army Corps of Engineers (Corps) have restored transportation and shipping and have re-opened ports throughout the region. The U.S. Department of Energy (DOE) and Department of Interior (DOI), Minerals Management Services (MMS) has worked to restore energy and water resources. The Department of Commerce, National Telecommunications and Information Administration has worked to restore communications throughout the region.

The US Department of Agriculture is actively working to rebuild industry and The National Ocean and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS) is assisting local communities in rebuilding Gulf oyster beds while also conducting fisheries monitoring. The Small Business Administration and Department of Commerce continues to implement programs designed to stimulate business redevelopment in the region. The U.S. Department of Labor (DOL) has focused on workforce redevelopment in hurricane-affected Gulf Coast states by investing funds in four primary initiatives that are already helping citizens pursue career opportunities while supporting the revitalization of the Gulf Coast. FEMA, Corps, USCG, and various other agencies are working together to restore the environment and parks.

An estimated 100 million cubic yards of debris have been removed from the region and approximately 1,450 miles of channels have been cleared. NOAA has surveyed and mapped approximately 800 square miles along the Gulf Coast to locate marine debris. In Mississippi alone, US Geological Survey (USGS) teams identified more than 235 sites along residential canals that require marine debris removal. In Mississippi, more than $429 million has been obligated for post-disaster mitigation projects through FEMA's Hazard Mitigation Grant Program. The USEPA along with FEMA and the Corps have contributed to the debris removal mission by providing technical advice and assistance, promoted recycling, and handled the disposal of over 4 million containers of household hazardous waste; assisted in the proper handling and recycling of over 380,000 large appliances (refrigerators, freezers, and air conditioners) and collected and recycled over 661,000 electronic goods to save important landfill space and ensure the reuse of metal components.

In July 2006, EPA completed cleanup of oil and hazardous materials in Mississippi and Alabama, and transitioned responsibility for remaining activities to the states. The Department of Health and Human Services (HHS) continues to help in providing Health Care, Social Services, Food and Education. There are numerous ongoing programs and people everywhere have contributed to the Gulf Coast Recovery and continue to remain committed to the Gulf Coast in time and money. HHS/FEMA continues to work at becoming better prepared in advance of future storms (HHS Website Ongoing Programs).

From the very start, the recovery effort included a large volunteer contingent. The mix of volunteers was widely based consisting of those who were local and from afar, concerned individuals, church and civic organizations and time honored volunteer institutions. The New Waveland Café operated by "hippies" (as affectionately described by locals) from all parts of the US, served three full meals per day to all comers. The Red Cross provided meals on wheel delivering food to the homes of residents. St Paul United Methodist Church and Jesus Christ Baptist Church hosted hundreds of volunteers on their property in huge tent cities complexes. Two years after the storm and with greatly diminished volunteer resources, the East Biloxi Coordination Center and Hope Force International combined the resources of seven volunteer organizations to construct a new home in Biloxi for a senior citizen whose home was destroyed by Katrina.

1.5 Mississippi State Strategy

The Mississippi Department of Marine Resources Coastal Preserves Program was developed in 1992 by authority of the Wetlands Protection Act. The Coastal Preserves Programs objective is to acquire, protect, and manage sensitive coastal wetland habitats along the Mississippi Gulf Coast, therefore ensuring the ecological health of Mississippi's coastal wetland ecosystems. The State currently has title to approximately 30,000 acres of the designated 72,000 acres of crucial coastal wetland habitat within Mississippi's 20 coastal preserve sites.

The Mississippi Emergency Management Agency is currently working with the residents of Bayou Cumbest to purchase property damaged by Hurricane Katrina from willing sellers. The Corps, Mobile District has been closely coordinating with Mississippi Emergency Management Agency to develop its environmental restoration project in conjunction with those purchased properties.

The Governor of the State of Mississippi has developed a Seven-Point Strategy for rebuilding coastal resources of the State. It is anticipated to be an on-going effort over the next 10 to 15 years. The strategy is summarized as follows:

- Implementation of breakwater structures for surge protection (natural surge diffusers, breakwaters, jetties seawalls, etc.);
- Deer Island restoration to pre-1900 footprint with fortification of the south side;
- Barrier Island restoration to pre-Camille conditions;
- Restoration of 10,000 acres of coastal marshes, beaches, and forests;
- Restoration of historical water flow to coastal Mississippi watersheds to provide water quality and quantity critical to estuarine and marine habitats, including efforts to divert freshwater from Louisiana into the Biloxi marshes;
- Restoration of submerged aquatic vegetation (SAVs) in Mississippi Sound; and
- Restoration and enhancement of reef systems in Mississippi waters and adjacent Federal waters (i.e. oysters, nearshore low-profile reefs, and offshore artificial reefs).

1.6 Systematic and Regional Integration with Louisiana Coastal Protection and Restoration (LACPR)

The hurricanes of 2005 affected the entire region of the northern Gulf of Mexico from the panhandle of Florida to the Texas coast causing direct destruction to the immediate coast and its population centers. It also had unprecedented impacts to the much broader region from the subsequent migration of the affected population, wholesale disruption of the region's economy, disruption of the region's educational infrastructure, and untold impacts on the human resources of the region. Although Congress authorized two separate studies with slightly different objectives, the Corps has taken a systematic and regional approach in formulating solutions and in evaluating the impacts and benefits of those solutions. In addition to the regional impacts of the Hurricanes of 2005, the two states share key resource issues including shoreline erosion and barrier island loss, wetlands loss, salinity intrusion, and storm surge and waves. The barrier islands reduce wave energy and help significantly in reducing erosion to the mainland. Wetlands, including marshes and near shore marine and estuarine habitat, are the nursery grounds for the entire marine food chain in the Gulf of Mexico. And, like the barrier islands, they also help to reduce wave energy. Linked to both the degradation and loss of the wetlands and barrier islands is the increase of salinity in the estuarine areas of the Mississippi, Breton, and Chandeleur Sounds. These increasingly scarce areas of the United States require a delicate mix of fresh and salt water to provide habitat for oysters, shrimp, sturgeon, and other fisheries which also provide an important economic source for both states. The following discusses the efforts undertaken to date by the MsCIP and LACPR teams to consider regional influences as part of the planning effort. A more detailed discussion of these efforts can be found in Appendix K, Plan Formulation, Section 11.

Both LACPR and MsCIP teams are working together to solve these issues at the local, regional, and national levels. Multiple focus groups, public meetings, and regional workshops have been held to make sure that the solutions presented in this report are comprehensive in nature, and also maintain the delicate balance between people and their environment. In addition, both efforts used the same plan formulation strategy, as well as shared the use of the many technical tools required to perform the evaluations. To this end, both teams are considering structural, nonstructural, and coastal restoration measures during the plan formulation. To ensure consistent communication and coordination, both teams have attended critical meetings regarding study goals and objectives, plan formulation, and Agency Technical (ATR) and Independent External Peer (IEPR)Review efforts. All modeling used in both efforts has been well coordinated, and both teams made use of, and jointly coordinated, the efforts of those Corps laboratories, Centers of Expertise, and ATR and IEPR teams involved in these studies. In addition, the development of the Risk Informed Decision Framework (RIDF) has been a joint effort of the two studies.

All potential impacts, both adverse and beneficial impacts, are being considered without regard to geographic boundaries. Any measures which induce adverse impacts must be eliminated from further consideration or their impacts satisfactorily mitigated on a regional basis. Several measures may have beneficial impacts outside specific study boundaries. For example, the diversion of freshwater from the Mississippi River to Lake Borgne via the Violet marsh area could not only reduce saltwater intrusion in the Mississippi Sound south of Hancock County, but it could also provide much needed sediments to the Biloxi marshes of Louisiana. Also, the systematic restoration of the coastal sediment budget and sand transport system along the Mississippi barrier islands could provide benefits to eastern Louisiana.

In both the MsCIP and LACPR studies, the regional influences of several proposed project alternatives on storm surge levels were examined with regional storm surge and wave modeling. The regional surge/wave model was specifically designed with this requirement in mind by having model domains and grid meshes that encompassed both Louisiana and Mississippi, and by developing the models consistently (for example, adoption of similar grid resolution throughout the model domain).

In addition to having a regional-scale and regionally-consistent storm surge/wave model, a regionally consistent definition of the hurricane hazard was also important. A multi-disciplinary team, the Risk Assessment Group (RAG), was assembled by the Corps to characterize the probabilities of different hurricanes that can impact the northern Gulf of Mexico region. Their work fully utilized the best of today's knowledge, data and technology. A significant achievement of the RAG, which supported both the MsCIP and LaCPR work and FEMA's remapping efforts, was the adoption of a unified general coastal flooding methodology that is being applied by Corps and FEMA. The unified approach involves coupled regional storm surge and nearshore wave models, the same approach originally taken by the Interagency Performance Evaluation Task Force (IPET). The RAG developed a number of new insights into the behavior of hurricanes. One notable and extremely important finding was the tendency for all major intense hurricanes to decrease in intensity prior to landfall. The RAG developed a regionally-consistent Joint Probability Method-Optimal Sampling approach (JPM-OS) for defining hurricane probabilities and for calculating probabilities associated with hurricanes having a certain set of characteristics (track, intensity, size, forward speed).

Several alternatives are presently being considered in both the MsCIP and LACPR studies to divert freshwater from the Mississippi River or other sources as a mechanism for promoting a reversal of a historic increase in salinity in the Mississippi Sound/Biloxi Marsh area. The intent of the diversion is to build wetlands, support fresher marshes and improve oyster reef health and productivity thus enhancing both their economic value and the ecological services they provide. However, the water diverted from riverine sources not only has lower salinity, but usually carries more sediment and nutrients than marine water. Diversions may result in areas of excess nutrients and thus cause algal blooms and eutrophication, greater light attenuation, and changed substrate characteristics, so their system-wide impacts need to be carefully evaluated. Spatially-explicit evaluations of habitat change over large areas are required for such system-wide impacts. Therefore, any proposed diversion alternative will need to be carefully evaluated in order to fully understand the positive and negative aspects of various diversion scenarios.

During the next steps in plan development in the LACPR and MsCIP investigations and or implementation, the joint study teams will collaborate at a Northern Gulf of Mexico integrated systems scale. The purpose of this effort will be to identify common stakeholder agreement on the configuration, performance, and cost of alternatives with a goal of achieving no adverse impacts, increased levels of risk reduction, and coastal restoration in those plans. The LACPR and MsCIP teams will hold joint meetings with stakeholders of the coastal areas in Louisiana and Mississippi to accomplish this task, as follows:

- Explain the process on how the range of alternatives were initially developed in both projects for coastal restoration and risk reduction,
- Present the individual elements and integrated system configurations of the array of developed alternatives that were evaluated through these investigations,
- Describe the performance, costs, and unintended adverse consequences found through modeling simulations of these alternatives,
- Solicit the viewpoints of stakeholders for both studies in joint meeting sessions to identify consensus and differences of opinion on the makeup, performance, and costs of these alternatives,
- Interact with the stakeholders of both studies for screening, refinement, and/or re-formulation of alternatives from a Northern Gulf of Mexico integrated systems scale perspective,
- Conduct iterations of planning and analysis for identifying common agreement on the configuration, performance, and cost of alternatives for attaining no adverse impacts, risk reduction, and coastal restoration, and
- Describe requirements for further alternative plan development and analysis.

1.6.1 Regional Storm Surge and Wave Modeling

Large-scale levee systems; other man-made barriers; restoration of barrier islands that involve substantial increases in an island's cross section, crest elevation or length; or wetland restoration on a massive scale, all have the potential to influence storm surge levels and wave conditions produced by extreme hurricanes on a regional scale. Levees and barriers are intended to protect against storm surge, but they also can cause a build-up of storm surge by obstructing or completely blocking the movement of water that is driven by hurricane-force winds. Barrier islands alter the movement of water toward the coast, providing some blocking action and by forcing the water to move through gaps between islands, an effect that is lessened once the storm surge overtops an island. The enhanced roughness of wetlands can slow the advance of storm surge somewhat, which can cause a small local increase in storm surge seaward of the wetland and slightly reduce the surge landward of the wetland or slow its arrival time slightly. Each of these processes might tend to retard the storm surge propagation in one area; but in the process of slowing the storm surge advance, the movement of water might be slightly redirected toward another location causing a local storm surge increase elsewhere. Natural and man-made protection and buffering features like wetlands and barrier islands do not decrease the mass of water driven into the region by the hurricane winds (mass is conserved); however, they do change the momentum and redistribute the storm surge.

Natural and man-made coastal protection measures can also significantly alter wave conditions during hurricanes, reducing the potential for wave-induced damage along the coastline during elevated storm surge levels. Levees and barriers can completely block wave energy; and barrier islands act to block ocean waves from reaching the mainland coastline or reduce wave energy. Even though the reduction is less, barrier islands greatly reduce ocean wave energy even when the surge has overtopped the barrier island. Wetlands reduce wave energy, although it is difficult to accurately quantify the reduction given the current lack of detailed knowledge about the physics of this process.

In an attempt to address structural effects on surge and waves, a combination of two models has been used. A completely coupled and consistent regional storm surge and wave modeling capability is available to examine the regional influences associated with planned and proposed project alternatives being developed in the LACPR and MsCIP studies, but only from the perspectives of project influences on storm surge levels and wave conditions. The model is based on the coupled ADCIRC-STWAVE models. The regional surge and wave model has been extensively validated using measured data acquired during Hurricanes Katrina and Rita, during the Katrina Interagency Performance Task Force (IPET) and MsCIP and LACPR projects.

This regional modeling capability was applied to examine regional-scale changes to storm surge levels associated with several of the proposed project alternatives, for example the influence of proposed barriers across Lake Pontchartrain on storm surge levels along coastal Mississippi, the influence of widespread Louisiana wetland restoration on storm surge levels in Mississippi, and the influence of Mississippi barrier island restoration on storm surges in Louisiana.

Time considerations did not provide for hydrodynamic model simulations for a variety of starting still-water surface elevations in order to more pointedly identify possible surge effects due to relative sea level rise. In lieu of the hydrodynamic modeling, sensitivity analyses were performed in the HEC-FDA models to determine the economic consequences of the various relative sea level rise scenarios. The results of those sensitivity analyses can be found in the economic appendix. Should additional efforts towards structural risk reductions be pursued, simulations will be performed as appropriate as recommended and selected project measures are advanced.

1.6.2 Regional Salinity/Water Quality Modeling

In addition to regional influences on storm surge and waves, construction of large-scale levee systems or other man-made barriers, restoration of barrier islands that might involve increasing an island's footprint or length, or wetland restoration on a large scale, all have the potential to influence water exchanges and current patterns during normal tidal action and typical wind conditions. Such persistent changes to the hydrodynamic regime can alter salinity and water quality regimes leading to changes to habitat.

Wetland restoration measures proposed for construction in the MsCIP study are relatively small-scale features within small estuaries, and the barrier island changes proposed for construction in the MsCIP study do not involve significant changes to the barrier island footprints as compared to that which existed in 1969 prior to Hurricane Camille. Therefore regional-scale influences on salinity and water quality due to these alternatives are not predicted to be significant. Wetland restoration and barrier island restoration at a much larger and widespread scale are being considered in the LACPR study. These restoration measures have the potential to reduce surge and waves, but can also induce significant regional changes in terms of salinity, water quality and habitat. Therefore, further studies in more detail in the future will be needed.

Both the MsCIP and LACPR studies are considering the diversion of freshwater from the Mississippi River or other sources as a mechanism for promoting a reversal of a historic increase in salinity in the Mississippi Sound/Biloxi Marsh area. The intent of the diversions is to build wetlands, support fresher marshes and improve oyster reef health and productivity thus enhancing both their economic value and the ecological services they provide. However, the water diverted from riverine sources not only has lower salinity, but usually carries more sediment and nutrients than marine water. Diversions may result in areas of excess nutrients and thus cause algal blooms and eutrophication, greater light attenuation, and changed substrate characteristics, so their system-wide impacts need to be carefully evaluated. Spatially-explicit evaluations of habitat change over large areas are required for such system-wide impacts.

A regional salinity and water quality model (WQM) (based on CE-QUAL-ICM coupled to the CH3D hydrodynamic model) has been developed covering an area from west of Lake Pontchartrain to east of Mobile Bay and south beyond the Chandeleur Islands in the Gulf. This model has been extensively validated for the Mississippi Sound region, as part of previous work done by the Engineering Research Development Center (ERDC) and Mobile District. The model has not yet been as extensively validated for the Lake Pontchartrain and Biloxi Marsh areas; however, in light of past experience with the model in numerous studies, it is expected that the current state of the model is yielding reasonable results in this region for the purposes of the "screening-level studies" that have been conducted to date to examine the possible benefits of freshwater diversions.

To more accurately answer detailed questions about changes to salinity and water quality, and to answer them with greater confidence (a level which can withstand a high level of technical scrutiny), additional resolution and model refinement and validation of the WQM, is needed. To answer more detailed questions about how changes in sedimentation, salinity and water quality translate to changes in landscape and habitat, additional model development, testing, and validation will be required. To date, the WQM has been applied to examine freshwater diversions at three locations: (1) diversion from the Mississippi River at Violet, LA, (2) diversion of all of the Escatawpa River flow into Grand Bay, MS, and (3) diversion from the Mississippi River at Bonnet Carre' spillway.

1.6.3 Regional Wetlands Restoration

The LACPR study is considering various restoration alternatives that will provide multiple benefits, particularly ecological benefits. These features have the potential to reduce storm surge and wave action, and the regional implications of these projects will be considered. Landscape features such as wetlands also have the potential to create frictional resistance and affect storm surge even when vegetation is inundated by the storm surge.

The impact of wetland restoration on storm surge at the mainland coast of both Louisiana and Mississippi was assessed with a sensitivity study. The sensitivity study was primarily a qualitative assessment that provides valuable information on trends and relative performance but one should be cautious about making quantitative assessments of surge reduction. It should be noted that the analysis does not consider the morphologic and vegetation cover changes to the wetlands caused by erosion and/or damage to vegetation that occurs during a storm's passage. The analysis also does not consider changes in the structure of the hurricane itself due to landfall infilling phenomenon that may be influenced by landscape features such as wetlands.

In a general sense, the influence of wetland restoration activities on storm surge and waves will be local in nature and relatively small for the types and spatial-scale of wetland restoration that are being considered and proposed in both the LACPR and MsCIP studies. Impacts on waves may be greater than impacts on storm surge, but they are expected to be more local and are not expected to have significant regional influences outside the local area. For example, the wetland restoration proposed in the MsCIP study is local, and will not have significant storm surge or wave influences in Louisiana.

1.6.4 Continued LACPR-MsCIP Northern Gulf of Mexico Planning and Analysis

The LACPR and MsCIP teams continue to collaborate on a number of issues at a regional scale. The LACPR and MsCIP teams will hold joint meetings with stakeholders of the coastal areas in Louisiana and Mississippi during the winter 2008 -spring 2009 timeframe on the diversion of freshwater from the Mississippi River into Lake Borgne and Mississippi Sound.

In its current state, the regional storm surge and wave model has been used to preliminarily examine regional influences and interactions that are created by MsCIP projects which are recommended for construction in the near-term (1 – 5 years), and selected conceptual LACPR measures with an implementation period yet undetermined. Based on this analysis it is unlikely that any of the MsCIP recommended plan features would have any negative influences on the region. Some conceptual hurricane and storm damage reduction measures applicable to Louisiana could have adverse impacts on other areas of the region. Should these conceptual measures be considered further, additional detailed analysis would need to be performed to determine the actual level of impact. Together, the MsCIP and LACPR study teams, along with key stakeholder representatives, will evaluate the issue of regional storm surge and wave influences and assess whether or not there is a significant regional influence, and if so jointly decide whether any additional risk is acceptable, whether the project(s) must be modified to lessen the increased risk, or whether the project(s) need to be reformulated.

Other possible structural concepts being tentatively considered for further study under the MsCIP would be subjected to similar detailed analysis to ensure that regional impacts are not caused by a locally beneficial action.

In addition all alternatives that involve large-scale wetland restoration, storm surge barriers, or large-scale levee/floodwall systems will be evaluated for regional influences on salinity, water quality and habitat. The hydrodynamic, water quality, and habitat experts from the MsCIP and LACPR study teams, plus outside peer reviewers for both projects, will make the assessment of which alternatives should be considered and integrated into the regional WQM model for this assessment. As was the case for the regional storm surge and wave model, the WQM model will be applied to examine regional influences of the recommended alternatives in the MsCIP study and the most preferable alternatives that surface in the LACPR study.

1.6.5 Coordination with FEMA

In addition to the significant coordination between the MsCIP and LACPR teams, the teams have also coordinated fully with the Federal Emergency Management Agency (FEMA) to ensure a unified approach in the development of appropriate hurricane and storm damage reduction alternatives. FEMA has different regional offices to manage different areas of the United States. FEMA Region IV serves the state of Mississippi, and FEMA Region VI serves the State of Louisiana. After Katrina, Regions IV and VI began the complex process of updating their Flood Insurance Rate Maps (FIRMS) to include storm surge. FEMA Region VI utilized the Corps, New Orleans District to provide the model for updating their FIRMS, while Region IV contracted with an Architect-Engineer firm for this effort. Both the MsCIP and LACPR teams employed a consistent methodology for storm surge modeling, and coordinated their efforts closely with both FEMA regions. FEMA Region IV's contractor adopted some slight differences in terms of the specifics of their modeling approach; however, the agencies reconciled the differences in water levels generated for Regions IV and VI, and used an averaging technique to achieve a unified approach and result.

1.6.6 Vertical Controls and Datum

A datum is a reference plane from which the vertical distance of a point is given as elevation. Common reference planes include mean sea level (MSL), the National Geodetic Vertical Datum of 1929 (NGVD '29), and the North American Vertical Datum of 1988 (NAVD '88). Mean Sea Level is a tidal datum and is adjusted every 20 years or so. The other datums are fixed in space but distances between the two vary by location. In the study area, as of the publication date of this report, MSL is within 0.5 feet of the other two datums, while NAVD '88 and NGVD '29 are within two inches of each other. Elevations reported herein should be understood to be in NAVD '88 unless otherwise stated.

1.7 Other Federal Disaster Assistance Programs

There are at least two other significant post-Katrina Federal programs currently operating within the communities of the project area. Both the Federal Emergency Management Agency (FEMA) and the United States Housing and Urban Development Administration (HUD) have ongoing programs within the project area that are designed to reduce future damages or to compensate landowners for damages.

1.7.1 FEMA Assistance Programs

FEMA has been operating several post-Katrina programs designed to compensate landowners for storm-related damages, reconstruct and repair damaged structures and reduce future flood damages and loss of life due to hurricane surge and other storm-related threats. FEMA administers the Individual Assistance Program (IAP), Public Assistance Program (PAP), Other than Housing Needs Assistance Program, Debris Removal Program, Temporary Housing Program and the Hazard Mitigation Grant Program within the project area. Each of these programs is administered locally by The Mississippi Emergency Management Agency (MEMA). Over 350,000 individuals and families have been helped by the assistance programs. Most of these grant programs cover losses or needs over and above any flood insurance payments that may be available to the landowner and the grants are provided tax-free.

The individual assistance program provides grant funds to individuals and families for temporary housing, and the repair, replacement or reconstruction of homes damaged by Katrina. Those repairs must be made in conformance with NFIP requirements according to the local floodplain management ordinances and the funds do not cover losses to second or vacation homes in the project area. This disaster assistance program is implemented under the Individuals and Households Program (IHP) and provides grant assistance for re-establishment of households in the affected areas.

Opportunities for applying flood damage mitigation measures to damaged homes are encouraged by FEMA administrators. However for those landowners without flood insurance, but receiving disaster assistance, the mitigation measures are optional except in those instances where a structure has been determined to be "substantially damaged" as defined by the NFIP. In these cases, a landowner must comply with the NFIP requirements of the local ordinances to elevate the structure regardless of whether or not the landowner has flood insurance. For those landowners with flood insurance, any structures that have been "substantially damaged" as defined by the NFIP would be required to comply with the elevation requirements of the local ordinances. In order to facilitate compliance with local ordinance provisions to elevate structures that have been substantially damaged, funds up to a maximum of $30K are available through the "Increased Cost of Compliance (ICC)" program (a part of the Standard Flood Insurance Policy coverage) to assist landowners in elevating their structures above the BFE. Additional long-term recovery funding can be provided through low-interest loans from the Small Business Administration.

As of April 2008, over 200,000 individuals and families have received Housing Assistance payments and over 130,000 have received Other Needs Assistance grants. Total payments to these two components of the FEMA assistance program have exceeded $1.2 billion. In addition, more than $2.8 billion has been obligated by FEMA in their Public Assistance program helping to reconstruct public buildings and facilities, utilities, roads and bridges and recreation facilities.

The Hazard Mitigation Grant Program is also being administered in the project area through the Mississippi Emergency Management Agency (MEMA). This program provides grant funds to address flood damages for structures and property that are subject to repetitive flooding or were damaged by Katrina and had been identified for acquisition in the state All-Hazards Mitigation Plan. Projects must show savings greater than costs. Some of the activities that can be implemented under the HMGP to protect either public or private property from future flood damages are:

1) Acquisition of property or relocation of buildings to convert the property to open space use

2) Retrofitting structures to minimize damages from high winds, flood, or other hazards

3) Elevation of flood prone structures (elevation under the HMGP is not permitted within the designated V-zone shown in the new published DFIRM)

4) Development and initial implementation of vegetative management programs

5) Minor flood control projects that do not duplicate the activities of other Federal agencies

6) Localized flood control projects, such as ring levees and floodwalls designed specifically to protect critical facilities

7) Post-disaster building code activities that support code officials during the reconstruction process

1.7.2 HUD Assistance Programs

The Homeowner Assistance Grant Program (a.k.a. HAP) is a disaster recovery program being implemented through the Mississippi Development Authority for those areas specifically damaged by Katrina hurricane surge inundation. The program is generally available to low to moderate income households (up to 120% of the median household income) with limited funding for higher-income households. The program is being implemented in two phases – Phase 1 for those structures located outside the 100-year flood zone established in the FIRM but were flooded by the Katrina surge and Phase 2 for those structures damaged by hurricane surge and located within the 100-year flood zone mapped in the FIRM.

The program has two components. The first component is a compensation grant of up to $150K (Phase 1) to compensate homeowners for losses to single-family, owner-occupied duplexes or mobile homes due to flooding by surge that were not covered by insurance. The percentage of the total grant available is dependent upon the insured value of the home times the percentage of damage determined in a damage assessment. Homeowners may repair, replace or reconstruct homes as they choose with the funds. No local permits for home repair or construction or evidence of the use of the funds for those purposes is required by HUD or MDA. Homeowners must comply with local NFIP requirements for elevating the structure and may apply for the second component of the program – the HUD elevation grant (see description below) – to defray the costs of elevating the home. In Phase 2 of the HAP, the compensation grant amount is limited to $100K.

Neither the compensation grant program nor the elevation grant program restricts any homeowner from rebuilding a destroyed or substantially damaged structure or elevating a damaged/repaired structure in the new DFIRM-designated V-zone. The only requirements for the compensation grant program are compliance with current NFIP guidelines as described in local floodplain management ordinances and current building codes. Any structure being elevated under either program would be raised to the new BFE established in the DFIRM flood zone mapping. In some locations the new BFE may be lower than the surge elevation that came ashore during Katrina. Residual damages during a recurrence of a Katrina-like storm as a result these elevation and compensation programs could be significant.

As of May 15, 2008, the HAP has received 19,401 applications for Phase 1 and 8,534 for Phase 2 of the program and has distributed grant funds to 20,437 of those applicants totaling more than $1.4 billion.

In addition to the Homeowners Assistance Program discussed above, the MDA is implementing, through the HUD Community Development Block Grant (CDBG) program, the Long Term Workforce Housing Program. The purpose of this program is to provide grants and loans for local jurisdictions, non-profits and for-profit organizations to provide long-term affordable housing in the three coastal counties and Pearl River County. These funds can be used to repair, rehabilitate, or reconstruct housing units for low and moderate income families and must include at least 40 dwelling units for each grant or loan request. The program projects that as many as 5,800 housing units may be created in these four counties with only local building code and NFIP local floodplain ordinance restrictions.

1.7.3 Non-Corps Federal Floodproofing (Elevation) Programs

Following the rescue and recovery operations in the project area, both FEMA and HUD entered the damaged Gulf areas and began to implement assistance (grant and loan) programs for elevating structures. Each of the two agencies has been offering floodproofing assistance to eligible landowners so that homes, businesses and public structures could be elevated to reduce future damages.

FEMA, through their Hazard Mitigation Grant Program (HMGP), has been providing elevation grants (through MEMA) to eligible landowners so that either new construction or retrofitted homes could be elevated in accordance with the local floodplain management ordinances. The grant would be in addition to any flood insurance payments that an insured property owner may have received. The grant amount would generally cover the total cost of the structure elevation. The HMGP elevation requirements specify that a new or retrofitted structure be elevated to or above the base flood elevation (BFE) that has been delineated in the new DFIRM whether or not the new DFIRM has been locally adopted or not. FEMA has prohibited elevation of structures within the new V-zone in the HMGP except for structures that must be located within the V-zone due to their water-related usage.

HUD has an elevation grant program that provides up to $30K to eligible landowners to assist in raising the first floor of either a new home or a retrofitted home to reduce future flood damages. The maximum $30K grant helps to defray the cost of elevating the home and is payable in two installments - $15K when the elevation permit is obtained and $15K when an occupancy permit is obtained. Neither HUD nor MDA are providing agency oversight for the elevation design or construction processes, but are relying on local NFIP and building code inspectors to assure compliance with the local ordinances. Since the program relies solely upon adherence to the local floodplain management ordinances, the HUD program has no restrictions on elevating homes within the V-zone shown on the new DFIRM, but has requirements for meeting building elevation construction standards within the V-zone.

Both of these programs provide monetary assistance to landowners that elevate their homes, but in the case of the HUD grant, the $30K limit may not provide the total amount necessary to cover the entire costs of elevating the structure according to the full requirements of the NFIP or the local building codes (IRC/IBC). When the distance between the ground surface and the BFE is minimal (1-3 feet) and the structure is being newly constructed, the grant may cover the increased costs of the extended foundation, utility lines and additional steps that support, service and access the raised first floor. Normally, the incremental cost of elevating new construction to meet NFIP requirements is less than retrofitting an existing structure.

Where an existing structure must be retrofitted with a new foundation or where a new structure must be raised to a higher level (8-15 feet) above the ground surface, the HUD assistance grant may not cover the homeowner's full cost. Retrofitting normally requires much preparatory work beneath the structure (dependent upon the foundation type; slab, crawl space, basement) followed by raising the first floor of the structure to the new design flood height (BFE) and installing new piling or masonry columns beneath the structure. Retrofitting an existing structure using current design guidelines and increased BFE heights can result in higher construction costs. These high costs may exceed the elevation grant by a significant amount. Significantly elevating a new structure (10-15 feet) can be quite expensive considering the costs of installing deep pilings, bracing the pilings, construction of extended utilities and providing access to the higher first floor. Any special needs of the household members under the American Disabilities Act (ADA) that require wheelchair ramps or chair lifts can add significantly to these costs.

1.7.4 Integration of Corps and Non-Corps Nonstructural Programs

In their implementation, components of the MsCIP and the FEMA HMGP program may be able to be integrated into a coordinated flood risk reduction program using permanent acquisition, structure elevation and both floodproofing and relocation of public structures. The restrictions in the HMGP prohibiting reconstruction or elevation in the V-zone are in lock-step with the MsCIP recommendations for that high-hazard zone. However, the current HUD assistance and elevation grant programs have no restrictions on elevating structures (new or retrofitted) or new residential construction in the V-zone to match the recommendations in the MsCIP that restrict redevelopment in that high-hazard zone. Sole reliance on the current local ordinance requirements and use of upgraded building standards in the high-hazard zone through the HUD programs may not be sufficient to avoid the potential loss of property and lives during a Category 5 hurricane.

In addition to the differences between elevation construction costs (based upon Corps project cost data) and the grant amount specified in the HUD elevation program – a difference that the landowner will bear, the lack of restrictions on elevating residential construction within the V-zone in the HUD grant program area is a concern. Funding redevelopment and elevation within the V-zone based solely upon local floodplain ordinance requirements would be in conflict with the MsCIP report recommendations. Generally, the BFE to which all new construction or retrofitted construction under the HUD assistance programs must raise the first habitable floor, may be lower than the hurricane surge that would be anticipated (and was experienced during Katrina) from a Category 5 hurricane. Hurricane surge depths in Katrina exceeded 25 feet in portions of the V-zone of the project area. The number of totally destroyed homes in the V-zone that had been elevated in compliance with the pre-Katrina BFE is a testament to the potential for significant residual damages and loss of life that could occur as a result of implementing an elevation grant program in the V-zone.

The MsCIP plan in comparison, although using the storm events of 2005 and especially Katrina as its benchmark for protection and reducing flood damages and loss of life, would substantially reduce residual damages and threats to public safety. Avoiding any new construction or elevation of existing structures in the high-hazard zone virtually eliminates the potential for such surge/wave-related losses in future similar storm events.

In terms of financial assistance, the MsCIP is founded on the premise of government-directed construction activities with associated design, regulatory and contracting controls to assure good quality construction, regulatory compliance and financial accountability. Both the FEMA and HUD programs are essentially grants to landowners, administered by local jurisdictions with local oversight for design quality, regulatory compliance and accountability. The MsCIP program costs are founded on the requirements of the Uniform Relocations Act and actual floodproofing construction costs while the HUD program has set grant limits regardless of the actual costs of the work required.

The differences (no matter how slight) between the MsCIP plan recommendations and the HUD grant programs, reinforces the need for a collaboratively developed plan for long-term flood risk reduction that can integrate these programs into one consistent long-range comprehensive strategy for creating disaster-resilient communities. As previously mentioned, the ongoing FEMA HMGP and the MsCIP plan recommendations appear to be very compatible. The best capabilities of the three Federal agencies can be brought to bear on the flooding problems of the project area through collaborative planning.

1.8 Public and Agency Involvement, Review, and Consultation*

NEPA is intended to ensure full public participation in the EIS process. Public participation includes effective communication between all Federal, state, local agencies, and tribal governments, and other persons or organizations [i.e. public and non-governmental organizations (NGOs)] that may have an interest in the project. A Notice of Intent (NOI) was published in the Federal Register on August 9, 2006, to inform the public of the Corps' intent to prepare an EIS for the MsCIP Comprehensive Plan. A Notice of Availability for the Draft Comprehensive Plan and Integrated Programmatic EIS was published on February 13, 2009 in the Federal Register. The public was invited to attend a public scoping meeting, a public workshop, and a public hearing to obtain public input and ensure compliance with NEPA. Other methods employed by the MsCIP study team to reach the general public and interested stakeholders included meeting announcements, brochures, news releases to local print and broadcast news media, and a web site. Further public communications include maintaining contact with public officials and agency representatives, ensuring that calls and letters from the public are addressed in a timely manner, and contacting stakeholders through placement of notices of public meetings in stakeholder newsletters. In addition, the Draft EIS was widely circulated and comments were incorporated into this Final EIS .

The MsCIP Interim Report effort and this subsequent MsCIP Comprehensive Report and Integrated Programmatic EIS effort have been coordinated with all other agencies tasked with addressing the damages resulting from the hurricanes of 2005. Agencies, educational institutions and interested individuals have been contacted via phone, e-mail, or public notice, to solicit ideas and input to the plan formulation process. Those entities that have chosen to participate have availed themselves of several opportunities to involve themselves in the MsCIP planning process, including Regional Coordination and Public Workshop meetings, interactive problem area identification sessions, and development of measures sessions, via open forums, web-based feedback and participation forums, and less formalized discussions. Active participants in the MsCIP planning process included: NPS, FEMA, USEPA, USFWS, NOAA, USGS, the State of Mississippi, Hancock, Harrison and Jackson counties, the eleven cities along the coast of Mississippi, several educational institutions (i.e. University of Southern Mississippi, and University of New Orleans), and a number of interested individuals.

1.8.1 EIS Scoping Process

NEPA regulations provide for the use of the scoping process to identify and assess reasonable alternatives to Proposed Actions that avoid or minimize adverse effects of these actions upon the quality of the human environment. "Scoping" is used to identify the scope and significance of environmental issues associated with a proposed Federal action through coordination with Federal, state, and local agencies; the general public; and any interested individuals and organizations prior to the development of an EIS. The process also identifies and eliminates from further detailed study issues that are not significant or have been addressed by prior environmental review. Several initial scoping meetings were held between April and August 2006 in conjunction with development of the interim report. A scoping workshop was held in Biloxi, MS, December 19, 2006, to gather public input for the programmatic EIS.

1.8.2 Additional Required Coordination

The proposed plans presented in the MsCIP Comprehensive Report and Integrated Programmatic EIS are very integrated and all encompassing. These efforts are so extensive that additional coordination is anticipated in order to accomplish these proposed plans. The Corps, Mobile District anticipates additional coordination to be necessary with the following entities: NOAA, FEMA, USFWS, NPS, NGOs, Universities, and other stakeholders. Internal coordination among Corps elements including ERDC, Mississippi Valley Division, and the New Orleans District will continue throughout the implementation of the comprehensive plan. This additional coordination is necessary to adequately address improvements from a holistic approach.

1.8.3 Study Participants and Coordination

Per the Council on Environmental Quality regulations on implementing the NEPA, the Corps, Mobile District requested that a number of State and Federal Agencies accept the status of Cooperating Agency on the Integrated Report and Programmatic EIS. In response to this request, dated October 30, 2006, the following entities are participating as cooperating agencies:

State:

- Mississippi Department of Archives and History
- Mississippi Department of Environmental Quality, Office of Pollution Control
- Mississippi Department of Marine Resources
- Mississippi Department Of Transportation
- Mississippi Emergency Management Agency
- Mississippi Museum of Natural Science
- Mississippi Secretary of State, Public Lands Division

Federal:

- Federal Emergency Management Agency, Region 4
- Minerals Management Service, Gulf of Mexico Region
- National Oceanic and Atmospheric Administration, National Marine Fisheries Service Southeast Region, , Protected Resources and Habitat Conservation Divisions
- National Park Service
- U.S. Department of Agriculture , Natural Resources Conservation Service
- U.S. Department of Transportation, Federal Highway Administration
- U.S. Environmental Protection Agency, Region 4
- U.S. Fish and Wildlife Service
- U.S. Geological Survey

Local:

- Gulf Regional Planning Commission

This study effort was accomplished with the participation of the following Federal and state agencies, local governments, and stakeholders:

- National Aeronautics and Space Agency
- National Weather Service
- Hancock, Harrison and Jackson Counties
- Communities of Bay St. Louis, Biloxi, D'Iberville, Gautier, Gulfport, Long Beach, Moss Point, Ocean Springs, Pascagoula, Pass Christian, and Waveland
- University of Southern Mississippi
- University of New Orleans
- Coastal Restoration Network
- The Nature Conservancy (TNC)
- The Audubon Society
- Sierra Club

1.8.3.1 LaCPR Modeling Team

The study team closely coordinated with members of the LaCPR technical team to ensure consistency between modeling efforts, data sources, and results. All hydrodynamic modeling results for the MsCIP project was closely coordinated with the LaCPR team. MsCIP and LaCPR applied an identical hydrodynamic modeling methodology and used consistent grids. The MsCIP storm suite included the storm suite modeled for LaCPR plus additional storms making landfall along and east of the Mississippi coast. The statistical methods applied for both were also consistent.

1.8.3.2 US Fish and Wildlife Service

Pursuant to the Fish and Wildlife Coordination Act of 1934 as amended the U.S. Fish and Wildlife Service (USFWS) has made recommendations to the MsCIP environmental team regarding potential impacts to wetlands, National Wildlife Refuge lands, Coastal Barrier Resource Act units, and fish and wildlife resources. The USFWS assisted in drafting portions of the Environmental Appendix, the environmental framework, and affected environment and environmental consequences sections of the Integrated Report and Programmatic EIS . They also worked jointly with the ERDC team in providing input on the modeling schemes and selection of potential restoration sites.

In their Planning Aid letter dated June 12, 2007, the USFWS recommended that environmental and non-structural measures be utilized wherever practicable and that, minimization and avoidance of impacts should be considered on all projects. In addition, the FWS prepared a Draft Fish and Wildlife Coordination Act Report (FWCAR) on June 12, 2008 and a Final FWCAR on April 23, 2009 that includes incorporation of sediment control measures during construction, maintaining disturbed areas with the use of native vegetation if at all possible, placing restrictive easements or covenants on all preserved and restored project areas, accounting for secondary development and indirect effects associated with projects during advanced design and feasibility studies, incorporation of environmental and non-structural measures in place of hard structures wherever practicable, and minimization and avoidance of impacts should be considered on all project elements. A copy of the Final FWCAR is included as Section 2 of the Environmental Appendix.

1.8.3.3 National Park Service

The NPS is a *Cooperating Agency* for the MsCIP Integrated EIS, and a NPS staff member was co-located with the MsCIP study team. The Mississippi Sound barrier islands consisting of Petit Bois, Horn, East and West Ship Islands and portions of Cat Island are located within Gulf Islands National

Seashore (Seashore), a park unit managed by the DOI/NPS. The National Seashore's purpose is to preserve, protect, and interpret its Gulf Coast barrier island and bayou ecosystem and its system of coastal defense fortifications, while providing for public use and enjoyment in a manner consistent with applicable laws and agency policies. Undeveloped natural resource areas protected by the NPS provide habitat for several endangered species, stop-over habitat for migratory birds, and critical nursery habitat for marine flora and fauna, and serve as an enclave for complex terrestrial and aquatic plant and animal communities that characterize the northern Gulf Coast. The Seashore also contains one of the most complete collections of publicly accessible seacoast defense structures in the U.S., from early French and Spanish exploration and colonization through World War II.

The NPS is mandated to preserve natural conditions and processes, and to preserve cultural resources (see Comprehensive Barrier Island Restoration Plan Appendix for additional detail). Effective management of the barrier islands requires adaptation to the dynamics of these coastal landforms that act as the interface between ocean and land, and bear the impacts of hurricanes, variations in sediment supply, and sea level rise anticipated from global warming.

The long-term erosion and land loss experienced by the barrier islands since the mid-1800's is of major concern to the NPS. The NPS in collaboration with the Corps and other agencies has concluded that proactive management actions are crucial, necessary, and consistent with 2006 NPS Management Policies to restore Ship Island and the barrier island sand transport system and budget affecting Petit Bois, Horn, East and West Ship Islands, and to protect cultural resources threatened by shoreline erosion. The NPS has been extensively involved in the MsCIP planning process, and has closely coordinated with the Corps, USGS, NMFS, EPA, NOAA, USFWS, and MDMR in the development of barrier island restoration options.

1.8.3.4 NOAA/National Marine Fisheries Service

Technical staff of NOAA Fisheries, Protected Resources Division (PRD) and Habitat Conservation Office (HCD) participated in numerous inter-agency on-site and virtual on-line meetings. During these meetings, specific goals of the MsCIP Comprehensive Plan were discussed as well as potential measures and alternatives that would be evaluated. Recommendations concerning marine resources in the area have been a vital part of formulation of these measures and alternatives.

1.8.3.5 Federal Emergency Management Agency, Region 4

All hydrodynamic modeling and the development of stage-frequency curves for coastal flooding was closely coordinated with the FEMA. The numerical modeling methodologies were similar and consistent grids were used by both teams. Results from the FEMA and Corps modeling efforts were generally consistent, with 90% of all results being within +/- 1.0 feet of each other. Final stage-frequency values were established by taking an ensemble average of the Corps and FEMA results, to ensure consistency of end results.

1.8.3.6 U.S. Geological Survey

Technical staff of the USGS participated in numerous inter-agency on-site meetings relative to the restoration of the barrier islands. USGS provided studies on the disposition of the barrier islands and potential sources of high quality sand for beach nourishment. They continue to advance knowledge in these fields through ongoing field studies, particularly detailed bathymetry around the Mississippi barrier islands and additional geotechnical information.

1.8.3.7 Natural Resource Conservation Service (NRCS)

Continuous coordination has occurred between the NRCS and the MsCIP team. This coordination includes the NRCS's ongoing project to restore the Forrest Heights Levee to pre-Katrina (original design) condition where the MsCIP team was invited to participate in the design review process and in public meetings. In addition, the NCRS has participated in MsCIP risk education workshops and public meetings regarding MsCIP's consideration of enhancements to the levee (see description, Section 5). With this and continued coordination, future projects to be planned and implemented by either agency would be executed more effectively and efficiently.

1.8.3.8 Mississippi Department of Marine Resources (MDMR)

Multiple MDMR personnel assisted the MsCIP study team throughout the development of the Comprehensive Report and Integrated Programmatic EIS. MDMR staff worked very closely with the MsCIP study team in the identification and project specific designs of most of the ecosystem restoration sites discussed and evaluated in this report. A more detailed discussion of these environmental restoration sites is located in Environmental Appendix.

1.8.3.9 Mississippi Department Wildlife, Fisheries, and Parks (MDWFP)

The study team has invited participation from technical staff of the MDWFP, through invitations to participate in numerous inter-agency on-site and virtual on-line meetings. During these meetings, specific goals of the MsCIP Comprehensive Plan were discussed, as well as potential measures and alternatives that would be evaluated. Comments from MDWFP were considered and were incorporated into the Comprehensive Report and Integrated Programmatic EIS.

1.8.3.10 Mississippi SHPO

The study team closely coordinated with the Mississippi SHPO regarding assessments of damages to archaeologically significant resources throughout coastal Mississippi. Also, Corps archaeologists provided assessments of potential actions or measures and resulting impacts to the remaining resources. These assessments were coordinated with the Mississippi SHPO for their review, comments, and concurrence.

1.8.4 Coordination, Collaboration and Data-Sharing with NGOs

The study team invited participation from members of NGOs, such as TNC, The Sierra Club, and The Audubon Society, as well as many other groups throughout the region and the state. Both regional and local members of these organizations have participated in various stakeholder meetings during which specific goals of the MsCIP Comprehensive Plan were discussed as well as potential measures and alternatives that would allow the Corps to meet stated goals and objectives. Comments from these NGOs have been considered and have been incorporated into the MsCIP Comprehensive Report and Integrated Programmatic EIS.

1.8.5 Coordination, Collaboration and Data-Sharing with Academic Institutions

The study team utilized members of academia, drawing on their research and knowledge of coastal systems. Specifically, members of the University of Southern Mississippi, Gulf Coast Research Laboratory, and Mississippi State University research and development community have participated in the public outreach meetings. Their input has been extremely valuable in efforts to bring the best expertise available to bear on developing this plan for recovery and improvement of coastal Mississippi.

1.8.6 Public Meetings

Early on, the MsCIP team placed a high value on incorporating public input and active stakeholder listening into the planning process. Various styles of public meetings were held. Public workshops included interaction between public participants and technical team members for information gathering. Public meetings were more formal. A public scoping meeting and a public hearing is required by NEPA and using these two complementary formats allowed the team to comply with NEPA as well as interact with public participants and local governmental and municipality representatives. A chronological overview of opportunities for citizen and stakeholder input during the MsCIP development process is described below:

- Over 60 Federal, State and local government agency representatives and other community leaders from business and industry gathered in Biloxi on April 7, 2006 to identify early needs, opportunities and recommendations for the MsCIP process. The meeting was designed to solicit input from members. The team developed guiding principle recommendations for the planning process and a list of specific proposals for consideration. Participants were able to view aerial maps of coastal Mississippi, examine the Corps' projects candidates, and attached local comments to coastal maps.
- Public Meetings were held in Harrison, Jackson and Hancock Counties on April 10, 11 and 13, 2006 to examine a broad range of potential coastal protection options and solicit public input on designing comprehensive improvements. Participants interactively indicated their level of agreement or disagreement with a series of prepared questions and statements. Additionally, participants were invited to submit comments via personal computer, comment card or directly to a court reporter during these sessions. A web-based database was launched that permitted public meeting attendees and others to submit comments on the planning concepts presented.
- An online agenda of the April 10-13, 2006 public meetings was posted on April 18, 2006 for displaced coastal residents or those who could not attend the public meetings.
- A second Regional Coordination meeting of governmental, business and industry stakeholders was held April 24 and 25, 2006 in Biloxi. The session probed for missing or overlooked items in the near-term planning process. A county-by-county review of projects and local ratings of these projects provided additional directional guidance.
- A second round of public workshops was conducted May 1, 2 and 4, 2006 where near-term projects and the screening criteria used to select them were presented. Additional public comment was captured via personal computer, comment card and court reporter. Participants responded interactively to a series of statements and questions exploring preliminary project selection criteria, balance of approach and other perceptions.
- A follow-up online workshop was held on May 3, 2006 for displaced coastal residents or those unable to attend public meetings.
- A third Regional Coordination Meeting including government partners, business and industry was held in Biloxi on August 21-22, 2006. Issue-related subgroups for structural, non-structural, barrier island restoration, and environmental solutions offered specific comments and recommendations to Corps planners and subject matter experts.
- A scoping session workshop was held on December 19, 2006 at the MDMR office in Biloxi to gather public input for the EIS. The workshop format enabled attendees to pose questions to Corps planners and subject matter experts in an informal setting. Participants were offered additional interactive and comment gathering opportunities.
- A project web portal was launched in January 2007 enabling user downloads, project team collaboration, and improved communication and coordination.
- Online meetings for structural, nonstructural, environmental, and barrier island working groups took place on February 6 and 9, 2007. Participants had the opportunity to submit comments and be part of a facilitated discussion.
- A public workshop was held on April 5, 2007 to help finalize MsCIP measures for structural, nonstructural, environmental issues, and barrier islands. A 2-part session

enabled participants to interact with Corps planners on emerging planning concepts in the first segment and formally comment on the plan during the second part.

- A Risk Analysis workshop was held on July 9 and 10, 2007 at the MDMR office in Biloxi, Mississippi assess stakeholder preferences.
- A follow-up to the Risk Analysis workshop was held on September 10 and 11, 2007.
- Public hearings were held with the public on March 16, 18, and 19, 2009 in each of the coastal counties in compliance with NEPA for the Draft Programmatic and Integrated EIS.
- In addition, numerous informal meetings (i.e. over 100 meetings) were held with NGOs, public, state and Federal resources agencies, and local counties, etc. at their request.

1.8.7 Continuing Outreach

The study team developed an interagency PDT, using lessons-learned after the hurricanes of 2005, and incorporating members from Federal and state resource agencies, state and local governments, members of state academia institutions, and various NGOs. Contacts for special interest groups and various focus groups have been compiled and maintained. The study team has developed and maintains a website dedicated to providing information and receiving comments. The intent is to create a transparent process focusing on the comprehensive, long term protection and sustainability of coastal Mississippi.

1.8.8 Internet Web Site

The MsCIP web sites are located at http://mscip.Corps.army.mil/ and also http://meetingroom.groupsolutions.us/.

1.8.9 Comments and Responses

A draft of this report was open to comments from 15 February 2009 through 31 March 2009. Copies of the report and all appendices were sent to the agencies and organizations listed in Section 1.9. Appendix L Comments and Responses contains all of the comments received by the Corps and the responses to those comments. This document has been revised based on those comments identified in the appendix.

1.9 List of Agencies, Organizations, and Others Who Have Received a Draft Report for Review and Comment

Indian Nations and Tribal Organizations

- Governor Bill Anoatubby, The Chickasaw Nation
- Chairman McClamrock Battise, Alabama-Coushatta Tribe of Texas
- Principle Chief A.D. Ellis, Muscogee (Creek) Nation of Oklahoma
- Chairman Buford Rolin, Tribal Historic Preservation Officer
- Chairman Earl Barby, United Keetoowah Band of Cherokee Indians
- Chairman Earl Barby, United Keetoowah Band of Cherokee Indians
- Chief Tarpie Yargee, Alabama Quaassart Tribal Town of the Creek Nation
- Chief Gregory Pyle, Choctaw Nation of Oklahoma
- Chairman Billy Cypress, Miccosukee Tribe of Indians of Florida
- Chairman Kevin Sickey, Coushatta Tribe of Louisiana
- Principal Chief Enoch Haney, Seminole Tribe of Florida
- Mekko Vernon Yarholar, Thlopthlocco Tribal Town

- Chief Beasley Denson, Mississippi Band of Choctaw Indians

Statewide and Federal Elected Officials

- Honorable Haley R. Barbour, Governor of Mississippi
- Honorable Gene Taylor
- Honorable Roger F. Wicker
- Honorable Thad Cochran

Federal Agencies

- U. S. Environmental Protection Agency Office of Federal Activities, NEPA Compliance Division
- Mr. J. I. Palmer, Jr., U. S. Environmental Protection Agency, Region 4
- Mr. Wesley Kerr, U.S. Department of Agriculture, Natural Resources Conservation Service
- Ms. Mary Miller, Deputy Regional Director, Federal Emergency Management Agency, Region 4
- Dr. Suzette Kimball, Eastern Region Director, U.S. Geological Survey, Leetown Science Center
- Mr. John Rodi, Minerals Management Service, Gulf of Mexico Region
- Dr. Roy E. Crabtree, Regional Administrator NOAA Fisheries
- Mr. Andrew H. Hughes , Division Administrator, U.S. Department of Transportation, Federal Highway Administration
- Ms. Brenda Bowen, Army Federal Register Liaison Officer
- Ms. Sherri L. Fields, Acting Associate Regional Director, National Park Service
- Mr. Sam Hamilton, S.E. Regional Director, U.S. Fish and Wildlife Service

State Agencies

- Tom Mann, Ph.D. , Mississippi Museum of Natural Science
- Mr. Thomas Waggener, Mississippi Department of Archives and History
- Mr. Claiborne Barnwell, Mississippi Department of Transportation
- Mr. Mike Womack, Mississippi Emergency Management Agency
- Ms. Margaret Bretz, Mississippi Secretary of State , Public Lands Division
- Dr. Bill Walker, Executive Director Mississippi Department of Marine Resources
- Mr. Jerry W. Cain, P.E., DEE, Chief, Environmental Permits Division, Mississippi Department of Environmental Quality, Office of Pollution Control

Local Officials and Agencies

- Mayor Xavier Bishop
- Pascagoula City Manager
- Gautier City Manager
- Mayor Connie Moran
- City Manger D'Iberville, MS
- Mayor A. J. Holloway
- Mayor Brent Warr
- William "Billy" Skellie
- Mayor Leo "Chipper" McDermott
- Mayor Eddie Favre
- Mayor John " Tommy" Longo
- Pascagoula Public Library
- Margaret Sherry Memorial Library
- Bay St. Louis – Hancock County Library
- Orange Grove Public Library
- Ocean Springs Municipal Library
- Hancock County Board of Supervisors

- Harrison County Board of Supervisors
- Jackson County Board of Supervisors

Regional Planning Organizations

- Mr. Kenneth Yarrow, Gulf Regional Planning Commission

Other Organizations

- Jennifer Evans-Cowley, PhD, AICP
- Cornelia Dean, The New York Times
- Mr. Barri A Shirley, Associate Executive Director, Business Services, Mississippi Baptist Convention Board

Individuals

Robert Adams
Karen & Michael Armstrong
James Ayers
Billy B. Floyd
Frances Baggett
Huey Bang
Jamie Bartel
Barbara Beben
James & Danielle Benfield
Cheryl Bennett
Mike Benvenutti
George Boddie
Sharon Bogin
John F. Bowie
Leonard Boyer
William O. Bradshaw
C. Brander
Chuck Breath
Kelyn Breland
Stacy Brothers
Bill Brown
Gail Chellino
Sandy Chesnut
Indra Chisholm
Norma Clark
Sabrina Clark Chandler
Andy Coburn
KM Construction
Terri & Jeff Cook
Sarah Cooke
Frank Crawford
Frank Culotta
Millie Deax
Michael DePue
Steven Dietz
Eric Dohner
Zachary R. Dotson
Tom & Donna Drake
Tab Eiler
Jason Elliott
Bart Evans
Jennifer Evans-Cowley, PhD, AICP
Lori Granger
Daniel Grenier
Jeff Groska
George Heckendorn
Joshua Hill
Daniel Hitchings
Peter R. Hoar
David Holman
Ted Hopkins
Milady Howard
Brad Humber
Alan Hunter
Marco J. Giardino
Carroll Johnson
Guy Johnson
Mike Kelley
Wesley Kerr
Charles & Alisa Killingsworth
Kenneth Klodz
Clement Ladner
Lynn Ladner
Chuck LaFleur
Uneeda Laitinen
Jerry Landrum
Christopher LeBlanc
Richard F. Lex
Shawn Lobree
Kathy Lohr
Nancy Lowentritt
David Manasco
Alyn Mayo-Bailey
Renda McClendon
Gerald Miller
Mike Miller
Paula Milo-Moultrie
Dave Miner
Cynthia Mirambel
Diane Mitchell
Marjorie Monde
Ray Newby
B. Nugent
Jerry Olson
Jim Phillips
Steve Phillips
Jim Poore
Stephanie Powell
Michael Pursley
Jeff Quebedeaux
Janet Quinn
E. Franklin Rawlings
Lonnie Ray
Rhonda Rhodes
Bud Richey
Nina Roland
Lisa Rose
Laurie Rounds
Tina Sanchez
Mary G. Seiley
David Sheperd
Judith B. Signaigo
Chris Smith
Thomas Spencer
W.H. Stamps
Ann Stieffel
Debra Stiglet
Bill Stone
Ramona Suttkus
Candy Swan
Michael Taylor
Peter M. Trapolin
John Trepagnier
Paul Tully
Donna Turner
Donna Garrett Turner
Cheyrl Ulrich
Donna Ulrich
Stephen Vizzini
Mike Waldrop
Kathleen Walsh
Richard Wheat
Geoffrey Wikel
Leslie Williams
Stuart Williamson
Barry Willis

Marsha
Karen Finley
Brenda Finnegan
Sheila Floyd
Charles Gallagher
Patricia Gaspard
Yvone Gelpi
Robert Goertz
Jim Osborn
David Painter
Amy Parish
Penny & Wayne Parker
Don E. Patecek
Darla Perilloux
Robyn Peterson
Audrey Petre
Nick Winstead
James Winston
Ron Yanic
Carly Zaniboni

1.10 Report Organization

This report is organized in the following manner (* indicates report sections required for an EIS):

- Section 1 – Introduction
  - Purpose and Need*
  - Public Involvement and Agency Coordination*
- Section 2 – Affected Environment* (Existing and Without-Project Conditions)
- Section 3 – Plan Formulation (Alternatives and Plans*)
- Section 4 – Environmental Effects*
- Section 5 – Description of Recommended Comprehensive Plan Components
- Section 6 – Implementation Requirements
- Section 7 – List of Primary Study Team Members and Report Preparers*
- Section 8 – List of Acronyms
- Section 9 – References*
- Section 10 – Index*
- Appendices
  - Appendix A Environmental
  - Appendix B Economic
  - Appendix C Real Estate
  - Appendix D Non Structural
  - Appendix E Engineering
  - Appendix F Cost Estimating
  - Appendix G Risk Appendix
  - Appendix H Barrier Islands
  - Appendix I Reserved for Future Use
  - Appendix J Reserved for Future Use
  - Appendix K Plan Formulation
  - Appendix L Comments and Responses

2 Study Area Description (Affected Environment*)

2.1 Study Area and Environmental Setting*

2.1.1 The MsCIP Environmental Framework

The area or the zone where water meets land can be described in various terms – it is a buffer area, the land-water interface, or an ecotone - the edge where the terrestrial ecosystem transitions into the aquatic ecosystem. Critical coastal habitats exist in this ecotone area: swamps, marshes, coastal ridges, coastal forests, littoral zone, dunes, and beaches. These coastal habitats serve as vital breeding areas, nursery grounds, and areas where much of the massive amounts of organic carbon needed to fuel aquatic food chains are produced. These areas capture sediments, nutrients and even contaminants eroded from the uplands before they enter the aquatic system. These areas also absorb wave, tide, and surge energy before impinging upon the upland.

Fundamentally, the Mississippi Coastal Improvements Program (MsCIP) is the framework for the protection, restoration, enhancement and re-establishment of the natural buffering capacities of these coastal habitats. Mississippi's coastal habitat system provides a comprehensive network of areas that are critical both to the environment and to society. The degradation of Mississippi's coastal habitat system has severely impacted the resiliency of the natural and man-made environment to past and future storm events.

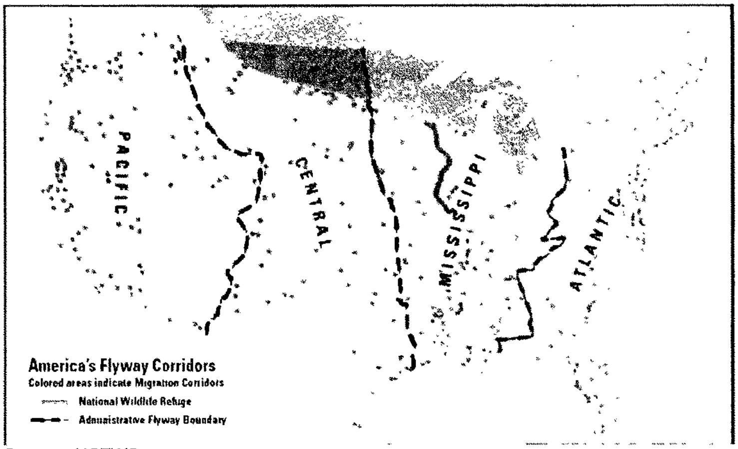
During the MsCIP plan formulation process (see full discussion in Section 4), a Lines of Defense (LOD) concept was developed based on existing natural and manmade coastal features. The LOD concept identifies and develops the storm surge reduction potential

- for natural features such as barrier islands, beaches and dunes, and local topography and
- for existing and potential future manmade features such as roadways, rail beds, seawalls, surge gates, etc.

Each LOD can be enhanced to provide greater storm surge damage reduction benefits. Coastal habitats, such as beaches/dunes and wetlands, provide the first and second LOD against future storms. Barrier islands are the first LOD and the first natural barrier against future storms. The second LOD includes beach and dune habitat along the coastal mainland which provide a natural buffer to storm impacts to the mainland.

2.1.2 General Description of the Study Area

Coastal habitats in Mississippi provide vital ecosystems for fish and wildlife that is found no other place in the world. The annual waterfowl migrations, both spring and fall, are one of the most amazing spectacles in nature. The MsCIP study area falls within the Mississippi Flyway. The longest migration route of any in the Western Hemisphere lies in this flyway. Its northern terminus is on the Arctic coast of Alaska and its southern end in Patagonia. Well timbered and watered, the entire region affords ideal conditions for the support of hosts of migrating birds. The two rivers that mark it, the Mackenzie emptying on the Arctic coast and the Mississippi in the Gulf of Mexico, have a general north-and-south direction, another factor in determining the importance of this route which is used by large numbers of ducks, geese, shorebirds, blackbirds, sparrows, warbler and thrushes. The majority of North American land birds, seeking winter homes in the tropics that come south through the Mississippi Flyway take the short cut across the Gulf of Mexico in preference to the longer, though presumably safer, land or island journey by way of Texas or the Antilles (Association of Fish and Wildlife Agencies 2008).



Source: USFWS

Figure 2-1
America's Flyway Corridors

Although waterfowl are what most people think of when they hear the word flyway or migration, many other birds migrate as well. Approximately two thirds of the breeding bird species of eastern United States forests migrate to tropical wintering areas in the Caribbean, Mexico, and Central and South America (Keast and Morton 1980). The movement of birds across the Gulf of Mexico each spring and fall is a prominent feature of Neoarctic-Neotropical bird migration system (Ramos 1988). From early April through mid-May, the day-to-day consistency of migration across the Gulf of Mexico is rarely interrupted, and then only when strong cold fronts are positioned over the southern Gulf of Mexico (Gauthreaux 1971).

The coastal woodlands and narrow barrier islands that lie scattered along the northern coast of the Gulf of Mexico provide important stopover habitat for Neotropical land bird migrants (Moore et al. 1990). They represent the last possible stopover before fall migrants make a non-stop flight (18-24 hr) of greater than 1,000 km, and the first possible landfall for birds returning north in spring (Moore and Kerlinger 1987). The loss of coastal habitat suitable for forest-dwelling migrants has resulted in severe fragmentation of the remaining habitat, with many woodlands average only a few hectares in area. Development in the coastal zone is likely to continue the fragmentation of stopover habitat in the future (Moore and Simons 1989). Additional pressures following hurricane events, such as Katrina, also results in the loss of more undeveloped lands.

Mississippi Sound is fed from the north by eight coastal mainland watersheds and drainage from the south by tidal exchange from the Gulf of Mexico. From west to east the mainland drainages include: Lake Borgne, the Pearl River, the Jourdan River, the Wolf River, the Tchoutacabouffa River, the Pascagoula River, and Mobile Bay. Combined drainage area from streams and rivers entering the Mississippi estuarine basin is approximately 19,660 square miles (mi^2). The Pearl River and

Pascagoula River drainage areas far exceed those of Biloxi and St. Louis Bays. Pascagoula River has a drainage area of 9,400 mi^2 with an average discharge of 15,185 cubic feet per second (ft^3/s). Pearl River drains 8,700 mi^2 and has an average discharge of 12,890 ft^3/s. The combined drainage area for rivers emptying into Biloxi and St. Louis Bays is 1,400 mi^2 with an average discharge of 2,790 ft^3/s (NMFS 1998). It is within this brackish estuarine water that several species of fish, classified as aquatic resources of national importance, thrive from the shallow waters to the deep sea 70 miles offshore.

The influx of rivers creates a salinity gradient within the Sound (Priddy et al. 1955). Both east-west and north-south gradients occur in the Sound in addition to vertical gradients. Generally, positive salinity gradients exist from the mainland seaward and vertically, surface to bottom (GMFMC 1998). Surface salinity is influenced by the discharge of freshwater from large rivers and is reduced during periods of higher flow in late spring and early summer (Thompson et al. 1999). Temperature follows expected salinity trends. Levels of dissolved oxygen are usually above lethal limits.

The Pascagoula and Pearl Rivers, Bayou Casotte, and Biloxi Bay are the primary sources of nutrients entering the Mississippi Sound. The temporal and spatial variability of estuarine salinity is dependent on water supply, evaporation, and mixing, and also management, which includes the direct influence of activities, such as water withdrawal for inland irrigation projects and diversions, and the indirect effects of global climate change. Oysters grow faster in areas with fluctuating salinities within their normal ranges, compared to constant salinity (Pierce and Conover 1954). Oyster reefs of commercial importance are sub tidal and form aggregates that cover thousands of acres of the Mississippi Sound. The aerial extent of oyster reefs in Mississippi is estimated at 10,000 to 12,000 acres, of which over half is located in the western Mississippi Sound south of Pass Christian.

The eighty-mile-long body of water north of the string of five barrier islands is the Mississippi Sound, a large dynamic estuary extending from Mobile Bay in Alabama on the east to Lake Borgne in Louisiana to the west. Mississippi Sound is located within the very center of what fisheries biologists term the Fertile Fisheries Crescent. The Gulf of Mexico produces 28 to 30 percent of the total fishery products of the United States. Gunter (1963) showed that between 1936 and 1962, production from the Gulf of Mexico increased at a rate of 7 times its former production, with the shrimp fishery being the most valuable in the country. The Fertile Fisheries Crescent has been called "the core of the Gulf's $800 million fishing industry." Mississippi Sound forms a major part of the Fertile Fisheries Crescent within the northern Gulf of Mexico.

The Fertile Fisheries Crescent can be divided into three sections, the West Florida Shelf, The Mississippi-Alabama Shelf and the Louisiana-Texas Shelf. The Mississippi-Alabama Shelf extends from the DeSoto Canyon westward to the Mississippi River Delta. Sediments within this area range from more carbonate in the eastern part to mostly terrigenous nearer the Mississippi River Delta. Bottom features within the area are small peaks of cemented together sediments called "pinnacles", dense fields of reef-like mounts, and low ridges that run parallel to shore. Also located within near shore waters are hard bottoms and rock outcroppings.

Recent studies have determined of the total fishes found within the northern Gulf of Mexico, excluding the southern Florida reef habitats, approximately 1,200 species, almost 400 species are found within the Mississippi-Alabama Continental Shelf. The Mississippi Sound estuary plays a key role in these numbers by providing prime habitat for various life stages of red snapper, tuna, redfish, Spanish and king mackerel, grouper, speckled trout, jack crevalle, cobia, amberjack, marlin, and various species of sharks. Mississippi Sound's productivity is unequalled in the Gulf which makes it ideal for avid sport fishermen, commercial fishing, and local recreational use. Biloxi, Mississippi, located in the center of Coastal Mississippi was once known as "The Seafood Capital of the World" and in 1910 canning factories located here shipped over 15 million cans of oysters, more than any place else in the world.

The fishing industry contributed $1.1 billion to the state's economy prior to the devastation by Hurricane Katrina. According to Mississippi Department of Marine Resources, during a five-year average before the storm, Mississippi shrimp accounted for five to seven percent of all the shrimp landings in the U.S. The commercial seafood industry which includes the harvesting, processing and distribution of all seafood products created a total economic impact of $900 million in 2003. The total ex-vessel value of commercial landings amounted to $46 million while the total plant-gate value of commercial seafood production was $338 million in 2003. The recreational fishing industry which includes saltwater and freshwater fishing produced a total economic impact of $463 million in 2001 and $1,306 million in 1996 (ASA).

2.1.3 General Impact of Recent Hurricanes

The destruction caused by the hurricanes of 2005 came in two forms: the wind and tidal action of the hurricane itself. When Hurricane Katrina struck the Gulf Coast, it was a Category 3 hurricane; it had been as high as Category 5 as it moved through the Gulf of Mexico. The hurricane was also massive, which meant that these intense winds were spread over a wide area – in fact the entire Gulf Coast. The same forces that flooded parts of New Orleans damaged or destroyed wetlands along the Gulf Coast. Barrier islands took the initial damage. Wetlands suffered less from wind damage than from flood waters that dumped saltwater, trash, and toxic chemicals into the fragile ecosystems. When saltwater is introduced into a freshwater habitat it kills the vegetation – i.e. valuable wet pine savannah habitat.

A hydric soil is one that is defined as "a soil formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper part." (Federal Register, 1994) Since the soils of these areas formed under hydric conditions due to the proximity of water, the historic spatial extent of the coastal wetlands can be estimated by the presence of these hydric soils. Analysis through GIS shows that 76% of all of the houses seriously damaged (damage estimated as greater than 90%) by Katrina, as defined by FEMA, were also located in areas mapped as hydric soils or areas composed of dredged material from adjacent channels. This correlation is an additional demonstration that the importance of restoring the coastal habitats extends beyond ecological interests into insuring the well-being of the human population.

Disturbance of soils and vegetation, such as vegetation covered by trash or complete removal of trees and/or marsh grasses, in coastal wetlands has resulted in the introduction and colonization of exotic species. The destruction of wetlands and coastal habitat occurred in a sensitive area for birds. As previously discussed, the northern Gulf Coast is a stopping point for birds in migration; it also serves as nesting ground for many species of terns and other water birds. Damage to the barrier islands was particularly bad for the nesting species; nests the following couple of years were lower for several species. The endangered Mississippi Sandhill Crane and a number of other threatened birds occur in the area. Twelve important bird areas lay in Hurricane Katrina's path: two in Florida and ten on the northern Gulf Coast. The hardest hit bird areas were the Breton NWR and the Gulf Islands National Seashore.

The habitats of several endangered species in the northern Gulf region were altered by the hurricanes. The endangered Alabama beach mouse has lost several acres of primary and secondary dunes that serve as habitat, and has lost scrub forest habitat, where it finds prey, to saline ocean waters. Along the Alabama coast, some nesting sites for the endangered Kemp's ridley sea turtle have been destroyed, and forested areas have been blown down in the Noxubee National Wildlife Refuge in Mississippi, where the listed redcockaded woodpecker has habitat.

The Gulf Coast states are significantly forested and are major producers of lumber and plywood. The U.S. Department of Agriculture Forest Service estimated 19 billion board feet of timber damaged on over 5 million acres in Mississippi, Alabama, and Louisiana. This would translate into an estimated

$5 billion loss in potential timber revenues according to the Forest Service. The forested area damaged represents 30% of the total timberland in the affected region, 90% of which occurred on non-federal lands. Eighty percent of the damage occurred in Mississippi. The Mississippi Forestry Commission issued a news release estimating that 1.3 million acres of forestland in the state had been damaged, with commercial timber valued at about $1.3 billion; urban tree damage in Mississippi was estimated at $1.1 billion.

The Gulf Coast where Hurricane Katrina struck is an especially important center of commercial and recreational fishing, producing 10% of the shrimp and 40% of the oysters consumed in the U.S. Further, commercial shrimpers fishing out of or delivering to Alabama, Mississippi, and Louisiana ports account for almost half of all U.S. shrimp production. Hurricane Katrina has destroyed or severely damaged fishing boats and processing and storage facilities throughout this area. The impact of Katrina on fish populations, habitat, and their viability for consumption was significant.

2.2 Significant Historic, Existing and Future (Without-Project) Resources*

2.2.1 Physiography, Geology

The Mississippi coast is situated in the Outer Coastal Plain Mixed Forest Province Ecoregion according to the USDA's *Description of the Ecoregions of the United States* (USDA 1995). Along the coast, flat coastal plains generally have gentle slopes and local relief of less than 100 feet. Water bodies of the area are typically characterized as sluggish streams, marshes, lakes, and swamps.

There are two major physiographic regions in the Mississippi coastal region. The Gulf Coast Flatwoods form an irregular belt through the southern half of the three-county region. This belt consists mainly of wet lowlands and poorly drained depressions, with some higher, adequately-drained areas. The second physiographic region, the Southern Lower Coastal Plain, is rolling and gently undulating interior uplands. Elevations range from sea level along the coast in Hancock, Harrison, and Jackson Counties to about elevation 420 feet NAVD-88 in the far northern areas of the coastal region. The slope of the land surface is generally oriented to the south. The area is underlain by a thick sequence of sedimentary deposits dipping to the south and west.

The coast of Mississippi is composed of sedimentary rocks and sediments deposited between the Cenozoic era and Quaternary period. Sedimentary layers of Pliocene, Miocene, Oligocene, and Eocene age currently found in the coastal Mississippi area consist of clay, silt, sand, gravel, and limestone. All these formations dip to the south-southwest. The geologic formations exposed on the surface of the Mississippian Gulf coast are up to 100 feet thick and consist of alluvium and terrace deposits (Otvos 1998). The Biloxi Formation, the Prairie Formation, and the Gulfport Formation were all deposited during this time. The Biloxi Formation was deposited during a period of rising sea level in marine and brackish water both nearshore and offshore. This formation is not exposed at the surface, except along the banks of the Industrial Seaway in Gulfport where it has been exposed from excavation. It ranges in thickness from 15 feet in Harrison County up to 120 feet in Jackson County, and consists of clay, fine sand, and sandy clay with abundant fossils. Both shells and microscopic foraminifera are found, and these fossils are used to identify the deposition environment (Oivanki 1998). The Prairie Formation, ranging from 15 to 40 feet thick, was deposited in river channels and inter-channel swamps. It is composed primarily of sands and muddy sands with petrified tree trunks and organic matter, and is visible along the Industrial Seaway road cut in Harrison County. The formation underlies the wide, generally flat coastal plain immediately north of the coastal marshes and beaches on the coast. The city of Bay St. Louis is built on the high sandy bluffs of the Prairie Formation (Oivanki 1998). The Gulfport Formation is a sand unit that was deposited during a time of sea level decline, following the highest sea level stage of the Pleistocene epoch. It forms the high ridge upon which the coastal cities of Pass Christian, Gulfport, and Biloxi are built. The coastal

Mississippi beaches are regularly replenished with sand dredged from the Mississippi Sound, and the source for much of this sand is the Gulfport Formation (Otvos 1998).

The physiography and geology of coastal Mississippi were largely unaffected by the hurricanes of 2005; however, saltwater intrusion into sediments and water bodies as a result of inundation during Hurricane Katrina in particular, has been evident. The storm surge associated with Katrina brought saltwater into many freshwater features that would not normally be impacted by saline waters. The level of saltwater intrusion by inundation caused die-off of many species, only some of which have re-grown by this late date. Die-off of trees impacted by saltwater was particularly severe on the barrier islands, which to-date, have never recovered. While much of the saltwater is no longer present in soils or rocks within the study area, its effect on vegetation has not been reversed in many areas. Measures to address die-off of vegetation in areas impacted by saltwater intrusion are addressed in later sections of this report and appendices.

Saltwater intrusion into the estuarine environment of Mississippi Sound is an issue related in only a limited fashion, to geology and soils, and measures to address saltwater intrusion resulting from human intervention was, in this study effort, investigated as a study in its own right, the results of which will be discussed further in this report, and in the separate Environmental Appendix.

2.2.2 Relative Sea Level Rise

The Corps planning guidance, specifically Appendix E, Section IV, Paragraph E-24 of the Planning Guidance Notebook (ER 1105-2-100), requires that potential relative sea level rise should be taken into consideration for coastal or estuarine projects at the feasibility level of study and recommends, given the uncertainty of future sea level rise estimates, preference be given to developing strategies that are robust over the entire range of potential sea level rise rates versus those that perform well only over a limited range of potential sea level rise rates.

Systematic long-term tide elevation observations suggest that the elevation of oceanic water bodies is gradually rising and this phenomenon is termed 'sea level rise.' The rate of rise is neither constant with time nor uniform over the globe. In addition to elevation of oceanic water bodies, however, is the gradual depression of land surface along the coast of Mississippi, referred to as "subsidence", which becomes an additional factor in the relationship between the land's elevation over time, and that of changing sea levels. Because the coast of Mississippi is affected by both subsidence and global sea level rise (adjusted for local conditions), these factors combine (and are referred to in this analysis) in a single element of "relative" sea level rise. Relative sea level rise (RSL) at a given location, then, is simply the change in mean sea level at that location with respect to an observer standing on or near the shoreline.

Historically, relative sea level rise has been determined by fitting a linear relationship to monthly mean or annual mean sea level, either of which is computed from tide gage observations. The slope of the fitted line gives the rate of sea level rise at the location of the tide gage. The computed rate includes the rate of subsidence or uplift of the location upon which the tide gage is founded, and thus the computed RSL rates may be extended locally or regionally to areas with similar geotechnical and tidal conditions.

Project performance in this study effort was evaluated for both an extrapolation of the observed historic rate plus subsidence, which resulted in a rate over a 100-year planning horizon of approximately two feet of relative sea level rise, and also for a rate higher than that historically observed, as suggested by the Intergovernmental Panel on Climate Change, equivalent to approximately 3.4 feet over an assumed 100-year planning horizon [Intergovernmental Panel on Climate Change (IPCC) 2001]. In addition, sensitivity analysis was also conducted by use of an alternate 50-year planning horizon.

Additional detail on relative sea level's effect on environmental resources, ecosystem restoration measures, potential structural and non-structural damage reduction measures, costs, and other factors, are contained in following sections of this report, and in the Engineering Appendix.

Future relative sea level rise was employed in the economic inundation damage and shoreline erosion analyses. Time considerations did not allow for hydrodynamic model simulations for a variety of starting still-water surface elevations in order to more pointedly identify possible surge effects due to sea level rise. Accordingly, a range of events are considered to estimate flood damages due to inundation. These events are characterized by the flooding source's stage-frequency relationship, which is derived from coastal tide gage data and hydrodynamic model simulations. Inundation analyses assumed that the stage-frequency curves were shifted by the amount of predicted sea level rise over the period of analysis in order to obtain an estimate of expected annual damage due to sea level rise. Shoreline erosion was evaluated using a more physics-based tool and dynamic event damage effects were captured to the extent that that tool captures dynamic erosion effects due to changed still water depths.

2.2.3 Climate

Coastal Mississippi is located in a region characterized by humid subtropical conditions. The coastal area of Mississippi exhibits temperate winters and long, hot summers, with rainfall fairly evenly distributed throughout the year. However, the coast is also subject to periods of both drought and flood, and the climate rarely seems to truly exhibit "average" conditions. Prevailing southerly winds provide moisture sufficient to maintain high humidity. Normal mean annual temperatures range from approximately 66 degrees at Pascagoula, to approximately 68 degrees at Gulfport. Temperatures routinely exceed 100F each year, and freezing temperatures reach the Gulf coast almost every winter (Mississippi State Climatologist 2006).

2.2.3.1 Hurricanes and Storm Surge on Mississippi Coast

The northern Gulf of Mexico, particularly that area between Mobile Bay to just west of the Mississippi River, is uniquely situated in regards to the formation and landfall for Atlantic tropical cyclones. Influencing factors include the circulation and bathymetry of the Gulf, the offshore topography of the northern Gulf Coast, and the abundant warm waters of the Gulf. Over 40 tropical cyclones have made landfall between Mobile Bay, Alabama and eastern Louisiana in the period 1800 – 2005. Two of these storms, Camille in 1969 and Katrina in 2005 were the largest storms to impact the southeastern US.

Abnormally high water levels along the coasts are typically associated with the passage of hurricanes. Many factors contribute to the magnitude of hurricane storm surge. Storm intensity is but one of many. The effect of waves, rainfall, sea level variations, and coastal topography are a few of the others (Harris 1963). Unfortunately, hurricane size and duration are often overlooked. Certainly, this was a major "lesson learned" with regard to Hurricane Katrina. Hurricane Katrina was an unusually large Gulf hurricane, perhaps the largest in two hundred years or more. By contrast, Hurricane Camille (August 1969), the previous standard for destructive hurricanes on the Gulf Coast, was a much smaller but extremely intense tropical cyclone which made landfall in almost the exact same locale. With sustained winds of 190 miles per hour (mph), Camille created a swath of destruction in the communities of Bay St. Louis, Waveland, and Pass Christian, Mississippi. However, a 25- to 30-foot tidal surge was confined to a small area near and east of the center; much smaller than that of Katrina. The levees at New Orleans were not breached during that event, but were overtopped during Hurricane Betsy in 1965. To the east, a storm surge of 15.5 feet was recorded at Biloxi. Conversely, Hurricane Katrina, packing 120 mph sustained winds at landfall, produced an unprecedented massive and devastating 24-foot storm surge at Biloxi, with record surge levels extending from well west into Louisiana to Mobile, Alabama. The historical record is replete with similar, but much smaller examples. Large, slow moving hurricanes such as the New

Orleans storms of 1915, 1947, and Betsy in 1965 produced much higher tidal surges than the small Category 3 Hurricane Elena, which directly hit Biloxi in September 1985.

Examination of Figure 2-2 illustrates the magnitude of Hurricane Katrina in comparison with other hurricane and high tidal events (based on a plot of each year's highest tidal/water level elevation) of the last approximately 123 years (1882-2005), at the Biloxi tidal gauge. Hurricane Katrina exceeded all previous events in damage, adjusted to 2006 dollars, and only the infamous Galveston hurricane of 1900 exceeded the death toll of Hurricane Katrina, despite the advanced warnings given.

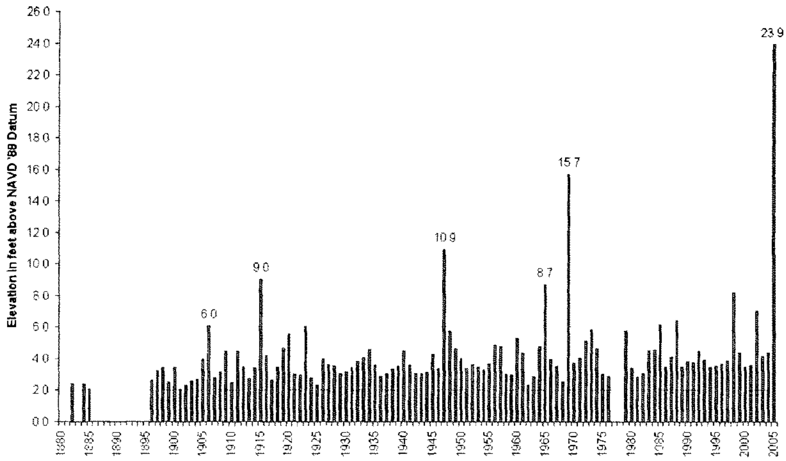


Figure 2-2
Maximum Annual Stage at Biloxi, MS Gage

2.2.3.2 Precipitation/Rainfall

Average annual rainfall ranges from approximately 65 inches at Biloxi and Gulfport, to approximately 67 inches at Pascagoula. Locally violent thunderstorms are a threat on an average of 60 days each year (Mississippi State Climatologist 2006). The area has been struck by at least eight hurricanes since 1895, and as of 2005 has been affected by 51 tropical disturbances (including hurricanes) since 1915.

2.2.4 Hydrology and Hydraulics

The coast of Mississippi is governed by often large volumes of rainfall, delivered on a very flat landscape. Principal rivers discharging to Mississippi Sound include the Pearl and Pascagoula Rivers; the Escatawpa River flows into the Pascagoula River at Pascagoula. Other principal rivers discharge into either Bay St. Louis or Biloxi Bay, which are connected to Mississippi Sound. The Wolf and Jourdan Rivers flow into Bay St. Louis, and the Biloxi and Tchoutacabouffa rivers flow into Biloxi Bay. River patterns meander broadly through this flat and often marshy landscape, and often display abandoned "oxbows" and off-channel wetlands. Numerous bayous are also interspersed within these coastal bays and along the Mississippi Sound shoreline. Many of these bayous have been heavily modified over the years by development and conversion for commercial, residential, industrial, or recreational purposes.

The landscape is generally low-lying on the eastern and western ends of the Mississippi Coast, with higher ground in the middle. The great majority of the ground surface south of Interstate-10, which crosses the state within five to ten miles of the coastline, is below elevation 25 feet NAVD-88 with the preponderance of the area below elevation 15 feet NAVD-88 in Jackson and Hancock counties and in the bay and riverine margins of Harrison County.

The occurrence of large rainfall and/or hurricane events in coastal Mississippi may normally cause extensive flooding, although nothing in the modern record has ever approached the severity of inundation caused by Hurricane Katrina. Rain-induced riverine flooding in the larger coastal river basins does not generally coincide with hurricane surge, though torrential tropical storm and hurricane rainfall can exacerbate flooding due to surge in the smaller coastal basins. Flooding may also be exacerbated by sediment and debris blockage of channels, culverts, bridges, and canals.

Numerous channels, culverts, bridges, and outfalls were impacted by sediment and debris displacement and deposition as a result of the hurricanes of 2005. Much of the debris has subsequently been removed, but much remains within coastal wetlands, creeks, and bayous, and continues to impair the hydrologic and ecologic functions of the larger ecosystem.

2.2.5 Coastal Processes

Coastal processes evident in coastal Mississippi include waves, tides, littoral currents, and severe storm events. These natural factors are the primary ones affecting coastal morphology, but coastal processes are also influenced by water depth, coastal subsidence, and man-made structures.

The study area includes the Mississippi Sound, which extends approximately 12 miles south of the coastline to where it intersects with the barrier islands. These barrier islands reduce the penetration of long swells arising out of the Gulf of Mexico, resulting in reduced wave energy within the Sound. The wave height is relatively low, with a mean tidal range of only 1.47 feet.

Beaches along the Mississippi coast extend for over 26 miles from about Bay St. Louis in the west to Pascagoula in the east. Many of these beaches are periodically replenished with sand. The Belle Fontaine headland in Jackson County is considered to be the only remaining natural beach on the Mississippi mainland coast. The beach is formed by natural sand deposition provided from longshore currents. However, as residents in the area have armored coastal areas to protect their homes, the natural sand source has been altered and the beach is now suffering from sand deficiency (Oivanki and Suhayda 1994). Beaches serve as both an environmental resource and as an absorber of surge and wave energy. The Gulf Coast is generally considered to be a low-energy area except during the hurricane season (Thurman 1991). Natural changes to the coastline are episodic, associated with major storms and flooding events. High energy, short duration storm events, such as hurricanes and tropical storms, are particularly devastating to the Mississippi coast where storm frequency is high and ground elevation is relatively low.

High waters and wave action associated with such severe storms are known to remove sand dunes from their given locations and displace large amounts of sand. Other less obvious properties and processes that can have an impact on the coastline include type, wind induced currents, tidal flow, channel bathymetry, and residual tidal circulation. The natural coastal erosion rate for Mississippi is only about 2 inches per year, but may ebb and flow in many areas.

The majority of groins, jetties, breakwaters, and seawalls found along coastal Mississippi were significantly damaged or completely destroyed during Hurricane Katrina. Plans for reconstruction of these features are underway and in some cases, reconstruction has begun, some of these being projects that were recommended for construction in the Interim Report. It is expected, through various funding mechanisms, most of these features will be reconstructed as originally designed or slightly modified.

The unprecedented storm surge from Hurricane Katrina caused substantial losses to the barrier islands due to erosion. The vast majority of eroded land has not recovered, nor have the resources associated with that land. Dune systems were severely damaged or in some cases flattened. Interior forests were stripped of much of the undergrowth which consists of shrub and herbaceous layers (MDMR 2006). Many trees, dune grasses and herbaceous shrubs were killed and have not returned. Over 30,000 structures were significantly destroyed (50 %or more), with another 15,000 to 25,000 suffering moderate to minimum inundation damage.

Hurricane Katrina deposited unknown quantities of debris in coastal Mississippi marshes, covering well over 1,000 acres several feet deep. Debris fields extend well into the adjacent maritime forests covering approximately 835 acres. Smaller areas of debris deposition exist along the entire coast of Mississippi (MDMR 2006).

Overall, the footprint of the mainland shoreline along coastal Mississippi appears to have changed very little as compared to pre-Hurricane Katrina conditions; however, the elevation of the shoreline was severely eroded in some areas, such as Bay St. Louis. Sand and soil was lost along the entire coastal Mississippi shoreline (MDMR 2006).

2.2.6 Environmental Resources

The primary study area consists of the three coastal counties comprising the State of Mississippi: Hancock, Harrison, and Jackson counties, and the coastal (offshore) ecosystem including its barrier islands. This area ranges in elevation from sea level to about 30 feet. The essentially flat to gently undulating, locally swampy Coastal Lowlands are underlain by alluvial, deltaic, estuarine, and coastal deposits and merge with the fluvial-deltaic, plains of the streams of the area. This portion of coastal Mississippi has been classified as an alluvial coast, a terraced, deltaic plain. According to the Cowardin et al (1979), *Classification of Wetlands and Deepwater Habitat of the United States*, there are five major wetland and deepwater systems, four of which are found within coastal Mississippi. They include marine, estuarine, riverine, and palustrine wetland systems. Further details on ecological resources and fish and wildlife can be found in the Environmental Appendix, *Chapter 1 Coastal Mississippi Environment.*

2.2.6.1 Ecological Habitats

The marine system consists of the open ocean overlying the continental shelf and its associated high energy coastline. Within coastal Mississippi, the marine system is the area along the Gulf of Mexico front south of the barrier islands. It is comprised of the intertidal beachfront of the barrier islands along the Gulf of Mexico, and subtidal habitat which consists of the unconsolidated sandy or silty water bottoms. Estuarine systems within coastal Mississippi consist of deepwater tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open partly obstructed or sporadic access to the open ocean and in which ocean water is occasionally diluted by freshwater runoff from the land. Mississippi Sound consists of both sub-tidal and inter-tidal estuarine systems.

Riverine systems are bounded on the landward side by upland, by the channel bank, or by wetlands dominated by trees, shrubs, and persistent emergents. Cowardin et al (1979) divides the riverine system into four sub-systems: tidal, lower perennial, upper perennial, and intermittent, two of which are found in coastal Mississippi. These include freshwater tidal marsh and lower perennial emergent wetlands.

The palustrine system includes nontidal wetlands dominated by trees, shrubs, and persistent emergents. It also includes small, shallow, permanent or intermittent water bodies, such as ponds or coastal plain depressional wetlands. Coastal Mississippi is interlaced with a rich and diverse complex system of vital wetlands that provide floodwater storage, groundwater recharge, water filtering and purification systems, as well as wildlife habitat that include Pine Savannahs, headwater slopes (Bayhead Drain), swamps, and ephemeral pools.

Numerous problems have been identified that impact the sustainability and productivity of coastal Mississippi wetland habitats. Freshwater newly emergent marshes are formed in pro-grading deltas that depend on flooding waters to supply their nutrient needs. One of the challenges facing the sustainability of the freshwater marsh is a lack of sediment from upstream. Lack of sediment also hampers natural accretion and causes further erosion and subsidence. Coastal Mississippi also has a problem with invasive species colonizing within areas that have been altered in some form or fashion due to man's disturbance. The majority of the coastal preserve systems have been invaded with these invasive species which continue to out-compete the native species, heavily depended on by native fauna. Also, pollutants cause eutrophic conditions, harm plants and wildlife. A more comprehensive discussion of the *Ecological Habitats* is been provided in the Environmental Appendix.

2.2.6.2 Wetlands

Coastal wetlands include swamps and tidal flats, coastal marshes, and bayous. They form in sheltered coastal environments often in conjunction with river deltas, barrier islands, and estuaries. They are rich in wildlife resources and provide nesting grounds and important stopovers for waterfowl and migratory birds, as well as spawning areas and valuable habitats for commercial and recreational fish. Intertidal and subtidal bottoms are populated by communities of macrofauna whose structure is dependent upon substrate, salinity, temperature, depth, and ecological relationships.

Coastal wetlands can be dominated by saltwater, as found along the Gulf coast of Louisiana, or they can contain a complex and changing mixture of salt and freshwater, like the estuaries of the Chesapeake, Galveston, and San Francisco Bays. Mississippi Sound is bordered to the east and west by two expansive marsh systems, Grand Bay Marshes along the eastern boundary and Hancock County Marshes along the western boundary. The Pascagoula River marsh system is located primarily inland of the shoreline. Western Hancock County along Mississippi Sound consists of extensive marshes that have suffered from lack of sediment and freshwater flows resulting in increased saltwater intrusion and coastal erosion. The lack of sediment has resulted in a reduction of natural accretion and marsh building. The Grand Bay Marshes and wet pine savannahs along the eastern portion of the state have also experienced severe coastal erosion and are further threatened by increased saltwater intrusion.

Freshwater marshes act in many ways like salt marshes, but the biota reflect the increased diversity made possible by the reduction of the salt stress found in saltwater marshes. Plant diversity is high, and more birds use these freshwater marshes than any other marsh type. Because they are inland from the saline parts of the estuary, they are close to urban centers, which make them more prone to human impacts associated with urbanization, runoff, development pressures, etc. The freshwater newly emergent marshes are formed in pro-grading deltas that depend on flooding waters to supply their nutrient needs. One of the challenges facing the sustainability of the freshwater marsh is a lack of sediment and the influx of pollutants from upstream. Marshes serve as floodwater retention and over time, the loss of these marshes has contributed to increased flooding throughout the coast, especially in the developed areas south of Interstate-10.

Oyster Bayou is a prime example of what has been described. Oyster Bayou was once a small tributary to Mississippi Sound that meandered through the historic grounds of Jefferson Davis' mansion, known as Beauvoir. As a result of the U.S. Highway 90 construction, development of the Mississippi Coast Coliseum, and many other residential and commercial developments, Oyster Bayou has been degraded and no longer functions as a natural system. Local efforts are currently underway to restore Oyster Bayou; however, additional study/efforts are needed to effectively restore this natural system.

Wet pine savannah wetlands found in Coastal Mississippi provide for diverse habitat for a number of plants and animals including many T&E species found only in these unique habitats. Wet pine savannah wetlands are commonly referred to as sponges that provide floodwater retention, groundwater recharge, and water purification. This wetland habitat is under increased developmental pressures due to the extreme and urgent housing need faced by Mississippians as they are trying to rebuild. This habitat is becoming fragmented and with the increased development, fire maintenance is increasingly harder to perform. Due to the nature of the flat coastal plains with little relief, these lands are some of the first to be considered for housing development. Urbanization and developmental pressure have created what are commonly referred to as forested wetlands. These wetlands are significantly different than what occurred naturally in wet pine savannah habitats. Lack of fire and altered hydrology allow hardwoods, various shrub species, and increased pine basal area to dominate what should be emergent grasses with very few pines in the overstory layer. Fragmentation causes loss of wildlife corridors and contiguous expanses of habitat necessary for continued species existence. Coastal Mississippi has lost over half of its wet pine savannahs due to urbanization throughout the area; thus, creating a threatened ecosystem that in turn is home to many T&E species, such as the Mississippi sandhill crane. Because of the loss of these habitats, the species dependent upon them are increasingly becoming diminished.

The anthropogenic loss of the habitat can be documented by looking at estimations of wetland loss on the Mississippi Coast. Eleuterius (1973) noted that approximately 1,000 acres of marshland was filled on the Mississippi Coast prior to the 1930's. However, wetland loss accelerated after that time. Oivanki et al. (1995) conducted a study that showed that 13% of the total coastal marsh area in the Mississippi coast zone was lost between the 1950's and 1992. The amount of wetland loss was highest in Jackson County and lowest in Harrison County. Developed land use tripled during the study period. It is the desire of the State of Mississippi to replace about 10,000 acres of this loss as stated. Failure to address the loss of this habitat in the Gulf of Mexico region threatens the long-term health of the entire ecosystem and human culture, with the attendant loss of billions of dollars of marine-related resources.

Wetlands, marshes, and nearshore marine and estuarine habitat are the nursery grounds for the entire marine food chain in the Gulf of Mexico. Pollution, development, and other factors are destroying such habitat throughout the Gulf region. As this habitat is destroyed, it further depletes the species that form the base of the food chain throughout the Gulf of Mexico. Numerous species of marine flora and fauna begin their life cycles in marshes and wetlands. Ultimately, the entire Gulf of Mexico ecosystem is threatened by the accelerated destruction of this habitat. More detailed information on these habitats can be found in the Environmental Appendix

2.2.6.3 Fish and Wildlife

Many species of invertebrates and vertebrates make up the various fauna population along the Gulf coast. Invertebrate populations in Mississippi Sound and the nearshore area of the Gulf of Mexico transfer energy through the coastal food web. Microscopic estuarine zooplankton live throughout the water column with limited mobility. Zooplankton includes such organisms as copepods, protozoans, chaetognaths, pteropods, tunicates, ctenophores, and siphonophores. Larval stages of benthic forms and eggs and larval stages of many fish species are often interspersed throughout zooplankton. Many important commercial species feed upon zooplankton.

Vittor and Associates (1982) investigated the macrofauna of Mississippi Sound and selected areas in the Gulf of Mexico. Over 532 taxa from offshore Mississippi and Alabama and 437 taxa from the Mississippi Sound were identified. Densities of individuals varied from 910 to 19,536 individual/ yard^2 for the offshore and 1,200 and 38,863 individual/ yard^2 for the Sound area. Abundance of macrofauna is temporal with greatest densities occurring from fall to spring.

Oyster production in Mississippi depends on public reefs managed by the Mississippi Department of Marine Resources (MDMR). The State of Mississippi accounts for about 13% to 17% of Gulf oyster landings. Reefs are located along the coast across the entire state with the largest reefs near the western boundary. According to a 1966 survey by W.J. Demoran, there were 9,934 acres of oysters. At that time, there were 582 acres of planted oyster beds. Additional acreage has been planted. A few small areas of oyster bottom have been leased for private development; however, production from these areas has been negligible. There have been considerable annual variations in size of productive areas due to natural environmental fluctuations, such as freshwater flow into the oyster beds. Many of Jackson County's most productive areas have been closed to harvest due to increased pollution associated with coastal development.

Many commercially important species of crustaceans are harvested in Mississippi Sound and the nearshore of the Gulf of Mexico. Brown shrimp (*Penaeus aztecus*) is the main shrimp species harvested by commercial fishermen in the Gulf of Mexico and is the most important commercial species in the Mississippi Sound and Mobile Bay area. White shrimp and blue crab are also harvested within the study area. In addition to those commercial species, there is a very diverse community of crustaceans within Mississippi Sound and adjacent waters including a wide variety of forms and habitat preferences. Epibenthic crustaceans dominate the diet of flounder, catfish, croaker, porgy, and drum. A description of the EFH and managed species are included in the Environmental Appendix, Section 1.5.

Christmas and Waller (1973) reported 138 fish species in 98 genera and 52 families taken from areas across Mississippi Sound. The major fisheries landed along the Mississippi Gulf coast are anchovies, menhaden, mullet, croakers, shrimp, and oyster. Jackson County, primarily the ports of Pascagoula and Moss Point, receives greater than 85% of all Mississippi landings, including all industrial fish (menhaden), 95% of the mullet, trout, and red snapper, and 74% of the croaker landed (Corps 1992).

Coastal wetlands of Mississippi Sound, St. Louis Bay, Biloxi Bay, Pascagoula Bay, and the tidal Pascagoula River provide the resource base for commercial and marine recreational fishing and tourism in Mississippi. The dockside value of commercial fish landings in Mississippi was almost $42 million in 1995. Recreational fisheries also play an important role in the state's economy. In 1991, 500,000 people spent more than $236 million fishing in Mississippi's waters, generating almost $14 million in state sales tax, resulting in $131 million in earnings, and supporting more than 8,000 jobs. Approximately one-quarter of the recreational fishing occurs in coastal waters. Communities, such as Moss Point, Pascagoula, Gautier, Ocean Springs, Biloxi, Long Beach, Gulfport, Pass Christian and Bay St. Louis, all depend on fishing to support their local economies.

Coastal Mississippi supports an array of reptiles, amphibians, birds, and mammals. Reptiles and amphibians found in the area include snakes, turtles, lizards, toads, frogs, salamanders, and crocodilians. Coastal Alabama and Mississippi have a great diversity of reptiles including 23 species of turtles, 10 species of lizards, 39 species of snakes, and the alligator. Eighteen species of salamanders and 22 species of frogs and toads are indigenous to the coastal region.

Mammals found within the area include marsupials, moles and shrews, bats, armadillos, rabbits, rodents, carnivores, even-toed hoofed mammals, and dolphins. Mammals occur within all habitats of the system, using underground burrows, the soil surface, vegetative strata, the air, and the water for feeding, resting, breeding, and bearing and rearing young. There are 57 species of mammals found in the area. Several species of mammals include the raccoon, river otter, gray fox, striped skunk, mink, whitetailed deer, bottlenose dolphin, beaver, possum, and nine-banded armadillo. A number of whales are known to occur offshore Mississippi and Alabama and occasionally are sighted within Mississippi Sound.

Over 300 species of birds have been reported as migratory or permanent residents within the area, several of which breed there as well. Shorebirds include osprey, great blue heron, great egret, piping plover, sandpiper, gulls, brown and white pelicans, American oystercatcher, and terns. Birds of the area eat a great variety of foods, are also food to many predators, and exhibit a diversity of nesting behaviors.

2.2.6.4 Federal T&E Species and Their Habitat Requirements

Coastal Mississippi is home to 26 federally listed T&E, or candidate species. Species known to occur within the project area are shown below. Table 2-1 lists those species that would typically occur within in-shore, estuarine, or upland habitats. Several other T&E species, listed by NOAA, PRD, are known from marine habitats in the Gulf of Mexico. These species are blue whale (*Balaenoptera musculus*), finback whale (*Balaenoptera physalus*), humpback whale (*Megaptera novaeangliae*), sei whale (*Balaenoptera borealis*), sperm whale (*Physeter catadon*), hawksbill sea turtle (*Eretmochelys imbricata*), and leatherback sea turtle (*Dermochelys coriacea*). These T&E marine species might be occasional visitors to the project area.

Table 2-1
Federally Listed T&E Species

Common Name	Scientific Name	Status	County	Habitat
Alabama red-bellied turtle	*Pseudemys alabamensis*	LE	Harrison, Jackson	Submerged aquatic vegetation in brackish coastal rivers; freshwater reaches
Black pine snake	*Pituophis melanoleucus ssp. lodingi*	C	Harrison, Jackson	Fire-dependent, upland longleaf pine forests
Brown pelican	*Pelecanus occidentalis*	LE	Hancock, Harrison, Jackson	Feeds over water in coastal areas, nests on small islands
Eastern indigo snake	*Drymarchon corais couperi*	LT	Harrison, Jackson	Fire-dependent, upland longleaf pine forests
Gopher tortoise	*Gopherus polyphemus*	LT	Hancock, Harrison, Jackson	Fire-dependent, upland longleaf pine forests
Green sea turtle	*Chelonia mydas*	LT	Hancock, Harrison, Jackson	Shallow coastal waters with SAV and algae, nests on open beaches.
Gulf sturgeon,	*Acipenser oxyrhynchus desotoi*	LT	Hancock, Harrison, Jackson	Migrates from large coastal rivers to coastal bays and estuaries
Inflated heelsplitter mussel	*Potamilus inflatus*	LT	Harrison	Soft, stable substrata in slow to moderate currents of tributaries and large rivers
Kemp's ridley sea turtle	*Lepidochelys kempii*	LE	Hancock, Harrison, Jackson	Nearshore and inshore coastal waters, often in salt marshes
Loggerhead sea turtle	*Caretta caretta*	LT	Hancock, Harrison, Jackson	Open ocean; also inshore areas, bays, salt marshes, ship channels, and mouths of large rivers
Louisiana black bear	*Ursus americanus luteolus*	LT	Hancock, Harrison, Jackson	Bottomland hardwood forest; frequently ranges into other habitats
Louisiana quillwort	*Isoetes louisianensis*	LE	Hancock, Harrison, Jackson	Small blackwater streams with sand and gravel substrate and forest cover
Manatee, West Indian	*Trichechus manatus*	LE	Hancock, Harrison, Jackson	Fresh and salt water in large coastal rivers, bays and estuaries.
Mississippi gopher frog	*Rana capito sevosa*	LE	Harrison, Jackson	Fire-dependent, upland longleaf pine forests; open, ephemeral upland pools

Common Name	Scientific Name	Status	County	Habitat
Mississippi sandhill crane	*Grus canadensis pulla*	LE	Jackson	Wet pine savannah
Pearl darter (Pascagoula River System)	*Percina aurora*	C	Jackson	Rivers and large creeks with sand and gravel bottoms and flowing water.
Piping plover	*Charadrius melodus*	LT	Hancock, Harrison, Jackson	Barrier islands and coastal beaches
Red-cockaded woodpecker	*Picoides borealis*	LE	Harrison, Jackson	Fire-dependent, upland longleaf pine forests
Yellow-blotched map turtle	*Graptemys flavimaculata*	LT	Jackson	Rivers and large creeks with habitat suitable for basking

LT = listed threatened, LE = listed endangered, C = candidate for listing, Bald eagle was delisted from threatened in August 9, 2007.

2.2.7 Water Quality

Mississippi Department of Environmental Quality (MDEQ) monitors the water quality of surface water throughout the state. Water quality assessments are made from this information that give general characterizations of water body health. The state's most comprehensive assessment report is found in the Federal CWA Section 305(b) Water Quality Inventory Report.

Water Quality Assessments are technical reviews of physical/chemical, bacteriological, biological, and/or toxicological data and information to determine the quality of the state's surface water resources. Monitoring data are compared to the "State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters" in order to make decisions on whether a water body is supporting or not supporting its designated uses such as aquatic life support, water contact recreation, fish/shellfish consumption, and drinking water. Detailed discussion on water quality can be found in the Environmental Appendix.

2.2.8 Hazardous, Toxic, and Radioactive Wastes

Due to the extent and large number of real estate parcels associated with the environmental, non-structural and structural measures along with the potential realignment of the structural aspects of this project, no site-specific preliminary assessments have been performed to identify the possibility of hazardous waste. For recommended plan features that include further study or construction, these studies will be conducted during the next phase of work. A limited number of preliminary assessments were completed during the Interim Project phase of work, but the extent of these assessments only covered the limited area designated for these projects. The real estate costs appearing in this report therefore will not reflect any costs for remediation design and/or treatment and/or removal or disposal of these materials in the baseline cost estimate.

2.2.9 Cultural and Archaeological Resources

Significant cultural resources as defined by the NHPA are those sites that are considered eligible for or are included in the National Register of Historic Places (National Register). These sites are known as historic properties. Historic properties can include buildings or other standing structures; historic or prehistoric districts (such as the historic districts in Biloxi and Ocean Springs); archaeological sites such as Indian mounds or other remains of prehistoric life; objects such as statues or paintings; or sunken vessels. Traditional cultural properties can also be considered significant cultural resources because of their traditional religious or cultural importance to an Indian tribe or other traditional community.

Properties, such as cemeteries or buildings that are less than 50 years old are usually not considered eligible for the National Register, but there are exceptions. For example, certain buildings associated with the Cold War are considered so important to our history that they are eligible for the National Register.

Along the Mississippi Gulf Coast, historic properties can be roughly defined within two categories. The categories are the built environment (standing structures) and archaeological sites. The vast majority of historic properties listed on the National Register are those of the built environment. To date 62 standing structures, 14 historic districts, and one ship have been listed. Fort Massachusetts and the French Warehouse sites are cultural resources found within Gulf Islands National Seashore on Ship Island. Fort Massachusetts has survived many hurricanes, including the most recent one – Hurricane Katrina. Many more standing structures are considered eligible for the National Register, but have not been formally nominated. These are also considered potential historic properties. Historic districts have been designated in Biloxi, Ocean Springs, and Bay St. Louis.

In contrast, very few archaeological sites have been formally nominated to the National Register. However, numerous sites still meet the criterion of definition as historic properties. These include prehistoric earthworks and mounds, shell middens, village sites, and historic occupation areas including extinct town sites. Currently over 200 recorded archaeological sites are considered potential historic properties.

In addition to National Register eligible properties, the Mississippi Coast also contains several National Historic Landmarks and designated Mississippi Landmarks. These include Beauvoir and the Mullato Bayou prehistoric earthworks.

The vast majority of historic and prehistoric sites are found along the immediate coastal strand and adjacent to estuarine systems. Preference for well drained, sandy soils adjacent to water sources is apparent. Coast wide survey work performed by both state (Giliberti n.d.) and private researchers (Blitz and Mann 2000) have found a distinctive focus on the immediate coastal and estuarine locations. Unfortunately, the geographic placement of these resources has made them extremely vulnerable to destruction from continued occupation and development, as well as vulnerable to the effects of tropical storms and hurricanes.

Modern development along the Mississippi coast has affected both archaeological sites and standing structures, including individual structures and historic districts in the project area. Key issues are soil disturbance and construction. Soil disturbance affects archaeological sites, and construction of new buildings and associated infrastructure can affect the view shed and "feel" of a historic building or district or cause demolition or alteration of historic buildings.

From the early 1970s to the present, construction in the project area has greatly increased. In fact, more development and construction has occurred in the three counties that are part of the project area than anywhere else in the state. Land use studies show that between 1972 and 2000 both medium-density and high-density urban land use areas increased by more than 90 percent in the study area; overall, developed land use increased by almost 70 percent during that period (MARIS 1992, 2000; USGS 1972; USGS and USEPA 1992). This sizeable increase in developed land is caused in part by the casinos and related infrastructure, residential, and commercial construction. The development involves large areas of soil disturbance, which destroys archaeological sites.

Previous archaeological and architectural studies along the Mississippi Gulf Coast have documented the destruction caused by natural forces, most notably hurricanes. Standing structures are often the most dramatic and visible witnesses to this destruction. However, prehistoric and historic archaeological sites are also extremely vulnerable. Shell middens, found along the immediate shoreline and within coastal marshes and estuaries, often are flipped and re-deposited by the storm surge and wave action of hurricanes. This effectively destroys much of the value of the sites. Sites such as Indian villages and historic town sites such as those along the bluff on Bay St. Louis can also be destroyed by such wave action. In addition, post storm activities offer many more mechanisms for site destruction. These include clearing of timber by use of skidders and other heavy equipment, debris removal, and reconstruction. The destructiveness of these activities is well documented from the years following hurricane Camille which struck the area in 1969.

Hurricane Katrina has been documented to have destroyed a vast majority of the standing historic properties within Hancock County, and a large number of those within Harrison and Jackson Counties. The size and strength of the storm surge has also undoubtedly had as much destruction on archaeological sites. Post hurricane activities have further impacted the remaining historic properties.

Protection from the immediate and post-effects of hurricanes should be considered as beneficial to cultural resources. While some historic properties may be adversely affected by protection plans, long term prevention of damage should be considered a positive measure for historic properties, in particular standing structures.

2.2.10 Socio-Economics

2.2.10.1 Land-Use and Land Cover

Land-use describes what is practiced, permitted, or planned. Land cover, an increasingly important attribute of land-use, describes what is physically on the ground. It is defined as the type of material that covers the earth's surface at a specific location at a specific time. Land-use is the manner in which human beings use a specific tract of the earth's surface. Land cover can change dramatically in a short period while land use remains the same. A field that had a land cover of wheat in May, for example, might be bare soil in August, though the land use remains agricultural.

In 2000, natural vegetation covered 82% of the three coastal counties. Forest, scrub-shrub/cutover/barren, and emergent wetlands were the predominant natural cover types. Developed land covered about only 8% of the counties. More than half of the developed land was medium-density urban land, 27% was high-density urban land, and the rest was transportation infrastructure (roads, streets, bridges). Impervious surfaces covered approximately 4% of the three-county region. The largest concentrations of developed land were near the coast along Highway 90 and south of Interstate-10.

In 2000, natural cover accounted for 84% of Hancock County's total acreage. Forest, scrub-shrub/cutover/barren, and emergent wetland were the predominant natural cover types. Developed land accounted for 5% of the county, and the rest was primarily transportation infrastructure and high-density urban land. Impervious surfaces covered slightly more than 2% of the county. Most of Hancock County's developed land is medium-density urban land and is in the coastal areas of Waveland, Clermont Harbor, Lakeshore, and Bay St. Louis south of U.S. Highway 90; the NASA Test Site complex in the western portion of the county; and the area between Interstate-10 and Bay St. Louis.

In 2000, natural vegetation covered 78% of Harrison County. Most of the natural areas were in forest, scrub-shrub/cutover/barren, and emergent wetlands. Developed land acreage accounted for 11% of the total land area. About half of the developed areas were medium-density urban land, and the remainder was either high-density urban land or transportation infrastructure. Impervious surface area covered 5% of the county in 2000. Developed land in Harrison County is primarily concentrated along the coastal strip between Pass Christian and Biloxi, the area straddling U.S. Highway 49 between Gulfport and Interstate-10, just north and west of the intersection of Interstate-10 and U.S. Highway 49, and north of Big Lake and the Back Bay of Biloxi and D'Iberville. Approximately two-thirds of this area is medium-density urban land and one-third is high-density urban land or transportation infrastructure, particularly in the cities of Gulfport and Biloxi.

In 2000, natural cover accounted for 84% of the land in Jackson County. Forest, scrub-shrub/cutover/barren, and emergent wetland were the most abundant natural cover types. Developed land acreage constituted 7% of the county's land area. About half of the developed land acreage was medium-density urban land and the rest was high-density urban land and transportation infrastructure. Impervious surfaces covered 3% of the county. Developed land in the county is primarily concentrated along the coastal strip between Ocean Springs and Pascagoula south of U.S. Highway 90. Most of the high-density urban land is concentrated in Pascagoula.

POST-HURRICANE KATRINA

Hurricane Katrina damaged tens of thousands of acres in Coastal Mississippi. Coastal Mississippi was subjected to intense winds and salt spray affecting hundreds of acres of standing trees, wetlands, and other vegetation and it is still unknown at this point how much will survive. The Mississippi Forestry Commission estimated that 60% of the coastal forests have been lost. The MDMR estimates 2,500 acres of state owned coastal preserve lands have suffered moderate to severe tree damage. Hurricane Katrina completely obliterated a 2-block zone along the entire Mississippi coastal shoreline and severely crippled the area located north to Interstate-10. Tens of thousands of uninhabitable or completely obliterated homes, thousands of small businesses, dozens of schools and public buildings have been ruined and remain unusable still. The highways, arterial roadways, ports, railroads, and water and sewer systems have suffered varying degrees of destruction and some suffered complete destruction.

Plans are being developed to address rebuilding and redevelopment within coastal Mississippi. Governor Haley Barbour introduced a commission focused on redevelopment of coastal Mississippi and several design charettes and public meetings were held in order for smart growth to occur. Destroyed and damaged infrastructure is being reconstructed and business owners and homeowners, through federally funded disaster relief funds, loan programs, and small business loan programs, are beginning reconstruction. Many residents of coastal properties are in the process of rebuilding their homes and some of those have already moved into the residences. Environmental restoration and hurricane protection programs are in initial planning stages, which should result in analysis of potential protection and redevelopment projects. In summary, rebuilding efforts in some areas of coastal Mississippi are quickly in motion while there are still some whole communities that have yet to rebuild.

2.2.10.2 Historic (Pre-Hurricane Katrina) Population Trends

The 1950-2000 population levels and growth for the U.S., Mississippi, the three-county study area, and each county are presented in Table 2-2. During this fifty year period, the population of the three-county study area grew by 186.6 percent. This is 5.6 times the Mississippi percentage population growth of 33.2 percent and 2.2 times the U.S. percentage population growth of 86.0 percent for the same timeframe. The three-county area accounted for 32.7 percent of the nominal population growth for Mississippi from 1950 to 2000.

Table 2-2
1950-2000 Population Levels and Growth (in thousands)

	U.S.	Mississippi	Study Area	Hancock County	Harrison County	Jackson County
1950	151,326	2,179	127	12	84	31
1960	179,323	2,178	189	14	119	56
1970	203,212	2,217	239	17	134	88
1980	226,546	2,521	301	25	158	118
1990	248,710	2,573	312	32	165	115
2000	281,421	2,903	364	43	190	131
50 Year Nominal Change	130,095	724	237	31	106	100
50 Year Percentage Change	86.0%	33.2%	186.6%	258.3%	126.2%	322.5%

Source: U.S. Census Bureau, 2000 Census

2.2.10.3 Existing (Post-Hurricane Katrina) Socio-economic Conditions

Population: The 2000-2005 population level and growth estimates for the U.S., Mississippi, the three-county study area, and each county are displayed in Table 2-3. The July 1, 2000 to July 1, 2005 timeframe is the most recent before Hurricane Katrina made landfall in late August of 2005. During this five year period, the population of the three-county study area grew by 2.86 percent. This is 1.4 times the Mississippi percentage population growth of 2.10 percent and 0.6 times the U.S. percentage population growth of 5.06 percent. The three-county study area accounted for 17.4 percent of the nominal population growth for Mississippi from 2000-2005. The three-county study area is one of the more densely populated areas in Mississippi. Hancock County has a lower population density than Harrison County or Jackson County.

Table 2-3
2000-2005 Estimates of Population Levels and Growth

	U.S.	Mississippi	Study Area	Hancock County	Harrison County	Jackson County
July 1, 2000	282,216,952	2,848,634	364,863	43,283	189,699	131,881
July 1, 2001	285,226,284	2,856,108	366,362	43,944	189,512	132,906
July 1, 2002	288,125,973	2,863,091	367,498	44,607	189,996	132,895
July 1, 2003	290,796,023	2,874,171	367,790	45,166	189,189	133,435
July 1, 2004	293,638,158	2,892,668	372,885	45,821	192,129	134,935
July 1, 2005	296,507,061	2,908,496	375,304	46,546	193,187	135,571
5 Year Nominal Change	14,290,109	59,862	10,441	3,263	3,488	3,690
5 Year Percentage Change	5.06%	2.10%	2.86%	7.54%	1.84%	2.80%

Source: U.S. Census Bureau, Population Division

The 2000-2004 population changes for the U.S., Mississippi, the three-county study area, each county, and major cities within each county are displayed in Table 2-4. The city with the greatest nominal or percentage population growth in the study area from 2000 to 2004 is Gautier with population growth of 5,172 persons or 44.28 percent.

Table 2-4
2000-2004 Urban Growth and Distribution

	2000	2004	2000-2004 Nominal Change	2000-2004 Percentage Change
U.S.	281,421,906	293,655,404	12,233,498	4.35%
Mississippi	2,844,658	2,902,966	58,308	2.05%
Three-County Area	363,988	373,762	9,774	2.69%
Hancock County	42,967	45,933	2,966	6.90%
Bay Saint Louis	8,209	8,293	84	1.02%
Waveland	6,674	7,120	446	6.68%
Harrison County	189,601	192,393	2,792	1.47%
Biloxi	50,644	50,115	-529	-1.04%
D'Iberville	7,608	7,757	149	1.96%
Gulfport	71,127	71,850	723	1.02%
Long Beach	17,320	17,258	-62	-0.36%
Pass Christian	6,579	6,758	179	2.72%
Jackson County	131,420	135,436	4,016	3.06%
Gautier	11,681	16,853	5,172	44.28%
Ocean Springs	17,225	17,698	473	2.75%
Pascagoula	26,200	25,865	-335	-1.28%

Source: U.S. Census Bureau, Population Division

<u>Racial Distribution</u>: Table 2-5 shows the racial distribution for the U.S., Mississippi, each county in the study area, and also includes the racial distribution for the major cities in each county as of 2000.

Table 2-5
2000 Population Racial Distribution (percent)

	White	Black	Hispanic	Asian	American Indian	Other	Multiple Races
U.S.	75.1	12.3	12.5	3.6	0.9	5.5	2.4
Mississippi	61.4	36.3	1.4	0.7	0.4	0.5	0.7
Hancock County	90.2	6.8	1.8	0.9	0.6	0.3	1.1
Bay Saint Louis	80.2	16.6	1.7	1.1	0.4	0.2	1.4
Diamondhead	95.3	1.8	2.9	0.9	0.4	0.5	1.1
Pearlington	77.6	20.4	1.4	0.1	0.4	0.1	1.4
Shoreline Park	94.6	2.0	1.9	0.3	1.0	0.3	1.7
Waveland	85.4	11.2	2.0	1.5	0.5	0.5	0.9
Harrison County	73.1	21.1	2.6	2.6	0.5	0.9	1.7
Biloxi	71.4	19.0	3.6	5.1	0.5	1.4	2.4
D'Iberville	78.2	11.4	2.6	7.0	0.4	0.9	2.1
Gulfport	62.2	33.5	2.6	1.3	0.4	0.5	1.6
Long Beach	87.5	7.4	2.3	2.6	0.4	0.7	1.4
Pass Christian	65.9	28.2	1.7	3.5	0.6	0.6	1.2
Jackson County	75.4	20.9	2.1	1.6	0.3	0.7	1.1
Escatawpa	80.5	17.6	0.6	0.7	0.3	0.1	0.7
Gautier	68.2	27.7	3.2	1.3	0.5	0.9	1.4
Moss Point	28.0	70.6	1.0	0.2	0.2	0.4	0.6
Ocean Springs	87.7	7.0	2.5	2.6	0.4	0.7	1.5
Pascagoula	67.2	29.0	3.9	1.0	0.2	1.7	1.0

Source: U S. Census Bureau, 2000 Census

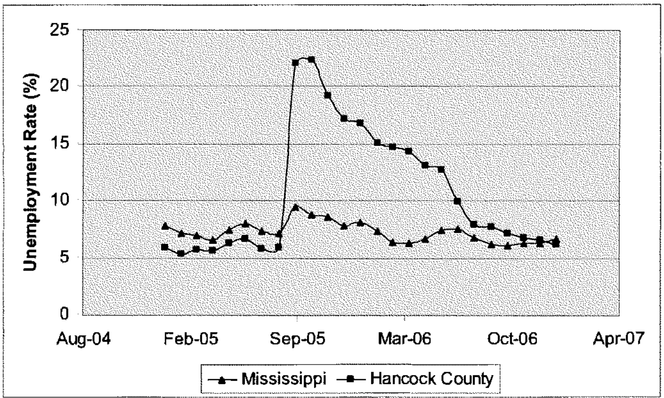
Employment Distribution: The 2002 distribution of employment by major sectors for Mississippi, the three-county study area, and each county is shown in Table 2-6. Approximately 5.4% of Mississippi's Professional and Technical employment could be found in Hancock County in 2002. Hancock County is home to the John C. Stennis Space Center. The Stennis Space Center, with over 4,600 employees is NASA's primary center for rocket propulsion testing. Harrison County is a popular vacation destination for its beaches and casinos. Harrison County accounts for 26.9 percent of Mississippi's employment in the arts and 20.0 percent of Mississippi's employment in food and accommodation services. Jackson County features Pascagoula Harbor. In 2004, 66.7 percent of Mississippi's waterborne commerce volume and 1.3 percent of U.S. volume moved through Pascagoula Harbor. Pascagoula Harbor's annual volume increased 44% from 1986 to 2004. Northrop Grumman Ship Systems' Ingalls Operations, with over 10,000 employees, can also be found in Jackson County. Jackson County accounted for 8.8 percent of Mississippi's employment in manufacturing.

Table 2-6
2002 Employment Distribution by Major Sector

	Mississippi	Study Area	Hancock County	Harrison County	Jackson County
Manufacturing	182,822	21,500	1,000	4,500	16,000
Wholesale	35,316	2,963	251	2,112	600
Retail	135,838	18,698	1,586	11,548	5,564
Real Estate	9,665	1,585	131	1,084	370
Professional & Technical	29,023	5,205	1,555	2,050	1,600
Administration	46,115	5,821	1,280	3,211	1,330
Education	1,678	204	20	100	84
Health & Social Care	131,976	17,549	500	12,429	4,620
Arts	9,292	2,700	100	2,500	100
Food & Accommodation	109,405	27,523	2,114	21,822	3,587
Other Services	22,180	3,558	176	2,067	1,315

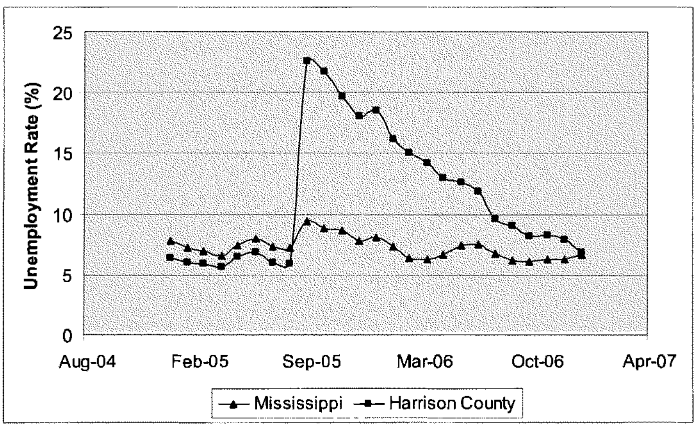
Source: U S Census Bureau, 2002 Economic Census

Unemployment: The non-seasonally adjusted unemployment rates for Mississippi and each county in the study area from January 2005 to January 2007 are displayed graphically in Figures 2-3, 2-4, and 2-5. Unemployment rates within the study area increased dramatically following Hurricane Katrina, but have since recovered to roughly pre-Katrina levels.



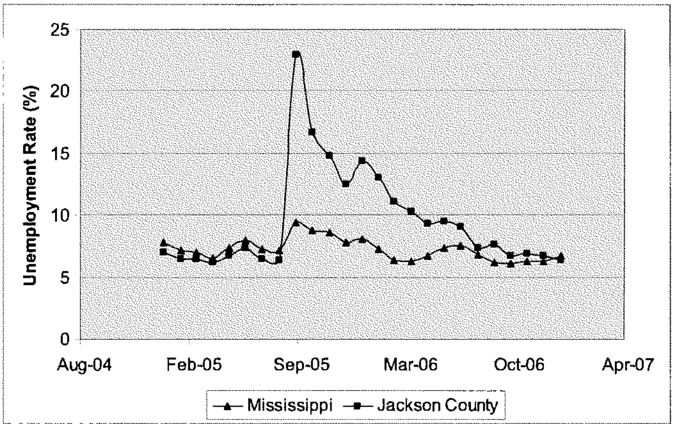
Source: Bureau of Labor Statistics

Figure 2-3
Non-Seasonally Adjusted Unemployment Rates for MS and Hancock County



Source: Bureau of Labor Statistics

Figure 2-4
Non-Seasonally Adjusted Unemployment Rates for MS and Harrison County



Source: Bureau of Labor Statistics

Figure 2-5
Non-Seasonally Adjusted Unemployment Rates for MS and Jackson County

Income and Poverty: Median income and poverty levels for the U.S., Mississippi and each county in the study area for 2004 are displayed in Table 2-7. Each of the three counties in the study area had a higher median income and a lower poverty rate than that of Mississippi in 2004.

Table 2-7
2004 Median Income and Poverty Levels

	Median Income	Nominal Poverty	Poverty Rate
U.S.	$44,334	37,039,804	12.7%
Mississippi	$34,278	549,224	19.3%
Hancock County	$36,285	7,737	16.6%
Harrison County	$35,576	31,809	16.9%
Jackson County	$40,418	20,256	15.0%

Source: U.S. Census Bureau, Small Area Income & Poverty Estimates

2.2.11 Transportation

The Mississippi Gulf Coast has two deep draft harbors, Gulfport and Pascagoula, and many other shallow draft channels, such as Pass Christian and Biloxi. Although there are some smaller airports throughout coastal Mississippi, the Gulfport-Biloxi International Airport is the only passenger airport accepting major commercial airlines. Stennis International Airport, located 8 miles north of Bay St. Louis, is used by NASA. The Mississippi Gulf Coast is served by three (3) railroads including two Class I railroads. These railroads are CSX Transportation Railroad, Kansas City Southern (KCS) Railroad, and Port Bienville Railroad. CSX is a Class I railroad serving the developed portion of the Mississippi Coastal Area. Its main lines traverse most of the region's municipalities. The 94-mile CSX track has an east-west orientation and serves as a major connection between the deepwater ports in New Orleans and Mobile. KCS Railroad is the second Class I railroad serving the study region. Its main line has a north-south orientation extending approximately 69 miles northward from the Port of Gulfport through Harrison, Stone, and Forrest (Forest) (Forest) Counties. The Port Bienville Shortline Railroad is a Class III railroad with 9 miles of track owned and operated by the Hancock County Port and Harbor Commission. It serves the Port Bienville Industrial Park and connects with the CSX southwest of Waveland.

2.2.12 Community Infrastructure and Municipal Services

This analysis considers the state of infrastructure as they currently exist, post-Katrina. The geographical region evaluated for utilities encompasses coastal Mississippi, which includes Hancock, Harrison, and Jackson Counties. Issues related to the release of contaminants municipal and industrial waste facilities in coastal Mississippi from the Hurricane Katrina surge were not significant as compared to Louisiana. With the exception of central Jackson County coastal Mississippi is predominately residential and light commercial. The major concerns dealt with public water and wastewater facilities and these are being considered for the 6 county coastal area by a state-commissioned consortium in parallel with the MsCIP effort. The existing industrial facilities fared rather well during Katrina. There was some discharge from the holding ponds at Dupont on St. Louis Bay but these were minor. There were no offsite discharges from the major industrial facilities, Northrup Grumman, Chevron, Mississippi Phosphate, First Chemical, located in Pascagoula due to the quality of their containment features.

2.2.12.1 Water Supply

Approximately 88 community water systems provide potable water to the tri-county area of the Mississippi Gulf Coast. The water they provide is available for residential, commercial, industrial, and agricultural use, including landscape irrigation, and it is delivered by a system of wells, water distribution piping, and water storage tanks that together make up the water supply infrastructure of coastal Mississippi. All of these systems rely on groundwater as their sole source of supply for drinking water, although in Jackson County surface water is used for industrial end use. The inland portions of the three-county region are largely without public water systems. Throughout the entire state of Mississippi, increased pumping rates has altered the natural groundwater flow direction. The natural groundwater flow direction is from the groundwater to the streams and rivers. As the water tables have fallen, the flow direction has reversed, with water from the rivers and streams recharging the groundwater.

2.2.12.2 Waste Water

In coastal Mississippi's three counties, 49.5 percent of Hancock County, 18.9 percent of Harrison County, and 27.0 percent of Jackson County do not have access to a public wastewater system. Those who are not connected to a public wastewater system employ on-site treatment, which consists of either package plants or septic tanks/drain fields. Package plants are small, self-contained wastewater treatment facilities built to serve a developed area, such as a subdivision or a school. Septic tanks and drain fields, typically installed at individual households, collect wastewater in an underground tank and slowly release the treated water to a drain field where it is absorbed and filtered by the surrounding soil (Corps, Mobile District, 2000).

The wastewater treatment facilities in the Three-County Region treat more than 45 million gallons of wastewater each day. Hancock County treatment facilities treat approximately 3.00 million gallons per day (MGD), Harrison County facilities treat 29.3 MGD, and Jackson County facilities, including Pascagoula and Escatawpa, treat 12.0 MGD (Peterson, 1999).

2.2.12.3 Storm Water

The City of Biloxi uses a variety of management techniques and systems to control storm water. The city requires developers to install storm water drainage facilities designed to control runoff quantity, but does not require specific storm water quality control measures (Corps, Mobile District, 2000). Storm water from Biloxi is discharged into two surface water sources—the Back Bay of Biloxi and the Mississippi Sound. There are four major runoff areas in the city: in East Biloxi, the storm water runoff flows south from Howard Avenue to the Mississippi Sound; in West Biloxi, south of Pass Road, the runoff flows south to the Mississippi Sound; in West Biloxi, north of Pass Road, the runoff flows south to the Back Bay of Biloxi; and in North Biloxi, the storm water drains south to the Back Bay of Biloxi (Corps, Mobile District, 2000).

The City of Gulfport's storm water drainage system has endured numerous problems during the past few years, as parts of the city, particularly in the Orange Grove area, have experienced both street and house flooding. Numerous improvement projects in the last few years have eliminated the house flooding problem, but the street flooding remains. The city has developed a storm drainage master plan that addresses the needs to eliminate any storm water-related flooding in the Gulfport and Orange Grove areas.

Jackson County and each municipality within the county have adopted a storm water plan that addresses the capabilities and requirements of the various storm water systems. In February 2003, Jackson County submitted a Phase II Storm Water Program to the EPA that addressed the following issues: a) General non-point source pollution; b) Raw sewage; c) Solid waste dumping; d) Illegal disposal of wastes; e) Lack of erosion and sediment controls; and f) Impaired water bodies and TMDL programs.

The Storm Water Program includes procedures to provide public education, public involvement, illicit discharges detection and elimination, construction site runoff controls, post-construction runoff controls, and pollution prevention/good housekeeping.

2.2.12.4 Solid Waste Disposal and Collection System

The State of Mississippi regulates three categories of non-hazardous solid waste landfills: Municipal Solid Waste Landfills that receive household waste and other types of Subtitle D material, such as commercial and industrial solid waste and non-hazardous sludge; Class I Rubbish Sites that accept construction and demolition (C&D) debris, brick, concrete, asphalt, natural vegetation, furniture, sawdust and wood shavings, plastic, and metal; and Class II Rubbish Sites that accept natural vegetation, brick, concrete, and asphalt (Corps, Mobile District, 2000). Permitting for a solid waste facility is handled by the MDEQ Permitting Board.

There is one permitted municipal solid waste landfill in the Three-County Region and seven Class I rubbish sites for construction-related waste. The Pecan Grove Landfill and Recycling Center, operated by Waste Management, Inc., receives approximately 90 percent of the total solid waste stream produced in the three coastal counties. The landfill is located in Pass Christian.

3 PLAN FORMULATION (ALTERNATIVES AND PLANS*)

3.1 Introduction

The MsCIP applied the six step planning process described in the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G, 1983). This planning process is more fully specified in Corps of Engineers' Engineering Regulation ER 1105-2-100 (the Planning Guidance Notebook, 22 April 2000).

The comprehensive nature of the congressional authorization was interpreted as a mandate to assess all aspects of storm related risk reduction measures including storm damage reduction, erosion reduction, ecosystem restoration, and saltwater intrusion in coastal Mississippi. Additionally, the study language specifically directed that the report "will recommend cost-effective projects", and furthermore, that the report "shall not perform an incremental benefit-cost analysis...and shall not make project recommendations based on maximizing net national economic development [NED] benefits". In response to the direction by Congress to develop a Comprehensive Plan, plan formulation was conducted from a "big picture" perspective which included consideration of many broad scale conceptual approaches to the identified problems and opportunities. The recommended features resulting from this planning effort constitute a Comprehensive Plan containing a combination of programmatic ecosystem restoration features, programmatic storm damage reduction features, and a number of large and small scale recommended plans that could be implemented immediately.

This Plan Formulation section of the report presents the results of extensive public outreach to stakeholders and residents used to identify problems and opportunities and to identify measures which would be appropriate for implementation in coastal Mississippi. This section of the report presents summaries of detailed technical information used in

- the analysis of existing and future without-project conditions,
- the development of problem-solving measures, and
- used in the analysis, evaluation, comparison, screening, and selection of alternative plans.

The selected plans resulting from the plan formulation process are presented as recommendations. These recommendations include recommended immediate actions and projects that would assist in the recovery of the physical and human environments, and recommended further studies and longer term programmatic actions required of a comprehensive plan of improvements for developing a truly resilient future for coastal Mississippi.

As mentioned above, the MsCIP team used the Corps planning process. This is compliant with the NEPA study process which compares and contrasts measures and alternatives for a full range of anticipated impacts and effects. The Corps planning guidance requires that impacts and effects be evaluated in a "System of Accounts" framework. The four evaluation accounts were established by the Principles and Guidelines (1983) to facilitate evaluation and display of effects of alternative plans. EC 1105-2-409, Planning in a Collaborative Environment (31 May 2005) also reemphasized the use of the four accounts in conducting Corps water resource feasibility studies as a means of ensuring that Federal water resources projects are planned and implemented in a collaborative manner with other Federal, state and local programs. Other information that is required by law or that will have a material bearing on the decision making process has been included in the accounts to organize information on effects. Briefly, the categories of effect considered under each of the four accounts include the following:

(a) The National Economic Development (NED) account displays changes in the economic value of the national output of goods and services.

(b) The Environmental Quality (EQ) account displays non-monetary effects on significant natural and cultural resources

(c) The Regional Economic Development (RED) account registers changes in the distribution of regional economic activity that result from each alternative plan. Evaluations of regional effects focus on plan induced changes in regional income, employment, output and population.

(d) The Other Social Effects (OSE) account registers plan effects from perspectives that are relevant to the planning process, but are not reflected in the other three accounts. Examples of effects categorized under the OSE account include: urban and community impacts; life, health, and safety factors; displacement; long-term productivity; and energy requirements and energy conservation.

Hurricane Katrina's disastrous impact upon the Gulf Coast served as a very sobering wakeup call for how the nation has prepared for natural disasters and where we have accepted risk. As a result, the Corps has developed a set of "12 Actions for Change" that it now focuses on to transform its priorities, processes and planning practices. These actions will be used to guide the Corps' ongoing and future work, and ensure that the organization is adaptable, flexible and responsive to the needs of the nation.

The "12 Actions for Change" fall within three overarching themes: Effectively implement a comprehensive systems approach; communication; and reliable public service professionalism. The actions are grouped as follows:

Effectively Implement a Comprehensive Systems Approach: Comprehensively design, construct, maintain and update engineered systems to be more robust, with full stakeholder participation.

1. Employ integrated, comprehensive and systems-based approach
2. Employ risk-based concepts in planning, design, construction, operations, and major maintenance
3. Continuously reassess and update policy for program development, planning guidance, design and construction standards
4. Employ dynamic independent review
5. Employ adaptive planning and engineering systems
6. Focus on sustainability
7. Review and inspect completed works
8. Assess and modify organizational behavior

Communication: Effective and transparent communication with the public, and within the Corps, about risk and reliability.

9. Effectively communicate risk
10. Establish public involvement risk reduction strategies

Reliable Public Service Professionalism: Improve the state of the art and the Corps' dedication to a competent, capable workforce on a continuing basis. Make the commitment to being a "learning organization" a reality.

11. Manage and enhance technical expertise and professionalism
12. Invest in research

Among the investigative teams that contributed to the development of the "12 Actions for Change" through their analysis in the aftermath of hurricanes Katrina and Rita were the Corps-commissioned Interagency Performance Evaluation Task Force, the American Society of Civil Engineers, the National Science Foundation-sponsored team led by UC-Berkeley, and Louisiana State University.

Hurricane Katrina demonstrated the need to be prepared and ready to broadly integrate the Corps' many mission capabilities. The '12 Actions for Change' provide a common organizational framework to help meet that objective.

The MsCIP study team embraced these actions throughout the planning process. The study team used a systems-based approach to develop comprehensive plans that were integrated across Corps' mission areas, as well as other local, state, and Federal agency projects and programs. The MsCIP also reassessed and sought policy changes to accommodate the never before seen devastation along the Mississippi Gulf Coast, and used a very dynamic independent and external review process. Alternatives were developed using adaptive planning and engineering systems and focused on sustainability of the environment and communities along the coast.

The organization of the MsCIP team allowed for flexibility across the traditional Corps' hierarchy, as well as incorporating team members from other agencies. This cooperative atmosphere created an organizational behavior allowing team members to focus on innovative and effective solutions to the problems with which they were tasked.

The MsCIP also developed and employed risk-based concepts which engaged stakeholders and allowed for informed decision making. The MsCIP planning process made extensive use of public and agency involvement, which introduced ideas, provided feedback, and gave first-hand accounts of the damages suffered as a result of the disaster. In an effort to demonstrate reliable public service professionalism, the public, state and local government input received at public workshops was also used to identify the degree of importance placed on environmental issues and to give indication of the likely Locally-Preferred Plans, should those be pursued as options to more cost-effective recommended plan features, consistent with Federal guidelines.

Finally, the results of the planning process (as expressed in the Systems of Accounts tables):

- identify cost-effective solutions,
- provide the best choices based on an extensive set of criteria, and
- identify the trade-offs made during the evaluation of alternatives.

The System of Accounts tables present the culmination of technical analyses, public input, and systematic evaluation. The selected alternatives stand out in their ability to fulfill the Congressional authorization and the needs of the nation.

3.1.1 The Federal Planning Process - Overview

Plan formulation for the Comprehensive Plan employed the six step planning process discussed in Corps of Engineers' Engineering Regulation 1105-2-100 (also known as the "Planning Guidance Notebook"). The six step planning process employed in the development of the Comprehensive Plan is displayed in Figure 3-1.

One departure from the traditional six step process was specifically directed by Congress for the MsCIP Comprehensive Plan:

"...Provided further, that the Secretary shall recommend a cost-effective project, but shall not perform an incremental benefit-cost analysis to identify the recommended project, and shall

not make project recommendations based upon maximizing net national economic development benefits..."

As a result, Steps 4, 5, and 6 employed cost effectiveness, rather than benefit-cost analysis, as the measure of economic effectiveness of alternative plans. Also, final plan selection was not subject to the limitation of recommending the NED plan without a specific waiver from the Secretary of the Army.

Steps in the plan formulation process include:

1. The specific problems and opportunities to be addressed in the study are identified, and the causes of the problems are discussed and documented. Planning goals are set, objectives are established, and constraints are identified.

2. Existing and future without-project conditions are identified, analyzed and forecast. The existing condition resources, problems, and opportunities critical to plan formulation, impact assessment, and evaluation are characterized and documented.

3. The study team formulates alternative plans that address the planning objectives. A range of alternative plans are identified at the beginning of the planning process and screened and refined in subsequent iterations throughout the planning process.

4. Alternative project plans are evaluated for effectiveness, efficiency, completeness, and acceptability. The impacts of alternative plans will be evaluated using the system of accounts framework (NED, EQ, RED, OSE) specified in the Principles and Guidelines and ER 1105-2-100.

5. Alternative plans will be compared. Contributions to National Economic Development (NED) will be used to prioritize and rank alternatives. The public involvement program will be used to obtain public input to the alternative identification and evaluation process.

6. A plan will be selected for recommendation, and a justification for plan selection will be prepared.

The Planning Guidance Notebook (ER 1105-2-100, dated 22 April 2000) states that "water and related land resources project plans shall be formulated to alleviate problems and take advantage of opportunities in ways that contribute to study planning objectives and, consequently, to the Federal objective" (page 2-1). Unlike traditional Corps planning reports, which are required to recommend only the project that maximizes net economic benefits (the Federal objective), this study was guided by unique authorizing language, that included the mandates that the study analysis, "*...shall not perform an incremental benefit-cost analysis...and shall* not *make project recommendations based on maximizing net national economic development* [NED] *benefits..*", but "*...shall recommend a cost-effective project...*". Cost-effectiveness is determined by comparison of estimated implementation costs to the level of benefits each alternative would provide.

Plan formulation has been conducted for this Feasibility Study with a focus on achieving the Congressional mandate to recommend a cost effective project consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. NED benefits were calculated and used in the cost-effectiveness analysis where appropriate, for example in the evaluation of damage reduction measures. Plan formulation also considered all effects, beneficial or adverse, to each of the four evaluation accounts identified in the Principles and Guidelines (1983): NED, EQ, RED and OSE.

3.1.2 The MsCIP Comprehensive Plan – The Planning Process

The Corps has taken a ***system wide*** approach in formulating the Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan to ensure that both the MsCIP and the Louisiana Coastal Protection and Restoration (LaCPR) efforts are fully coordinated and develop complementary plans for the restoration of the U.S. Gulf coastal region ***as an integrated system***.

In addition, the planning effort has taken a "top down" ***comprehensive planning*** approach, beginning with development of a Comprehensive Plan to address the overall water resources problems and opportunities of the region. Building off of the comprehensive identification of problems and opportunities, the planning effort then proceeded to develop site specific problems, opportunities and solutions that contribute to accomplishing the ***Comprehensive Vision*** for the restoration and protection of the Mississippi Gulf Coast. The results of this effort are presented in this report and include a comprehensive regional plan that addresses hurricane and storm damage reduction and environmental restoration needs, as well as recommending a variety of site specific projects for either for immediate implementation or for further investigation and subsequent implementation.

This draft Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan Report and Integrated Environmental Impact contains both a Comprehensive Plan and a variety of water resource development projects that were developed through the comprehensive planning process. The Report also contains options for additional study for those components of the Comprehensive Plan which require additional investigations prior to identifying a specific recommendation for construction.

The planning process utilized in the MsCIP study was a highly iterative process. Multiple iterations of the six planning steps were required due to the fact that new problems or data were constantly being identified during the planning process as feasibility level investigations were conducted. Additionally, the development of large scale plans, such as "Lines of Defense" (LOD), brought new problems and opportunities to light, which needed to be included into the planning process.

The following is an outline providing additional details of the MsCIP planning process (*with sub-steps or iterative steps italicized*). Figure 3-1, which graphically depicts the process, was used at public meetings. The traditional Corps' planning process was supplemented with tasks that allow for the consideration of the stakeholders acceptability of risk in evaluating and comparing measures or alternative plans. This can be seen in steps 5 e-g below and in the figure on the following page.

1) Identify Problems and Opportunities
    a. *Further refine Problems and Opportunities as new information becomes available*
    b. Identify Constraints
        i. *Further refine Constraints as new information becomes available*
2) Inventory and Forecast Resources
    a. *including multiple Future Without-Project Scenarios to account for uncertainty in future development and sea level rise*
3) Preliminary Measures Developed for Each Problem Area
    a. *followed in later iterations by formulation of true alternative plans*
4) Evaluation of Effects of Measures
    a. *followed in later iterations by Alternative Plans*
5) Comparison of Measures
    a. *followed in later iterations by comparison of Alternatives*

  b. Measure Screening by Traditional Initial Screening Criteria - Technical, Environmental and Economic Feasibility
    i. followed in successive iterations by screening by progressively more rigorous criteria
  c. Refinement of Measures - Employ Data at Higher Level of Detail
  d. Development of evaluation metrics, units of measure, etc.
  e. "Weighting" of evaluation metrics by residents of coastal Mississippi
  f. Risk-Informed Decision-Making with Refined Data
  g. *Presentation of measure and/or alternative plans, including benefits, costs, risks and consequences to decision-making population*

6) Selection and Presentation of Recommended Plans.

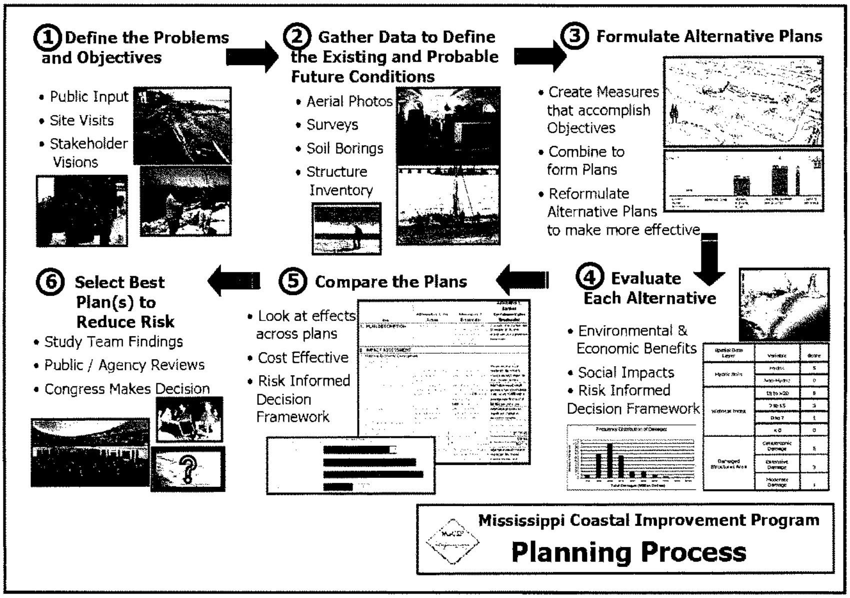


Figure 3-1
MsCIP Planning Process

The planning process depicted in Figure 3-1 is described in this chapter through a series of discussions concerning measures, preliminary alternatives, and final alternatives. Measures are the building blocks of alternatives. Preliminary alternatives which meet the planning criteria are developed further into final alternatives. Recommendations are selected from the list of final alternatives. Measures, preliminary alternatives, and final alternatives each go through a process of development, evaluation, comparison, and screening (or selection in the case of final alternatives). In the following sections, the development, evaluation, comparison, and screening of measures is discussed in sections 3.6 through 3.9. Preliminary alternatives are developed, evaluated, compared, and screened in sections 3.11 through 3.14. Final alternatives are developed, evaluated, and compared in sections 3.15 through 3.18. The selection of recommended alternatives is presented in section 3.20.

3.1.3 Addressing Risk and Uncertainty

The MsCIP team used standard conventions and definitions used in risk assessment, although some leeway was incorporated into the overall use of risk terminology, due to the on-going use of certain terms, such as "risk", in ways that are much broader than those in the risk assessment arena might use them. The broadest use of the term "Risk", as used in the MsCIP study, could be characterized as the potential for negative outcomes, under certain action and no-action conditions, both now and in the future. The public uses this term to refer to their own personal risks, be it risks to their health, income, residences, cultural integrity, or community, and thus, the MsCIP team had to adopt this convention. The MsCIP team also had to similarly use this term to characterize risks of environmental outcomes, such as functional damage to ecosystems, loss of species (or multiple species) integrity and survival, and many other negative outcomes. Because the public and stakeholders had to understand the nature of their risks and potential consequences for a large range of possible future conditions that by their nature were, in many cases, only qualitatively defined, the use of "risk" in this broader framework was by necessity, adopted.

"Risk ", in a narrower definition also used in the MsCIP study, could be defined as the probability of a certain outcome, under certain conditions. An example of this would be the probability (5% in any given year, for example) of a certain damage level, expressed in dollars ($10,000,000, for example), occurring in the event of a certain-sized hurricane-caused surge and wave depth and extent event. This could be expressed both as a probability of a certain outcome given a certain event, but can also be expressed as a sum of damages expected under a range of events, such as an average of all damages expected, over a time horizon such as fifty years, were nothing to be done to prevent those damages.

Risk, or the probability of certain events or outcomes, was more readily defined for some type of outcomes, such as hurricane-caused surge and wave depth, than for other types of outcomes, such as human reactions, or the number of deaths caused, by an oncoming hurricane. For some factors, probabilities were defined quantitatively; in many other cases, they could only be estimated qualitatively, as a range of possible outcomes.

In addition to addressing risk and uncertainty in the technical analyses conducted for this Feasibility Study the MsCIP planning process incorporated three additional aspects of risk and uncertainty:

- stakeholder weighting of potential negative consequences of planning measures;
- alternative projections of post-Katrina re-development; and
- alternative projections of future sea-level rise.

Please see the Risk Appendix, for more information on how the MsCIP team incorporated risk into the planning process.

3.1.3.1 Stakeholder Weighting of Consequences

The Corps' Engineering and Research Development Center (ERDC) developed an evaluation tool for the MsCIP team to address public preferences concerning potential negative consequences of alternatives. The evaluation tool was developed through "weighing-in" of the public and agency personnel preferences, which reflected the factors most important to them, in deciding what might be done to address identified problems. Most notable among these potential negative consequences were impacts to population, environmental recovery and preservation, cultural, aesthetic and historic resources, and other factors. The evaluation tool is often referred to as the Risk-Informed Decision Framework (RIDF), and is described in detail in the RIDF Appendix.

3.1.3.2 Accommodating Uncertainty in Future Re-Development Through Scenario Testing

Given the magnitude of the long-term rebuilding effort in Hancock, Harrison, and Jackson Counties, two re-development scenarios were identified. The first scenario assumes the full redevelopment of structures as existed pre-Hurricane Katrina to exactly what they were before the storm (i.e. if a structure was a residence before it will rebuild as a residence, a condominium will rebuild as a condominium, etc.). The second scenario also assumes full re-development of the study area to its pre-Katrina levels, with the exception that commercial and multi-unit housing development would dominate the coastline. This scenario is based on observations of re-building efforts in other counties and states along the Gulf Coast and Florida Panhandle following Hurricane Ivan in 2004. Those re-development efforts suggest that a large portion of the beach front areas may re-develop to condominium structures. In addition to condominiums, Mississippi law has changed since hurricane Katrina, now allowing for casinos to be built within 100 feet of the Mississippi Sound (with certain restrictions).

3.1.3.3 Accommodating Uncertainty in Future Sea Level Rise Through Scenario Testing

Analysis of historical data suggests a relative sea level rise of approximately nine inches along the Mississippi coast during the 20th century. Relative sea level rise is what an observer standing on the shoreline over a long period would observe, which includes the combined effects of land subsidence (or uplift) and the rise of sea level in and of itself. For the last twenty five years, the climate change community has also been arguing that sea level rise will accelerate in the 21st century, though to date, there is no clear confirmation that acceleration is actually taking place.

It is important to recognize that sea level has been rising, and it's prudent (and required by Corps regulations) to recognize the uncertainties inherent in sea-level rise projections. Given the long term nature of this phenomenon, future sea level rise was projected over a 100-year period. However, because the period of analysis specified by ER 1105-2-100 for Corps water resource projects of this type is 50-years, two alternative future without project condition scenarios were developed based on potential sea level rise conditions over a 50 year time period:

- expected (i.e. moderate, or 'central value') relative sea level rise of about 2 feet; and
- high relative sea level rise of about 3.4 feet.

3.1.3.4 Most Probable Future Scenario

Numerous outputs are examined according to these alternative scenarios, including equivalent annual damages, damages reduced, and the annual probability of a surge level being exceeded.

Overall, six alternative without-project condition scenarios were developed to address the uncertainty concerning coastal redevelopment in Mississippi and future sea level rise:

- Scenario 1 is a residential redevelopment with no relative sea level rise over the 50-year period of analysis.
- Scenario 2 is a mixed residential and commercial redevelopment with no relative sea level rise,

- Scenario 3 is a residential redevelopment with a maximum relative sea level rise depending on location of 2.0-feet over the period of analysis,
- Scenario 4 is a mixed residential and commercial redevelopment and a maximum relative sea level rise of a 2.0-foot,
- Scenario 5 is a residential redevelopment with a relative sea level rise depending on location of 3.4-feet, and
- Scenario 6 is a mixed residential and commercial redevelopment with a maximum relative sea level rise depending on location of 3.4-feet.

Extensive analysis was conducted on the six future without-project scenarios. This analysis is documented in the Economics and Engineering Appendices. The result of the analysis is that future without-project Scenario 3 is the most probable without-project future condition. The combination of pre-Hurricane Katrina redevelopment with a moderate sea-level rise of 2.0 feet was determined to be adequate for reporting and communicating the impacts of the comprehensive plan components being recommended for construction. The remainder of this document is based on the most probable future scenario, which is Scenario 3.

3.2 Identifying Problems and Opportunities

The first step in the Federal water resources planning process is the identification of problems and opportunities. Problems are the undesirable, negative conditions that will be addressed by the planning study. Opportunities express the desirable conditions that could be achieved in the future. The identification of problems and opportunities for the MsCIP employed a "top down" approach, beginning with identifying comprehensive problems and opportunities at the system wide level. Once this was accomplished, the study team, with input from the interested public, used these system wide problems and opportunities as an organizing principle to identify and define site specific problems and opportunities throughout the study area.

Input on identifying problems and opportunities, were solicited from, and then discussed, with members of the public, state, local, and other Federal agencies, representatives of industry and commerce, and resource agencies concerned with study area resources, at the series of open meetings, at individual meetings, and through other open forums. The meetings also included web-casts intended on reaching those that could not physically attend one of the in-field meetings.

3.2.1 Public and Agency Involvement

Public and agency involvement was integral to the planning process. The Corps' first step in the planning process was to canvass local residents of Hancock, Harrison, and Jackson counties to understand the needs and perspective of the local population. Canvassing was followed by presentations, workshops, and focus groups which provided input into identifying problems and opportunities, and later helped to guide the formulation and selection of measures, alternatives, and plans. Exhibit 3-1 presents a synopsis public and agency involvement in the planning process.

Exhibit 3-1

- Teams canvassed 3 counties – talked to local residents
- Public Input sessions – 194 problems/opportunities
- Local Government Presentation sessions – presentation of preliminary measures
- Regional Coordination meetings
  - Broke out into focus groups based on interest
  - Follow-up focus groups, conference calls, web-cast, emails
- Development of a Risk Informed Decision (RID) Process
- Public Participation in RID Process
  - Assessed variety of options
  - Developed a spreadsheet based method
  - First round Stakeholder Group meetings to refine definitions and prioritize evaluation metrics
    - Groups identified by interest
      - Fed agencies
      - State and local agencies
      - Business leader
      - NGO's
      - Possible other
  - Second round Stakeholder Group meetings
    - Further refinement of metrics
      - Testing understanding and usability by the stakeholders
      - Introduction of weighting of measures
    - Presentation of table so that stakeholders could see application of metrics to actual measures
      - Cluster analysis identified how weights were grouped
      - Weights, which indicate stakeholder preferences, were summed by group to be used in plan selection

3.2.2 *Problems*

The plan formulation process began during the Interim Phase of the study, with development of a comprehensive list of problem areas. These are documented in the Coastal Mississippi Interim Report. Each of the system wide problems identified were related to one of the five comprehensive areas of: a) hurricane storm damage, b) coastal zone erosion, c) damage to fish and wildlife resources, d) saltwater intrusion, and e) other water related resource issues, which are described in more detail in the following sections.

3.2.2.1 Hurricane Storm Damage Problems

Hurricane and storm damage was a system wide problem for the three county MsCIP study area. These system wide problems were identified and described in numbers 1 through 5 and are a function, or aggregate, of more localized problems throughout the study area, which are depicted in numbers 6 and 7. In order to identify the problems associated to more site specific areas, the three county MsCIP study area was delineated into 54 planning sub-units which are depicted in Figure 3-2. The 54 planning sub-units were created based on hydrodynamic and economic characteristics.

They represent areas to which localized hurricane storm surge problems are reasonably consistent throughout. For a detailed explanation of the planning sub-units see the Economic Appendix.

Hurricane-induced storm surge damage includes:

- Over 238 deaths and other serious injury to human health and safety within the three-county (Hancock, Harrison, and Jackson) MsCIP study area,
- Significant damage (50-percent or more destroyed) to over 32,000 structures and their contents within the three-county (Hancock, Harrison, and Jackson) MsCIP study area;
- Moderate to minimal damage to an additional 25,000 to 30,000 structures and their contents within the three-county (Hancock, Harrison, and Jackson) MsCIP study area;
- Damage to business and industry resulting in a significant loss to regional output within the three-county (Hancock, Harrison, and Jackson) MsCIP study area;
- Significant increase in the unemployment to well over twenty-percent within the three-county (Hancock, Harrison, and Jackson) MsCIP study area;
- Significant damage to structures in planning sub-units 1, 2, 3, 4, 5, 6, 7 and 38 in Hancock County...planning sub-units 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 20, and 39 in Harrison County...planning sub-units 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 51, 52, 53, and 54 in Jackson County;
- Significant damage to public infrastructure in the population centers of Pearlington (sub-unit 6) , Bay St. Louis (sub-unit 2), Long Beach (sub-units 8, 9, and 10), Gulf Port (sub-units 11, 12, 13, 14, and 15), Biloxi (sub-units 16, 17, 18, and 20), Ocean Springs (sub-units 21 and 22) , Belle Fontaine (sub-unit 26), Gulf Park Estates (sub-unit 27), Pascagoula (sub-unit 52), and Moss Point sub-unit 51) as well as other more rural areas.

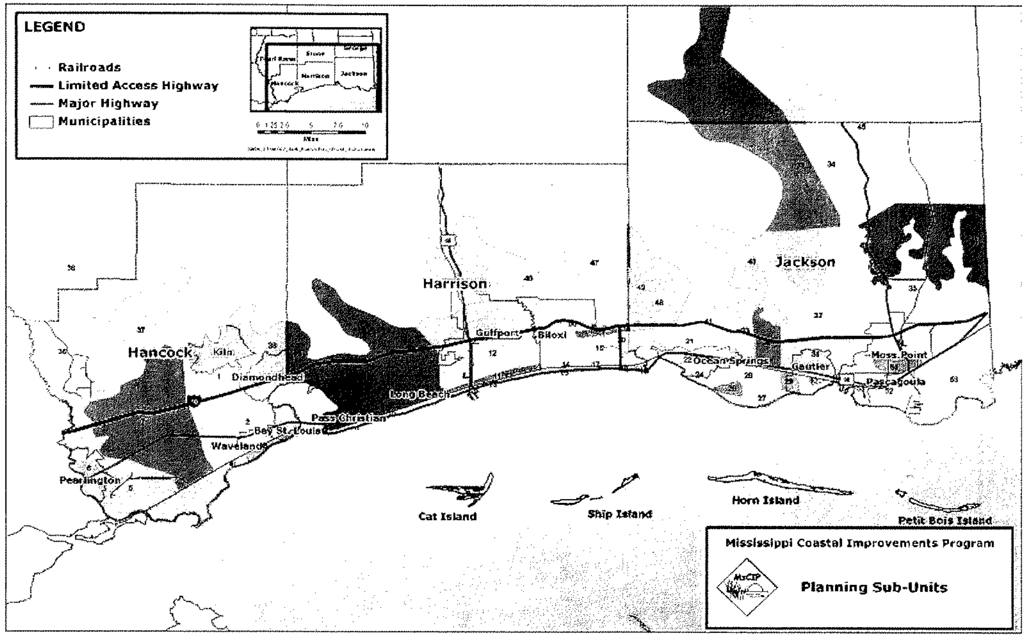


Figure 3-2. Planning sub-units and municipalities for the MsCIP Study area.

3.2.2.2 Coastal Zone Erosion

Hurricanes have induced erosion of coastal wetlands and coastal infrastructure within the three county study area, including:

- Mississippi Sound seagrass habitat loss, which coincides with areas where rapid coastal erosion and massive long-term movement of sand have occurred;
- The Belle Fontaine natural beach and dune system, located along in the central portion of Coastal Mississippi, which is the only natural beach remaining, has experienced severe erosion to a point that it is virtually non-existent; and
- Hurricane Katrina completely submerged the entire barrier island chain, segmenting several of the islands and causing significant erosion

3.2.2.3 Damage to Fish and Wildlife

Hurricane-induced storm surge caused significant damage to coastal ecosystems and fish and wildlife resources within the three-county study area. For example, in coastal wetland preserves and areas identified in the State's wetland restoration initiative the storm surge removed large areas of vegetation in some areas and other areas were filled in with sediment and debris. The sites that had the vegetation removed experienced extensive exotic vegetation propagation, which has out-competed native species. Prior to the hurricane these sites provided valuable habitat, which has now been severely degraded by exotic species. Sites destroyed by hurricane distributed debris and sediment were found then to be either completely covered by thick debris fields, or to have been filled in with sediment to elevations not suitable for re-colonization of native species.

Coastal wetland preserve and state wetland initiative areas which have been severely degraded by hurricane-induced storm surge include Wachovia (1200 acres), Ansley (900 acres), LaFrances (45 acres), Gulf Island National Seashore (Petit Bois, Horn, Ship and Cat Islands in Jackson, Harrison and Hancock Counties) (7000 acres), Dantzler (900 acres), Admiral Island (123 acres), Deer Island (450 acres), DuPont (650 acres), and Pascagoula River Marsh (11,500 acres).

Specific examples of ecosystem damage include:

- Admiral Island (123 acres) Extensive debris fields washed in from Bayou Lacroix during Hurricane Katrina. Approximately 10 acres are covered in a mat of crushed houses, boats, and other debris.
- Wachovia (1200 acres) experienced significant marsh debris and scour from storm surge. However, the scoured areas appear to be forming high quality open-water habitat evident by a high level of dragon fly activity and breeding. The debris is predominantly natural material, mostly the marsh "rolled up" from the scoured areas. Much of the remainder of the tract is forest and savannah, which has suffered wind damage in the form of downed trees and vegetation. This has increased fuel loads and complicated access across the property. The increase in fuel loads is significant because the fuel loads at Wachovia were already high. Invasive species, particularly Chinese tallow, are now at the present site.
- Ansley (900 acres) - The site is primarily marsh, which has experienced limited scouring. There are significant debris fields within the marsh that extend into the forested areas. Pine timber fared relatively well but hardwoods were heavily damaged. There are significant invasive infestations, primarily Chinese tallow tree.
- Barrier Islands - Hurricane Katrina and other recent storms have over washed barrier islands in the Northern Gulf causing severe erosion, severely damaging or destroying facilities and resources, depositing massive amounts of debris, degrading habitats, and setting the stage for infestations of noxious, invasive plant and animal species.

- Deer Island (450 acres) - During Katrina, Deer Island lost a significant amount of sand beach and dunes. Related to this, a large number of slash pine trees were killed with mortalities approaching 100% near the east end. The loss of these trees will lead to more catastrophic erosion in the future.
- Dantzler property (900 acres) was further from Katrina's core and suffered less direct wind and tidal surge damage than many of the other Coastal Preserves. However, serious long term consequences are anticipated due to the distribution of Chinese tallow tree propagules across the site.
- Pascagoula Marsh System - Katrina left the Pascagoula marsh system exposed to an explosion of invasion exotic species. Gaps left by vegetation loss and disturbances in hydrology regimes will increase the recruitment and growth of such exotic species. The two species that are of the greatest concern are *Salvinia molesta* (Giant Salvinia) and *Sapium sebiferum* (Chinese tallow). Disturbed areas often support dense, nearly monospecific colonies of *Phragmites australis* common reed which is becoming a greater threat to native species population.

3.2.2.4 Saltwater Intrusion

The western area of coastal Mississippi to suffer greatly from increased saltwater intrusion; especially hit hard are oyster resources and coastal marshes.

- Historic oyster reefs located within western Mississippi Sound have declined from lack of freshwater flows resulting from increased saltwater intrusion. Oyster predators, thriving in salty waters, destroy the beds.
- Hancock County marshes, located within the western portion of coastal Mississippi, have suffered increased saltwater intrusion as well as lack of sediment.

Following identification of these system wide problems, the study team, in conjunction with an extensive public involvement program, compiled a list of site specific problems in each of the three counties, organized according to the four problem classifications identified above. A detailed listing of site specific problems is provided in the Plan Formulation Appendix. Table 3-1 presents a synopsis of system-wide and county problems and related needs identified by stakeholders during the workshops and public meetings. These problems and related needs are the basis for the plan formulation process.

Table 3-1
Examples of Stakeholder Input: Coordination with Local Communities

Stakeholder Identified Problems	Stakeholder Identified Needs
• Loss of life and human injury due to ineffective communication • Insufficient capacity at storm shelters	• Coastal Mississippi Hurricane Evacuation Plan
• Storm surge damages and environmental degradation due to development in low lying areas	• Wetland Area Buyouts
• Erosion and intrusion of salt water	• Barrier Island Restoration • Restore or enhance Mississippi Oyster Reefs • Freshwater Diversion
• Erosion and storm damage	• Widen beaches, jump start dunes (Hancock, Harrison, and Jackson Counties)
• Storm surge flooding caused damage to structures and infrastructure	• Provide protection for public facilities • Surge gates along Biloxi and St Louis Bays • Seawalls, levees and ring levees (Forrest Heights Levee, etc.) • Hurricane and Storm Damage Reduction at population centers (Gautier, Ocean Springs, etc.) • Floodproof Existing Infrastructure
• Storm surge caused sedimentation in wetland areas	• Restore wetland functions (Grand Bay Swamp, Hancock County Marsh, etc.) • Restoration of Pine Savannah • Complete snagging and clearing to increase flood water conveyance

3.2.2.5 Other Water Resource Problems

In addition, hurricane-caused problems were also investigated in a series of on-going site investigations conducted in partnership with local representatives, to ensure a complete grasp on the nature of all identified problems, and to ensure development of a full range of suitable measures and plans to deal with the identified problems. Categorical hurricane-caused problems identified by the study team, State, County, and City officials, residents, and agency staff included numerous problems which are typically addressed by agencies other than the Corps of Engineers. These problems concern issues such as hurricane education, warning, and evacuation; municipal infrastructure; and inland transportation infrastructure. Development of the Comprehensive Plan for coastal Mississippi includes problems to be addressed by the Corps of Engineers and by other agencies. Recommendations included in the Comprehensive Plan would necessarily include actions to be taken by agencies other than the Corps of Engineers.

3.2.3 Opportunities

Comprehensive, ***system-wide opportunities*** were identified during the MsCIP planning process to guide the development and evaluation of solutions to the region's water resource problems. An overall theme of Comprehensive Plan opportunities is not merely to reverse the harm done by the hurricanes of 2005, but as importantly to promote the long-term future sustainability of physical, human, and environmental resources within the study area. Comprehensive, system-wide opportunities include:

- Assist in sustainable redevelopment of hurricane damaged physical, environmental, and human resources within the MsCIP study area;
- Reduce the susceptibility of residential, commercial, and public structures and infrastructure to hurricane induced storm damages within the three-county (Hancock, Harrison, and Jackson) MsCIP study area;
- Assist in the recovery and long-term sustainability of coastal wetlands that support important fish and wildlife resources within the study area;
- Accelerate the recovery and assist in the long-term sustainability of maritime forest environments that suffered hurricane induced damages;
- Restore barrier island environments that suffered hurricane induced storm damages in a manner that promotes long-term sustainability of their fish and wildlife resources;
- Reduce saltwater intrusion within the Mississippi Sound coastal environment;
- Assist in the recovery of coastal ecosystems and infrastructure damaged by erosion during the hurricane events of 2005 and support programs that promote long-term erosion reduction and limit erosion potential during future hurricane events.

Because of the massive scope of opportunities associated with each problem area or site, for all problem areas and sites identified as fitting within the mandate given the study team and the authorities provided the Corps, details on opportunities associated with each site are discussed in more detail in the discussion on each site or problem area, as well as the Plan Formulation Appendix. For storm damage reduction and erosion control formulation and screening processes, these discussions are contained in the Engineering Appendix. For ecosystem restoration and saltwater intrusion reduction formulation and screening processes, these discussions are contained in the Environmental Appendix. The results of each evaluation and screening process are summarized in following sections of this chapter.

3.3 Planning Goals and Objectives

In response to the Federal Goal, as established by Congress, the following goals were established for the MsCIP by the Corps of Engineers Project Development Team (PDT), cooperating agencies and affected public. The system-wide goals established for this study were developed in clear recognition of the linkages between structural and nonstructural storm damage reduction and ecosystem restoration opportunities. System-wide goals are intended to address the coastal landscape of the entire Gulf Region, including the area specifically evaluated in the LaCPR program. MsCIP system-wide goals identified in the Comprehensive Plan effort include the following:

- Identify measures to minimize risk to loss of life and safety caused by hurricane and storm surge;
- Recommend cost-effective measures for restoration of nationally and regionally significant environmental resources within a context of long-term sustainability;

- Recommend cost-effective measures to reduce damages from hurricanes and storms without encouraging re-development in high-risk areas;
- Recommend cost-effective measures to mitigate damages caused by saltwater intrusion into nationally significant ecosystems;
- Recommend cost-effective measures to restore eroded coastal resources as part of a system-wide approach to develop a resilient coastline;
- Identify other water resource related programs and activities integral to the development of a comprehensive system-wide plan.

The system-wide objectives established for this study provide specific targets to measure progress towards achieving the comprehensive goals outlined above. Projects formulated as part of the Comprehensive Plan were evaluated based on their ability to contribute to achieving the targets established in these objectives. System-wide objectives include the following:

- Reduce loss of life caused by hurricane and storm surge by 100%;
- Reduce damages caused by hurricane and storm surge by $150M-$200M annually, per coordination with state and local interests based on knowledge of damages from previous hurricane
- Restore 10,000 acres of fish and wildlife habitat including coastal forests, coastal wetlands, wet pine savannah, submerged aquatic sea grasses, oyster reefs, and beaches and dunes by the year 2040;
- Manage seasonal salinities within the western Mississippi Sound such that optimal conditions for oyster growth (surrogate for other aquatic resources, 15 ppt during summer months) are achieved on an annual basis by 2015;
- Reduce erosion to barrier islands, mainland, and interior bay shorelines by 50%;
- Create opportunities for collaboration with local, state, and Federal agencies to facilitate implementation of programs and activities that maximize the use of resources in achieving the comprehensive goal.

3.4 Planning Constraints

There are a number of issues that constrain the development of certain potential measures that might be used to address the identified problem set. Planning constraints are limited to laws and regulations that constrain the planning process. Among these include:

- Measures developed must not negatively impact the resources within the NPS's Gulf Islands National Seashore, particularly with respect to the agency's 2006 Management Policies as well as from those constraints created by inclusion of Horn and Petit Bois Islands as Wilderness Areas;
- Measures developed must avoid, minimize, or mitigate any negative impacts to T&E species identified as residing within areas potentially impacted by study recommendations;
- Measures developed must comply, to the maximum extent practicable, with State of Mississippi Coastal Management Plan;
- Measures developed must meet the guidelines for maintenance of State Water Quality standards;
- Measures must comply with provisions of the Clean Water Act (CWA);

- Measures must comply with provisions of the National Historic Preservation Act (NHPA);
- Measures must comply with the Clean Air Act (CAA);
- Measures must comply with the Endangered Species Act (ESA);
- Measures must comply with the Coastal Barrier Resources Act (CBRA);
- Measures must be consistent with the Magnuson-Stevens Fishery Conservation and Management Act as amended by the Sustainable Fisheries Act of 1996.

3.5 Preliminary Screening of Public Input

Following the initial identification of problems, problem areas, and potential opportunities resulting from the Public Input Sessions, a preliminary screening analysis was conducted. The goal of the preliminary screening was to select items for further consideration which:

- Were caused or exacerbated by the hurricanes of 2005;
- Could not recover without intervention;
- Were consistent with the areas of investigation identified in the Congressional Authorization (storm damage reduction, erosion, fish and wildlife preservation [ecosystem restoration], saltwater intrusion, or related water resource issues;
- Were significant ecosystem resources (scarcity of resource), from a national or regional perspective;
- Were technically or environmentally feasible
- Were not already being addressed by others.

In keeping with the comprehensive nature of the investigation, no attempt was made to restrict items to those that were solely within the Corps' authority to implement. To facilitate future coordination of the comprehensive planning effort, the team did attempt to identify the most likely entity to take the lead role in addressing each item. The complete list of problems, problem areas, and opportunities screened as part of this process are shown in the Plan Formulation Appendix, including which entity would be the most likely responsible agency / actor. Examples of opportunities that can be performed by others include:

- FEMA updating the Coastal Mississippi Hurricane Evacuation Plan to reflect lessons learned during hurricane Katrina;
- Forming a monitoring network, that will survive and function throughout a major storm, to provide data that is critical to emergency managers. This could be accomplished through an update of FEMA's "Integrated Public Alert and Warning System";
- Considering the use of "brown water" systems to minimize demand on ground and surface waters and limit saltwater intrusion. This could possibly be accomplished by the U.S. Environmental Protection Agency;
- Inspecting and Rehabilitating Wastewater and Piping Systems within the three coastal Mississippi counties. This could possibly be accomplished by a State Regional Water and Wastewater Authority;
- Repairing the breach on the West end of Deer Island. This is being accomplished through the Corps' Flood Control and Coastal Emergencies Program;

- Reopening the Highway 90 bridges as quickly as possible. This was accomplished by the Mississippi Department of Transportation, and;
- Utilize the old HW 90 bridge rubble as artificial reef material. This was accomplished by the State of Mississippi DOT.

Other problem areas and suggestions are being accomplished through the MsCIP Interim projects, or are carried forward for consideration in the Comprehensive Plan.

3.6 Development of Measures

After narrowing the list of problems, the MsCIP study team developed potential problem-solving measures. Measures are defined simply as "a feature or activity at a particular site". The initial measures were developed independently within the structural, environmental, and nonstructural sub-teams, and then later evaluated to determine their role within a Comprehensive Plan. Measures were further developed at each of the Regional Coordination, agency, and public workshops.

3.6.1 Development of Storm Damage Reduction and Erosion Reduction Measures

Examples of measures developed for storm damage reduction were supplied by the study team, agencies, and public, and included:

- Levees, seawalls, or embankments (barriers to surge);
- Gates, berms, and breakwaters (barriers to surge);
- Elevating structures (elevation above inundated area);
- Acquisition and removal from high-risk areas (removal from high-risk inundation zones);
- Zoning and Building Code modification (removal of the most damageable or critical infrastructure or services from highest risk areas);
- Floodplain Management (removal of the most damageable or critical infrastructure or services from highest risk areas);
- Moving back from the shoreline (removal of the most at-risk development, most damageable or critical infrastructure, or services from highest risk areas);

Examples of measures for erosion reduction, supplied by the study team and public, included:

- Placement of additional sand;
- Placement of harder erosion-control features, such as shell materials, construction debris, rubble, stone, geo-textiles;
- Supply of additional sand to littoral zone / island sediment budget;
- Reduction of sand-robbing activities in the near-shore or barrier island zones.

3.6.2 Development of Ecosystem Restoration, Preservation of Fish and Wildlife and Saltwater Intrusion Reduction Measures

Examples of measures for ecosystem restoration and fish and wildlife preservation, supplied by the study team and public, included:

- Acquiring and restoring currently undeveloped lands;
- Restoring previously degraded wetlands;

- Removal of sediment and/or debris choking streams and estuaries;
- Re-grading to historic conditions and topography;
- Preserving habitats to reduce fragmentation;
- Removal of invasive species;
- Removal of dead vegetation, deadfalls, and other vegetation that interferes with natural functions;
- Planting of native species in areas in which those species were killed by the hurricanes; and
- Filling of drainage channels that interfere with natural functions.

Examples of measures for saltwater intrusion (seawater encroachment into a freshwater body) reduction, supplied by the study team and public, included:

- Reallocation of freshwater supply by re-regulation of reservoirs and
- Diversion of freshwater sources to direct more freshwater into areas of critical need.

Development of measures was also based on consideration of potential benefits and the potential negative outcomes it might cause (i.e., induced flooding). All of the structural measures were also developed in such a way that they could be laid out as either stand-alone concepts, or as components of a multi-featured plan for a given area (i.e., structural, nonstructural, or ecosystem restoration plan).

3.7 Evaluation of Measures

Each problem area or site and its associated measures were evaluated to determine

- the level of effort required for more detailed development of site specific solutions,
- the need for additional data and more rigorous technical analyses (such as detailed modeling),
- the need for more site specific environmental analysis in order to project potential positive and negative environmental impacts, and
- other factors which are required for informed decision making.

Evaluation at this preliminary phase of study was based on discussions between study team members and technical experts, and on the results of preliminary modeling, such as storm surge modeling or calculations of ecosystem benefits.

3.7.1 Evaluation of Hurricane Storm Damage Reduction (HSDR) and Erosion Reduction Measures

Early evaluation indicated many areas of the coast that are not highly developed, and other areas that contain significant obstacles to formulation of structural measures. It was found to be extremely difficult in many areas to employ structural measures to reduce damages because of environmental concerns and the location of structures. Other areas, such as portions of Harrison County, are more appropriately addressed by structural measures because the entire coastline is densely developed with a lesser degree of environmental resource concentration. Many outlying areas were found to require individual structural means to achieve storm damage reduction.

Review of the coastline in Mississippi using aerial photographs, topographic maps, LIDAR surveys, and storm inundation data revealed that natural topography could play a major role in forming storm barriers. Other features such as the offshore barrier islands, extensive beaches in many areas, and existing beach-front roadways were also determined to have a substantial role in potential damage reduction. The modeling also indicated that the high ground followed by the CSX Railway crossing the entire state near the coast, functioned as a barrier to surge during Katrina, and thus, should be considered as a potential inland barrier during future events.

Review of the inundation maps generated during the surge modeling of Katrina and other events also indicated that the extensive low-lying areas associated with two bays that extend inland from the coast would require more refined methods than a simple barrier, to solve the surge inundation issue. It was apparent that any continuous storm protection systems would have to consider these as breaks in the line. Closing off rivers and bays with surge gates have been used in Europe to protect inland areas and different designs of gate structure were evaluated and considered in the development of comprehensive plans for coastal Mississippi.

Almost all problem areas or sites along the Mississippi coastline were found to have environmental considerations that required adjustment or modification to structural measures to address those concerns. However, in Jackson County, the Pascagoula River system separates the city of Pascagoula from most of the coast to the west. This river system with its vast marshes areas is one of the last major free-flowing rivers in the southeast, and has numerous environmental resource concerns. In the western portion of the state, extensive marshes along with the Pearl River separate Mississippi from Louisiana. In addition to these environmental concerns, other technical issues also made structural damage reduction in these areas problematic.

3.7.2 Evaluation of Ecosystem Restoration and Saltwater Intrusion Reduction Measures

The MsCIP team used several environmental models to help evaluate the performance of potential ecosystem restoration measures. These models included:

- A Mississippi and Alabama Gulf Coast Tidal Fringe Hydrogeomorphic model (HGM);
- A Wet Pine Savannah HGM;
- A Fish Habitat Index (FHI) Model for Evaluation of Coastal Maritime Forest/Beach-Dune Habitat; and
- A Geographic Information System (GIS) based Spatial Decision Support Model (SDSS) for Wetland Restoration.

The HGM and FHI models are discussed in more detail in the Environmental Appendix.

The SDSS model related areas of hydric soils and other factors to the long-term survivability of a wetlands resource. The model scales and combines multiple GIS layers to identify and evaluate potential wetland restoration sites within the three coastal counties. The results of the model were used in conjunction with local expertise to evaluate potential wetland restoration areas.

The results of the HGM modeling were used for evaluating tidal fringe wetlands and wet pine savannah habitats. The tidal fringe HGM model was also used to evaluate impacts to tidal fringe wetlands that would result from HSDR measures such as levees. These functional assessments helped to determine mitigation requirements for unavoidable wetland impacts by structural components of a comprehensive plan. Likewise, the wet pine savannah HGM allowed the team to assess impacts to wet pine savannah habitats at various environmental restoration sites.

Evaluation of saltwater intrusion reduction methods involved the investigation of freshwater diversion measures at several locations. These measures would divert freshwater from the Mississippi River or other sources to reverse recent increases in salinity in the Mississippi Sound/Biloxi marshes.

Reduced salinity would support fresher marshes and oyster reef health and productivity, thus enhancing both their economic value and the ecological services they provide.

The evaluation of diversion measures was conducted through a water quality model (WQM). This model predicted water quality constituents, including nutrients, phytoplankton, dissolved oxygen, temperature, salinity, and underwater light intensity to assess relative changes from a baseline condition.

More detailed information on these models can be found in the Environmental Appendix

3.8 Comparing Measures

Once a measure for an area was determined to contribute to the overall comprehensive plan, it was then compared to other measures developed for that site or problem area. Again, comparison at this phase of study was based on discussion between study team members and technical experts, to determine the *relative* potential damage reduction or environmental output achievable, and problems encountered or solved, particularly in comparison with the "No-Action" Plan.

Comparison of structural and non-structural damage reduction measures, and erosion control measures, was conducted by comparison of their relative ability to reduce damages, with consideration given as to their potential environmental mitigation requirements or negative impacts, potential costs, and other potential issues. Comparison of ecosystem restoration measures, and saltwater intrusion measures, was conducted by comparison of their relative ability to achieve the desired environmental output as compared to the "No-Action" Plan, relative to their potential costs.

3.9 Screening Measures

3.9.1 Screening Criteria

After the measures were developed and evaluated, they were screened based on the inter-disciplinary study team's understanding of each site's potential to meet a variety of criteria and its contribution to the comprehensive plan. Each measure/problem area combination had to meet the following criteria:

- Technical feasibility (i.e., will a given measure provide a sound technical solution to the identified problem(s)?);
- Environmental feasibility (i.e., will a given measure provide a sound solution to the identified problem(s), without creating environmental resource problem of its own?), and;
- Some potentially cost-effective measures for the identified problem area.
- Does not induce development (e.g., building a levee around undeveloped land)
- Does not induce flooding (e.g., creating a barrier that moves more water into an area, thereby increasing flood damages.

In addition, for ecosystem restoration or saltwater intrusion reduction, the site or problem area had to be identified as having:

- no ability to either heal on its own, unaided by human intervention, or;
- national and/or regional significance in regards to the type of ecosystem it represents;
- the need for assistance to restore vital hydrologic links;
- the potential need to manually remove blockages created by hurricane-deposited debris that was impacting function;

- the potential need to remove excess sediment deposited by the hurricanes that had changed the nature of the land's surface and resulted in degraded function and value;
- the potential need to remove invasive species that had entered the area since the hurricanes and caused displacement of native plant species (and potentially wildlife depending on native species), degrading function of the ecosystem; or
- the potential need for planting of native species vital to restoration of a significant ecosystem and restoration of its functions and values.

3.9.2 Screening Results

The purpose of the screening process is to "weed out" unproductive measures, or those that do not meet the planning objectives. Application of the screening criteria resulted in the removal from further consideration of a large number of less significant areas, and many areas that the study team determined were capable of recovery on their own or did not contribute to the overall comprehensive plan. Preliminary analysis indicated that there were many solutions or measures that were *obviously* cost-prohibitive, unequivocally environmentally damaging, or simply technically infeasible.

Due to the large number of measures involved, and the fact that initial evaluation and screening was done on a case-by-case basis by the study team in the field or in discussion held for each site, no detailed discussion of each measure/problem area combination is contained here, although numerous preliminary measures and their evaluation, comparison, and screening are referenced in the Engineering and Environmental appendices.

The list of ecosystem measures and areas to be considered for more detailed analysis was narrowed to the following comprehensive aspects:

- Restoration of barrier islands. Includes entire restoration of the MS barrier islands including littoral placement, re-vegetation, and restoration of Submerged Aquatic Vegetation.
- Restoration of dune habitat. Using dune barriers along the MS coast as either an ecosystem restoration measure, or in combination with dune use as a storm damage reduction barrier.
- Reduction of saltwater intrusion by restoring fresh water flows from the Escatawpa, Pearl, and Mississippi Rivers.
- Restoration of coastal Mississippi wetlands and forests by evaluating historical wetland areas, frequently flooded populated areas, and current wetland and forest areas degraded by the storms of 2005.

Many types of structural and nonstructural protection measures were also reviewed. Some examples of the types of measures that were screened out due to a lack of technical or environmental feasibility are identified below and depicted in Figure 3-3. These measures were discussed with the stakeholders as to why they were screened. For example, the idea of considering offshore breakwater measures came up often in stakeholder and public workshops. The study team determined that while breakwaters may reduce some of the wave energy, they would not significantly reduce flood damages resulting from storm surge, and would have significant environmental and navigation impacts. For these reasons, which were discussed with the stakeholders, the following measures were screened from further consideration:

- Inflatable barriers:
- Concrete sidewalks or roadways that could be rotated upwards to form a seawall;
- Sliding panel gates; and
- Offshore breakwaters.

- Contiguous Barrier Island 'Wall'
- Galveston type Seawall

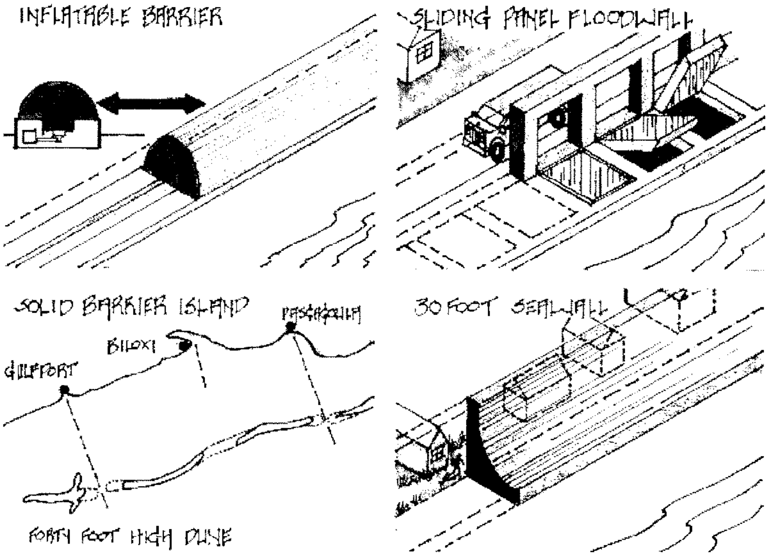


Figure 3-3
Preliminary Damage Reduction Measures Screened Out

Due to the relatively low elevations, type of construction, and the nature of storm surge throughout the coastal area, several preliminary nonstructural measures were also screened from further evaluations. These include:

- Elevating structures on fill material are not allowed in VE zones, which includes most of the area where these type of measures would be considered.
- Dry floodprofing of residential structures only provides protection up to 3 feet and does not makes sense in this area because most of the structures at "high risk" were destroyed, could be more safely elevated or removed from future surge events.
- Likewise, wet floodproofing of residential structures would not be a valid alternative because of the continued risk to life and safety.

Additional information on these measures can be found in the Engineering, Environmental, and Nonstructural Appendices.

3.10 Lines of Defense Concept

The list of damage reduction concepts and/or alignments to be retained for further analyses resulted in the development of a "Lines of defense" (LOD) concept depicted in Figure 3-4. The LOD concept incorporates a group of alternative measures which function together as a comprehensive approach to addressing the problems and opportunities. This grouping of alternative measures integrates structural, non-structural, and ecosystem restoration measures. This concept progresses geographically from the offshore barrier islands to what could be considered the inland surge extent of the worst possible theoretical storm. This storm, labeled the Maximum Possible Intensity (MPI) event, would be used to define a line that, based on ground surface elevation, the storm surge would not exceed. The lines of defense would be designed to provide increasing levels of damage reduction as storm events increased in size up to the MPI. Some lines would not provide much protection from large storms, and several areas of the coast could not be included in continuous line of defense. These areas would be addressed by a ring levee system or designated to a non-structural solution during the second round of evaluation. At this stage of the planning process, the conceptual LOD elements were primarily evaluated as stand alone measures, although the potential cumulative effects on damage reduction and construction costs were bracketed (i.e., likely high and low values). The cumulative effects of multiple LOD measures would be further evaluated, if multiple structural LOD elements were recommended.

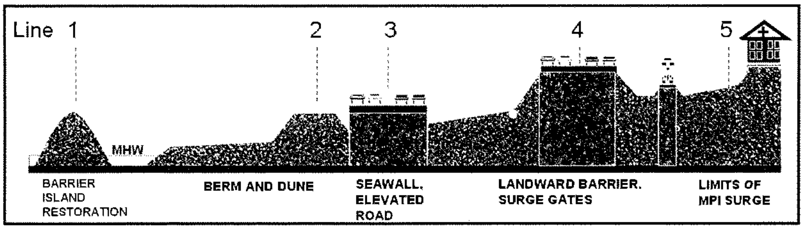


Figure 3-4
Lines of Defense Concept

3.10.1 First Line of Defense – Barrier Islands

The coastline of mainland Mississippi is bordered on the south by the Mississippi Sound, a shallow body of water that separates the coast from four barrier islands that lie several miles to the south. These barrier islands, managed by Gulf Islands National Seashore, are located along a littoral drift zone that moves sand westward creating three elongated islands and then to the westward most island where littoral currents are not as well defined. From east to west, the islands are Petit Bois, Horn, Ship, and Cat. Ship Island has been breached by prior hurricanes and now is actually two small islands, West Ship Island and East Ship Island, with a shallow sand bar between the two. Since Hurricane Camille in 1969, this breach has existed with varying amounts of natural rebuilding between later storms. The western ends of both Petit Bois and Ship Islands have migrated into maintained navigation channels and the continuing littoral drift of the sand into the channels is causing an artificial termination of the migration.

Soon after Hurricane Katrina, it was reported that many in Mississippi felt that if the islands had been in the condition that existed prior to Hurricane Camille, there would have been less damage along the coast from Hurricane Katrina. In addition, the widening of the breach has resulted in an increase of waters of Gulf salinity entering the western Mississippi Sound area causing damage to many of the estuarine resources such as oysters. Restoration of barrier islands was also included in the Mississippi Governor's Restoration Plan, as described in Section 1.4 State Strategy, which called for restoring the islands to their pre-Camille footprint. This measure (identified as LOD-1) was selected to be carried forward for further analysis.

3.10.2 Second Line of Defense – Dunes along Existing Beaches

Essentially all the beaches along coastal Mississippi are man-made. Harrison County has the most beach-front - 26-miles extending from Biloxi Bay to St. Louis Bay. Hancock County has several miles of beach and Jackson County only a short length. In total, the beaches extend along less than half of the Mississippi coastline. Most of the dunes that previously existed along these beaches were destroyed by Katrina and much of the beach was damaged. Reconstruction of the dunes, following implementation of the interim MsCIP beach projects, will likely provide reduction of damaging wave action from smaller storms and habitat for nesting shorebirds, as has been shown in other areas along the gulf coast.

The beaches, situated immediately seaward of developed areas, provide a location where elevated dunes could be constructed to provide some protection from smaller hurricanes. In addition, the further development of dunes along the coast could provide essential habits for a number of threatened or endangered species. This measure (identified as LOD-2) was selected to be carried forward for further analysis.

3.10.3 Third Line of Defense – Raised Roadway or Seawall and Ring Levees

All of the beaches described in LOD-2 have a roadway landward (North) of the beach. These roads vary from local or county roads to US Highway 90, a major, four-lane highway that extends across the entire Harrison County coast. The existing roadways vary in elevation from four to five feet NAVD-88 in Jackson and Hancock County and up to about elevation 15 feet NAVD-88 in Harrison County. All of these roads are evacuation routes and all have been damaged in past hurricanes. In a damaged or destroyed condition, these roads make re-entry to the area difficult after a hurricane has passed. Raising and using these roadways and associated seawall as barriers defines the 3rd line of defense (LOD-3) and will be carried forward for further analysis.

The nonstructural components of LOD-3 include many elements: evacuation planning, building codes etc. and acquisition or flood proofing of all properties within the '100-yr' floodplain. These nonstructural components are also carried forward for further analysis.

Environmental components within this area include the restoration of the natural landscape with it's inherent fish and wildlife value, particularly for neotropical migrants and other coastal birds, and ability to provide buffer for surge reduction to adjacent areas. There environmental components are also carried forward for further analysis.

3.10.4 Fourth Line of Defense – Inland Barrier

To preserve the shoreline environment as much as possible, a 4th line of defense (LOD-4) for very large storms is envisioned that would be a structure inland from the coast (and LOD-3). This line of defense could be designed to a high elevation that would reduce the risk from a very large storm surge, such as the "Maximum Possible Intensity" (MPI) hurricane, and will also be supplemented by nonstructural solutions such as elevating or buying out structures and additional environmental solutions associated with restoring natural landscapes. The components associated with this line of defense was selected to be carried forward for further analysis.

3.10.5 Fifth Line of Defense – Maximum Surge Limit

This line of defense will be a line on a map that indicates the extent of surge resulting from the "Maximum Possible Intensity" storm. Structures that are situated or built above (North of) this line should not be inundated from surge by large storm events. Measures associated with this line of defense would include relocation of existing emergency services such as hospitals, or police and fire stations to an area above the MPI surge. This fifth line of defense (LOD-5) was selected to be carried forward for further analysis.

A planning session conducted on the five conceptual lines of defense resulted in numerous refined variations of each of the lines. The further development of these concepts was made in a study team meeting that included engineers, environmentalists, planners, and geologists. Information from along the coastline was utilized that included large scale aerial photography, topographic maps, navigation maps, and a large collection of pre and post-Katrina photographs.

Figures 3-5, 3-6, and 3-7 indicate the initial alignments of the lines of defense for each of the three Mississippi coastal counties, Hancock, Harrison, and Jackson.

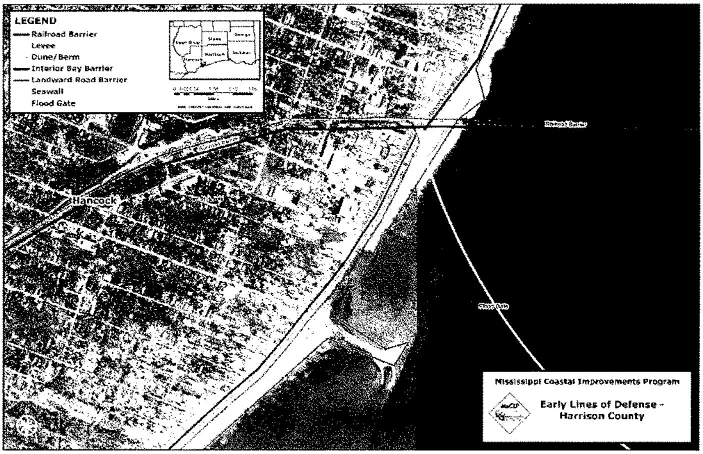


Figure 3-5
Initial Lines of Defense for Hancock County

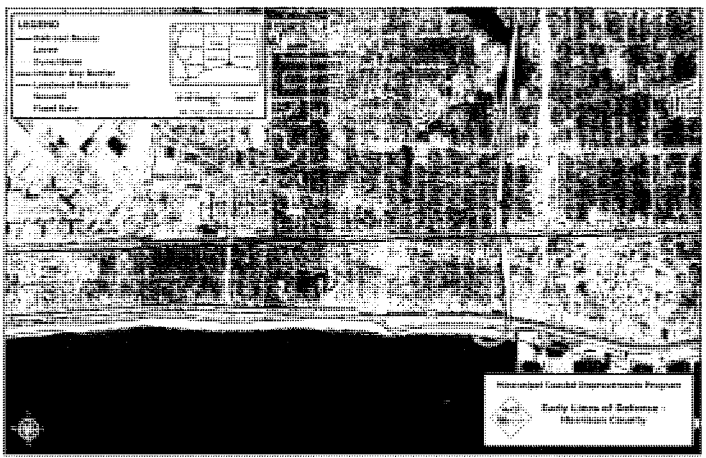


Figure 3-6 Initial Lines of Defense for Harrison County

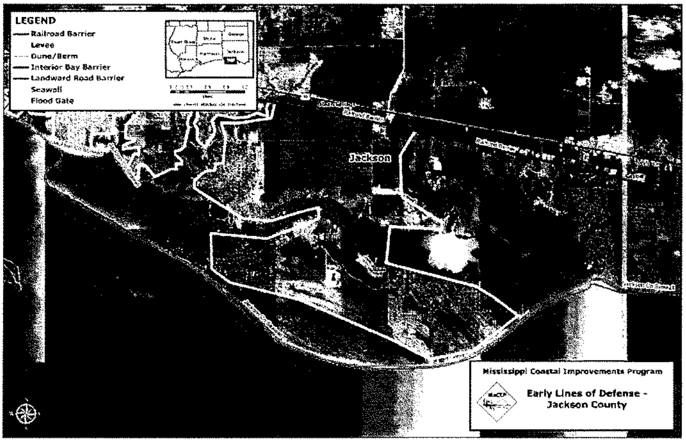


Figure 3-7
Initial Lines of Defense for Jackson County

3.11 Development of Preliminary Alternatives

The development of alternatives consisted of modifying measures to achieve higher desired comprehensive outputs (e.g., higher damage reduction benefits, greater ecosystem benefits), and to better serve the original intended purpose, based on feedback from stakeholder input, modeling efforts or better data availability. The combination of measures into alternatives was based on the following factors:

- development of more detail in design,
- cost estimation,
- environmental aspects and potential impacts,
- potential damages prevented,
- site considerations,
- more detailed technical requirements,
- more detailed source material and source area information,
- variations in materials that could be used to solve the problem in a similar way,
- species benefits or impacts considerations, and
- many other technical, environmental, or economic issues.

The list of preliminary alternatives, including structural and nonstructural alternatives, developed during this round is presented in Table 3-2.

Table 3-2
Preliminary Alternatives

Name (Alternatives screened out during this round are in *bold italics*)	Description (All elevations based on NAVD88 vertical datum)
Offshore Zone (LOD-1)	
Deer Island Restoration	Complete Restoration of Island back to its pre-Camille footprint
Increasing Islands Footprint (Option A)	Restore islands by sand dredged from off-shore
Placing River Sand in Littoral Zone (Option B)	Restore islands by placing dredged river sand in the littoral zone
Placing Off-shore Sand in Littoral Zone (Option C)	Restore islands by placing dredged sand in the littoral zone
Creating 2 FT Island Dunes with Beach Sand (Option D)	Restore islands by shaping existing beach sand into 2' high dunes
Creating 6 FT Island Dunes with Off-shore Sand (Opt E)	Restore islands by creating 6' high dunes with off-shore sand
Barrier Island No Action	
Barrier Island Restoration to Protect MS Sound Estuary	Study to recommend optimal solution to protect the MS Sound Estuary
Emergency Ship Island Restoration	Phased Advanced Engineering and Design to protect Ft. Mass. and Estuary
Sub Aquatic Vegetation Pilot Project	Tests various methods of planting SAVs in MS Sound
MS Sound Sub Aquatic Vegetation Restoration	Restore 4400 acres of lost SAVs in MS Sound using pilot results
Coastal Zone (LOD-2 and LOD-3)	
Hancock 40' Dune @ Elevated Roadway (Option A)	***Dune adjacent to the seawall with a 40' crest at elevation 10***
Hancock 50' Dune @ Elevated Roadway (Option B)	***Dune adjacent to the seawall with a 50' crest at elevation 8***
Hancock 20' Dune @ Elevated Roadway (Option C)	***Dune adjacent to the seawall with a 20' crest at elevation 10***
Hancock 30' Dune @ Elevated Roadway (Option D)	***Dune adjacent to the seawall with a 30' crest at elevation 8***
Hancock Dune Option A plus sea oats (Option E)	***Like option A + plantings on toe of dunes***
Hancock Dune Option B plus sea oats (Option F)	***Like option B + plantings on toe of dunes***
Hancock Dune Option C plus sea oats (Option G)	***Like option C + plantings on toe of dunes***
Hancock Dune Option D plus sea oats (Option H)	***Like option D + plantings on toe of dunes***
Hancock 55' Dune and beach berm (Option I)	***Dune w/ 55' crest at elev. 10 & beach berm on south side***
Hancock Dune Option I plus sea oats (Option J)	***Like Option I but with plantings on toe of berm***
Coastal Beach No Action	
Comprehensive 60' wide x 2' high Dune plus sea oats (Option K)	60' wide X 2' high berm with sea oats planted on 30" centers
Harrison 40' Dune @ Elevated Roadway (Option A)	***Dune adjacent to the seawall with a 40' crest at elevation 10***
Harrison 50' Dune @ Elevated Roadway (Option B)	***Dune adjacent to the seawall with a 50' crest at elevation 8***
Harrison 20' Dune @ Elevated Roadway (Option C)	***Dune adjacent to the seawall with a 20' crest at elevation 10***
Harrison 30' Dune @ Elevated Roadway (Option D)	***Dune adjacent to the seawall with a 30' crest at elevation 8***
Harrison Dune Option A plus sea oats (Option E)	***Like option A + plantings on toe of dunes***
Harrison Dune Option B plus sea oats (Option F)	***Like option B + plantings on toe of dunes***
Harrison Option C plus sea oats (Option G)	***Like option C + plantings on toe of dunes***
Harrison Dune Option D plus sea oats (Option H)	***Like option D + plantings on toe of dunes***
Harrison 55' Dune and beach berm (Option I)	***Dune w/ 55' crest at elev. 10 above datum and add beach berm***
Harrison Dune Option I plus sea oats (Option J)	***Like Option I but with plantings on toe of berm***
[redacted]	
Hancock Seawall/Elevated Roadway at Elevation 11	***Seawall and Elevated Beach Road to Elevation 11***
Harrison Seawall/Elevated Roadway at Elevation 16	***Seawall and Elevated Beach Road to Elevation 16***
Jackson Seawall/Elevated Roadway at Elevation 11	***Seawall and Elevated Beach Road to Elevation 11***

Biloxi Bay Surge Gate at Elevation 20	***Required for LOD3 (same as LOD4 Biloxi Surge Barrier Option A)***
St Louis Bay Surge Gate at Elevation 20	***Required for LOD3 (same as LOD4 St Louis Bay Surge Option A)***
Pearlington No Action	
Pearlington Nonstructural at ABFE (Reach 6)	Buyouts and/or raising structures accounting for a 20' surge
Pearlington Ring Levee at Elev. 20 (Reach 6)	Ring levee around Pearlington, Elev. 20'
Pearlington Nonstructural for Elevation 20 (Reach 6)	Buyouts and/or raising structures accounting for a 20' surge
Pearlington Ring Levee at Elev. 30 (Reach 6)	Ring levee around Pearlington, Elev. 30'
Pearlington Nonstructural for Elevation 30 (Reach 6)	Buyouts and/or raising structures accounting for a 30' surge
ABFE Nonstructural for (Reach 5)	Includes everything in Reach 5
ABFE Nonstructural for (Reach 36)	Includes everything in Reach 36
Pearlington Ring Levee for up to a 'Moderate to Low Risk Event'	Ring levee around Pearlington designed for a 100-500 year event
Pearlington Nonstructural for up to a 'Moderate to Low Risk Event'	Nonstructural options for Pearlington to handle a 100-500 year event
Pearlington Ring Levee plus NS up to a 'Moderate to Low Risk Event'	Reach 5-6
Pearlington Ecosystem Restoration with NS Buyouts	Buyouts and Ecosystem Restoration of high risk properties
ABFE Nonstructural for Reaches 5,6,36)	Nonstructural buyouts / elevation of structures
Pearlington North Eco Restoration Plan - 1	76 Acres - residential infrastructure
Pearlington South Restoration Plan - 2	11 Acres - residential infrastructure
Port / West Ecosystem Restoration Plan - 3	49 Acres - residential infrastructure
Ansley Ecosystem Restoration Plan - 4	2024 Acres - residential infrastructure
Heron Bay Ecosystem Restoration Plan - 5	595 Acres - residential infrastructure
Bayou Caddy Ecosystem Restoration Plan - 8	362 Acres - residential / commercial infrastructure
Bay St. Louis / Waveland No Action	
ABFE Nonstructural for Reach 4	Nonstructural buyouts / elevation of structures
Clermont Harbor Ecosystem Restoration Plan - 9	210 Acres - residential infrastructure
ABFE Nonstructural for Reach 3	Nonstructural buyouts / elevation of structures
ABFE Nonstructural for Reaches 3,4	Nonstructural buyouts / elevation of structures
Henderson Point No Action	
Henderson Point Nonstructural for Reach 9	
Henderson Point B Accelerated Buyout	Nonstructural buyout of properties
Pass Christian Nonstructural for Reach 10	Nonstructural buyouts / elevation of structures
Pass Christian Beach Front Eco Restoration Plan - 20	21 Acres - Low forested drainage area / residential
Pass Christian Nonstructural for Reach 13	Nonstructural buyouts / elevation of structures
Pass Christian Nonstructural for Reach 15	Nonstructural buyouts / elevation of structures
Biloxi Front Beach Ecosystem Restoration Plan - 26	41 Acres South of Hwy 90 (commercial retail outlet)
Pass Christian Nonstructural for Reach 18	Nonstructural buyouts / elevation of structures
Nonstructural for Reaches 10,13,15,18	Nonstructural buyouts / elevation of structures
Ocean Springs No Action	
Ocean Springs Ring Levee at Elev. 20	Ring levee around Ocean Springs, Elev. 20'
Ocean Springs Nonstructural for Elevation 20	Buyouts and/or raising structures accounting for a 20' surge
Ocean Springs Ring Levee at Elev 30	Ring levee around Ocean Springs, Elev. 30'
Ocean Springs Nonstructural for Elevation 30	Buyouts and/or raising structures accounting for a 30' surge
Ocean Springs Nonstructural for Reach 22	Nonstructural buyouts / elevation of structures

Ocean Springs Nonstructural for Reach 24	Nonstructural buyouts / elevation of structures
Nonstructural for Reaches 22,24	Nonstructural buyouts / elevation of structures
Gulf Park / Belle Fontaine No Action	
Pine Island Plan - 30	238 Acres - restore to emergent tidal marsh
Nonstructural for Reach 28	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 26	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 27	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 31	Nonstructural buyouts / elevation of structures
Gulf Park Estates Ring Levee at Elev 20 (Option A)	Ring levee around Gulf Park Estates, Elev 20'
Gulf Park Estates Alternate Ring Levee at Elev. 20 (Option C)	Ring levee around Gulf Park Estates Elev 20' requires ABO plan
Gulf Park Estates Nonstructural for Elevation 20	Buyouts and/or raising structures accounting for a 20' surge
Gulf Park Estates Ring Levee at Elev 30 (Option B)	Ring levee around Gulf Park Estates, Elev. 30'
Gulf Park Estates Alternate Ring Levee at Elev 30 (Option D)	Ring levee around Gulf Park Estates Elev. 30' requires ABO plan
Gulf Park Estates Nonstructural for Elevation 30	Buyouts and/or raising structures accounting for a 30' surge
Gulf Park Estates Nonstructural ABO Plan	Nonstructural Advanced Buyout Plan for areas not in Ring Levee
Belle Fontaine Ring Levee at Elev. 20 (Option A)	Ring levee around Belle Fontaine, Elev. 20'
Belle Fontaine Alternate Ring Levee at Elev. 20 (Option C)	Ring levee around Belle Fontaine Elev. 20' requires ABO plan
Belle Fontaine Nonstructural for Elevation 20	Buyouts and/or raising structures accounting for a 20' surge
Belle Fontaine Ring Levee at Elev. 30 (Option B)	Ring levee around Belle Fontaine, Elev. 30'
Belle Fontaine Alternate Ring Levee at Elev. 30 (Option D)	Ring levee around Belle Fontaine Elev. 30' requires ABO plan
Belle Fontaine Nonstructural for Elevation 30	Buyouts and/or raising structures accounting for a 30' surge
Belle Fontaine Nonstructural ABO Plan	Nonstructural Advanced Buyout Plan for areas not in Ring Levee
Belle Fontaine Ecosystem Restoration Plan - 31	1517 Acres (Contained in ABO area named Belle Fontaine)
Nonstructural for Reaches 26,27,28	Nonstructural buyouts / elevation of structures
Gautier No Action	
Nonstructural for Reach 29	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 30	Nonstructural buyouts / elevation of structures
Gautier Ring Levee at Elev. 20	Ring levee around Gautier, Elev. 20'
Gautier Nonstructural for Elevation 20	Buyouts and/or raising structures accounting for a 20' surge
Gautier Ring Levee at Elev. 30	Ring levee around Gautier, Elev. 30'
Gautier Nonstructural for Elevation 30	Buyouts and/or raising structures accounting for a 30' surge
Nonstructural for Reaches 29,30	Nonstructural buyouts / elevation of structures
Moss Point / Pascagoula No Action	
Pascagoula/Moss Point Ring Levee at Elev. 20 (Option A)	Ring levee around Pascagoula/Moss Point, Elev. 20'
Pascagoula / Washington St. Ring Levee at Elev. 20 (Option C)	Ring levee around Pascagoula/Washington Street @ Elev 20'
Moss Point Alternate Ring Levee at Elev 20 (Option E)	Ring levee around Moss Point, Elev 20'
Washington St + Moss Point Alternate Ring Levee at Elev. 20 (Opt G)	Ring levee around Washington St + Moss Point Alt at Elev. 20
Pascagoula / Moss Point Nonstructural for Elevation 20	Buyouts and/or raising structures accounting for a 20' surge
Pascagoula/Moss Point Ring Levee at Elev. 30 (Option B)	Ring levee around Pascagoula/Moss Point, Elev. 30'
Pascagoula / Moss Point Nonstructural for Elevation 30	Buyouts and/or raising structures accounting for a 30' surge
Pascagoula / Washington St. Ring Levee at Elev. 30	Ring levee around Pascagoula/Washington Street @ Elev. 30'

(Option D)	
Moss Point Alternate Ring Levee at Elev. 30 (Option F)	Ring levee around Moss Point, Elev. 30'
Washington St + Moss Point Alternate Ring Levee at Elev. 30 (Opt H)	Ring levee around Washington St + Moss Point Alt at Elev. 30
Nonstructural for Reach 54	Nonstructural Plan for areas not inside Ring Levee
Nonstructural for Reach 53	Nonstructural Plan for areas not inside Ring Levee
Nonstructural for Reach 52	Nonstructural Plan for areas not inside Ring Levee
Nonstructural for Reach 51	Nonstructural Plan for areas not inside Ring Levee
Nonstructural for Reaches 51,52,53, 54	Nonstructural buyouts / elevation of structures
Griffin Point Ecosystem Restoration Plan - 32	183 Acres - restore to emergent tidal marsh
Bayou Chico Ecosystem Restoration Plan - 33	259 Acres - restore to emergent tidal marsh
Grand Bay / Bayou Cumbest Ecosystem Restoration Plan - 34	1517 Acres (Contained in ABO area named Belle Fontaine)
Inland Zone (LOD-4)	
Inland Zone No Action	
Inland Barrier A Levee at Elev. 20	3 County Levees at Elev. 20' plus surge gates
Inland Barrier D Levee at Elev. 20 with Roadway	3 County Levees at Elev 20' plus surge gates with roadway on top
Inland Barrier F Menge Ave. Levee at Elev. 20	3 County Levees at Elev 20' with no Bay St Louis Surge gate
Inland Barrier I Menge Ave Levee at Elev 20 w/ Roadway	3 County Levees at Elev. 20' with no Bay St. Louis Surge gate w/ roadway
Nonstructural at Inland Barrier Footprint for Elevation 20	Coast-wide Nonstructural comparison for inland barriers
Inland Barrier B Levee at Elev. 30	3 County Levees at Elev. 30' plus surge gates
Inland Barrier E Levee at Elev. 30 with Roadway	3 County Levees at Elev. 30' plus surge gates with roadway on top
Inland Barrier G Menge Ave. Levee at Elev. 30	3 County Levees at Elev. 30' with no Bay St Louis Surge gate
Inland Barrier J Menge Ave. Levee at Elev. 30 w/ Roadway	3 County Levees at Elev 30' with no Bay St. Louis Surge gate w/ roadway
Nonstructural at Inland Barrier Footprint for Elevation 30	Coast-wide Nonstructural comparison for inland barriers
Inland Barrier C Levee at Elev. 40	3 County Levees at Elev 40' plus surge gates
Inland Barrier H Menge Ave. Levee at Elev. 40	3 County Levees at Elev. 40' with no Bay St. Louis Surge gate
Nonstructural at Inland Barrier Footprint for Elevation 40	Coast-wide Nonstructural comparison for inland barriers
Nonstructural for Reach 7	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 37	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 38	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 1	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 2	Nonstructural buyouts / elevation of structures
Lower Bay Rd Ecosystem Restoration Plan - 6	227 Acres - residential infrastructure
Lakeshore Ecosystem Restoration Plan - 7	275 Acres - residential / commercial infrastructure
Bay St. Louis No Action	
Bay St Louis Ring Levee at Elevation 20	Ring levee around Bay St. Louis, Elev. 20'
Bay St Louis Nonstructural for Elevation 20	Buyouts and/or raising structures accounting for a 20' surge
Bay St. Louis Ring Levee at Elevation 30	Ring levee around Bay St. Louis, Elev. 30'
Bay St. Louis Nonstructural for Elevation 30	Buyouts and/or raising structures accounting for a 30' surge
Shoreline Park ABO Plan	buyouts of structures in high risk zones
Shoreline Park Ecosystem Restoration Plan	Restore tidal marsh - Requires buyout
Bayou LaCroix Ecosystem Restoration Plan - 10	260 Acres - residential infrastructure
Admiral Island DSS Ecosystem Restoration Plan - 11	245 Acres - (ABO area in Shoreline Park B and 2/3 of site is demo project and state owned)

State's Admiral Island Ecosystem Restoration	Exotic control and Debris Removal
Chapman Road Ecosystem Restoration Plan - 13	146 Acres - (ABO area in Shoreline Park C)
Diamondhead Ecosystem Restoration Plan - 15	434 Acres
Henderson Point / Pass Christian No Action	
Henderson Point A Nonstructural ABO Plan	Nonstructural Advanced Buyout Plan for areas not in Ring Levee
Delisle Ecosystem Restoration Plan - 16	Harrison County 121 Acres - removal of residential infrastructure
Ellis Ecosystem Restoration Plan - 17	443 Acres
Pine Point Shores East Ecosystem Restoration Plan - 18	103 Acres - removal of residential structures
Pine Point Shores West Ecosystem Restoration Plan - 19	84 Acres - removal of residential structures
Bayou Portage Ecosystem Restoration Plan - 21	44 Acres - Restore to emergent tidal marsh
Nonstructural for Reach 8	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 39	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 40	Nonstructural buyouts / elevation of structures
Gulf Port No Action	
Nonstructural for Reach 12	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 40	Nonstructural buyouts / elevation of structures
Turkey Creek Ecosystem Restoration Plan - 22	948 Acres - Restore Wet Pine Savannah
Forrest Heights No Action	
Forrest Heights 17' Levee Option	Levee around Forrest Heights, Elev. 17'
Forrest Heights 21' Levee Option	Levee around Forrest Heights, Elev. 21'
Brickyard Bayou at Courthouse Rd Eco Plan - 23	15 Acres - Restore to emergent tidal marsh
Biloxi River - Shorecrest Eco Restoration Plan - 24	15 Acres - Restore to emergent tidal marsh
Biloxi River - Eagle Point Eco Restoration Plan - 25	17 Acres -
Biloxi No Action	
Nonstructural for Reach 14	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 17	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 19	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 16	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 20	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 48	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 50	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 47	Nonstructural buyouts / elevation of structures
Keegan Bayou Ecosystem Restoration Plan - 27	55 Acres - restore to emergent tidal marsh
Ocean Springs No Action	
Nonstructural for Reach 21	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 23	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 25	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 32	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 33	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 34	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 35	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 41	Nonstructural buyouts / elevation of structures

Nonstructural for Reach 42	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 43	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 44	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 45	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 46	Nonstructural buyouts / elevation of structures
Nonstructural for Reach 49	Nonstructural buyouts / elevation of structures
Nonstructural Elevations for Waveland	Elevation of Houses in the City of Waveland
Moss Point Municipal Structures Relocation	Relocating Municipal services to higher ground
Escatawpa Freshwater Diversion	Decrease salinity to wetlands / MS Sound by diverting freshwater
Pearl River Freshwater Diversion	Decrease salinity to wetlands / MS Sound by diverting freshwater
Bonnie Carne Freshwater Diversion	Decrease salinity to wetlands / MS Sound by diverting freshwater
Violet Freshwater Diversion	Decrease salinity to wetlands / MS Sound by diverting freshwater
St. Martin Ecosystem Restoration Plan - 28	Jackson County 468 Acres - restore to emergent tidal marsh
Fort Point Ecosystem Restoration Plan - 29	84 Acres - restore to emergent tidal marsh

3.11.1 Refinement of Preliminary Structural Alternatives

In order to conduct an evaluation of preliminary alternatives, additional development of the LOD concept was required. The LOD concept was modeled using both the ADCIRC model, to determine the degree of surge height reduction, and also the Beach-FX model, which was used to determine beach behavior (primarily the erosion resulting) during a hurricane event. In addition to numerous separate "lines" (barriers to surge), additional combinations of measures were also modeled to determine the most comprehensive package of measures.

The first Line of Defense, designated as LOD-1, was modeled to help predict what effects the islands have in storm reduction. LOD-1 alternatives included restoration to a pre-Camille condition, restoration to a pre-Katrina condition, restoration to a condition equivalent to the 1920's, and one in which additional height and length was created on each island. Model results are discussed in Section 2-10 of the Engineering Appendix.

Adding higher dunes and/or dune vegetation to shoreline beaches was designated as LOD-2. These dunes would not provide protection from large storms, but would be beneficial for smaller storms and would provide recreational and environmental benefits. Each of the three counties has beaches which are appropriate for adding dunes. For each county, 11 options were considered for adding some measure of dune creation. Most of the options have versions that included adding vegetation and sand fencing as well as dunes without these features. Eight of the options in each county have the dune placed against roadways that parallel the beaches with the assumption that these roadways would be elevated as a separate measure. Each of these options have a dune crest elevation less than the adjacent roadway (possibly raised in the future under LOD-3 options) to prevent sand from constantly being blown onto the road These options have some value as protection for the road, but more value as an ecological benefit. Two other options include a stand-alone dune out on the beach that could provide some level of surge defense along with ecological benefits. Each county also has an option with a wide sand berm fully planted with sea oats, the preferred vegetation to help stabilize dunes. This option will allow the sea oats to trap wind-blown sand and naturally build a dune with time. The dune options in all three counties total 33 different alternatives that could be considered.

The roadways that coincide with the beaches, while not continuous along the coast, were designated as LOD-3. It was envisioned that raising these roadways would have minimal environmental impact and provide the first hardened barrier to surge damage. The new road elevations would not be high enough to act as a seawall for very large storms, but like LOD-2, they would be beneficial for smaller, more frequent storms.

While different elevations were initially considered for the roadways, the technical difficulty of raising the roads over six feet was realized. This is due to the numerous intersecting roads, driveways, and parking areas that could not be constructed without extreme grades. The existing beachfront roads in Hancock and Jackson have a typical grade elevation of 5.0 and the general grade elevation for US 90 in Harrison County is 10.0 although it varies from elevation 7.0 to 16.0 depending on the exact location. With the existing road elevations, a top elevation of 11.0 was selected for study in Hancock and Jackson County and a top elevation of 16.0 was selected for study in Harrison County for a total of three options. It was also recognized that LOD-3 would require barriers placed at the mouths of the bays to be effective against back-flooding. The locations of the barriers are shown in Section 2-1 of the Engineering Appendix.

Some areas of the coast were not associated with beaches or existing roadways, which allow for a continuous defense line. When including environmental and/or technical concerns, these areas could only be viewed as stand-alone projects such as ring levees. These areas include five communities in Jackson County, one in Harrison County, and two in Hancock County. For discussion purposes, these ring levees were also included in LOD-3. Each of the conceptual ring levees have been evaluated for construction at two elevations, 20.0 and 30.0. Costs include interior drainage, pumping stations, gates for roadways and overtopping protection. Some sites also have one or more alternate alignments. The alternate alignments were selected to lessen the impacts on wetlands, lessen the intensity of wave action or to decrease the construction costs versus adding non-structural solution areas. With all ring levee elevations and alternate alignments, there were 24 different options for further consideration.

One of the areas being considered as a stand alone project is the Forrest (Forest) Heights community in Harrison County. Since its establishment by freed slaves and their descendants, federally funded construction programs (including the Gulfport Regional Airport, U.S. Highway 49, and Interstate 10) have impacted this community. The Federal Government is prohibited from adversely impacting identifiable minority or low-income communities by proposed flood damage reduction measures, so this area was also considered as a stand alone project.

Further inland, an existing railroad grade provided a levee-like barrier to storm surge from Katrina in some areas. This railway extends all the way across the State, crossing both St. Louis Bay and Biloxi Bay. In Harrison County, the railway parallels the coastline just a few blocks inland. Using a parallel, high-ground alignment as the railway system, an inland barrier was envisioned that could be constructed to such an elevation as to protect from a large storm surge, even larger than Katrina. This system would require that the bays be closed off with barriers to form a continuous line of defense to be effective against surge. As LOD-4, this barrier was studied at elevations up to the maximum storm surge or maximum possible intensity (MPI) storm that could be predicted based on simulated hurricane events. These selected elevations are 20.0, 30.0 and 40.0.

Possible options for LOD-4 also included omitting the surge barrier across St. Louis Bay. This would require that LOD-4 be terminated along the east side of the bay. An alternate alignment to satisfy this option was selected at Menge Avenue in Pass Christian where the LOD-4 levee could be extended northward to higher ground. This option would also leave the town of Bay St. Louis without any type of surge protection. If this alternate alignment is used, Bay St. Louis hurricane defenses could be included as a ring levee with an option under LOD-3. Many alignments for project termination on the western and eastern sides of the state were considered before one that was selected, mostly due to technical and environmental reasons. This system would not cross the Pearl River on the western side of the state nor the Pascagoula River in Jackson County. Including all the different elevations and alignments for LOD-4, there are a total of 22 options including the six options for the surge gates. A general discussion of the LOD's is included in Section 2.1 of the

Engineering Appendix. A more detailed discussion can be found in Part 3 of the Engineering Appendix.

While actually a non-structural measure, LOD-5 was designated as the limit of an MPI event surge. It would be an area north of any potential surge damage that would be recommended for location of critical infrastructure such as hospitals, long-term care facilities, and emergency facilities.

To proceed with initial cost estimates, various components of the structural options were conceptually designed to the selected elevations described in previous paragraphs. The initial elevations selected for each component of the lines of defense are assumed to bracket a wide range of potential storms with corresponding surge elevations. Using these preliminary designs, rough order of magnitude cost estimates were completed for each of the structural options. These cost estimates can be used to develop cost curves for rough estimates after final design elevations are selected. With these cost curves, future studies can also evaluate varied levels of protection based on risk assessments as well as taking into account future estimates of relative sea level rise.

3.12 Evaluation of Preliminary Alternatives

Evaluation of preliminary alternatives utilized modeling results and technical analyses conducted for each alternative and site or problem area. The study team then discussed their evaluations as a group to arrive at a consensus as to what was being discovered about the benefits or issues with each alternative, and its conceptual application to the site or problem area in question. This evaluation process also involved the application of numerous technical models, to determine, for instance, the behavior of waves, under both a without-project and with-project condition, or the benefit over time to a particular ecosystem created by a particular alternative.

The list of alternatives developed for each problem area was further refined, and additional data were presented for consideration, based on continued technical, environmental, and cost-effectiveness analyses. More detailed input from the resource agencies, public and private entities, and technical staff was obtained. Consideration of potentially combining alternatives into multi-purpose alternatives, capable of dealing with more than one identified problem at a given site was also attempted. The screened list of alternatives was then combined into a well-balanced group that included both non-structural and if applicable, structural measures that could potentially address the entire suite of environmental problems plaguing an individual site or problem area. Formulation of these alternatives also incorporated the following criteria:

- Does a potential alternative provide for an improvement in function and/or habitat values of significant resources that might also provide for potential preservation of fish and wildlife and their habitats?
- Does a proposed action or project negatively impact low income or minority populations and/or children [i.e. Executive Orders (EOs) Environmental Justice and Protection of Children)?
- Does a proposed alternative provide a potential reduction in coastal erosion?
- Does a proposed alternative provide a potential reduction in the extent or level of saltwater intrusion (encroachment)?
- Does the proposed project fit in with, or complement, the objectives of the State of Mississippi and/or locals' plans and desires for the area?
- Does the proposal contribute to the short-term or long-term recovery of coastal Mississippi?

Using these questions as continued evaluative tools, the PDT employed these additional criteria specified in ER 1105-2-100:

- effectiveness

- completeness
- acceptability
- efficiency and cost-effectiveness.

Additional evaluative questions asked by the study team in its development of information on alternatives, but not considered screening criteria, also included:

- Does the alternative provide a reduction in risk at that specific site, or in other locations?
- Does the alternative provide a reduction in damage at that specific site, or in other locations?
- Can the alternative be combined as a component of a multi-purpose alternative?
- Can the measure be capable of dealing with more than one identified problem at a given site?
- Does a proposed alternative provide an increase in the level of education on hurricane risks?
- Does a proposed alternative provide a increase in time before one would be warned of an impending hurricane event (i.e., more time to prepare)?
- Does a proposed alternative provide an increased level of precision in information on the level of threat (i.e., better information on landfall location and magnitude of the event)?
- Does a proposed alternative provide an increase in the effectiveness of hurricane/storm warning to area residents and visitors?
- Does a proposed alternative provide better education as to evacuation options, required items a family or business might want to evacuate, and definitive information on routes to safety?
- Does this effort duplicate or compliment the work of others?
- Does the problem (or would lack of a solution to the alternative) enhance protection of life?
- Does the problem (or would lack of a solution to the alternative) enhance protection of property?
- Is a potential alternative sustainable after implementation?
- Does a potential alternative still provide a potential reduction in hurricane or storm damage (if applicable)?
- Does a potential alternative still provide a potential reduction in coastal erosion (if applicable)?
- Does a potential alternative still provide a potential reduction in the extent or level of saltwater intrusion (if applicable)?
- Does a potential alternative still provide for potential preservation of fish and wildlife and their habitats (if applicable)?
- Does a proposed action or project negatively impact low income or minority populations?
- Is the cost reasonable in the light of the risk and consequences of not implementing the project?
- Are there unresolved issues (with other groups or organizations) regarding this problem or proposed solution that may lead to longer implementation times?
- Would a proposed activity or project have potential regulatory and/or environmental issues that would preclude being implemented in the near-term?
- Does the proposed project fit in with, or complement the objectives of the State and/or locals plans and desires for this area?
- Would the implantation of the proposed project preclude other future options that may have a higher level of contribution or damage reduction?

- Does the proposed project contribute to the short or longer-term recovery of coastal Mississippi?

3.13 Comparison of Preliminary Alternatives

Comparison of preliminary alternatives consisted of analysis of "No-Action", future "without-project", and future "with-project" conditions for each site or problem area. Comprehensive plan development includes consideration of multiple mission, site and resource specific features. Inclusion of a feature into the comprehensive mean indicates that the feature meets the criteria and satisfies the goals and objectives of the MsCIP. Expediency is also a factor in ecosystem restoration site evaluation. Restoration sites which are currently state property or which are identified as potential restoration sites by existing state initiatives can more readily be restored and are more suitable for inclusion into a construction recommendation.

Data presented for comparison in Round Two included preliminary costs, benefits (monetary, or economic, environmental outputs, societal, etc.) to be derived from implementation, problems related to implementation, more detailed design considerations, environmental outputs and potential impacts, potential damages prevented, geotechnical/site considerations, more detailed technical requirements, source material and source area considerations, variations in materials that could be used to solve the problem in a similar way, species benefits or impacts considerations, and many other technical, environmental, or economic issues.

3.13.1 Storm Damage Reduction Alternatives

Comparison of damage reduction alternatives focuses on how effectively it reduced surge height and extent compared to other measures of similar output. This involved numerous iterations of potential height and geographic coverage, since literally thousands of potential alignments of levee or embankment might be created. The goal in damage reduction alternative formulation was to reduce damages to the maximum extent possible for a given type of structural or non-structural measure. While many different measures such as levees, gates, seawalls, relocations, or structure elevations might produce a similar monetary damage reduction benefit, numerous iterations were necessary to develop the least costly and most productive alternative.

In general, non-structural plans including significant amounts of permanent acquisitions meet the objectives of storm damage reduction and reduced threats to life and public safety while providing substantial amounts of land for ecosystem restoration as wetlands and other sensitive habitat. Generally speaking these plans also are environmentally friendly having only minimal impacts (construction impacts at redevelopment sites) that can be mitigated and do not disproportionately affect low income or minority populations. Conversely, plans featuring substantial displacement of households may not be well accepted by the communities or local governments due to potential social and economic impacts (lost tax revenues).

The most notable differences in flood damage reduction alternatives were found when comparing 3rd line of defense (elevated seawall and beach roadways) with nonstructural alternatives along the same area (see Table 3-3). The structural alternatives are very costly for the amount of damages reduced compared to the nonstructural alternatives. This is due to the need for surge barriers across the bays, which must be construction in tandem with each structural alternative.

Table 3-3
Expected Annual Damage Reduction

Alternatives	Expected Annual Damage Reduction (Annual $)[1]	Residual Damage (Annual $)[1]	Implementation Cost ($)	Annual O&M (Annual $)	Average Annual Cost (Annual $)
(No Action)	$0	$0	$0	$0	$0
Seawall/Elevated Roadway[2]	$52,030,000	$374,010,000	$5,002,500,000	$60,148,000	$306,127,051
ABFE Nonstructural at Seawall/Elevated Roadway Footprint	$200,860,000	$225,180,000	$8,483,400,000	$110,000	$417,249,166

1/ Equivalent annual damages reduced are rounded to the nearest thousand dollars.
2/ The elimination of the seawall and elevated roadway option also eliminate the beach and dune placement options that are dependent on the raising of the seawall and roadway. Section 3.14 discusses this screening in more detail.

3.13.2 Ecosystem Restoration Alternatives

Preliminary alternatives for ecosystem restoration include site specific restoration efforts, potential freshwater diversion projects, restoration of barrier islands, submerged aquatic vegetation and multi-faceted restoration of Deer Island.

3.13.2.1 Preliminary Site Specific Restoration Alternatives

The plan formulation process for the environmental element if founded in the context of the overall comprehensive natural system and its current state post-hurricane impacts. The MsCIP environmental team compared the post-hurricane conditions to the pre-hurricane conditions. In some cases, ecological contrasts were very great while in other instances not much change had occurred. The environmental team worked with a variety of Federal, state, and local entities to adequately address the magnitude of problems plaguing Coastal Mississippi. Minor problems to complex integrated problems were identified and discussed amongst the team members – structural, environmental, and non-structural. Development of a comprehensive list of problem areas consisted of single or multiple problems associated with a given site that were first identified as having been caused or exacerbated by the hurricane events. These sites were identified with a) coastal erosion; b) damage to fish and wildlife resources, and/or c) saltwater intrusion.

Due to the large area and MsCIP condensed study schedule; the team compiling all existing data, such as topographic maps, navigational charts, water quality reports, soil maps, etc, that would be useful in assessing potential restoration efforts. The environmental PDT also had ERDC develop the GIS-based SDSS analysis tool that could effectively assist the team in quickly narrowing down evaluation sites. The environmental PDT also coordinated closely with both the non-structural and structural PDTs to assess impacts of implementing those measures. In addition, the environmental PDT provided ample input to minimize environmental impacts, such as moving the footprint(s) and/or providing natural defenses rather than hardened structures against storm damage.

Identification of potential environmental restoration sites was not only in the context of preservation of fish and wildlife habitat but also for the purposes of storm-and flood-damage reduction and the protection of life and property When residential and/or commercial structures and/or land are purchased for the purpose of reduction of risk from storm events (i.e. non-structural component), the structures are demolished and the land is no longer available for residential and/or commercial development. Historically, when land is purchased across the U.S., it is left in it's existing physical condition (minus structures) rather than restoring it to its historic setting. The philosophy pursued during the development of the comprehensive plan included the restoration of the functional natural landscape. A significant amount of the project land area is either occupied by wetlands or had been wetlands before development encroached upon these sensitive habitat areas. It is widely recognized that wetlands and especially those tied hydraulically to the Gulf and its bays are a significant component of the aquatic and terrestrial health of the Gulf aquatic ecosystems. In addition to reuse for ecosystem restoration, evacuated floodplain areas could be used for recreation uses that would be compatible with the inherent flood risk. The locations of these recreation areas and appropriate facility development would be coordinated with the counties and the municipalities in which the evacuated parcels are located.

- Development of a GIS based SDSS tool allowed the Corps, Mobile District, working in cooperation with the USFWS and MDMR, to identify and prioritize potential wetland restoration areas throughout Coastal Mississippi. Initial runs of the SDSS tool identified numerous sites - 1,086 potential wetland restoration areas. These initial runs had to be screened by the Corps, Mobile District, MDMR, and USFWS personnel. The professional team ranked several variables, such as land ownership, proximity to State and other preserved lands, such as the Grand Bay NERR and wildlife management areas, acreage of site, proximity to water, site complexity, potential diversity of natural ecosystem at the site, existing and historical soils, etc., to screen the large list of SDSS sites.

3.13.2.2 Preliminary Deer Island Restoration Alternatives

Deer Island, located south of Biloxi, has maintained its coastal maritime forest, beach/dune complex, freshwater lake, and emergent tidal marsh habitat over time but has lost approximately 300 acres to erosion since the late 1800s. This uninhabited island is one of the last natural islands along the Gulf Coast and was designated as part of the Mississippi Coastal Preserve by MDMR. Deer Island provides the mainland with hurricane/storm protection by helping to dissipate wave energy prior to its reaching the shoreline of the coast The island also provides various species, such as blue herons, osprey, and feral pigs, with necessary habitat hard to find in this highly developed area. Within Mississippi Sound a number of island features have existed over time and today Deer Island is one of only four mainland islands left in existence in the Sound. Figure 3-8 displays a recent aerial photograph of Deer Island.

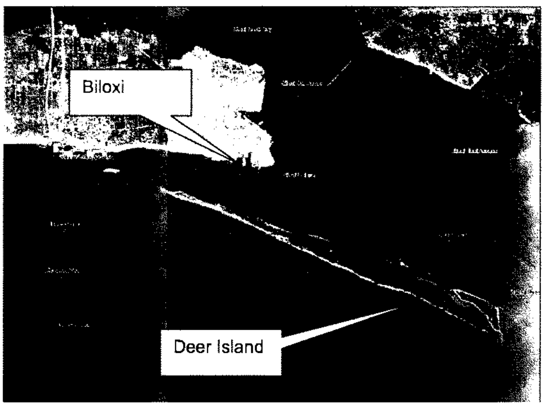


Figure 3-8
Deer Island Aerial Photograph

This unique mix of habitats on Deer Island is critical to the continued health of a number of fish and wildlife species. In addition to supporting many species of migratory waterfowl and shore/wading birds, Deer Island is located on the Mississippi flyway for many varieties of migratory neo-tropical species. The site is particularly important to grassland species, many of whom winter here, and migrate to northern states, Canada or the Arctic for the summer. Unless constrained by bad weather or insufficient fat reserves, birds are selective and they will search for a preferred habitat type in which to stop over. Most of these habitats have been impacted and/or destroyed nationally, regionally, and locally by development and/or natural events. Failure to address the loss of these types of habitats nationally, regionally, and locally (i.e. Deer Island) threatens the long-term health of the entire ecosystem. A delicate environmental web exists between these vital habitats. A shift in any of these habitats can cause detrimental effects, such as water quality issues or a reduction in fishery population due to emergent marsh loss. The beach/dune systems provide the first defense against wave action (i.e. tropical storms/hurricanes). Loss of these natural systems across the nation has resulted in many impacts, such as the loss of migratory bird nesting, higher property destruction, and reduction in sea turtle nesting. Emergent tidal marsh habitats serve as natural floodwater retention and over time, the loss of these marshes has contributed to increased flooding throughout the coast. Coastal maritime forests are typically found along the Gulf barrier islands. Unfortunately, following Hurricane Katrina approximately 80 to 90% of the habitat was significantly damaged and today only Cat Island in the west and Dauphin Island, Alabama to the east continue to have vibrant forest habitat. Deer Island's maritime forest was severely impacted by the tidal surge resulting in the loss of almost the entire pine forest. The community of the island is unique in that it is "trapped", and the climate and environment are relatively "harsh", resulting in a system that has very specifically adapted to the special conditions of the site.

In 2005, the Corps restored 45 acres of emergent marsh habitat via beneficial use of dredged material program within a containment site on the northeastern portion of the island. However, due to Hurricane Katrina, the site has experienced severe erosion. As a result, it was determine that the breakwaters associated with this project are not sufficient to keep up with current erosion rates.

Another project, authorized under Section 528 of the Water Resources Development Act (WRDA) of 2000, consists of the filling of the western breach of the island. This effort is part of an overall restoration plan for the island, but due to funding limitations, the breach component will likely be the only portion completed. Thus, the additional items of that restoration plan, along with restoration of the 2005 project, have been considered in this comprehensive study. The MsCIP team determined that the following alternatives need to be evaluated further for consideration:

- Restoring the Southern Shoreline. This alternative would restore 30 acres of dune habitat, 78 acres of emergent tidal marsh habitat, 78 acres of coastal maritime forests, and 86 acres of beach habitat along the southern shoreline of the island.
- Restoring the containment area associated with the 2005 beneficial use of dredged material project. This alternative would restore the containment dikes, place new dredged material into the existing containment site, and plant 30 acres of emergent tidal marsh.
- Developing new breakwater protection for the Island. This alternative would extend both the southern and northeastern breakwaters to form a solid line of protection.
- Restoring eroded marsh from the northeastern end of the island. This alternative would restore 20 acres of emergent tidal marsh habitat adjacent to the existing 2005 containment site project.
- Combination restoration plan. This plan would extend both existing breakwaters, restore 128 acres of emergent tidal marsh habitat, 78 acres coastal maritime forest, 86 acres of beach habitat, and 30 acres of dune habitat.

In 2003, because of loss of wetland marsh areas, an aquatic restoration project was proposed near the eastern tip of Deer Island. The project was authorized under the continuing authority of Section 204 of the Water Resources Development Act of 1992, as amended. Dredged material from maintenance of Biloxi Harbor was used to create approximately 45 acres of tidal marsh on the north shore of the east end of the island. Wetland vegetation was planted by over 100 volunteers in April 2005. The created marsh area withstood Hurricane Katrina with minor scouring within the site but with a minor breach of the containment dike of the marsh area. Plants within the marsh area are thriving. Figure 3-9 displays the existing Section 204 project.

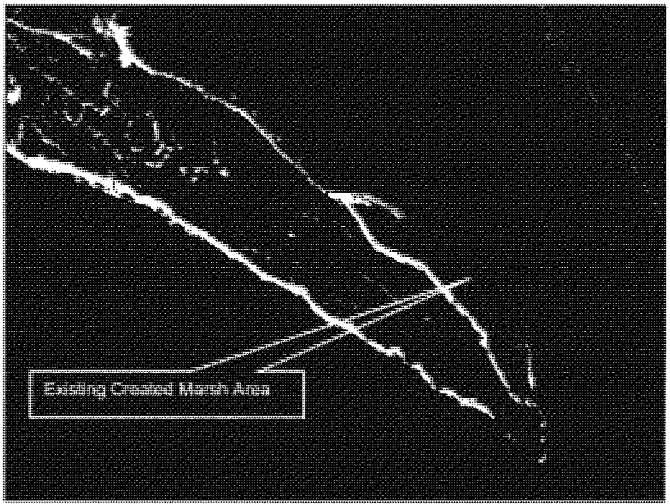


Figure 3-9
Existing Section 204 Project at Deer Island

Currently, the island has a large breach on its western end and a small breach has formed in the central area of the island in what is known as the Grand Bayou area. As the island degrades, the Federally authorized shallow draft Biloxi West Approach and Biloxi Lateral navigation channels that run between the City of Biloxi and Deer Island will experience increased shoaling and will require more frequent and costly maintenance dredging activities. Dredging in this area occurs twice as frequently as similar nearby channels. Deer Island also provides erosion protection to the mainland of the City of Biloxi. As the island continues to degrade, the impacts of increased wave action on the mainland shoreline will increase the amount of storm damages that can be suffered by commercial development congregated in this area.

In summary, there is a need to restore the shoreline of Deer Island, fill the breach areas, repair/improve existing marsh and maritime forest areas, and add additional marsh area. These efforts will provide protection to the mainland areas behind the island and improve critical coastal wetlands.

3.13.2.3 Preliminary Freshwater Diversion Alternatives

The barrier islands of the Mississippi Sound, the Grand Bay Savannahs and Marshes in the Escatawpa River basin of Jackson County, and the Hancock County Marshes on the western end of the Mississippi Sound, have degraded over the years. The levee systems built in eastern Louisiana and other man-made structures (i.e. railroads and highways) in the Escatawpa River basin have resulted in the loss of historic freshwater surface flows from the Mississippi, Pearl, and Escatawpa Rivers. This problem was greatly exacerbated by Hurricane Katrina and other storms in 2005. The lack of freshwater, and erosion of the barrier islands, have enabled more saline-tolerant predators to enter the Mississippi Sound, causing a decline in fish and wildlife resources. Particularly hard hit were the oyster resources.

Freshwater diversions would enable the redistribution of freshwater and much needed sediments to several degraded ecosystems of coastal Mississippi. A sensitivity analysis was conducted by the MsCIP team in order to see if diversion of freshwater flows could indeed reduce salinity within the Mississippi Sound. Hydrodynamic circulation, salinity, and water quality model calibrations were made using a water quality model developed by ERDC in 1998 for a previous project near Gulfport, Mississippi. This analysis was conducted at three sites: (1) increased diversion of freshwater flows from the Mississippi River at the existing Bonnet Carre' spillway, (2) a new diversion of freshwater flow from the Mississippi River at the Violet Marsh, and (3) a new diversion of all of the Escatawpa River flow into Grand Bay savannahs and marshes. Results showed that these diversions do have the potential to significantly influence coastal salinities.

Using this data, two new freshwater diversion alternatives were assessed. One is located near the community of Violet, in the St. Bernard Parish of Southern Louisiana. This diversion structure would be located on the eastern bank of the Mississippi River, and would help restore the Hancock County Marshes. The second alternative is located within the eastern portion of the state along the Escatawpa River, and would help to restore the Grand Bay Savannahs and Marsh. While increasing flows at the existing diversion at Bonnet Carre' in Louisiana was considered, this alternative is believed to have significant negative environmental impacts to the Lake Pontchartrain ecosystem, as well as strong opposition from area residents.

It should be noted that freshwater diversions may also result in areas of excess nutrients. This can cause algal blooms, lower light attenuation, and other signs of eutrophication. Therefore, any diversion project needs to be carefully evaluated in order to insure the proper habitat and water quality conditions are met. Due to the time constraint of this MsCIP Comprehensive Report and Integrated Programmatic EIS, the MsCIP team was only able to qualitatively determine that freshwater input into the systems does change the overall environment. It is known that these systems have been altered and/or starved by lack of freshwater inflow. An integrated environmental web exists in these rivers and also in Mississippi Sound, which needs to be fully identified, in order to completely understand various effects that could possibly occur.

3.13.2.4 Preliminary SAV Alternatives

The continued survival and growth of SAV may be threatened by the cumulative effects of man's activities in addition to natural processes in the coastal marine environment. Natural causes of SAV decline, such as disease, storm events, salinity fluctuation, and hypoxic events, coupled with declining water quality caused by anthropogenic eutrophication currently threaten the health of many SAV systems (Montague and Ley 1993, Durako and Kuss 1994, Olesen and Sand-Jensen 1994, Zieman et al 1994). These habitats provide vital refuges, feeding, resting, staging, and spawning grounds for a variety of species found in Mississippi Sound and also in the Gulf of Mexico. Past studies throughout the years have attributed anywhere from 50% to 90% of all marine species utilize this vital habitat at some point in their life state.

In 1969, an estimated 20,000 acres of SAVs were documented in Mississippi and coastal bays. As of 1998, only 2000 acres were documented (Moncrieff 1998), see Table 3-5. Dramatic decreases have been noted on every Mississippi barrier island. Areas of SAV habitat loss coincide with areas where rapid coastal erosion and massive long-term movement of sand has been well-documented (Otvos 1981 and Oivanki 1994). Loss of vegetated areas corresponds with potential loss in water clarity over time due either to: (1) anthropogenic influences, (2) cyclic shifts in precipitation patterns, which would affect both salinity and turbidity, or (3) a combination of these factors (Moncrieff 1998). Primary reasons for the disappearance of SAVs are most likely an overall decline in water quality, extended periods of depressed salinities, and physical disturbances, such as tropical storms and hurricanes (Moncrieff 1998). Physical loss of habitat and decreased light availability coupled with declining water quality are the most visible features that directly affect SAVs (Moncrieff 1998).

Moncrieff (1998) identified approximately 14,900 acres as being suitable SAV habitat [i.e. Potential Seagrass Habitat (PSGH)].

Table 3-5
SAV Historical, 1992 and Potential Habitat

Location	1969 (acres)	1992 (acres)	Potential SAV Habitat
Buccaneer State Park	206	55	316
Cat Island	598	169	5,128
Ship Island	1,536	253	1,603
Dog Keys Pass	2,079	0	1,149
Horn Island	5,567	530	4,350
Petit Bois Island	1,690	364	1,810
Point-aux-Chenes Bay	1,306	627	534
Totals	12,982	1,998	14,890

Reference Moncrieff 1998

Therefore, the MsCIP team determined the need to include an alternative that would aid in restoring SAVs in Mississippi Sound and adjacent bays. Due to this large-scale effort and uncertainties of successful restoration of other efforts, the team decided that a smaller restoration effort may need to be conducted before lessons learned could be applied to any larger-scaled effort.

3.14 Screening of Preliminary Alternatives

Screening of preliminary alternatives included screening of structural, non-structural, and ecosystem restoration components of a comprehensive plan. The screening process involved comparison of the relative benefits, impacts, costs, societal impacts, or other outputs of a given plan, as compared to each other and the "No-Action" Plan.

A large number of site-specific alternatives were eliminated, such as some seawall or beach berm/dune alternatives, based on their failure to achieve significant damage reduction. Screening also eliminated a large number of embankment/levee options, as too environmentally damaging or technically infeasible. These included levees, embankments, and floodwalls across embayments and channels in western Hancock and eastern Jackson Counties, levees across Grand Bay Marsh, or the Pearl River delta systems, and across wetland areas along other parts of the coast, as shown in Table 3-6.

Table 3-6
Summary of Round Two Screening of Measures

Preliminary Alternatives Screened Out of the Analysis
Hancock 40' Dune @ Elevated Roadway (Option A)
Hancock 50' Dune @ Elevated Roadway (Option B)
Hancock 20' Dune @ Elevated Roadway (Option C)
Hancock 30' Dune @ Elevated Roadway (Option D)
Hancock Dune Option A plus sea oats (Option E)
Hancock Dune Option B plus sea oats (Option F)
Hancock Dune Option C plus sea oats (Option G)

Preliminary Alternatives Screened Out of the Analysis
Hancock Dune Option D plus sea oats (Option H)
Harrison 40' Dune @ Elevated Roadway (Option A)
Harrison 50' Dune @ Elevated Roadway (Option B)
Harrison 20' Dune @ Elevated Roadway (Option C)
Harrison 30' Dune @ Elevated Roadway (Option D)
Harrison Dune Option A plus sea oats (Option E)
Harrison Dune Option B plus sea oats (Option F)
Harrison Option C plus sea oats (Option G)
Harrison Dune Option D plus sea oats (Option H)
Jackson 40' Dune @ Elevated Roadway (Option A)
Jackson 50' Dune @ Elevated Roadway (Option B)
Jackson 20' Dune @ Elevated Roadway (Option C)
Jackson 30' Dune @ Elevated Roadway (Option D)
Jackson Dune Option A plus sea oats (Option E)
Jackson Dune Option B plus sea oats (Option F)
Jackson Option C plus sea oats (Option G)
Jackson Dune Option D plus sea oats (Option H)
Hancock Seawall/Elevated Roadway at Elevation 11
Harrison Seawall/Elevated Roadway at Elevation 16
Jackson Seawall/Elevated Roadway at Elevation 11
Biloxi Bay Surge Gate at Elevation 20
St Louis Bay Surge Gate at Elevation 20

The following discussion highlights those alternatives which were deemed "no longer feasible." More detailed information can be found in the accompanying appendices.

Lines of Defense (LOD) 2 and 3. The original concept behind these two lines of defense was to create barriers which would reduce flood damages from moderately sized storm surges. Larger storm surges (similar to Hurricane Katrina) would be addressed by the fourth line of defense. The "most workable" solution for the third line of defense included elevating the roadways along the beach. They would in turn be connected to "surge gates" across Bay Saint Louis and Biloxi Bay to keep water from entering around the sides of the roadway. Just raising the roadway up to an elevation of 6 feet, an elevation that could be overtopped by less than a "1 percent" chance storm, proved to be challenging. The side slopes of an elevated roadway, along with ramps to get local traffic onto the roadway, would require the buyout and removal of most of the houses they were designed to protect. Also, the surge gates proved to be exceedingly costly for the amount of damage reduction benefits received. Therefore, all of the LOD 3 options, parallel to the coast were eliminated from further consideration. Ecosystem restoration benefits were also an objective of the second line of defense and several of the dune options were designed to work in tandem with the elevated road options. A cost effectiveness analysis eliminated several of these options (see the Economic Appendix for more information), and others were eliminated because they needed LOD3 in place. This left only the low dune options designated as i, j, and k to carry forward for further evaluation. All nonstructural alternatives were carried forward for further analysis.

Ecosystem Restoration Alternatives. The Corps' SDSS tool was used to screen the 1,086 potential wetland restoration areas. The Corps, Mobile District began investigations for identifying potential environmental restoration sites for the purposes of storm-and flood-damage reduction, flood reduction, preservation of fish and wildlife habitat, and removal of habitable structures within high hazard areas. Initial runs of the SDSS tool yielded numerous sites that had to be screened by the Corps, Mobile District, MDMR, and USFWS personnel. The professional team ranked several variables, such as land ownership, proximity to State and other preserved lands, such as the Grand Bay NERR and wildlife management areas, acreage of site, proximity to water, site complexity, potential diversity of natural ecosystem at the site, existing and historical soils, etc., to screen the large list of SDSS sites. The team used these ranked variables for evaluation in order to identify those critical natural systems that would benefit the comprehensive system. Identified environmental restoration sites include a combination of those identified based on the SDSS results, as well as some additional sites (i.e. State Initiatives). These were made using only the non-natural land-use and 100-year flood calculations as the original site selectors (i.e. no damage layers were used), and sites were greater than or equal to 5 acres.

The sites contained the following characteristics:

- Sites were greater than 5 acres in size;
- Sites contained an SDSS Restorability class greater than Low or Medium Low;
- Sites contained an SDSS Habitat class greater than Low or Medium Low; and
- Sites contained an SDSS Storm Surge/Flood Protection class greater than Low.

A subset of potential restoration sites were identified by the SDSS tool and then ground-truthed by the MsCIP environmental team, including ERDC, Corps, MDMR, and USFWS. This interagency team allowed us to both confirm the accuracy of the SDSS results and to collect additional on-site information pertinent to restoration efforts. There are some major benefits in using a GIS-based SDSS approach to wetland restoration. First, it allows for the relatively rapid assessment of the large number of restoration sites across the wide study area. Second, potential sites can be evaluated and restored in a watershed or landscape context, which allows us to comprehensively evaluate the overall natural system. This approach can maximize the benefits of wetland restoration, as opposed to simply restoring wetlands where convenient or where property is available. Essentially use of this SDSS tool allowed the MsCIP environmental team to assess the entire coastline as a holistic natural system; thus, the team was more effectively able to analyze needs in Coastal Mississippi.

The SDSS effort resulted in the following products:

1. A Model Builder based SDSS tool, which can be subsequently edited and applied to other areas along Coastal Mississippi in the future as funding becomes available;
2. Maps, such as aerial photography, topographic, soil layers, etc., depicting areas in the study region that have a high probability of being successfully restored into wetland functions that buffer and/or store stormwater, and provide suitable habitat for fish and wildlife;
3. Photograph documentation and data sheets containing information on ground-truthed potential restoration sites.

Based on these evaluations approximately 1040 of the sites initially identified were screened from further consideration. Forty-three sites were identified that would likely provide the desired ecosystem benefits. These sites were carried forward for final analysis and are identified in Table 3-7.

Table 3-7
Wetland Restoration Sites in Coastal Mississippi

Site	Restoration Acres
(1) Pearlington, Hancock	76 acres (State owns 2,200 acres in the Pearlington area)
(2) Pearlington South, Hancock	11 acres
(3) Port /West, Hancock	49 acres
(4) Ansley, Hancock	2,023 acres (State owns 6,000 acres west of Lakeshore Road)
(5) Heron Bay	594 acres
(6) Lower Bay	226 acres
(7) Lakeshore, Hancock	275 acres
(8) Bayou Caddy/Lakeshore, Hancock	362 acres
(9) Clermont Harbor, Hancock	209 acres
(10) Bayou La Croix, Hancock	259 acres
(11) Shoreline Park, Hancock	889 acres
(12) Chapman Road, Hancock	146 acres
(13) Jourdan River – Interstate 10 Development, Hancock	638 acres
(14) Diamondhead, Hancock	433 acres
(15) Delisle, Harrison	120 acres (State owns 1,000 acres)
(16) Ellis Property, Harrison	443 acres
(17) Pine Point East, Harrison	103 acres (State owns 40-50 tax forfeited lots)
(18) Pine Point West, Harrison	83 acres (State owns 40-50 tax forfeited lots)
(19) Pass Christian Beach Front, Harrison	21 acres
(20) Pass Christian Site – Bayou Portage, Harrison	43 acres
(21) Brickyard Bayou, Harrison	14 acres
(22) Biloxi River – Shorecrest, Harrison	15 acres
(23) Biloxi River – Eagle Point, Harrison	17 acres
(24) Biloxi Front Beach - South of Highway 90, Harrison *	40 acres
(25) Keegan Bayou, Harrison	54 acres
(26) St. Martin, Jackson	467 acres
(27) Fort Point, Jackson	83 acres
(28) Pine Island, Jackson	237 acres
(29) Belle Fontaine, Jackson	1,516 acres
(30) Griffin Point, Jackson	182 acres
(31) Bayou Chico, Jackson	258 acres
(32) Grand Bay/Bayou Cumbest, Jackson	2,666 acres

Site	Restoration Acres
(33) Wachovia, Hancock	1,200 acres total – 800 marsh, 200 forested, 200 savannah
(34) Ansley, Hancock	900 acres – 800 marsh, 100 forested
(35) LaFrancis Camp Trenaisse, Hancock	45 acres total – all open water
(36) DuPont, Harrison	650 acres – 170 marsh, 480 forested
(37) Dantzler, Jackson (Alternate)	900 acres – 500 marsh, 385 forested
(38) Pascagoula River Marsh, Jackson	11,150 acres
(39) Turkey Creek, Harrison	880 acres total – wet pine savannah
(40) Dantzler, Jackson	385 acres – wet pine savannah
(41) Franklin Creek Floodway, Jackson	149 acres – wet pine savannah
(42) Bayou Cumbest, Jackson	148 acres – 110 marsh, 38 scrub wetland
(43 Admiral Island, Hancock	123 acres – 62 marsh, 61 scrub wetland

* Removed following further evaluation

3.15 Development of Final Alternatives

All of the development of measures and alternatives, evaluation, and screening conducted to this point in the plan formulation process has resulted in a relatively small set of alternatives to be analyzed at the highest level of detail (Phase I). Other Comprehensive Plan measures and alternatives identified through the planning process are retained as Phase II and Phase III study efforts to be accomplished during the next 30 to 40 years. The final refinement of Phase I alternatives consisted of incorporating comments from team members and stakeholders, as well as making adjustments based on the last set of evaluations. The final refinement was directed at identifying the most cost-effective options within the four key areas of study:

- Hurricane / storm damage reduction;
- Ecosystem restoration for preservation of fish, wildlife and habitat functions and values;
- Saltwater intrusion / encroachment reduction; and
- Coastline Erosion.

Saltwater intrusion/encroachment reduction and coastal erosion reduction purposes are encompassed under the discussions of hurricane / storm damage reduction and ecosystem restoration alternatives.

Each alternative was refined to achieve more damage reduction, more ecosystem benefits, greater freshwater inflow, or better salinity reduction, particularly during the period of greatest importance in the life cycles of select organisms.

The set of final storm damage reduction alternatives is listed and discussed below. Additional discussion is also provided for LOD 4 and LOD 5, which are not advanced as final alternatives. Each of the final alternatives was refined based on higher detail data collection and technical analyses where applicable. The System of Accounts Tables, located later in this section, display the evaluation and comparison of the final alternatives.

Final Hurricane / Storm Damage Reduction Alternatives

- LOD – 1 Barrier Island restoration
- LOD – 2 Beach/Dune restoration
- LOD – 3 Ring Levees
- High Hazard Risk Reduction Plans
- Elevation of Structures
- Relocation of Municipal Services

3.15.1 Barrier Islands

Modifications to the Mississippi barrier islands were identified as LOD-1. The islands were among the first storm reduction aspects that were discussed in Mississippi's Recovery Plan. Through many meetings, a set of options were formulated that could be combined into an alternative that would meet with approval of the state of Mississippi, plus be consistent with the 2006 NPS Management Policies. The options included:

Barrier Island Plan B – Replenishing sand in the littoral zone from inland river source;

Barrier Island Plan C – Replenishing sand in the littoral zone from offshore source;

Barrier Island Plan D – Reshaping the south beach to form 2-foot dune structure;

Barrier Island Plan E – Constructing a 6-foot dune structure using offshore source;

Barrier Island Plan F – SAV restoration;

Barrier Island Plan G – Restoration of the Ship Island breach; and

Barrier Island Plan H – Comprehensive Environmental Restoration of Barrier Islands Plan.

3.15.2 Beach and Dune System

Modifications to coastal Mississippi's beach and dune system were identified as LOD-2. Alternatives that would provide some degree of protection along the mainland beaches include constructing dunes in several configurations (Dune Options I, J, and K). Options I and J provide a 10-foot elevation stand alone dune, while Option K consists of a low elevation dune with dune vegetation onto the existing beaches (See Figure 3-10).

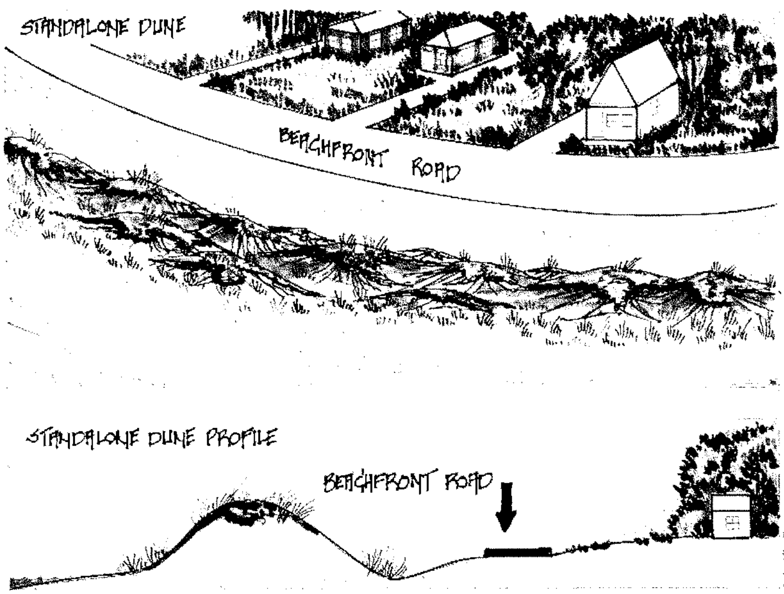


Figure 3-10
Rendering of Dune Options

3.15.3 Ring Levees

Ring Levees have been identified as a component of LOD-3. Many parts of the Mississippi coast do not have the topography or population density necessary to support a continuous barrier such as a levee parallel to the coast. To help provide some storm defense for these areas, such as the Forrest (Forest) Heights community, ring levees could be used. The alignment of these ring levees was initially selected to provide the maximum protection for the population centers. As initial alignments were evaluated, alternate alignments were selected in some cases to minimize impact on wetlands, provide attenuation from direct wave attack, or decrease the quantity of fill required for levee construction. Examples of alternate alignments include Gulf Park Estates, Belle Fontaine, and Pascagoula in Jackson County. The crest elevations for these ring levees could vary depending on the amount of risk that that community is willing to assume. The recommended crest elevation is typically designed for a surge and waves with a 0.2 percent annual chance of being exceeded.

Due to the accelerated nature of this study, the study team was unable to develop feasibility level designs for any of the ring levees other than Forrest Heights. Further, based on input received at the various public and stakeholder meetings, the structural measures did not receive a majority of support. There is, however, sufficient information to make basic comparisons with nonstructural flood damage reduction alternatives, so these alternatives were carried forward for further consideration.

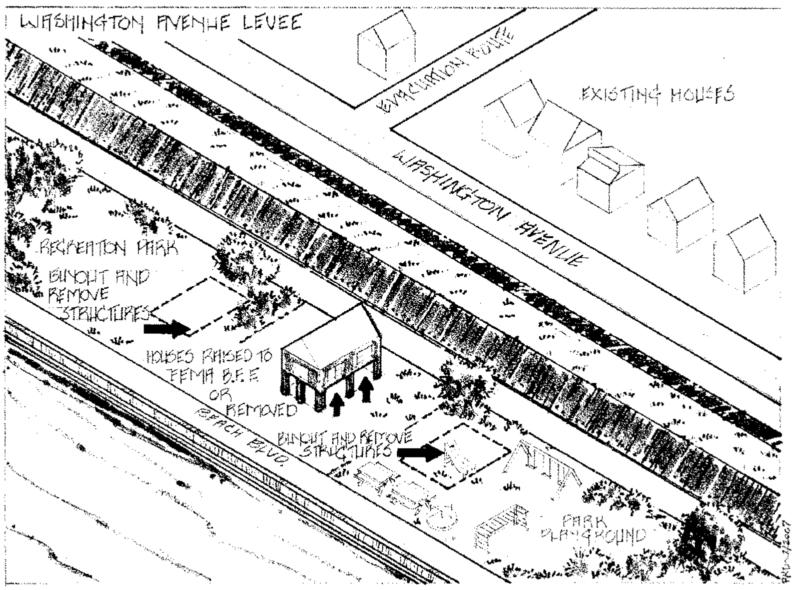


Figure 3-11
Rendering of a Ring Levee Alternative in Pascagoula.

3.15.4 Inland Barrier System

An inland barrier system (LOD-4) was not advanced as a final alternative, but the following information is provided for clarification. Alternatives within this line of defense, which could reduce the risk of inland flood damages from larger storms, are comprised of inland levees with surge barriers across the mouths of the two large bays in Mississippi. In combination, this barrier could extend from the first watershed divide east of the Pearl River in Hancock County westward to the last watershed divide west of the Pascagoula River following parallel to an existing railway. While surge gates were not deemed cost effect in tandem with a LOD-3 barrier, this barrier could be designed to provide a defense from a very large storm, thus providing substantially more benefits. However, it would have some aspects that may not have public or political support. Depending on the selected crest elevation, the levee may be hardly noticeable in some areas with naturally high topography such as portions of Biloxi, but may be a very high feature in areas with low topography such as Pass Christian. Another feature is the surge gates that would be required to prevent back-flooding into the bays. Evaluation of the requirements to have the gates as a component revealed that the closure of St. Louis Bay could be omitted provided that the levee did not cross into Hancock County, but the closure of Biloxi Bay is required to provide any beneficial defense for Gulfport or Biloxi. The surge gate evaluation provided an alternate levee alignment in Harrison County that could omit this defense in western Harrison County and Hancock County. The alternate alignment would parallel the railway through Harrison County westward to the Menge Avenue crossing where the levee would turn north to high ground. Due to its east-west extent in Harrison County, this portion of the levee system could also be used to support the construction of a major roadway on top of the levee by widening the crest.

3.15.5 Non-Structural Risk Reduction

While the discussion of nonstructural measures at public meetings was emotionally charged, there was a general consensus that any relocations resulting from the 2005 storms not displace large portions of communities. This resulted in the development of multiple non-structural elements of the comprehensive plan, including evacuation planning, building codes etc. and acquisition or flood proofing of properties within the area identified as having a 1% annual chance of inundation from hurricane and storm surges (aka '100-yr' floodplain). A portion of this area is designated the high-hazard zone and in this area flood proofing by elevation is not considered appropriate due to the forces associated with the surge therefore permanent acquisition of properties and removal of structures is the only option for risk reduction. Permanent acquisition of coastal properties is an effective way to reduce flood damages and loss of life due to drowning as a result of hurricane surge. Parcels within the designated area (with or without structures) can be purchased at fair market value under the provisions of the Uniform Relocations Assistance and Real Property Acquisition Policies Act of 1970 (P.L. 91-646).

Last resort housing benefits may be available to those displaced persons who relocate to a DSS structure located above the Katrina inundation elevation (or the 500 yr. flood event as defined on FEMA NFIP mapping) to further the objectives of migrating the population northward and away from the coast. Specific recommendations for implementation of provisions of the Uniform Relocations Act as they may apply to acquisitions of property in the project area are contained within the Real Estate Appendix.

Acquisition or flood proofing of all properties within the '100-yr' floodplain equates to approximately 59,000 parcels. Obviously it is not realistic to consider that this action could be undertaken within a short timeframe due to impacts on local tax base, ability to acquire, cost etc. It is more realistic to consider that this component could be phased in over a 25 – 40 year period. Therefore, a phased implementation of separable elements was developed, including a flood proofing demonstration, a high hazard area risk reduction plan (HARP Phase I) and a long-term risk reduction plan (HARP Phase II). The flood proofing demonstration could lead to further study of specific areas of the coast and subsequent implementation by the Federal government or it could lead to increased involvement of local government or residents in providing for the risk reduction. Each of these elements is described in more detail below.

3.15.5.1 High Hazard Area Risk Reduction Plan (HARP) Phase I

The first phase of the non-structural High Hazard Area Risk Reduction Plan (HARP Phase I) involves the buyout of those properties that have been frequently flooded, or are at very high probability of future damage due to storm surge. The HARP would target parcels within the high-hazard zone that are currently occupied or could be re-occupied by new structures or those interspersed vacant parcels that could be occupied in the future. Of the total approximated 15,000 parcels located in the high-hazard zone, 2,000 parcels would be included in the first phase HARP. That number of parcels could be addressed by real estate resources over approximately a 5 year period, provided that Federal funds would be appropriated. Further information on the High Hazard Area Risk Reduction Plan can be found in the Nonstructural and Real Estate Appendices.

Also within the HARP footprint are 4 municipal structures in Moss Point, MS that have been identified as being public facilities that may be eligible for replacement through the Real Estate "substitute facility doctrine". The Moss Point municipal complex is discussed in more detail in Section 3.15.5.3 below.

3.15.5.2 High Hazard Area Risk Reduction Plan Phase II

During public involvement sessions a significant portion of the population believed that the rebuilding process might already be too far advanced to relocate a significant number of residents to another location at this time. Therefore, the second phase of the HARP is to develop a strategy where buyouts along the coast can occur quickly over a long period of time as properties and funding become available. This could also occur after the next significant storm event, and before another major reconstruction effort within the high-hazard surge-plain begins. The long-term risk reduction plan is envisioned as a coordinated effort between HUD, FEMA, and the Corps that would be applied as future storms impact the area.

3.15.5.3 Relocating Municipal Services

During the delineation of the coastal high-hazard zone (HARP footprint) and the non-floodproofing zone (where surge inundation depths would exceed 13 feet at the BFE), it became apparent that a number of structures within the municipal facilities complex of Moss Point, MS would be included in the area where permanent acquisition would be the recommended action to reduce flood damages. As discussed below, public facilities, when determined to be eligible for substitution, may be relocated to a flood-safe area. For public facilities that are considered to be critical components of a local or regional post-disaster response and recovery system, relocation to a flood-safe site enables that facility to operate both during and immediately after the disaster to reduce loss of life and maintain essential emergency services.

In acquisition situations where the existing structure or facility is determined by Corps Real Estate staff to be a publicly-owned and operated building or facility, the Corps of Engineers Real Estate regulations (ER 405-1-12) concerning the disposition of public facilities and structures would establish the methodology for determining value. Under this regulation, acquisition of publicly-owned facilities and structures required to be purchased to meet the project design objectives should be based upon the "Substitute Facility Doctrine". Since just compensation for an acquisition is based upon fair market value at the time of purchase and since publicly-owned and operated structures and property may not have a "market value" such as do residential and commercial structures, the cost of constructing a substitute facility may be used as a measure of just compensation.

Generally the substitute facility will serve the owner in the same manner as the existing facility with regard to size, usage and functionality. Typically the substitute facility doctrine is used to address the acquisition of schools, city halls, police and fire stations, and other state, municipal and county owned and operated facilities and structures and they are all collectively referred to as "relocations" in Corps water resources projects. Within the zones identified by the Corps to be too hazardous to elevate structures (high-hazard zone and non-floodproofing zone), there are likely to be publicly-owned and operated facilities and structures that will fall under the category of "relocations".

Coincidently, the team became aware of local efforts by the leadership of Moss Point, MS to address surge inundation damages to several public buildings within that same municipal complex. Members of the team met with the Mayor of Moss Point and other city officials to discuss whether the proposed acquisition of those structures under the Corps MsCIP may lead to a plan for relocating those facilities that would be in concert with the replacement concepts described above.

As a result of those meetings, a preliminary public facilities replacement plan for Moss Point, MS was developed. The purpose of this replacement component of the HARP (in addition to protection of critical public facilities) would be to demonstrate to the other 10 affected municipalities that replacement of critical facilities is an effective way of maintaining services within the community while protecting those structures from flood damages. Communities that face such issues outside of the delineated Corps' HARP area could use their Capital Improvements Programs to fund fully or partially (cost-sharing situation) the necessary relocations. For those public structures that may be located in the high-hazard zone (HARP) or where surge inundation depths would preclude floodproofing.

The public buildings replacement project would include the Moss Point city hall, police station, fire station and community recreation center. Each of these four facilities was severely damaged during Katrina by surge inundation and waves and prevented local authorities from assisting citizens during the emergency. The City of Moss Point identified several strategic locations within the city where relocated public facilities would be safe from future events. Tentative replacement locations for each of the four facilities to be relocated are shown on Figure 3 -12. The final arrangement of the replacement facilities (multi-use single structure, multiple-structure complex or dispersed facilities) would be determined in collaboration with the municipal officials during the relocations planning phase of the project.

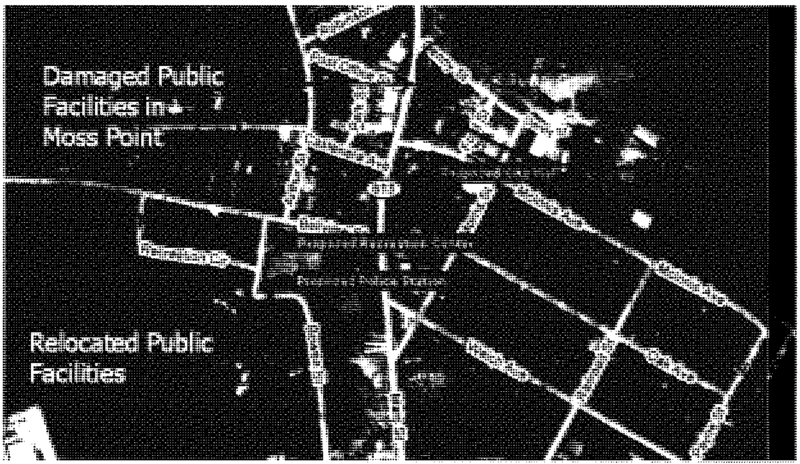


Figure 3-12
Moss Point Public Facilities Relocation Project

Should other similarly situated facilities by identified during the implementation of the HARP Phase I they would be included as part of that comprehensive plan element.

3.15.5.4 Waveland Floodproofing Project

In an effort to demonstrate the feasibility and effectiveness of wet floodproofing as a means of reducing flood damages in the project area, a project has been formulated as a part of the overall nonstructural program. This project would provide an opportunity to evaluate the technical aspects of the FEMA 550 guidelines as a basis for elevating structures in the program, allow for the public and local officials to see first-hand the application of floodproofing measures by elevating residential structures and affirm Corps cost data and contracting procedures that would support expanded applications of this flood damage reduction method in the MsCIP project area. Given the large number of parcels which would be eligible for floodproofing by elevation and other methods, innovative contracting methods would need to be tested to assure that good quality construction that was both acceptable to the structure owner and that limited the liability of the Corps could be applied in an efficient manner across the project area.

Using available GIS data, a geographic area within one of the most hard hit areas of the coast, Waveland, was identified where wet floodproofing would be an effective method of reducing flood damages. This selected area is outside of the identified high-hazard zones where wave action and surge would endanger an elevated residential structure and its occupants. In this initial study phase the ABFE-2 feet was used as the design flood elevation for elevating approximately 25 residential structures. Prior to implementation (if the project is approved), the newest approved local ordinance (City of Waveland local floodplain management ordinance) base flood elevation (or higher) would be used to set the raised elevation of the first habitable floors of the structures. The location of the proposed project is shown in Figure 3-13.

The 25 residential structures are mainly single-family, wood frame structures on structural slab foundations (two observed crawl-spaces). Many of the residences have a brick veneer exterior. Heights of elevation range between 4 and 6 feet at the ABFE-2 feet inundation level. Using the elevation methods described above, it is anticipated that a combination of the segmented block foundation (0-4 feet high) and the concrete column foundation (> 4 feet elevation) would be used in the project.

The results of this project, including design aspects and costs, would be made available to local municipal officials as well as residents for their use in applying the 550 Guidelines or in developing local ordinances governing the wet floodproofing of structures within appropriate areas of the 100 year floodplain.

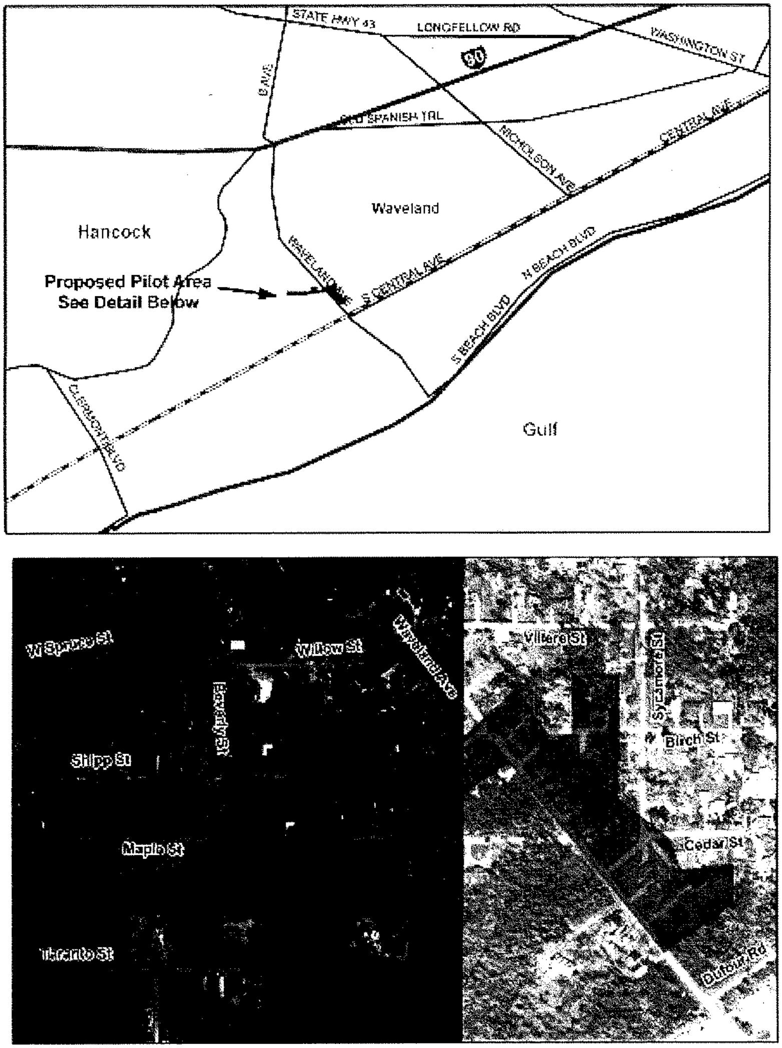


Figure 3-13
Location of Proposed Waveland, MS Pilot Floodproofing Project

3.15.5.5 Maximum Possible Intensity Line (Line of Defense #5)

This is only a recommendation without a program requirement and has no direct implementation cost. The one option that will provide a very low probability of future damage from storm surge is moving all critical or emergency infrastructure construction northward / inland of the limits of the surge. This line would be based on the "Maximum Possible Intensity" (MPI) storm event modeling and could be accomplished by collaborative efforts at the local, county, and state levels.

3.15.6 Final Ecosystem Restoration Alternatives

The set of final ecosystem restoration alternatives includes actions which would directly address the salt water intrusion and fish and wildlife preservation aspects of the Congressional authorization. Some of the alternatives also provide secondary storm damage reduction and erosion reduction benefits. The following measures were carried forward into the final array of ecosystem restoration alternatives.

Final Ecosystem Restoration Alternatives

- Freshwater Diversions
- Restoration of Historical Wetlands at Multiple Sites
- Submerged Aquatic Vegetation (SAV) Restoration
- Deer Island Ecosystem Restoration

3.15.5.6 Freshwater Diversions

Diversion of Mississippi River freshwater and/or sediments in the vicinity of Violet, Louisiana has been strongly considered because of a number of positive factors. These include proximity of the river to target coastal wetland restoration areas' ability to influence Mississippi Sound salinities, strong public support, and high confidence in potential environmental benefits. The Violet Diversion Project is under consideration as a joint bi-state effort between Mississippi, Louisiana, and the Corps, Mobile and Corps, New Orleans Districts. This freshwater diversion project could have a positive impact to the Biloxi marshes of southeast Louisiana and wetlands in Hancock County (Mississippi Sound ecosystem). Preliminary results from modeling a simulated diversion of 7,500 cubic feet per second of Mississippi River water near Violet, Louisiana, suggest that after 180 days of initiation of the diversion, salinities would be lowered in Western Mississippi Sound sufficiently to warrant additional examination (Dortch et al 2007). A diversion at Violet was authorized in WRDA of 2007 but additional design and analysis is necessary to determine the specifics of the project and adequately examine the environmental impacts. Further refinement of the models should address current limitations and must be made to estimate potential beneficial or deleterious effects on oysters, seagrasses, marsh systems, and other coastal resources. Although this alternative appears viable at this point, additional information is needed to determine current problems within Hancock County Marshes and potential impacts to existing coastal resources as well as navigation impacts.

Historically, the estuarine marsh within the Grand Bay NERR represented the former deltaic environments of the Pascagoula and Escatawpa Rivers in eastern Jackson County. The outlets of these rivers have shifted westward over time, severely limiting the inflow of freshwater, nutrients, and sediments into the Bayou Cumbest area of the reserve. Currently, it is speculated that much of the freshwater entering the Grand Bay NERR estuary is from surface runoff through Bayou Heron and Bayou Cumbest, within the Bangs Lake Hydraulic Unit, measuring approximately 21,374 acres. Human disturbances to the area have also altered historic sheet flow and surface water flows into the area, as well as the natural migration of the Pascagoula and Escatawpa Rivers. A freshwater diversion project along the Escatawpa River, if feasible, may serve to enhance the wildlife resources of the area. This need for freshwater diversion of the Escatawpa River flows to the Grand Bay savannahs and marshes would help restore the predominant wet pine savannah habitat. The study team's recommendation is to develop a refined hydrodynamic model for the area, inputting biological, water quality, and physical data into the model to evaluate a variety of freshwater diversion alternatives.

3.15.6.2 Environmental Restoration of Historical Wetland Sites

The resulting 43 potential wetland restoration sites were selected as critical elements of the comprehensive plan. A three phased approach was utilized for management purposes. Phase I environmental projects consists of those restoration projects that can clearly demonstrated the habitats – wet pine savannah, emergent tidal marsh, beach and dune, scrub shrub, and SAVs - to be restored in the comprehensive restoration effort. Phase II consists of the other 6 State Initiative projects which are owned by Mississippi's Coastal Preserve Program and that can be restored following implementation of Phase I. Phase III consists of all of the remaining environmental restoration projects. These sites are identified in Table 3-8 and shown in Figure 3-14

Table 3-8
Wetland Restoration Sites in Coastal Mississippi

Site	Restoration Acres	Environmental Setting
(1) Pearlington, Hancock	76 acres (State owns 2,200 acres in the Pearlington area)	Emergent aquatic vegetation Bayhead Swamps trees Bayhead Swamps shrubs Riverine/levee forests
(2) Pearlington South, Hancock	11 acres	Emergent aquatic vegetation Bayhead Swamps trees Bayhead Swamps shrubs Riverine/levee forests
(3) Port /West, Hancock	49 acres	Emergent aquatic vegetation
(4) Ansley, Hancock	2,023 acres (State owns 6,000 acres west of Lakeshore Road)	Emergent aquatic vegetation Wet pine savannah
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(9) Clermont Harbor, Hancock	209 acres	Emergent aquatic vegetation
(10) Bayou La Croix, Hancock	259 acres	Emergent aquatic vegetation
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(12) Chapman Road, Hancock	146 acres	Emergent aquatic vegetation
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Site	Restoration Acres	Environmental Setting
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(16) Ellis Property, Harrison	443 acres	Emergent aquatic vegetation Pine savannah - wet pine flatwoods.
(17) Pine Point East, Harrison	103 acres (State owns 40-50 tax forfeited lots)	Emergent aquatic vegetation Wet pine savannah habitat
(18) Pine Point West, Harrison	83 acres (State owns 40-50 tax forfeited lots)	Emergent aquatic vegetation Wet pine savannah habitat
(19) Pass Christian Beach Front, Harrison	21 acres	Emergent aquatic vegetation Bayhead swamps trees Bayhead Swamps shrubs
(20) Pass Christian Site – Bayou Portage, Harrison	43 acres	Emergent aquatic vegetation Bayhead swamps trees Bayhead Swamps shrubs
(21) Brickyard Bayou, Harrison	14 acres	Emergent aquatic vegetation Bayhead swamps trees Bayhead swamps shrubs
(22) Biloxi River – Shorecrest, Harrison	15 acres	Emergent aquatic vegetation Bayhead swamps trees Bayhead swamps shrubs Riverine/levee forests
(23) Biloxi River – Eagle Point, Harrison	17 acres	Emergent aquatic vegetation Bayhead swamps trees Bayhead swamps shrubs Riverine/levee forests
(24) Biloxi Front Beach - South of Highway 90, Harrison*	40 acres	Dune System
(25) Keegan Bayou, Harrison	54 acres	Emergent aquatic vegetation Wet Pine Savannah habitat
(26) St. Martin, Jackson	467 acres	Emergent aquatic vegetation
(27) Fort Point, Jackson	83 acres	Emergent aquatic vegetation
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(29) Belle Fontaine, Jackson	1,516 acres	Dune System
(30) Griffin Point, Jackson	182 acres	Emergent aquatic vegetation
(31) Bayou Chico, Jackson	258 acres	Emergent aquatic vegetation
(32) Grand Bay/Bayou Cumbest, Jackson	2,666 acres	Emergent aquatic vegetation
(33) Wachovia, Hancock	1,200 acres total – 800 marsh, 200 forested, 200 savannah	Emergent aquatic vegetation, Bayhead Swamps trees Bayhead Swamps shrubs Riverine/levee forests

Site	Restoration Acres	Environmental Setting
(34) Ansley, Hancock	900 acres – 800 marsh, 100 forested	Emergent aquatic vegetation, Wet pine savannah
(35) LaFrancis Camp Trenaisse, Hancock	45 acres total – all open water	Open Water
(36) DuPont, Harrison	650 acres – 170 marsh, 480 forested	Emergent aquatic vegetation, Bayhead Swamps trees Bayhead Swamps shrubs Riverine/levee forests
(37) Dantzler, Jackson (Alternate)	900 acres – 500 marsh, 385 forested	Emergent aquatic vegetation, Bayhead Swamps trees Bayhead Swamps shrubs Riverine/levee forests
(38) Pascagoula River Marsh, Jackson	11,150 acres	Emergent aquatic vegetation, Bayhead Swamps trees Bayhead Swamps shrubs Riverine/levee forests
(39) Turkey Creek, Harrison	880 acres	Wet pine savannah
(40) Dantzler, Jackson	385 acres	Wet pine savannah
(41) Franklin Creek Floodway, Jackson	149 acres	Wet pine savannah
(42) Bayou Cumbest, Jackson	148 acres	Emergent aquatic vegetation, scrub shrub wetland
(43 Admiral Island, Hancock	123 acres	Emergent aquatic vegetation, scrub shrub wetland

1 * Removed following further evaluation

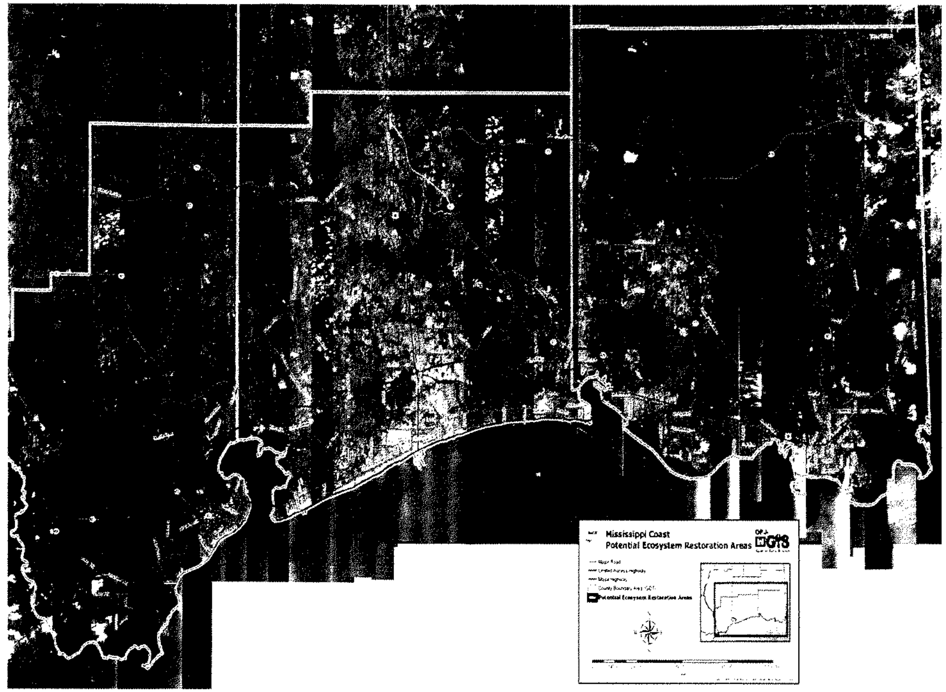

Figure 3-14
Potential Wetland Restoration Sites

Due to the time constraints of this study, an array of potential alternatives was developed for 5 sites (Phase I) – Turkey Creek, Bayou Cumbest, Franklin Creek, Admiral Island, and Dantzler. These sites were chosen by the team for various reasons. The five sites developed for ecosystem restoration implementation were selected because they were either:

- Already vacant lands with wetlands degraded by the storms of 2005;
- Previously functioning wetlands which would not require relocating residents; or
- Developed wetland areas where residents are willing to relocate.

The Turkey Creek site was selected due to having one land owner, critical resources that have ongoing developmental pressures, and an existing analysis conducted of the ecosystem functions (i.e. HGM wetland analysis conducted by ERDC during HGM development). FEMA's ongoing Hazard Grant Mitigation Program, including buy-outs, allowed the team to focus on Bayou Cumbest. In addition, this site has critical historic and existing degraded emergent tidal marsh habitat vital State of Mississippi's comprehensive ecosystem. Restoration of these critical marsh systems is essential to the State's and national seafood industry. The Franklin Creek project site has been funded for homeowner's assistance and relocation as part of the MsCIP Interim Report. Removal of these structures would allow for the team to restore the critical wet pine savannah habitat that has been historically developed by residential and commercial structures. Admiral Island and Dantzler restoration areas are state owned properties under MDMR Coastal Preserves Program. These protected sites were once functioning on their own prior to the storm season of 2005. However, the storms removed native vegetation resulting in vast open-spaces, which allowed exotic species to out compete historically productive native species (i.e. tidal marsh and wet pine savannah species); thus, reducing the sites' vital natural functions.

Without intervention, Deer Island would continue its degradation and ultimately increased wave action would occur along the mainland at the City of Biloxi. The southern shorelines would continue to erode; thus, adversely impacting those dependant species, such as birds and crabs. Wave action from daily occurrences and storm events would eventually erode the beach and then begin eroding the emergent tidal marsh and coastal maritime forests. Furthermore, the Section 204 emergent tidal marsh restoration site would continue to degrade. Ultimately, this unique habitat would continue to change from a productive beach/dune, emergent tidal marsh, and coastal maritime forest habitat to stressed and non-functioning habitats. Deer Island contains a diverse habitat of beach/dunes, emergent tidal marshes, and coastal maritime forests. Its proximity to the City of Biloxi provides a certain amount of protection to the city from waves generated by approaching hurricanes. Currently, the uninhabited island is part of the MDMR Coastal Preserves Program. Restoration efforts have been funded under the Section 528 of WRDA of 2000 for breaches at the west end and near Grand Bayou, and parts of the southern shoreline. Although a substantial restoration effort in its own right, there are significant opportunities to further restore the island and repair hurricane-caused damage to the islands' ecosystems.

For the SAV restoration effort, MsCIP team assessed the continued survival and growth of seagrasses (i.e. SAVs) and found them threatened by the cumulative effects of man's activities, in addition to, natural processes in the coastal marine environment. Natural causes of SAV decline, such as disease, storm events, salinity fluctuation, and hypoxic events, coupled with declining water quality caused by anthropogenic eutrophication currently threaten the health of many SAV systems (Montague and Ley 1993, Durako and Kuss 1994, Olesen and Sand-Jensen 1994, Zieman et al 1994). These marine and brackish habitats provide vital refuges, feeding, resting, staging, and spawning grounds for a variety of species found in Mississippi Sound and also in the Gulf of Mexico. Past studies throughout the years have attributed anywhere from 50% to 90% of all marine species to utilize this vital habitat at some point in their life state. In 1969, an estimated 20,000 acres of SAVs were documented and as of 1998, only 2,000 acres were documented (Moncrieff 1998).

SAV restoration efforts across the nation have proven to be rather challenging and many examples can be identified close to Mississippi, such as in Florida. Thus, Bayou Cumbest was chosen due to its small size to produce data, such as salinity, water quality, currents, substrates, composition of sediments, boating traffic (propeller scarring/turbidity), transplant success rates, and heterogeneity of species composition, in order to determine the success criteria for future recovery efforts of SAV within brackish systems in Coastal Mississippi. Future SAV restoration site could include area north of Buccaneer State Park, Cat Island, Ship Island, Dog Keys Pass, Horn Island, Petit Bois Island, and Point aux-Chenes.

After discussing the potential SAV pilot project with biologists at ERDC, it has been determined there currently are no assessment tools for quantifying benefits of SAV restoration projects. Although quantified outputs of ecosystem projects have traditionally been used as the basis for justification, little data is available for use in establishing baseline conditions of existing SAVs, organisms currently using established beds, and the specific causes for the overall decline of brackish SAVs. As part of the data collection described above, an index would be developed most likely using acreages and density quantifying environmental outputs generated through the success of the SAV restoration pilot project. This quantifiable environmental output would then be used to demonstrate cost effective criteria for future brackish SAV systems.

For the five environmental restoration sites – Turkey Creek, Bayou Cumbest, Franklin Creek, Admiral Island, and Dantzler - final alternatives were determined by a cost effective analysis using IWR Plan (see the Economic Appendix for more details on this analysis). The existing Deer Island FHI evaluation from the Section 204 and WRDA Section 528 were used to develop the cost effective alternatives. For the SAV effort, limited knowledge of the functional restoration prohibited the team in developing cost effective alternatives; thus, a pilot project was identified at Bayou Cumbest to obtain the much needed described data. Final alternatives are shown in table 3-9:

Table 3-9
Final Ecosystem Restoration Alternatives

Ecosystem Restoration Alternative	Description
Turkey Creek No Action	
Turkey Creek Plan 1	Restoration of 879 Acres Maintained by Burning
Turkey Creek Plan 2	Restoration of 879 Acres Maintained by Mowing
Turkey Creek Plan 3	Restoration of 689 Acres Maintained by Burning
Turkey Creek Plan 4	Restoration of 689 Acres Maintained By Mowing
Turkey Creek Plan 5	Restoration of 190 Acres Maintained by Burning
Turkey Creek Plan 6	Restoration of 190 Acres Maintained by Mowing
Bayou Cumbest No Action	
Bayou Cumbest Plan 1	Excavate Fill, Remove Exotics, Plant Natives at 0.5 meter density, and fill ditches
Bayou Cumbest Plan 2	Excavate Fill, Remove Exotics, Plant Natives at 1.0 meter density, and fill ditches
Bayou Cumbest Plan 3	Excavate Fill, Remove Exotics, Plant Natives at 2.0 meter density, and fill ditches
Bayou Cumbest Plan 4	Excavate Fill, Remove Exotics, Plant Natives at 0.5 meter density
Bayou Cumbest Plan 5	Excavate Fill, Remove Exotics, Plant Natives at 1.0 meter density
Bayou Cumbest Plan 6	Excavate Fill, Remove Exotics, Plant Natives at 2.0 meter density

Admiral Island No Action	
Admiral Island Plan 1	Excavate Fill, Remove Exotics, Plant Natives at 0.5 meter density, and fill ditches
Admiral Island Plan 2	Excavate Fill, Remove Exotics, Plant Natives at 1.0 meter density, and fill ditches
Admiral Island Plan 3	Excavate Fill, Remove Exotics, Plant Natives at 2.0 meter density, and fill ditches
Admiral Island Plan 4	Excavate Fill, Remove Exotics, Plant Natives at 0.5 meter density
Admiral Island Plan 5	Excavate Fill, Remove Exotics, Plant Natives at 1.0 meter density
Admiral Island Plan 6	Excavate Fill, Remove Exotics, Plant Natives at 2.0 meter density
Dantzler No Action	
Dantzler Plan 1	385 Acre Restoration Maintained by Burning
Dantzler Plan 2	385 Acre Restoration Maintained by Mowing
Dantzler Plan 3	151 Acre Restoration Maintained by Burning
Dantzler Plan 4	151 Acre Restoration Maintained by Mowing
Dantzler Plan 5	234 Acre Restoration Maintained by Burning
Dantzler Plan 6	234 Acre Restoration Maintained by Mowing
Franklin Creek No Action	
Franklin Creek Plan 1	Restoration of 149 Acres North and South of Railroad Maintain by Burning
Franklin Creek Plan 2	Restoration of 149 Acres North and South of Railroad Maintain by Mowing
Franklin Creek Plan 3	Restoration of 56 Acres and Maintain by Burning
Franklin Creek Plan 4	Restoration of 56 Acres and Maintain by Mowing
Deer Island No Action	
Deer Island Plan 1 Southern Shoreline Restoration	Restore 30 acres of dune, 78 acres of emergent tidal marsh, 78 acres of coastal maritime forests, and 86 acres of beach habitats along the southern shoreline.
Deer Island Plan 2 Containment Area Restoration	Placement of dredged material into the existing containment site and planting 30 acres of emergent tidal marsh.
Deer Island Plan 3 Breakwater Protection	Extend both the southern and northeastern breakwaters to form a solid line of protection.
Deer Island Plan 4 Eastern Marsh Restoration	Restore 20 acres of emergent tidal marsh via beneficial use of dredged material adjacent to the existing containment site project.
Deer Island Plan 5 Combination Restoration Plan	Extend both existing breakwaters, restore 128 acres of emergent tidal marsh habitat, 78 acres coastal maritime forest, 86 acres of beach habitat, and 30 acres of dune habitat.
SAV No Action	
SAV Pilot Project	Restoration of 5 Acres in Bayou Cumbest
SAV Buccaneer State Park	Restoration of Potential SAV Habitat of 316
SAV Cat Island	Restoration of Potential SAV Habitat of 5,128
SAV Ship Island	Restoration of Potential SAV Habitat of 1,603
SAV Dog Keys Pass	Restoration of Potential SAV Habitat of 1,149
SAV Horn Island	Restoration of Potential SAV Habitat of 4,350

SAV Petite Bois Island	Restoration of Potential SAV Habitat of 1,810
SAV Point-aux-Chenes Bay	Restoration of Potential SAV Habitat of 534
Freshwater Diversion	Western Portion of Mississippi Sound
Freshwater Diversion	Eastern Portion of Mississippi Sound

3.16 Evaluation of Phase I Final Alternatives

3.16.1 Evaluation of Hurricane and Storm Damage Reduction Alternatives

The final evaluation process for hurricane / storm damage reduction alternatives involved the following considerations:

- determination of final surge and wave heights for a given event frequency,
- surge behavior under these same events,
- costs required for structural and non-structural designs or lists of features applying to a certain design level,
- final determination of damage reduction benefits derived for a certain design,
- societal and other OSE benefits and outcomes for each plan,
- secondary benefits over time to a particular ecosystem created by a particular measure.

3.16.2 Evaluation of Ecosystem Restoration Alternatives

The final evaluation process for ecosystem restoration alternatives was a cost-effective analysis conducted at the site level for five of the 38 ecosystem restoration sites previously identified using the SDSS process. The Institute for Water Resources (IWR) Plan model was used to conduct the cost effectiveness analysis for each of the measures and alternatives for the Admiral Island, Dantzler, Turkey Creek, Bayou Cumbest, and Franklin Creek sites. The analyses followed the methodologies established in the US Army Corps of Engineers Institute for Water Resources publications, Evaluation of Environmental Investment Procedures Manual, Interim: Cost Effectiveness and Incremental Analyses, May 1995, IWR Report #95-R-1 and Cost Effectiveness Analysis for Environmental Measuring: Nine Easy Steps, October 1994, IWR Report 94-PS-2. The nine steps outline in the cited IWR report have become the standard practice for identifying what are known as "Best Buy" ecosystem restoration measures, or those measures that yield the greatest 'bang for the buck' at various levels of output.

The IWR Measure model was developed based on these nine steps and is the preferred Corps of Engineers model for the evaluation for ecosystem restoration measures. For the MsCIP Comprehensive Plan Report, Congressional Authority stated, "...but shall not perform an incremental benefit-cost analysis to identify the recommended project...." Following this authorization, only the first five steps of the nine easy steps, which are bolded below, were used in the IWR Plan evaluation, resulting in the identification of cost effective plans for restoration purposes. The nine steps are:

- Formulation of combinations:
  Step 1 - Display Outputs and Costs
  Step 2 – Identify Combinable Management Measures
  Step 3 – Calculate Outputs and Costs
- Cost Effective Analysis:
  Step 4 – Eliminate Economically Inefficient Solutions
  Step 5 – Eliminate Economically Ineffective Solutions

- Development of Incremental Cost Curve
  Step 6 – Calculate average costs
  Step 7 – Recalculate average costs for additional output
- Incremental Cost Analysis:
  Step 8 – Calculate incremental costs
  Step 9 – Compare successive outputs and incremental costs

Specific details of the site specific cost effective analyses can be found in the Economic Appendix. Table 3-10 summarizes the cost effective plans for the Beach and Dune, Turkey Creek, Bayou Cumbest, Admiral Island, Dantzler, and Franklin Creek Areas. The existing Deer Island FHI evaluation from the Section 204 and WRDA Section 528 were used to develop the cost effective alternatives. For the SAV effort, limited knowledge of the functional restoration prohibited the team in developing cost effective alternatives; thus, a pilot project was identified at Bayou Cumbest to obtain the much needed described data.

Table 3-10
Final Ecosystem Restoration Alternatives

Ecosystem Restoration Alternative	Description
LOD 2 No Action	
LOD 2 Option I	10-foot by 50-foot Dune without Plantings
LOD 2 Option J	10-foot by 50-foot Dune with Plantings
LOD 2 Option K	2-foot by 60-foot Dune with Plantings
Turkey Creek No Action	
Turkey Creek Plan 1	Restoration of 879 Acres Maintained by Burning
Turkey Creek Plan 3	Restoration of 689 Acres Maintained by Mowing
Turkey Creek Plan 5	Restoration of 190 Acres Maintained by Burning
Bayou Cumbest No Action	
Bayou Cumbest Plan 1	Excavate Fill, Remove Exotics, Plant Natives at 0.5 meter density, and fill ditches
Bayou Cumbest Plan 2	Excavate Fill, Remove Exotics, Plant Natives at 1.0 meter density, and fill ditches
Bayou Cumbest Plan 3	Excavate Fill, Remove Exotics, Plant Natives at 2.0 meter density, and fill ditches
Bayou Cumbest Plan 6	Excavate Fill, Remove Exotics, Plant Natives at 2.0 meter density
Admiral Island No Action	
Admiral Island Plan 1	Excavate Fill, Remove Exotics, Plant Natives at 0.5 meter density, and fill ditches
Admiral Island Plan 2	Excavate Fill, Remove Exotics, Plant Natives at 1.0 meter density, and fill ditches
Admiral Island Plan 3	Excavate Fill, Remove Exotics, Plant Natives at 2.0 meter density, and fill ditches
Admiral Island Plan 6	Excavate Fill, Remove Exotics, Plant Natives at 2.0 meter density
Dantzler No Action	
Dantzler Plan 1	385 Acre Restoration Maintained by Burning
Dantzler Plan 3	151 Acre Restoration Maintained by Burning
Dantzler Plan 5	234 Acre Restoration Maintained by Burning

Ecosystem Restoration Alternative	Description
Franklin Creek No Action	
Franklin Creek Plan 1	Restoration of 149 Acres North and South of Railroad Maintain by Burning
Franklin Creek Plan 3	Restoration of 56 Acres and Maintain by Burning
Barrier Island No Action	
Barrier Island Plan B	Replenishing sand in the littoral zone from inland river source
Barrier Island Plan C	Replenishing sand in the littoral zone from offshore source
Barrier Island Plan D	Reshaping the south beach to form 2-foot dune structure
Barrier Island Plan E	Constructing a 6-foot dune structure using offshore source
Barrier Island Plan F	SAV restoration
Barrier Island Plan G	Restoration of the Ship Island breach
Barrier Island Plan H	Comprehensive Environmental Restoration of Barrier Islands Plan
Deer Island No Action	
Deer Island Plan 1 Southern Shoreline Restoration	Restore 30 acres of dune, 78 acres of emergent tidal marsh, 78 acres of coastal maritime forests, and 86 acres of beach habitats along the southern shoreline.
Deer Island Plan 2 Containment Area Restoration	Placement of dredged material into the existing containment site and planting 30 acres of emergent tidal marsh.
Deer Island Plan 3 Breakwater Protection	Extend both the southern and northeastern breakwaters to form a solid line of protection.
Deer Island Plan 4 Eastern Marsh Restoration	Restore 20 acres of emergent tidal marsh via beneficial use of dredged material adjacent to the existing containment site project.
Deer Island Plan 5 Combination Restoration Plan	Extend both existing breakwaters, restore 128 acres of emergent tidal marsh habitat, 78 acres coastal maritime forest, 86 acres of beach habitat, and 30 acres of dune habitat.
SAV No Action	
SAV Pilot Project	Restoration of 5 Acres in Bayou Cumbest
SAV Buccaneer State Park	Restoration of Potential SAV Habitat of 316
SAV Cat Island	Restoration of Potential SAV Habitat of 5,128
SAV Ship Island	Restoration of Potential SAV Habitat of 1,603

Ecosystem Restoration Alternative	Description
SAV Dog Keys Pass	Restoration of Potential SAV Habitat of 1,149
SAV Horn Island	Restoration of Potential SAV Habitat of 4,350
SAV Petite Bois Island	Restoration of Potential SAV Habitat of 1,810
SAV Point-aux-Chenes Bay	Restoration of Potential SAV Habitat of 534

The results of the comparison of measures were presented to Stakeholders as part of the risk informed decision making process. Table 3-11 shows the results of the preliminary final evaluation of alternatives. Please note that the damages reduced/avoided and residual damage values are expressed in average annual dollars. These alternatives were carried forward into the System of Accounts analysis.

Table 3-11
Preliminary Display of Final Plans to Stakeholders

Measure	Tidal Habitat Restored (Acres)	Tidal Habitat Lost (Acres)	Non-Tidal Habitat Restored (Acres)	Non-Tidal Habitat Lost (Acres)	Damages Reduced / Avoided ($)	Residual Damages ($)	Cost to Implement Plan ($)	Local Cost Burdens (1-10)	Regional Economic Benefits (1-10)	Cultural and Historical Heritage (1-10)	Public Service Disruptions (1-10)	Personal Impacts (1-10)	Long-Term Sustainability (1-10)	Consequences as of Plan Failing (1-10)	Residual Risk (1-10)
Barrier Island No Action	0	4058	0	2705	$-	$426,040,000	$ -	10	1	1	1	1	1	2	1
Barrier Island Option A	644	0	2036	0	$ -	$426,040,000	$ 942,200,000	4	5	5	3	3	6	5	5
Barrier Island Option B	1029	0	686	0	$ -	$426,040,000	$ 1,013,800,000	3	5	4	2	3	4	3	4
Barrier Island Option C1 & C2	326	0	217	0	$ -	$426,040,000	$ 232,900,000	7	2	6	2	3	5	4	5
Barrier Island Option D	0	0	820	0	$ -	$426,040,000	$ 14,200,000	9	1	5	2	3	1	2	3
Barrier Island Option E	0	0	907	0	$ -	$426,040,000	$ 39,200,000	8	1	6	2	3	1	3	3
Barrier Island Option F	4400	4058	0	2705	$ -	$426,040,000	$ 264,500,000	3	2	2	2	3	1	2	3
Barrier Island Option G	130	1227	477	2453	$ -	$426,040,000	$ 114,100,000	5	1	7	2	3	3	4	3
Barrier Island Comp Plan	456	0	694	0	$ -	$426,040,000	$ 347,902,000	5	2	8	3	3	6	6	6
LOD2 No Action	0	0	0	0	$ -	$426,040,000	$ -	10	1	3	1	1	2	2	2
LOD2 Option I	0	0	351	0	$ -	$426,040,000	$ 63,880,000	3	2	4	2	2	4	5	2
LOD2 Option J	0	0	351	0	$ -	$426,040,000	$ 65,480,000	4	2	5	3	3	5	4	2
LOD2 Option K	0	0	304	0	$ -	$426,040,000	$ 15,430,000	7	1	6	3	3	7	4	2
Turkey Creek No Action	0	0	0	0	$ -	$ 16,890,000	$ -	10	1	3	1	1	10	10	1
Turkey Creek Ecosystem Plan 1	0	0	879	0	$ -	$ 16,890,000	$ 7,200,000	4	1	6	1	1	5	7	5
Turkey Creek Ecosystem Plan 3	0	0	689	0	$ -	$ 16,890,000	$ 5,900,000	6	1	5	1	1	6	6	4
Turkey Creek Ecosystem Plan 5	0	0	190	0	$ -	$ 16,890,000	$ 2,300,000	8	1	4	1	1	7	5	3
Bayou Cumbest No Action	0	0	0	0	$ -	$ 6,674,000	$ -	10	1	3	1	1	10	10	1
Bayou Cumbest Acquisition	0	0	0	0	$ 459,000	$ 6,674,000	$ 15,500,000	7	1	1	2	2	7	10	5
Bayou Cumbest Ecosystem Plan 1	373	0	0	0	$ 459,000	$ 6,674,000	$ 74,610,000	4	1	1	2	2	6	7	6
Bayou Cumbest Ecosystem Plan 2	373	0	0	0	$ 459,000	$ 6,674,000	$ 58,720,000	5	1	1	2	2	5	7	6
Bayou Cumbest Ecosystem Plan 3	373	0	0	0	$ 459,000	$ 6,674,000	$ 50,830,000	6	1	1	2	2	4	7	6
Bayou Cumbest Ecosystem Plan 6	373	0	0	0	$ 459,000	$ 6,674,000	$ 50,780,000	6	1	1	2	2	4	7	6
Admiral Island No Action	0	0	0	0	$ -	$ 150,860,000	$ -	10	1	2	1	1	10	10	1
Admiral Island Ecosystem Plan 1	118	0	0	0	$ -	$ 150,860,000	$ 42,900,000	4	1	3	1	1	6	7	6
Admiral Island Ecosystem Plan 2	118	0	0	0	$ -	$ 150,860,000	$ 38,400,000	5	1	3	1	1	5	7	6
Admiral Island Ecosystem Plan 3	118	0	0	0	$ -	$ 150,860,000	$ 36,100,000	6	1	3	1	1	4	7	6
Admiral Island Ecosystem Plan 6	118	0	0	0	$ -	$ 150,860,000	$ 36,000,000	6	1	3	1	1	4	7	6
Dantzler No Action	0	0	0	0	$ -	$ 7,130,000	$ -	10	1	3	1	1	10	10	1
Dantzler Ecosystem Plan 1	0	0	385	0	$ -	$ 7,130,000	$ 1,880,000	6	1	6	1	1	5	7	5
Dantzler Ecosystem Plan 3	0	0	151	0	$ -	$ 7,130,000	$ 870,000	7	1	5	1	1	6	6	4
Dantzler Ecosystem Plan 5	0	0	234	0	$ -	$ 7,130,000	$ 1,040,000	8	1	4	1	1	7	5	3
Franklin Creek No Action	0	0	0	0	$ -	$ 7,130,000	$ -	10	1	3	1	1	10	10	1
Franklin Creek Ecosystem Plan 1	0	0	149	0	$ -	$ 7,130,000	$ 1,630,000	6	1	6	1	1	5	7	5
Franklin Creek Ecosystem Plan 3	0	0	56	0	$ -	$ 7,130,000	$ 550,000	7	1	5	1	1	6	6	4
Forrest Heights No Action	0	0	0	0	$ -	$ 816,791	$ -	10	1	3	2	2	10	10	1
Forrest Heights Plan 1	0	0	0	9	$ 331,036	$ 485,755	$ 6,000,000	5	1	8	5	5	6	8	5
Forrest Heights Plan 2	0	0	0	20	$ 331,508	$ 485,283	$ 9,000,000	5	1	9	6	6	5	9	6
Nonstructural No Action	0	0	0	0	$ -	$426,040,000	$ -	10	1	3	2	2	10	10	1
Long-term Homeowners Assistance and Relocations Plan	0	0	0	0	$ 209,665,350	$ 216,374,650	$ 7,999,019,430	2	6	3	6	8	5	9	9
Very High Risk Homeowners Assistance and Relocations Plan	0	0	0	0	$ 22,380,000	$ 403,660,000	$ 482,000,000	5	3	5	5	5	8	9	7

Note: Refinement of values were made after stakeholder meetings and are captured in system of accounts.

3.17 Comparison of Phase I Final Alternatives

Comparisons identify which of the final alternatives (plans) is the best and identify which of the final alternatives should be included as a recommended action of the comprehensive plan. The comprehensive plan is comprised of a number of mission, site, and resource specific features. Therefore, comparisons are made among alternatives directed at specific features. Comparisons are not made across features. For example, ecosystem restoration alternatives at a specific location are compared to each other, but ecosystem restoration alternatives are not compared to storm damage protection alternatives. Because no one plan is likely to be best in all categories of importance, we have to compare the effects of the various plans and make tradeoffs among the differences observed. In the previous section, the effects of each plan were examined individually. In this comparison step, we look at the important effects across all plans.

The best plan cannot be selected from among a set of good plans unless there is some way to compare them. It is only by comparison that a plan is no longer good enough, or that a good plan becomes the best plan. The purpose of plan comparison is to identify the most important effects, and to compare the plans against one another across those effects.

The comparison of MsCIP Phase I alternatives started with presenting the future without-project conditions and future "with-project" conditions for each site or problem area, in both a descriptive presentation, and also in a "System of Accounts" comparison format. Data presented for comparison of final alternatives included:

- revised costs,
- benefits (monetary, or economic, environmental outputs, societal, etc.),
- potential impacts related to implementation,
- detailed design considerations,
- environmental outputs,
- damages prevented,
- geotechnical/site considerations,
- more detailed technical requirements,
- source material and source area considerations, and
- other technical, environmental, or economic issues.

The "System of Accounts" analysis presents information in four separate "accounts" or categories for comparison that include:

- "National Economic Development" (NED), which in this case only compares and contrasts the cost-effectiveness of each group of alternatives,
- "Regional Economic Development "(RED), which discusses the potential regional impacts of each group of alternatives,
- Environmental Quality (EQ), which discusses potential positive and negative environmental impacts of each group of alternatives and their environmental quality implications, and
- Other Social Effects (OSE) evaluations, which discusses and contrasts the potential social, and other effects of each group of alternatives.

The alternatives were also compared and contrasted according to their achievement of the additional criteria of a) effectiveness; b) completeness; c) acceptability, and d) efficiency (cost-effectiveness) according to applicable Corps guidelines.

In addition to these four traditional accounts, information on potential risks, uncertainties, and consequences, is also presented in System of Accounts format, for comparison at the same level of scrutiny of the information presented in other accounts.

The System of Accounts tables also include a "stakeholder risk score" which identifies stakeholder preferences for each of the final alternatives presented in the Systems of Accounts tables. The "stakeholder preference score" rates each alternative as a percentage of a theoretical "perfect plan" (in the eyes of the stakeholder groups). The higher the percentage, the more acceptable the alternative is to the stakeholder. Development of the "stakeholder preference score", which entailed more than a year of developing and integrating public and agency input, is discussed in section 3.19 Risk Assessment and Education in Plan Formulation, which follows the System of Accounts tables. The System of Accounts tables are presented in their entirety in section 3.18.

3.18 System of Accounts Tables

The following System of Accounts Tables (Tables 3-12 through 3-21) presents the detailed evaluation of Phase I Final Alternatives. Selected alternatives are highlighted. The System of Accounts Tables present evaluation results for each of the four accounts (NED, RED, OSE, and NER) and proves evaluation information elicited from the public involvement process described in section 3.19 below. Public and stakeholder input were solicited through the presentation of measures and preliminary alternatives, to all stakeholder groups, at a series of public workshops. Workshops were conducted to elicit "stakeholder preferences" on potential solutions to each identified problem area. Stakeholders were also asked to "score" measures and preliminary alternatives, in comparison to one another. The results of this process are presented in the System of Accounts tables, as both "Stakeholder Preference" scores, and a summary of stakeholder preferences (the final row in each problem area's account summary). Stakeholder input into the plan evaluation process is discussed in sections 3.19 and 3.20, and in greater detail in Attachment 1 to the Risk Appendix

Table 3-12
System of Accounts table for Barrier Island Alternatives

Problem Area: Barrier Island Restoration, Hancock, Harrison, and Jackson Counties, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: The benefits of Plan H are greater than the sum of the benefits of its component parts (Plans C & G).

Item	No Action	Plan A	Plan C	Plan G	Plan H
A. PLAN DESCRIPTION	No Federal Action	Restore Barrier Island Chain Footprint	Replenish Sand in Littoral Zone of Ship & Petit Bois Islands	Restoration of Ship Island Breach	Combination of C + G
B. IMPACT ASSESSMENT					
1. National Economic Development					
a. Beneficial Impacts					
(1) Damages Prevented	$0	$18,866,000	$10,468,000	$7,616,000	$18,866,000
(2) Emergency Costs Avoided	$0				
(3) Recreation	$0	$466,000	$117,000	$466,000	$466,000
(4) Total Beneficial Impacts	None.	$19,332,000	$10,585,000	$8,082,000	$19,332,000
b. Adverse Impacts					
(1) Project Cost	$0	$942,200,000	$147,400,000	$181,400,000	$328,800,000
(2) Interest During Construction	$0	$119,317,000	$18,667,000	$22,972,000	$41,639,000
(3) Average Annual First Cost	N/A	$58,376,000	$9,133,000	$11,239,000	$20,372,000
(4) Annual O&M	$0	$0	$0	$0	$0
(5) Total Avg. Annual Costs	$0	**$58,376,000**	**$9,133,000**	**$11,239,000**	**$20,372,000**
2. Environmental Quality (EQ)					
(1) Ecosystem Restoration	No benefit	Restoration of 644 acres of tidal habitat and 2036 acres of nontidal habitat.	Restoration of 326 acres of tidal habitat and 217 acres of nontidal habitat.	Restoration of 130 acres of tidal habitat and 477 acres of nontidal habitat.	Restoration of 456 acres of tidal habitat and 694 acres of nontidal habitat.

Problem Area: Barrier Island Restoration, Hancock, Harrison, and Jackson Counties, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: The benefits of Plan H are greater than the sum of the benefits of its component parts (Plans C & G).

(2) Protection of Fisheries	**Loss of $43,618,143** in average annual fishery landings	Avoidance of **$43,618,143** in lost fishery landings	Avoidance of **$6,542,721** in lost fishery landings.	Avoidance of **$21,809,072** in lost fishery landings.	Avoidance of **$43,618,143** in lost fishery landings.
(3) Water Circulation	Area would become more open Gulf in nature as islands erode	Preservation of MS sound circulation	Minor Preservation of MS sound circulation	Significant preservation of MS sound circulation	Preservation of MS sound circulation
(4) Noise Level Changes	No change in noise levels	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction
(5) Public Facilities	Loss of the barrier islands would result in loss of National Park resources	National Park resources would be preserved	National Park resources would be enhanced by supplemental sand supply.	National Park resources would be enhanced by supplemental sand supply.	National Park resources would be preserved.
(6) Aesthetic Values	Continued degradation of natural aesthetic values	Significant aesthetic improvement	Moderate aesthetic improvement	Moderate aesthetic improvement	Significant aesthetic improvement
(7) Natural Resources	Continued degradation of islands and loss of function of MS Sound.	Significant reduction in loss of island and function of MS Sound	Minor reduction in loss of island and function of MS Sound.	Moderate reduction in loss of island and function of MS Sound.	Significant reduction in loss of island and function of MS Sound.
(8) Biological Resources	Continued degradation and loss of biological resources.	Significant improvement in biological resources.	Moderate improvement in biological resources	Moderate improvement in biological resources	Significant improvement in biological resources.
(9) Air Quality	No anticipated effect on air quality	Air emission would be *de minimus*	Air emission would be *de minimus*	Air emission would be *de minimus*	Air emission would be *de minimus*

Problem Area: Barrier Island Restoration, Hancock, Harrison, and Jackson Counties, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: The benefits of Plan H are greater than the sum of the benefits of its component parts (Plans C & G).

(10) Water Quality	Water quality is anticipated to deteriorate with future loss of the island system (salinity increase will decrease size of estuarine zone).	Temporary negative impacts to water quality due to construction but overall long-term improvements to water quality are anticipated	Temporary negative impacts to water quality due to construction but overall long-term improvements to water quality are anticipated	Temporary negative impacts to water quality due to construction but overall long-term improvements to water quality are anticipated	Temporary negative impacts to water quality due to construction but overall long-term improvements to water quality are anticipated.
(11) Public Services	Possible increase in interruption of services as islands continue to erode	Increased stability of barrier islands would reduce likelihood of interruption of public services.	Increased stability of barrier islands would reduce likelihood of interruption of public services.	Increased stability of barrier islands would reduce likelihood of interruption of public services.	Increased stability of barrier islands would reduce likelihood of interruption of public services.
(12) Cultural and Historical Preservation	Alternative would result in future loss of important cultural resources at Ship Island	Alternative would preserve cultural and historical artifacts, including Fort Massachusetts and the French Warehouse	Alternative would provide some reduction in impact to cultural and historical artifacts, including Fort Massachusetts and the French Warehouse.	Alternative would preserve cultural and historical artifacts, including Fort Massachusetts and the French Warehouse	Alternative would preserve cultural and historical artifacts, including Fort Massachusetts and the French Warehouse.
(13) Total Quality of the Environment	Significant negative impact on the total quality of this environment if the islands erode away	Significant positive impacts on the total quality of environment (i e future production of Mississippi Sound)	Positive impact on the total quality of environment (i.e. future production of Mississippi Sound)	Moderate positive impact on the total quality of environment (i.e. future production of Mississippi Sound)	Significant positive impacts on the total quality of environment (i.e. future production of Mississippi Sound)
3. Regional Economic Development (RED)					
(1) Impact on Sales Volume	No impact to the local economy	Increase of **$2,289,546,000** in additional sales volume.	Increase of **$358,182,000** in additional sales volume.	Increase of **$440,802,000** in additional sales volume.	Increase of **$798,984,000** in additional sales volume.

Problem Area: Barrier Island Restoration, Hancock, Harrison, and Jackson Counties, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: The benefits of Plan H are greater than the sum of the benefits of its component parts (Plans C & G).

(2) Impact on Income	Negative impact to individuals involved in fishing industry as islands erode and MS Sound environment changes.	Increase of **$480,984,800** in additional local income.	Increase of **$75,246,410** in additional local income.	Increase of **$92,603,120** in additional local income	Increase of **$167,849,530** in additional local income.
(3) Impact on Employment	Negative impact to individuals involved in fishing industry as islands erode and MS Sound environment changes.	Increase of **14,100** new jobs.	Increase of **2,206** new jobs.	Increase of **2,714** new jobs.	Increase of **4,920** new jobs.
(4) Tax Changes	Possible negative impacts as islands erode and chance of storm damage increases	None	None	None	None
4. Other Social Effects (OSE)					
a. Beneficial Impacts					
(1) Security of Life, Health, and Safety	Continued risks to life, health and safety	Significant decrease in risks to life, health and safety.	Moderate decrease in risks to life, health and safety.	Moderate decrease in risks to life, health and safety.	Significant decrease in risks to life, health and safety.
(2) Community Cohesion	Negative impacts as islands continue to erode and damages from waves and storms increase above the existing level	Significant positive impact as community observes coastal resources being restored and stability of barrier islands and MS Sound increased.	Positive impact as community observes coastal resources being restored and stability of barrier islands and MS Sound increased.	Positive impact as community observes coastal resources being restored and stability of barrier islands and MS Sound increased.	Significant positive impact as community observes coastal resources being restored and stability of barrier islands and MS Sound increased.

Problem Area: Barrier Island Restoration, Hancock, Harrison, and Jackson Counties, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: The benefits of Plan H are greater than the sum of the benefits of its component parts (Plans C & G).

(3) Tax Values	Negative impacts as islands erode and chance of storm damage increases	Moderate increase in tax values due to decreased risk to properties.	Small increase in tax values due to decreased risk to properties.	Small increase in tax values due to decreased risk to properties	Moderate increase in tax values due to decreased risk to properties.
(4) Community Growth	Could have negative impact on community structure as islands continue to erode	Moderate stabilization to community structure	Minor stabilization to community structure	Moderate stabilization to community structure	Moderate stabilization to community structure
(5) Property Values	Negative impacts as islands erode and chance of storm damage increases	Moderate increase in property values due to decreased risk to properties.	Small increase in property values due to decreased risk to properties	Small increase in property values due to decreased risk to properties.	Moderate increase in property values due to decreased risk to properties.
(6) Displacement of Businesses	Potential impacts to businesses from increased risk of surge damage.	Reduced risk of displacement of businesses.	Reduced risk of displacement of businesses	Reduced risk of displacement of businesses	Reduced risk of displacement of businesses.
(7) Public Facilities	Negative impacts to public facilities from increased risk of surge damage.	Reduced risk to public facilities	Reduced risk to public facilities	Reduced risk to public facilities.	Reduced risk to public facilities.
(8) Injurious Displacement of Farms	N/A	N/A	N/A	N/A	N/A
b. Preservation of life	Could contribute to loss of life as risk to mainland shoreline becomes greater.	Could reduce loss of life with decreased risk to mainland shoreline.	Could reduce loss of life with decreased risk to mainland shoreline.	Could reduce loss of life with decreased risk to mainland shoreline	Could reduce loss of life with decreased risk to mainland shoreline.

C. PLAN EVALUATION

1. Contributions to Planning Objectives

Problem Area: Barrier Island Restoration, Hancock, Harrison, and Jackson Counties, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: The benefits of Plan H are greater than the sum of the benefits of its component parts (Plans C & G).

a. Flood, Hurricane and/or Storm Damage Reduction	Increased risk in damage reduction from further degradation of islands	Significant avoidance of increased risk.	Minor avoidance of increased risk	Moderate avoidance of increased risk.	Significant avoidance of increased risk.
b. Recovery of lost environmental resources	Alternative will result in continued loss of environmental resources.	Barrier Island restoration will accrue significant benefits	Littoral zone disposal will accrue minor benefits	Ship Island restoration will accrue moderate benefits.	Barrier Island restoration will accrue significant benefits.
2. Response to Planning Constraints					
a. Avoid environmental impacts and minimize induced damages	Continued loss of significant environmental resources.	Beneficial effect on environmental resources.	Beneficial effect on environmental resources	Beneficial effect on environmental resources	Beneficial effect on environmental resources.
b Institutional Acceptability	Is not supported by state or local government	Is supported by local and state governments	Is somewhat supported by local and state governments	Is supported by local and state governments	Is supported by local and state governments
3. Response to Evaluation Criteria					
a. Acceptability	NO	No, does not meet all Federal policies and regulations (i.e. Wilderness Act)	YES	YES	YES
b. Completeness	NO	YES	NO, it does not avoid all of the future degradation	NO, it does not avoid all of the future degradation	YES
c Effectiveness	NO	YES	NO, not a completely effective solution.	NO, not a completely effective solution.	YES
d. Efficiency (Cost-Effectiveness; i.e , most efficient use of Federal and Non-Federal Funds)	NO	No, over 2 1/2 times as expensive as plan H	No, less efficient than plan A and H.	No, less efficient than plan A and H.	YES, most efficient / cost effective plan.

Problem Area: Barrier Island Restoration, Hancock, Harrison, and Jackson Counties, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: The benefits of Plan H are greater than the sum of the benefits of its component parts (Plans C & G).

e Integration	N/A	Seamless addition to system.	Seamless addition to system	Seamless addition to system.	Seamless addition to system.
f Reversibility	This issue does not apply	Alternative could be reversible, given means to remove sand.	Alternative could not be reversible, given placement in open-water.	Alternative could be reversible, given means to remove sand.	A portion of this alternative could not be reversible, given placement in open-water.
4. Stakeholder Preference Score (From MCDA weightings analysis)					
a. Summary Score	**15.53%**	**71.69%**	**62.28%**	**41.70%**	**72.03%**
Cluster Group A	27.16%	67.62%	63 08%	47.53%	73.93%
Cluster Group B	18.82%	70.58%	63.58%	45.57%	73.93%
Cluster Group C	11.83%	74 03%	63 92%	41.81%	73.58%
Cluster Group D	4.30%	74.51%	58 55%	31.90%	66.66%
b. Stakeholder Preference	All groups ranked this plan lowest	Plan ranked very high, but less than H.	Plan ranked lower than A and H	Plan ranked lowest of all action plans.	Plan ranked highest overall
D. Implementation Responsibility	Does not have any implementation responsibilities	Elements would be joint Federal/Non-Federal implementation responsibility	Elements would be joint Federal/Non-Federal implementation responsibility	Elements would be joint Federal/Non-Federal implementation responsibility.	Elements would be joint Federal/Non-Federal implementation responsibility.
E. State and other Non-Federal Coordination	Would require no State or other Non-Federal coordination activities	Would require significant State or other Non-Federal coordination activities	Would require significant State or other Non-Federal coordination activities	Would require significant State or other Non-Federal coordination activities	Would require significant State or other Non-Federal coordination activities
F. Risk Evaluation					
1. Risk and Vulnerabilities					
a. Risk of Failure	N/A	Low	Moderate	Moderate	Low

Problem Area: Barrier Island Restoration, Hancock, Harrison, and Jackson Counties, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: The benefits of Plan H are greater than the sum of the benefits of its component parts (Plans C & G).

b. Residual Risk	Significant risk to MS sound ecosystem. All barrier islands will overtop during large surge events, and will not provide significant reduction of surge and waves.	Minor reduction residual risk to MS sound ecosystem. All barrier islands will overtop during large surge events, and will not provide significant reduction of surge. Plan A would provide a significant reduction to waves.	Moderate reduction residual risk to MS sound ecosystem. All barrier islands will overtop during large surge events, and will not provide significant reduction of surge and waves.	Moderate reduction residual risk to MS sound ecosystem. All barrier islands will overtop during large surge events, and will not provide significant reduction of surge and waves.	All barrier islands will overtop during large surge events, and will not provide significant reduction of surge. Plan A would provide a moderate reduction to waves.
c. Reliability	N/A	Plan A would provide a moderate level of reliability, would be resistant to damage from storm events, and would not require significant maintenance.	This plan would provide a low level of reliability, would receive damage from storm events, and would require significant maintenance.	This plan would provide a low level of reliability, would receive damage from storm events, and would not require significant maintenance.	Plan A would provide a moderate level of reliability, would be resistant to damage from storm events, and would not require significant maintenance
d. Relative Sea Level Rise	Problems will be substantially exacerbated by an increasing relative rise of sea level	This Plan will be minimally impacted by an increasing relative rise of sea level over the period of analysis	This Plan will be moderately impacted by an increasing relative rise of sea level over the period of analysis	This Plan will be moderately impacted by an increasing relative rise of sea level over the period of analysis	This Plan will be minimally impacted by an increasing relative rise of sea level over the period of analysis

Problem Area: Barrier Island Restoration, Hancock, Harrison, and Jackson Counties, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: The benefits of Plan H are greater than the sum of the benefits of its component parts (Plans C & G).

e. Risk of Ecosystem Damage	Ecosystem damage will continue to accrue at a rate at least that of recent history with substantial negative outcomes.	Risk of ecosystem damage will be minimal throughout the period of analysis.	Risk of ecosystem damage will be moderate throughout the period of analysis.	Risk of ecosystem damage will be moderate throughout the period of analysis.	Risk of ecosystem damage will be minimal throughout the period of analysis.
f. Risk to Life and Safety	Significant threats to Life and Safety from storm surge will continue to rise due to continued deterioration of the Barrier Islands.	Threats to Life and Safety from storm surge will still exist, but this plan will provide the least risk to life and safety.	Significant threats to Life and Safety from storm surge will still exist, but this plan will provide less risk to life and safety than the No Action Plan.	Threats to Life and Safety from storm surge will still exist, but this plan will provide less risk to life and safety than the No Action Plan and Plan C.	Threats to Life and Safety from storm surge will still exist, but this plan will provide the least risk to life and safety, except for Plan A.
g. Risk to Mental and Physical Health	Significant threats to Mental and Physical Health from storm surge will continue to rise due to continued deterioration of the Barrier Islands.	Threats to Mental and Physical Health from storm surge will still exist, but this plan will provide the least risk to Mental and Physical Health.	Significant threats to Mental and Physical Health from storm surge will still exist, but this plan will provide less risk to Mental and Physical Health than the No Action Plan.	Threats to Mental and Physical Health from storm surge will still exist, but this plan will provide less risk to Mental and Physical Health than the No Action Plan and Plan C.	Threats to Mental and Physical Health from storm surge will still exist, but this plan will provide the least risk to Mental and Physical Health, except for Plan A.

Problem Area: Barrier Island Restoration, Hancock, Harrison, and Jackson Counties, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: The benefits of Plan H are greater than the sum of the benefits of its component parts (Plans C & G).

2. Recommendations and Preferences					
a. Federal Recommendation					This Plan has the highest NED benefits, substantial RED benefits, substantial EQ benefits, the greatest achievement of OSE outcomes, does not violate any local, state, or Federal statues, laws, and regulations, and is the most cost effective and efficient recommendation of the Barrier Island component of the Comprehensive Plan
b. Stakeholder Preference					This Plan has the highest stakeholder preference score, and creates a low risk environment.

Table 3-13
System of Accounts table for Beach and Dune Alternatives

Problem Area: Beach and Dune Placement, Hancock, Harrison, and Jackson Counties, Mississippi				
Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.				
Item	**No Action**	**Measure I**	**Measure J**	**Measure K**
A. PLAN DESCRIPTION	No Federal Action	Dune 5 feet high and 50 feet wide and extend berm to match and include the sand fence	Dune 5 feet high and 50 feet wide and extend berm to match and include the sand fence and with plantings	Dune 2 feet high and 60 feet wide with berm expansion, sand fencing and plantings
B. IMPACT ASSESSMENT				
1. National Economic Development				
a. Beneficial Impacts				
(1) Damages Prevented	$0	Minimal level of damages prevented.	Minimal level of damages prevented	Minimal level of damages prevented.
(2) Emergency Costs Avoided	$0	$0	$0	$0
(3) Recreation	No significant change in recreation benefits	Expanding berm area could provide minimal benefits	Expanding berm area could provide minimal benefits	Expanding berm area could provide minimal benefits
(4) Total Beneficial Impacts	None			
b. Adverse Impacts				
(1) Project Cost	$0	$63,880,000	$65,480,000	$15,430,000
(2) Interest During Construction	$0	$1,911,000	$1,960,500	$460,800
(3) Average Annual First Cost	N/A	$3,534,443	$3,623,058	$853,690
(4) Annual O&M	$0	$17,158,897	$17,588,675	$0
(5) Total Avg. Annual Costs	$0	**$20,693,340**	**$21,211,733**	**$853,690**

Problem Area: Beach and Dune Placement, Hancock, Harrison, and Jackson Counties, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

Item	No Action	Measure I	Measure J	Measure K
2. Environmental Quality (EQ)				
(1) Ecosystem Restoration	Alternative would provide no ecosystem restoration benefits.	Alternative would provide a Functional Habitat Index (FHI) increase of **412**.	Alternative would provide a Functional Habitat Index (FHI) increase of **652**.	Alternative would provide a Functional Habitat Index (FHI) increase of **736**.
(2) Water Circulation	N/A	No Impact	No Impact	No Impact
(3) Noise Level Changes	no change in noise levels	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction
(4) Public Facilities	No change in public facilities	Minor protection of public facilities public facilities.	Minor protection of public facilities public facilities.	Minor protection of public facilities public facilities.
(5) Aesthetic Values	No significant change in aesthetic values	Moderate aesthetic improvement	Significant aesthetic improvement	Significant aesthetic improvement
(6) Natural Resources	Existing resources would continue to be impacted during future storm events	Moderate restoration of beach and dune resources.	Significant restoration of beach and dune resources.	Significant restoration of beach and dune resources.
(7) Biological Resources	Existing resources would continue to be impacted during future storm events	Moderate increase in biological resources utilizing beach habitat including T&E species	Significant increase in biological resources utilizing beach and dune habitat including T&E species	Significant increase in biological resources utilizing beach and dune habitat including T&E species
(8) Air Quality	No anticipated effect on air quality	Air emission would be *de minimus*	Air emission would be *de minimus*	Air emission would be *de minimus*
(9) Water Quality	No anticipated effect on water quality	Minor transitory impacts during construction	Minor transitory impacts during construction	Minor transitory impacts during construction
(10) Public Services	Damages to public services would continue	Overall negative effect due to wind blown sand on roadway	Overall negative effect due to wind blown sand on roadway	Small but positive effect on public services from reduced inundation risk.

Problem Area: Beach and Dune Placement, Hancock, Harrison, and Jackson Counties, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

Item	No Action	Measure I	Measure J	Measure K
(11) Cultural and Historical Preservation	Damage to cultural and historical resources north of the beach would continue	Would provide some reduction of risk to cultural and historical artifacts located north of the beach	Would provide some reduction of risk to cultural and historical artifacts located north of the beach	Would provide some reduction of risk to cultural and historical artifacts located north of the beach
(12) Total Quality of the Environment	Some degradation of the environment would continue during storm events	Environmental quality of the area would be moderately improved	Environmental quality of the area would be significantly improved	Environmental quality of the area would be significantly improved
3. Regional Economic Development (RED)				
(1) Impact on Sales Volume	No impact to the local economy	increase of **$830,227,800** in additional sales volume.	Increase of **$851,240,400** in additional sales volume	Increase of **$33,413,200** in additional sales volume.
(2) Impact on Income	No impact to the local economy	Increase of **$181,540,007** in additional local income	Increase of **$186,094,644** in additional local income.	Increase of **$7,306,957** in additional local income.
(3) Impact on Employment	No impact to the local economy.	Increase of **5,164** new jobs.	Increase of **5,296** new jobs.	Increase of **208** new jobs.
(4) Tax Changes	N/A	N/A	N/A	N/A
4. Other Social Effects (OSE)				
a Beneficial Impacts				
(1) Security of Life, Health, and Safety	No Impact	Small reduction in risk during storm events	Small reduction in risk during storm events	Small reduction in risk during storm events
(2) Community Cohesion	No negative impacts on community cohesion	No negative impacts on community cohesion	No negative impacts on community cohesion	No negative impacts on community cohesion

Problem Area: Beach and Dune Placement, Hancock, Harrison, and Jackson Counties, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

Item	No Action	Measure I	Measure J	Measure K
(3) Tax Values	Tax values could decline due to damage from future storm events	Tax values could decline due to damage from future storm events	Tax values could decline due to damage from future storm events	N/A
(4) Community Growth	No effect on community growth	No effect on community growth	No effect on community growth	No effect on community growth
(5) Property Values	Property values could decline due to damage from future storm events	Minor impact in preservation of property values	Minor impact in preservation of property values	Minor impact in preservation of property values
(6) Displacement of Businesses	No Impact	Small reduction of risk of displacement of businesses immediately adjacent to shoreline	Small reduction of risk of displacement of businesses immediately adjacent to shoreline	Small reduction of risk of displacement of businesses immediately adjacent to shoreline
(7) Public Facilities	No Impact	Some reduction of risk of damage to public facilities immediately adjacent to the shoreline	Some reduction of risk of damage to public facilities immediately adjacent to the shoreline	Some reduction of risk of damage to public facilities immediately adjacent to the shoreline
(8) Injurious Displacement of Farms	N/A	N/A	N/A	N/A
b. Preservation of life	Taking no action could contribute to future loss of life	Minor reduction in the chance of loss of life during future events	Minor reduction in the chance of loss of life during future events	Minor reduction in the chance of loss of life during future events
C. PLAN EVALUATION				
1. Contributions to Planning Objectives				
a. Flood, Hurricane and/or Storm Damage Reduction	No improvement	Alternative will result in minor improvement in damage reduction.	Alternative will result in minor improvement in damage reduction.	Alternative will result in minor improvement in damage reduction.

Problem Area: Beach and Dune Placement, Hancock, Harrison, and Jackson Counties, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

Item	No Action	Measure I	Measure J	Measure K
b. Recovery of lost environmental resources	No improvement	Will provide habitat to various biological resources with those numbers increasing with time	Will provide habitat to various biological resources with those numbers increasing with time.	Will provide significant habitat to various biological resources with those numbers increasing with time.
2. Response to Planning Constraints				
a Avoid environmental impacts and minimize induced damages	Continued loss of environmental resources.	Alternative is anticipated to have a beneficial effect on environmental resources	Alternative is anticipated to have a beneficial effect on environmental resources	Alternative is anticipated to have a beneficial effect on environmental resources.
b. Institutional Acceptability	Not supported by state or local government	Is supported by local and state governments	Is supported by local and state governments	Is supported by local and state governments
3. Response to Evaluation Criteria				
a Acceptability	NO	YES	YES	YES
b. Completeness	NO	YES	YES	YES
c. Effectiveness	NO	YES	YES	YES
d. Efficiency (Cost-Effectiveness; i.e., most efficient use of Federal and Non-Federal Funds)	NO	YES	YES	YES, the most cost effective
e. Integration	N/A	Seamless part of overall system	Seamless part of overall system.	Seamless part of overall system.
f Reversibility	N/A	Could be reversible	Could be reversible	Could be reversible

Problem Area: Beach and Dune Placement, Hancock, Harrison, and Jackson Counties, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

Item	No Action	Measure I	Measure J	Measure K
4. Stakeholder Preference Score (From MCDA weightings analysis)				
a. Summary Score	**23.30%**	**54.19%**	**65.54%**	**77.86%**
Cluster Group A	30.99%	44.52%	58.00%	74.04%
Cluster Group B	28 07%	49.57%	61.64%	75.23%
Cluster Group C	22.00%	53.83%	64.90%	80.50%
Cluster Group D	12.12%	68.83%	77.63%	81.66%
b. Stakeholder Preference	All groups ranked this plan lowest	Plan ranked low, but higher than no action.	Plan ranked high, but lower than measure k.	Plan ranked highest of all action plans.
D. Implementation Responsibility	No implementation responsibilities	Joint Federal/Non-Federal implementation responsibility.	Joint Federal/Non-Federal implementation responsibility.	Joint Federal/Non-Federal implementation responsibility.
E. State and other Non-Federal Coordination	No State or other Non-Federal coordination activities	Would require limited, State or other Non-Federal coordination activities	Would require limited, State or other Non-Federal coordination activities	Would require limited, State or other Non-Federal coordination activities
F. Risk Evaluation				
1. Risk and Vulnerabilities				
a. Risk of Failure	N/A	Low	Low	Low
b. Residual Risk	All dunes will overtop during most surge events, and will not provide significant reduction of surge and waves. Residual risk of ecological failure of dune ecosystems would remain very high	Large residual risk from surge and waves would remain in the event of project implementation, from moderate to large events. Residual risk of ecological failure of dune ecosystems would still exist, but at less risk than No-Action Plan	Large residual risk from surge and waves would remain in the event of project implementation, from moderate to large events. . Residual risk of ecological failure of dune ecosystems would still exist, but at less risk than No-Action Plan	Large residual risk from surge and waves would remain in the event of project implementation, from moderate to large events. . Residual risk of ecological failure of dune ecosystems would still exist, but at less risk than No-Action Plan

Problem Area: Beach and Dune Placement, Hancock, Harrison, and Jackson Counties, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

Item	No Action	Measure I	Measure J	Measure K
c. Reliability	N/A	Plan would provide for reliable reduction of surge and wave damage from events less than 10 ft. in depth, but would require periodic repair and rehabilitation after damaging surge and wave events.	Plan would provide for reliable reduction of surge and wave damage from events less than 10 ft. in depth, but would require periodic repair and rehabilitation after damaging surge and wave events.	Plan would provide for reliable reduction of surge and wave damage from events less than 2 ft. in depth, but would require periodic repair and rehabilitation after damaging surge and wave events.
d. Relative Sea Level Rise	Problems will be substantially exacerbated by an increasing relative rise of sea level	This Plan will be minimally impacted by an increasing relative rise of sea level over the period of analysis	This Plan will be minimally impacted by an increasing relative rise of sea level over the period of analysis	This Plan will be moderately impacted by an increasing relative rise of sea level over the period of analysis due to low height of berm dune. May require eventual addition of height to compensate.
e. Risk of Ecosystem Damage	Ecosystem damage will continue to accrue at a rate at least that of recent history with substantial negative outcomes.	Risk of dune ecosystem damage will be moderate throughout the period of analysis.	Risk of dune ecosystem damage will be moderate throughout the period of analysis.	Risk of dune ecosystem damage will be moderate throughout the period of analysis.

Problem Area: Beach and Dune Placement, Hancock, Harrison, and Jackson Counties, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

Item	No Action	Measure I	Measure J	Measure K
f. Risk to Life and Safety	Significant threats to Life and Safety from storm surge will continue to rise due to continued deterioration of the dune system.	Significant threats to Life and Safety from storm surge will still exist, but this plan will provide less risk to life and safety than the No Action Plan or plan K	Significant threats to Life and Safety from storm surge will still exist, but this plan will provide less risk to life and safety than the No Action Plan or plan K	Significant threats to Life and Safety from storm surge will still exist but this plan will provide less risk to life and safety than the No Action Plan
g. Risk to Mental and Physical Health	Significant threats to Mental and Physical Health from storm surge will continue to rise due to continued deterioration of the dune system.	Significant threats to Mental and Physical Health from storm surge will still exist, but this plan will provide less risk to Mental and Physical Health than no action or plan K.	Significant threats to Mental and Physical Health from storm surge will still exist, but this plan will provide less risk to Mental and Physical Health than the No Action Plan or plan K.	Significant threats to Mental and Physical Health from storm surge will still exist, but this plan will provide less risk to Mental and Physical Health than the No Action Plan.
2. Recommendations and Preferences				
a. Federal Recommendation				Plan K provides best balance of ecosystem and damage reduction benefits, at considerably lower cost than Plans I & J, and at similar risk. Provides considerable benefits compared to No-Action Plan.

Problem Area: Beach and Dune Placement, Hancock, Harrison, and Jackson Counties, Mississippi				
Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.				
Item	**No Action**	**Measure I**	**Measure J**	**Measure K**
b. Stakeholder Preference				Stakeholder preference indicated by summary scores of Plan K. Lower scores achieved by Plan J, but even lower for Plan I. Lowest scores achieved for No-Action Plan.

Table 3-14
System of Accounts table for Turkey Creek Alternatives

Problem Area: Turkey Creek Ecosystem Restoration, Harrison County, Mississippi				
Problems ID: Environmental damages suffered by flooding due to hurricanes; Potential future environmental damages from storm and hurricane events.				
Item	**No Action**	**Plan 1**	**Plan 3**	**Plan 5**
A. PLAN DESCRIPTION	No Federal Action	Restoration of 879 Acres North and South of Railroad Maintain by Burning	Restoration of 689 Acres South of Railroad Maintain by Burning	Restoration of 190 Acres North of Railroad Maintain by Burning
B. IMPACT ASSESSMENT				
1. National Economic Development				
a. Beneficial Impacts				
(1) Damages Prevented	$0	Moderate level of damage reduction from improved storm water storage	Moderate level of damage reduction from improved storm water storage	Moderate level of damage reduction from improved storm water storage
(2) Emergency Costs Avoided	$0	$0	$0	$0
(3) Recreation	No significant change in recreation benefits	Significant opportunity for ecotourism	Significant opportunity for ecotourism	Moderate opportunity for ecotourism
(4) Total Beneficial Impacts	None.			
b. Adverse Impacts				
(1) Project Cost	$0	$7,636,000	$5,887,000	$1,871,000
(2) Interest During Construction	$0	$169,000	$130,000	$41,000
(3) Average Annual First Cost	N/A	$419,000	$323,000	$101,000
(4) Annual O&M	$0	$60,000	$47,000	$13,000

Problem Area: Turkey Creek Ecosystem Restoration, Harrison County, Mississippi

Problems ID: Environmental damages suffered by flooding due to hurricanes; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3	Plan 5
(5) Total Avg Annual Costs	$0	$479,000	$370,000	$114,000
2. Environmental Quality (EQ)				
(1) Ecosystem Restoration	No ecosystem restoration benefits	Average Annual Functional Units (AAFU) increase of **2,046**.	Average Annual Functional Units (AAFU) increase of **1,565**.	Average Annual Functional Units (AAFU) increase of **481**
(2) Water Circulation	No effect on water circulation	No effect on water circulation	No effect on water circulation.	No effect on water circulation
(3) Noise Level Changes	Alternative would result in no change in noise levels	Alternative would result in temporary increase in noise levels during construction	Alternative would result in temporary increase in noise levels during construction	Alternative would result in temporary increase in noise levels during construction
(4) Public Facilities	Development likely to be commercial/residential	Opportunity for passive recreation	Opportunity for passive recreation	Opportunity for passive recreation
(5) Aesthetic Values	Future development would change aesthetics	Significant aesthetic improvement	Significant aesthetic improvement	Significant aesthetic improvement
(6) Natural Resources	Continued degradation of existing natural resources	Restoration of 879 acres of regionally significant coastal wet pine savannah habitat	Restoration of 689 acres of regionally significant coastal wet pine savannah habitat.	Restoration of 190 acres of regionally significant coastal wet pine savannah habitat.

Problem Area: Turkey Creek Ecosystem Restoration, Harrison County, Mississippi

Problems ID: Environmental damages suffered by flooding due to hurricanes; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3	Plan 5
(7) Biological Resources	Biological resources would degrade due to altered hydrology and lost as future development proceeds	Significant improvement of habitat and associated biological resources	Significant improvement of habitat and associated biological resources	Moderate improvement of habitat and associated biological resources
(8) Air Quality	No effect on air quality	Air emission would be *de minimus* & intermittent with maintenance burning	Air emission would be *de minimus*& intermittent with maintenance burning	Air emission would be *de minimus* & intermittent with maintenance burning
(9) Water Quality	No anticipated effect on water quality	Significant long-term improvements are anticipated.	Significant long-term improvements are anticipated.	Some long-term improvements are anticipated.
(10) Public Services	Development would result in a significant need of additional public services	N/A	N/A	N/A
(11) Cultural and Historical Preservation	N/A	N/A	N/A	N/A
(12) Total Quality of the Environment	Continued degradation without development could become significant with development.	Total quality of environment would be significantly improved	Total quality of environment would be significantly improved.	Total quality of environment would be moderately improved.

Problem Area: Turkey Creek Ecosystem Restoration, Harrison County, Mississippi

Problems ID: Environmental damages suffered by flooding due to hurricanes; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3	Plan 5
3. Regional Economic Development (RED)				
(1) Impact on Sales Volume	No impact to the local economy.	Increase of **$19,602,000** in additional sales volume.	Increase of **$15,237,000** in additional sales volume.	Increase of **$4,815,000** in additional sales volume.
(2) Impact on Income	No impact to the local economy	Increase of **$4,149,260** in additional local income.	Increase of **$3,225,297** in additional local income.	Increase of **$1,019,217** in additional local income.
(3) Impact on Employment	No impact to the local economy.	Increase of **124** new jobs.	Increase of **97 new jobs**.	Increase of **31** new jobs.
(4) Tax Changes	Taxes could increase as land use changes	Alternative would result in no change in taxes	Alternative would result in no change in taxes	Alternative would result in no change in taxes
4. Other Social Effects (OSE)				
a. Beneficial Impacts				
(1) Security of Life, Health, and Safety	N/A	N/A	N/A	N/A
(2) Community Cohesion	No Impact	Forrest Heights, a culturally significant minority community in the Turkey Creek watershed, would benefit significantly	Forrest Heights, a culturally significant minority community in the Turkey Creek watershed, would benefit significantly	Forrest Heights, a culturally significant minority community in the Turkey Creek watershed, would receive moderate benefit from this alternative

Problem Area: Turkey Creek Ecosystem Restoration, Harrison County, Mississippi

Problems ID: Environmental damages suffered by flooding due to hurricanes; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3	Plan 5
(3) Tax Values	No Impact.	Land would be taxed differently because it would be owned by State.	Land would be taxed differently because it would be owned by State.	Land would be taxed differently because it would be owned by State.
(4) Community Growth	No Impact.	Would restrict development in this area of Gulfport	Would restrict development in this area of Gulfport.	Would restrict development in this area of Gulfport.
(5) Property Values	No Impact	Adjacent property values could increase due to greenspace and less frequent flooding	Adjacent property values could increase due to greenspace and less frequent flooding	Adjacent property values could increase due to greenspace and less frequent flooding
(6) Displacement of Businesses	No Impact.	No Impact.	No Impact.	No Impact.
(7) Public Facilities	No Impact	No Impact.	No Impact.	No Impact
(8) Injurious Displacement of Farms	N/A	N/A	N/A	N/A
b. Preservation of loss of life	No Impact	Moderate reduction of risk within Turkey Creek watershed	Moderate reduction of risk within Turkey Creek watershed	Moderate reduction of risk within Turkey Creek watershed
C. PLAN EVALUATION				
1. Contributions to Planning Objectives				
a. Flood, Hurricane and/or Storm Damage Reduction	N/A	YES	YES	YES
b. Recovery of lost environmental resources	N/A	YES	YES	YES

Problem Area: Turkey Creek Ecosystem Restoration, Harrison County, Mississippi

Problems ID: Environmental damages suffered by flooding due to hurricanes; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3	Plan 5
2. Response to Planning Constraints				
a. Avoid environmental impacts and minimize induced damages	No Action could significant increase impacts	YES	YES	YES
b. Institutional Acceptability	N/A	YES	YES	YES
3. Response to Evaluation Criteria				
a. Acceptability	N/A	YES	YES	YES
b Completeness	N/A	YES, most complete	YES, moderately complete	YES, least complete
c. Effectiveness	N/A	Most effective	Highly effective	Moderately effective
d. Efficiency (Cost-Effectiveness; i.e., most efficient use of Federal and Non-Federal Funds)	N/A	YES, moderately efficient balance of habitat benefit/cost/risk.	YES, moderately efficient balance of habitat benefit/cost/risk.	YES, moderately efficient balance of habitat benefit/cost/risk
e. Integration	N/A	Seamless part of overall system.	Seamless part of overall system.	Seamless part of overall system
f Reversibility	This issue does not apply	No-land could not be resold for development	No-land could not be resold for development	No-land could not be resold for development

Problem Area: Turkey Creek Ecosystem Restoration, Harrison County, Mississippi

Problems ID: Environmental damages suffered by flooding due to hurricanes; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3	Plan 5
4. Stakeholder Preference Score (From MCDA weightings analysis)				
a. Summary Score	**62.23%**	**43.20%**	**42.27%**	**39.07%**
Cluster Group A	79 63%	26.30%	33.16%	44.64%
Cluster Group B	67.39%	38.70%	39.23%	42.19%
Cluster Group C	61.90%	43.81%	42.00%	37.21%
Cluster Group D	40 00%	64.00%	54.67%	32.24%
b. Stakeholder Preference	Plan ranked highest by stakeholders.	All action plans ranked lower than no action by stakeholders.	All action plans ranked lower than no action by stakeholders.	All action plans ranked lower than no action by stakeholders.
D. Implementation Responsibility	N/A	Joint Federal/Non-Federal implementation responsibility.	Joint Federal/Non-Federal implementation responsibility.	Joint Federal/Non-Federal implementation responsibility.
E. State and other Non-Federal Coordination	Would require no State or other Non-Federal coordination activities	Would require limited State or other Non-Federal coordination activities	Would require limited State or other Non-Federal coordination activities	Would require limited State or other Non-Federal coordination activities
F. Risk Evaluation				
1. Risk and Vulnerabilities				
a. Risk of Failure	N/A	Low	Low	Low

Problem Area: Turkey Creek Ecosystem Restoration, Harrison County, Mississippi

Problems ID: Environmental damages suffered by flooding due to hurricanes; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3	Plan 5
b. Residual Risk	Residual risk to loss of environmental resources is extremely high. Residual risk to adjacent communities remains high from storm-induced flooding.	Residual risk of ecosystem damage is significantly lower level than No-Action Plan. Residual risk to adjacent communities would be moderately reduced .	Residual risk of ecosystem damage is at significantly lower level than No-Action Plan. Residual risk to adjacent communities would be moderately reduced	Residual risk of ecosystem damage is at moderately lower level than No-Action Plan. Residual risk to adjacent communities would be moderately reduced
c. Reliability	N/A	Would provide a moderate level of reliability, would be resistant to damage from storm events, and would not require significant maintenance.	Would provide a moderate level of reliability, would be resistant to damage from storm events, and would not require significant maintenance.	Would provide a minor level of reliability, would be resistant to damage from storm events, and would not require significant maintenance.
d. Relative Sea Level Rise	Problems could be exacerbated by an increasing relative rise of sea level	This Plan would not be impacted by an increasing relative rise of sea level over the period of analysis	This Plan would not be impacted by an increasing relative rise of sea level over the period of analysis	This Plan would not be impacted by an increasing relative rise of sea level over the period of analysis

Problem Area: Turkey Creek Ecosystem Restoration, Harrison County, Mississippi

Problems ID: Environmental damages suffered by flooding due to hurricanes; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3	Plan 5
e. Risk of Ecosystem Damage	Risk of ecosystem damage is significant as increased development proceeds	Risk of ecosystem damage will be minimal	Risk of ecosystem damage will be minimal	Risk of ecosystem damage will be moderate
f. Risk to Life and Safety	This plan will not reduce threats to life and safety.	This plan would provide a small but positive contribution to reducing threats to life and safety by provision of additional stormwater storage.	This plan would provide a small but positive contribution to reducing threats to life and safety by provision of additional stormwater storage.	This plan would provide a small but positive contribution to reducing threats to life and safety by provision of additional stormwater storage.
g. Risk to Mental and Physical Health	Significant threats to Mental and Physical Health from flooding would still exist.	Moderate threats to Mental and Physical Health from flooding would still exist.	Moderate threats to Mental and Physical Health from flooding would still exist.	Significant threats to Mental and Physical Health from flooding would still exist.

Problem Area: Turkey Creek Ecosystem Restoration, Harrison County, Mississippi

Problems ID: Environmental damages suffered by flooding due to hurricanes; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3	Plan 5
2. Recommendations and Preferences				
a. Federal Recommendation			Federal recommendation is for Plan 3, which achieves best balance of plan outcomes, at lower costs than Plan 1, achieves objectives for problem solving at this site, with much higher benefit than Plan 5 or No-Action Plan.	
b. Stakeholder Preference	Initial Stakeholder preference scores indicated the No-Action Plan		Even though the initial stakeholder preference scores pointed towards the No-Action Plan, additional consultation with local and state entities show strong support for Plan 3	

Table 3-15
System of Accounts table for Bayou Cumbest Alternatives

Problem Area: Bayou Cumbest Restoration, Jackson County, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: Acquisition only is not a stand alone alternative

Item	No Action	Plan 1	Plan 2	Plan 3	Plan 6
A. PLAN DESCRIPTION	No Federal Action	Excavate Fill, Remove Exotic Species, Plant native species at 0.5 meter density, and fill ditches, plus acquisition	Excavate Fill, Remove Exotic Species, Plant native species at 1.0 meter density, and fill ditches, plus acquisition	Excavate Fill, Remove Exotic Species, Plant native species at 2.0 meter density, and fill ditches, plus acquisition	Excavate Fill, Remove Exotic Species, and Plant native species at 2 meter density, plus acquisition
B. IMPACT ASSESSMENT					
1. National Economic Development					
a. Beneficial Impacts					
(1) Damages Prevented	$0	$0	$0	$0	$0
(2) Emergency Costs Avoided	$0	$0	$0	$0	$0
(3) Recreation	$0	Possible increase in ecotourism	Possible increase in ecotourism	Possible increase in ecotourism	Possible increase in ecotourism
(4) Total Beneficial Impacts	None.	$0	$0	$0	$0
b. Adverse Impacts					
(1) Project Cost	$0	$28,000,000	$22,350,000	$21,030,000	$21,020,000
(2) Interest During Construction	$0	$620,000	$520,000	$470,000	$470,000

Problem Area: Bayou Cumbest Restoration, Jackson County, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: Acquisition only is not a stand alone alternative

Item	No Action	Plan 1	Plan 2	Plan 3	Plan 6
(3) Average Annual First Cost	N/A	$1,538,000	$1,282,000	$1,155,000	$1,154,000
(4) Annual O&M	$0	$2,000	$114,000	$112,000	$1,266,000
(5) Total Avg. Annual Costs	$0	$1,540,000	$1,396,000	$1,267,000	$2,420,000
2. Environmental Quality (EQ)					
(1) Ecosystem Restoration	No ecosystem restoration benefits.	Restoration of approximately 110 acres with an average annual functional unit (AAFU) values of **191.**	Restoration of approximately 110 acres with an average annual functional unit (AAFU) values of **188**	Restoration of approximately 110 acres with an average annual functional unit (AAFU) values of 184.	Restoration of approximately 110 acres with an average annual functional unit (AAFU) values of **164**
(2) Water Circulation	No anticipated effect on water circulation	No anticipated effect on water circulation	No anticipated effect on water circulation.	No anticipated effect on water circulation	No anticipated effect on water circulation.
(3) Noise Level Changes	No change in noise levels	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction
(4) Public Facilities	N/A	N/A	N/A	N/A	N/A
(5) Aesthetic Values	No significant change in aesthetic values	Significant improvement to natural aesthetic values	Significant improvement to natural aesthetic values	Significant improvement to natural aesthetic values	Significant improvement to natural aesthetic values

Problem Area: Bayou Cumbest Restoration, Jackson County, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: Acquisition only is not a stand alone alternative

Item	No Action	Plan 1	Plan 2	Plan 3	Plan 6
(6) Natural Resources	Continued degradation with possible increase of invasive species	Alternative would result in restoration of coastal marsh resources	Alternative would result in restoration of coastal marsh resources.	Alternative would result in restoration of coastal marsh resources.	Alternative would result in restoration of coastal marsh resources.
(7) Biological Resources	Continued degradation with possible increase of invasive species	Biological resources would be significantly improved versus the no-action alternative	Biological resources would be significantly improved versus the no-action alternative	Biological resources would be moderately improved versus the no-action alternative	Biological resources would be somewhat improved versus the no-action alternative
(8) Air Quality	Alternative would have no anticipated effect on air quality	Air emission would be *de minimus*	Air emission would be *de minimus*	Air emission would be *de minimus*	Air emission would be *de minimus*
(9) Water Quality	No impact.	Temporary negative impacts to water quality due to construction , significant long-term improvements.	Temporary negative impacts to water quality due to construction , significant long-term improvements.	Temporary negative impacts to water quality due to construction , significant long-term improvements.	Temporary negative impacts to water quality due to construction , significant long-term improvements.
(10) Public Services	Public services to community would continue to be interrupted during storm events	No impact. Reduced need for public services in the area	No impact. Reduced need for public services in the area	No impact. Reduced need for public services in the area	No impact. Reduced need for public services in the area

Problem Area: Bayou Cumbest Restoration, Jackson County, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: Acquisition only is not a stand alone alternative

Item	No Action	Plan 1	Plan 2	Plan 3	Plan 6
(11) Cultural and Historical Preservation	No impact	No impact.	No impact.	No impact.	No impact.
(12) Total Quality of the Environment	Environmental quality will degrade thru time	Environmental quality would be improved	Environmental quality would be improved.	Environmental quality would be improved.	Environmental quality would be improved.
3. Regional Economic Development (RED)					
(1) Impact on Sales Volume	No impact	Increase of **$59,451,160** in additional sales volume.	Increase of **$54,072,720** in additional sales volume.	Increase of **$48,910,520** in additional sales volume.	Increase of **$48,910,520** in additional sales volume.
(2) Impact on Income	No impact.	Increase of **$11,594,495** in additional local income.	Increase of **$10,545,562** in additional local income.	Increase of **$9,538,801** in additional local income.	Increase of **$9,538,801** in additional local income.
(3) Impact on Employment	No impact.	Increase of **337** new jobs.	Increase of **306** new jobs.	Increase of **277** new jobs.	Increase of **277** new jobs.
(4) Tax Changes	No impact	Would result in loss of some local tax revenue due to acquisition of properties.	Would result in loss of some local tax revenue due to acquisition of properties.	Would result in loss of some local tax revenue due to acquisition of properties.	Would result in loss of some local tax revenue due to acquisition of properties.

Problem Area: Bayou Cumbest Restoration, Jackson County, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: Acquisition only is not a stand alone alternative

Item	No Action	Plan 1	Plan 2	Plan 3	Plan 6
4. Other Social Effects (OSE)					
a Beneficial Impacts					
(1) Security of Life, Health, and Safety	HMGP purchase of properties currently reducing	Minor additional reduction in potential loss of life from evacuation of persons and property	Minor additional reduction in potential loss of life from evacuation of persons and property.	Minor additional reduction in potential loss of life from evacuation of persons and property	Minor additional reduction in potential loss of life from evacuation of persons and property.
(2) Community Cohesion	Community currently being dispersed with HMGP action	Community would continue to be dispersed	Community would continue to be dispersed	Community would continue to be dispersed	Community would continue to be dispersed
(3) Tax Values	Currently being impacted via HMGP acquisition	Ownership and land use changes would impact tax value	Ownership and land use changes would impact tax value	Ownership and land use changes would impact tax value	Ownership and land use changes would impact tax value
(4) Community Growth	Growth being shifted as residents relocate	Growth would continue to be shifted to other areas of coastal Mississippi	Growth would be shifted to other areas of coastal Mississippi	Growth would be shifted to other areas of coastal Mississippi	Growth would be shifted to other areas of coastal Mississippi
(5) Property Values	Currently being impacted via HMGP acquisition	Minor temporary negative impact to additional adjacent properties during acquisition phase	Minor temporary negative impact to additional adjacent properties during acquisition phase.	Minor temporary negative impact to additional adjacent properties during acquisition phase.	Minor temporary negative impact to additional adjacent properties during acquisition phase.

Problem Area: Bayou Cumbest Restoration, Jackson County, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: Acquisition only is not a stand alone alternative

Item	No Action	Plan 1	Plan 2	Plan 3	Plan 6
(6) Displacement of Businesses	N/A	N/A	N/A	N/A	N/A
(7) Public Facilities	N/A	Enhances opportunities for passive recreation	Enhances opportunities for passive recreation	Enhances opportunities for passive recreation	Enhances opportunities for passive recreation
(8) Injurious Displacement of Farms	N/A	N/A	N/A	N/A	N/A
b. Preservation of loss of life	Currently being reduced via HMGP acquisition	Some additional reduction in potential loss of life	Some additional reduction in potential loss of life.	Some additional reduction in potential loss of life.	Some additional reduction in potential loss of life.
C. PLAN EVALUATION					
1. Contributions to Planning Objectives					
a Flood, Hurricane and/or Storm Damage Reduction	Some reduction being gained via HMGP acquisition	Additional reduction in damages at project site and minor improvement to storm water conveyance through restoration.	Additional reduction in damages at project site and minor improvement to storm water conveyance through restoration.	Additional reduction in damages at project site and minor improvement to storm water conveyance through restoration.	Additional reduction in damages at project site and minor improvement to storm water conveyance through restoration.

Problem Area: Bayou Cumbest Restoration, Jackson County, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: Acquisition only is not a stand alone alternative

Item	No Action	Plan 1	Plan 2	Plan 3	Plan 6
b. Recovery of lost environmental resources	Continued loss of environmental resources.	Significant opportunity to recover environmental resources negatively impacted in past	Significant opportunity to recover environmental resources negatively impacted in past	Significant opportunity to recover environmental resources negatively impacted in past	Significant opportunity to recover environmental resources negatively impacted in past
2. Response to Planning Constraints					
a. Avoid environmental impacts and minimize induced damages	Continued loss of environmental resources.	Positive effect on environmental resources.	Positive effect on environmental resources.	Positive effect on environmental resources.	Positive effect on environmental resources.
b Institutional Acceptability	HMGP acquisition has local support	Is supported by local and state governments	Is supported by local and state governments	Is supported by local and state governments	Is supported by local and state governments
3. Response to Evaluation Criteria					
a. Acceptability	NO	YES	YES	YES	YES
b Completeness	NO	YES	YES	YES	YES
c. Effectiveness	NO	YES	YES	YES	YES
d. Efficiency (Cost-Effectiveness; i.e., most efficient use of Federal and Non-Federal Funds)	NO	YES	YES, but moderate risk of exotic species return over period of analysis.	YES, but high risk of exotic species return over period of analysis.	YES, but high risk of exotic species return over period of analysis.

Problem Area: Bayou Cumbest Restoration, Jackson County, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: Acquisition only is not a stand alone alternative

Item	No Action	Plan 1	Plan 2	Plan 3	Plan 6
e. Integration	N/A	Seamless part of overall system.	Seamless part of overall system.	Seamless part of overall system.	Seamless part of overall system
f Reversibility	N/A	NO - land could not be resold for development	NO - land could not be resold for development	NO - land could not be resold for development	NO - land could not be resold for development
4. Stakeholder Preference Score (From MCDA weightings analysis)					
a. Summary Score	**48.52%**	**55.99%**	**57.45%**	**57.83%**	**57.84%**
Cluster Group A	59.26%	46.09%	48.51%	49 61%	49 62%
Cluster Group B	50.00%	53.81%	56.31%	57.43%	57.44%
Cluster Group C	54.39%	50.88%	51.95%	51.89%	51 90%
Cluster Group D	30.43%	73 19%	73.03%	72.40%	72.40%
b. Stakeholder Preference	No clear stakeholder preference indicated, but all action plans preferred to no action plan.	No clear stakeholder preference indicated, but all action plans preferred to no action plan.	No clear stakeholder preference indicated, but all action plans preferred to no action plan.	No clear stakeholder preference indicated, but all action plans preferred to no action plan.	No clear stakeholder preference indicated, but all action plans preferred to no action plan.
D. Implementation Responsibility	No additional implementation responsibilities	Joint Federal/Non-Federal implementation responsibility.	Joint Federal/Non-Federal implementation responsibility.	Joint Federal/Non-Federal implementation responsibility.	Joint Federal/Non-Federal implementation responsibility.

Problem Area: Bayou Cumbest Restoration, Jackson County, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: Acquisition only is not a stand alone alternative

Item	No Action	Plan 1	Plan 2	Plan 3	Plan 6
E. State and other Non-Federal Coordination	No State or other Non-Federal coordination activities	Would require State or other Non-Federal coordination activities	Would require State or other Non-Federal coordination activities	Would require State or other Non-Federal coordination activities	Would require State or other Non-Federal coordination activities
F. Risk Evaluation					
1. Risk and Vulnerabilities					
a. Risk of Failure	N/A	Very low risk of failure	Very low risk of failure.	Very low risk of failure.	Very low risk of failure.
b. Residual Risk	Residual risk to properties not acquired in HMGP remain substantial due to storm surge.	Residual risk to additional properties reduced. Residual risk of ecosystem damage would be substantially lower than No-Action Plan.	Residual risk to additional properties reduced. Residual risk of ecosystem damage would be substantially lower than No-Action Plan, and Plans 3 & 6	Residual risk to additional properties reduced. Residual risk of ecosystem damage would be substantially lower than No-Action Plan but higher than plans 1 & 2.	Residual risk to additional properties reduced. Residual risk of ecosystem damage would be substantially lower than No-Action Plan but higher than plans 1 & 2.

Problem Area: Bayou Cumbest Restoration, Jackson County, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: Acquisition only is not a stand alone alternative

Item	No Action	Plan 1	Plan 2	Plan 3	Plan 6
c. Reliability	N/A	This plan would provide a significantly greater degree of reliability than all other plans, but at much higher cost, would be most resistant to damage from storm events, and would require some maintenance.	This plan would provide a significantly greater degree of reliability than Plans 3 and 6, and at lesser cost than Plan 1; would be resistant to damage from storm events, and would require moderate maintenance.	This plan would provide a significantly lesser degree of reliability than Plans 1 and 3, would be somewhat resistant to damage from storm events, and would require high maintenance.	Plan would provide a significantly lesser degree of reliability than all other action plans; would be least resistant to damage from storm events of all action plans, and would require significant maintenance
d. Relative Sea Level Rise	Problems will be substantially exacerbated by an increasing relative rise of sea level	This Plan will be minimally impacted by an increasing relative rise of sea level over the period of analysis	This Plan will be minimally impacted by an increasing relative rise of sea level over the period of analysis	This Plan will be minimally impacted by an increasing relative rise of sea level over the period of analysis	This Plan will be minimally impacted by an increasing relative rise of sea level over the period of analysis

Problem Area: Bayou Cumbest Restoration, Jackson County, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: Acquisition only is not a stand alone alternative

Item	No Action	Plan 1	Plan 2	Plan 3	Plan 6
e. Risk of Ecosystem Damage	Ecosystem damage will continue to accrue at a rate at least that of recent history with substantial negative outcomes.	Risk of ecosystem damage will be least throughout the period of analysis.	Risk of ecosystem damage will be minimal throughout the period of analysis.	Risk of ecosystem damage will be most throughout the period of analysis.	Risk of ecosystem damage will be most throughout the period of analysis.
f. Risk to Life and Safety	Threats being reduced via HMGP acquisition	Additional reduction in threats via HMGP acquisition	Additional reduction in threats via HMGP acquisition	Additional reduction in threats via HMGP acquisition	Additional reduction in threats via HMGP acquisition
g. Risk to Mental and Physical Health	Risks being reduced via HMGP acquisition	Additional reduction via HMGP acquisition	N/A	N/A	N/A

2. Recommendations and Preferences

Problem Area: Bayou Cumbest Restoration, Jackson County, Mississippi

Problems ID: Ecosystem and Structural damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.
Note: Acquisition only is not a stand alone alternative

Item	No Action	Plan 1	Plan 2	Plan 3	Plan 6
a. Federal Recommendation			Plan 2 achieves best balance of outcomes, at similar cost to Plans 1,3, and 6, but with substantially greater functional improvement and greater reliability of outcomes when compared to all other plans.		
b. Stakeholder Preference	No clear stakeholder preference indicated, but all action plans preferred to no action plan.		Even though the initial stakeholder preference scores were slightly higher for plans 3 & 6 the differences are not significant. Additional consultation with local and state entities shows strong support for Plan 2		

Table 3-16
System of Accounts table for Admiral Island Alternatives

Problem Area: Admiral Island Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack have threatened environmental sustainability of the area.

Item	No Action Plan	Plan 1	Plan 2	Plan 3	Plan 6
A. PLAN DESCRIPTION	No Federal Action	Excavate Fill, Remove Exotic Species, Plant native species at 0.5 meter density, and fill ditches	Excavate Fill, Remove Exotic Species, Plant native species at 1.0 meter density, and fill ditches	Excavate Fill, Remove Exotic Species, Plant native species at 2.0 meter density, and fill ditches	Excavate Fill, Remove Exotic Species, and Plant native species at 2.0 meter density
B. IMPACT ASSESSMENT					
1. National Economic Development					
a. Beneficial Impacts					
(1) Damages Prevented	$0	Moderate level of damages prevented from increased flood storage capacity.	Moderate level of damages prevented from increased flood storage capacity.	Moderate level of damages prevented from increased flood storage capacity.	Moderate level of damages prevented from increased storm storage capacity
(2) Emergency Costs Avoided	$0	$0	$0	$0	$0
(3) Recreation	N/A	Possible ecotourism benefits	Possible ecotourism benefits	Possible ecotourism benefits	Possible ecotourism benefits
(4) Total Beneficial Impacts	None.				
b. Adverse Impacts					
(1) Project Cost	$0	$26,340,000	$23,790,000	$22,490,000	$22,440,000
(2) Interest During Construction	$0	$580,000	$530,000	$500,000	$500,000
(2) Average Annual First Cost	N/A	$1,447,000	$1,306,000	$1,235,000	$1,232,000
(3) Annual O&M	$0	$2,000	$58,000	$58,000	$58,000
(4) Total Avg. Annual Costs	$0	$1,449,000	$1,364,000	$1,293,000	$1,290,000

Problem Area: Admiral Island Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack have threatened environmental sustainability of the area.

Item	No Action Plan	Plan 1	Plan 2	Plan 3	Plan 6
2. Environmental Quality (EQ)					
(1) Ecosystem Restoration	No ecosystem restoration benefits Potential for further loss of habitat function.	Average Annual Functional Units (AAFU) increase of **61**	Average Annual Functional Units (AAFU) increase of **60**.	Average Annual Functional Units (AAFU) increase of **59**	Average Annual Functional Units (AAFU) increase of **49**
(2) Water Circulation	No anticipated effect on water circulation	No anticipated effect on water circulation.	No anticipated effect on water circulation.	No anticipated effect on water circulation.	No anticipated effect on water circulation.
(3) Noise Level Changes	No change in noise levels	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction
(4) Public Facilities	N/A	N/A	N/A	N/A	N/A
(5) Aesthetic Values	The aesthetic value of the resource would continue to degrade as invasive species outcompete native species	Alternative would result in improvement of the aesthetic experience through restoration of natural vegetative habitat	Alternative would result in improvement of the aesthetic experience through restoration of natural vegetative habitat	Alternative would result in improvement of the aesthetic experience through restoration of natural vegetative habitat	Alternative would result in improvement of the aesthetic experience through restoration of natural vegetative habitat
(6) Natural Resources	Existing natural resources would continue to be degraded	Alternative would result in restoration of natural vegetative habitat with improved natural resource value.	Alternative would result in restoration of natural vegetative habitat.	Alternative would result in restoration of natural vegetative habitat.	Alternative would result in restoration of natural vegetative habitat

Problem Area: Admiral Island Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack have threatened environmental sustainability of the area.

Item	No Action Plan	Plan 1	Plan 2	Plan 3	Plan 6
(7) Biological Resources	Biological resources would continue to be degraded	Biological resources would be significantly improved versus the no-action alternative	Biological resources would be significantly improved versus the no-action alternative.	Biological resources would be moderately improved versus the no-action alternative	Biological resources would be somewhat improved versus the no-action alternative.
(8) Air Quality	No Impact	Air emission would be *de minimus*	Air emission would be *de minimus*	Air emission would be *de minimus*	Air emission would be *de minimus*
(9) Water Quality	No anticipated effect on water quality	Temporary negative impacts to water quality due to construction but overall water quality would be greatly improved by marsh restoration.	Temporary negative impacts to water quality due to construction but overall water quality would be greatly improved by marsh restoration.	Temporary negative impacts to water quality due to construction but overall water quality would be moderately improved by marsh restoration.	Temporary negative impacts to water quality due to construction but overall water quality would be moderately improved by marsh restoration.
(10) Public Services	N/A	N/A	N/A	N/A	N/A
(11) Cultural and Historical Preservation	N/A	N/A	N/A	N/A	N/A
(12) Total Quality of the Environment	Quality of environment would continue to degrade	Environmental quality would be improved significantly	Environmental quality would be improved significantly.	Environmental quality would be improved significantly.	Environmental quality would be improved

Problem Area: Admiral Island Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack have threatened environmental sustainability of the area.

Item	No Action Plan	Plan 1	Plan 2	Plan 3	Plan 6
3. Regional Economic Development (RED)					
(1) Impact on Sales Volume	No impact to the local economy.	Increase of **$52,686,000** in additional sales volume to the local economy	Increase of **$49,750,000** in additional sales volume to the local economy.	Increase of **$47,150,000** in additional sales volume to the local economy.	Increase of **$46,950,000** in additional sales volume to the local economy
(2) Impact on Income	No impact to the local economy	Increase of **$12,704,442** in additional local income to the local economy	Increase of **$11,996,469** in additional local income to the local economy.	Increase of **$11,369,518** in additional local income to the local economy	Increase of **$11,321,291** in additional local income to the local economy.
(3) Impact on Employment	No impact to the local economy.	Increase of **319** new jobs to the local economy.	Increase of **301** new jobs to the local economy.	Increase of **285** new jobs to the local economy	Increase of **284** new jobs to the local economy
(4) Tax Changes	N/A	N/A	N/A	N/A	N/A
4. Other Social Effects (OSE)					
a. Beneficial Impacts					
(1) Security of Life, Health, and Safety	Continued risks to life, health and safety	Some reduction in risk due to improved storm water storage.	Some reduction in risk due to improved storm water storage.	Some reduction in risk due to improved storm water storage.	Some reduction in risk due to improved storm water storage.
(2) Community Cohesion	N/A	N/A	N/A	N/A	N/A
(3) Tax Values	N/A	N/A	N/A	N/A	N/A
(4) Community Growth	N/A	N/A	N/A	N/A	N/A

Problem Area: Admiral Island Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack have threatened environmental sustainability of the area.

Item	No Action Plan	Plan 1	Plan 2	Plan 3	Plan 6
(5) Property Values	Property values in adjacent areas could decrease with of areas	Property values in adjacent areas could improve through restoration of the natural habitat and open greenspace	Property values in adjacent areas could improve through restoration of the natural habitat and open greenspace.	Property values in adjacent areas could improve through restoration of the natural habitat and open greenspace.	Property values in adjacent areas could improve through restoration of the natural habitat and open greenspace.
(6) Displacement of Businesses	N/A	N/A	N/A	N/A	N/A
(7) Public Facilities	N/A	N/A	N/A	N/A	N/A
(8) Injurious Displacement of Farms	N/A	N/A	N/A	N/A	N/A
b. Preservation of loss of life	N/A	N/A	N/A	N/A	N/A
C. PLAN EVALUATION					
1. Contributions to Planning Objectives					
a. Flood, Hurricane and/or Storm Damage Reduction	N/A	YES	YES	YES	YES
b. Recovery of lost environmental resources	NO	YES	YES	YES	YES
2. Response to Planning Constraints					
a Avoid environmental impacts and minimize induced damages	NO	YES	YES	YES	YES
b. Institutional Acceptability	NO	YES	YES	YES	YES
3. Response to Evaluation Criteria					
a Acceptability	NO	YES	YES	YES	YES

Problem Area: Admiral Island Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack have threatened environmental sustainability of the area.

Item	No Action Plan	Plan 1	Plan 2	Plan 3	Plan 6
b Completeness	N/A	YES	YES, but minor risk of exotic species return over period of analysis.	YES, but moderate risk of exotic species return over period of analysis.	YES, but high risk of exotic species return over period of analysis.
c. Effectiveness	N/A	YES	YES	YES	YES
d Efficiency (Cost-Effectiveness; i.e , most efficient use of Federal and Non-Federal Funds)	N/A	Moderate efficient balance of habitat benefit/cost/risk.	Most efficient balance of habitat benefit/cost/risk.	Moderate efficient balance of habitat benefit/cost/risk.	Least efficient balance of habitat benefit/cost/risk
e. Integration	N/A	Seamless part of overall system.	Seamless part of overall system.	Seamless part of overall system.	Seamless part of overall system.
f. Reversibility	N/A	N/A	N/A	N/A	N/A
4. Stakeholder Preference Score (From MCDA weightings analysis)					
a. Summary Score	**58.39%**	**47.77%**	**48.37%**	**48.25%**	**48.29%**
Cluster Group A	79 63%	28 40%	30.03%	30.71%	30.76%
Cluster Group B	64 58%	40.97%	42.59%	43.25%	43.29%
Cluster Group C	57.78%	48 89%	48.81%	48.04%	48.07%
Cluster Group D	31.58%	72.81%	72.04%	71.01%	71 02%

Problem Area: Admiral Island Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack have threatened environmental sustainability of the area.

Item	No Action Plan	Plan 1	Plan 2	Plan 3	Plan 6
b. Stakeholder Preference	No clear stakeholder preference indicated, although no action plan ranked higher than action plans.(58.39%) but there is no clear preference	All action plans ranked lower than no action by stakeholders (47.77%) but there is no clear preference	All action plans ranked lower than no action by stakeholders. (48.37%) but there is no clear preference	All action plans ranked lower than no action by stakeholders. (48.25%) but there is no clear preference	All action plans ranked lower than no action by stakeholders. (48.29%) but there is no clear preference
D. Implementation Responsibility	Does not have any implementation responsibilities	Elements would be joint Federal/Non-Federal implementation responsibility	Elements would be joint Federal/Non-Federal implementation responsibility.	Elements would be joint Federal/Non-Federal implementation responsibility.	Elements would be joint Federal/Non-Federal implementation responsibility.
E. State and other Non-Federal Coordination	Would require no State or other Non-Federal coordination activities	Would require State or other Non-Federal coordination activities	Would require State or other Non-Federal coordination activities	Would require State or other Non-Federal coordination activities	Would require - State or other Non-Federal coordination activities
F. Risk Evaluation					
1. Risk and Vulnerabilities					
a. Risk of Failure	N/A	Very low risk of failure	Low risk of failure.	Moderate risk of failure.	Moderate risk of failure.

Problem Area: Admiral Island Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack have threatened environmental sustainability of the area.

Item	No Action Plan	Plan 1	Plan 2	Plan 3	Plan 6
b. Residual Risk	Residual risk of all actions will remain substantial due to lack of restoration	. Residual risk to ecosystem would be much reduced from that of any other plan.	Residual risk of ecosystem damage would be much reduced from all other plans other than Plan 1	Residual risk of ecosystem damage would be much higher than Plans 1 and 2	Residual risk of ecosystem damage would be much higher than all other action plans
c. Reliability	N/A	This plan would provide a significantly greater degree of reliability than Plans 2, 3 and 6, but at higher cost than all other plans and would require maintenance.	This plan would provide a significantly greater degree of reliability than Plans 3 and 6, but at lower cost than Plan 1 and would require some maintenance.	This plan would provide a significantly lesser degree of reliability than Plans 1 and 2; and would require moderate maintenance.	Plan would provide a significantly lesser degree of reliability than all other action plans; and would require moderate maintenance
d. Relative Sea Level Rise	Problems will be substantially exacerbated by an increasing relative rise of sea level	This Plan will be minimally impacted by an increasing relative rise of sea level over the period of analysis	This Plan will be minimally impacted by an increasing relative rise of sea level over the period of analysis	This Plan will be minimally impacted by an increasing relative rise of sea level over the period of analysis	This Plan will be minimally impacted by an increasing relative rise of sea level over the period of analysis

Problem Area: Admiral Island Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack have threatened environmental sustainability of the area.

Item	No Action Plan	Plan 1	Plan 2	Plan 3	Plan 6
e. Risk of Ecosystem Damage	Ecosystem damage will continue to accrue at a rate at least that of recent history with substantial negative outcomes.	Risk of ecosystem damage will be minimal throughout the period of analysis.	Risk of ecosystem damage will be minimal throughout the period of analysis.	Risk of ecosystem damage will be minimal throughout the period of analysis.	Risk of ecosystem damage will be minimal throughout the period of analysis.
f. Risk to Life and Safety	N/A	N/A	N/A	N/A	N/A
g. Risk to Mental and Physical Health	N/A	N/A	N/A	N/A	N/A

Problem Area: Admiral Island Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack have threatened environmental sustainability of the area.

Item	No Action Plan	Plan 1	Plan 2	Plan 3	Plan 6
2. Recommendations and Preferences					
a. Federal Recommendation			Plan 2 achieves best balance of outcomes, at similar cost to Plans 1,3, and 6, but with substantially greater functional improvement and greater reliability of outcomes when compared to all other plans.		
b. Stakeholder Preference	No clear stakeholder preference indicated, but slight overall preference for no action plan.		Even though the stakeholder preference scores pointed marginally towards the No-Action Plan, there is no clear preference, additional coordination with state indicates strong support for plan 2.		

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Table 3-17
System of Accounts table for Dantzler Alternatives

Problem Area: Dantzler Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3	Plan 5
A. PLAN DESCRIPTION	No Federal Action	385 Acre Restoration Maintain by Burning	151 Acre Restoration Maintain by Burning	234 Acre Restoration Maintain by Burning
B. IMPACT ASSESSMENT				
1. National Economic Development				
a. Beneficial Impacts				
(1) Damages Prevented	$0	Would provide a moderate level of damages prevented from increased flood storage capacity.	Would provide a moderate level of damages prevented from increased flood storage capacity.	Would provide a moderate level of damages prevented from increased flood storage capacity.
(2) Emergency Costs Avoided	$0	$0	$0	$0
(3) Recreation	No significant change in recreation benefits	Opportunity for ecotourism to increase	Opportunity for ecotourism to increase	Opportunity for ecotourism to increase
(4) Total Beneficial Impacts	None.			
b. Adverse Impacts				
(1) Project Cost	$0	$1,880,000	$870,000	$1,040,000
(2) Interest During Construction	$0	$41,000	$19,000	$23,000
(3) Average Annual First Cost	N/A	$103,000	$48,000	$57,000
(4) Annual O&M	$0	$26,000	$10,000	$16,000
(5) Total Avg. Annual Costs	$0	$129,000	$58,000	$73,000

Problem Area: Dantzler Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3	Plan 5
2. Environmental Quality (EQ)				
(1) Ecosystem Restoration	No ecosystem restoration benefits.	Average Annual Functional Units (AAFU) increase of **1,244**.	Average Annual Functional Units (AAFU) increase of **488**.	Average Annual Functional Units (AAFU) increase of **756**.
(2) Water Circulation	No effect on water circulation.	No effect on water circulation.	No effect on water circulation.	No effect on water circulation.
3) Noise Level Changes	No change in noise levels	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction
(4) Public Facilities	N/A	N/A	N/A	N/A
(5) Aesthetic Values	Aesthetic values would continue to decrease	Significant improvement in aesthetic values	Improvement in aesthetic values	Significant improvement in aesthetic values
(6) Natural Resources	Continued degradation of natural resources	Existing natural resources would be restored to historic wet pine savannah habitat conditions.	Existing natural resources would be partially restored to historic wet pine savannah habitat conditions.	Existing natural resources would be partially restored to historic wet pine savannah habitat conditions.

Problem Area: Dantzler Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3	Plan 5
(7) Biological Resources	Continued degradation of biological resources	Biological resources would be significantly improved versus the no-action	Biological resources would be somewhat improved versus no-action	Biological resources would be moderately improved versus no-action
(8) Air Quality	No effect on air quality	Air emission would be *de minimus* and intermittent during burning	Air emission would be *de minimus* and intermittent during burning	Air emission would be *de minimus* and intermittent during burning
(9) Water Quality	Continued negative impacts on water quality	Temporary negative impacts to water quality due to construction but would have a long-term significant improvement to water quality.	Temporary negative impacts to water quality due to construction but would have a long-term moderate improvement to water quality	Temporary negative impacts to water quality due to construction but would have a long-term moderate improvement to water quality.
(10) Public Services	N/A	N/A	N/A	N/A
(11) Cultural and Historical Preservation	No effect on cultural and historical preservation	No effect on cultural and historical preservation	No effect on cultural and historical preservation	No effect on cultural and historical preservation
(12) Total Quality of the Environment	Significant continued degradation of the environment	Environmental quality would be significantly improved versus the no-action and other	Environmental quality would be somewhat improved versus the no-action.	Environmental quality would be moderately improved versus the no-action and Plan 3.

Problem Area: Dantzler Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3	Plan 5
		alternative restoration plans.		
3. Regional Economic Development (RED)				
(1) Impact on Sales Volume	No impact to the local economy	**Increase of $3,985,600** in additional sales volume.	Increase of **$1,844,400** in additional sales volume	Increase of **$2,204,800** in additional sales volume
(2) Impact on Income	No impact to the local economy.	Increase of **$777,294** in additional local income.	Increase of **$359,705** in additional local income.	Increase of **$429,992** in additional local income.
(3) Impact on Employment	No impact to the local economy.	Increase of **22** new jobs.	Increase of **10** new jobs.	Increase of **12** new jobs
(4) Tax Changes	N/A	N/A	N/A	N/A
4. Other Social Effects (OSE)				
a. Beneficial Impacts				
(1) Security of Life, Health, and Safety	Continued risks to life, health and safety	Decrease in risks to life, health and safety, due to re-establishment of stormwater conveyance.	Decrease in risks to life, health and safety, due to re-establishment of stormwater conveyance.	Decrease in risks to life, health and safety, due to re-establishment of stormwater conveyance
(2) Community Cohesion	N/A	N/A	N/A	N/A
(3) Tax Values	N/A	N/A	N/A	N/A
(4) Community Growth	No effect on community growth	No effect on community	No effect on community	No effect on community

Problem Area: Dantzler Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3	Plan 5
		growth	growth	growth
(5) Property Values	N/A	N/A	N/A	N/A
(6) Displacement of Businesses	N/A	N/A	N/A	N/A
(7) Public Facilities	N/A	N/A	N/A	N/A
(8) Injurious Displacement of Farms	N/A	N/A	N/A	N/A
b. Preservation of loss of life	N/A	Will result in improvement in safety to lives provided by restoration of stormwater conveyance.	Will result in improvement in safety to lives provided by restoration of stormwater conveyance.	Will result in improvement in safety to lives provided by restoration of stormwater conveyance.
C. PLAN EVALUATION				
1. Contributions to Planning Objectives				
a. Flood, Hurricane and/or Storm Damage Reduction	NO	YES	YES	YES
b Recovery of lost environmental resources	NO	YES	YES	YES
2. Response to Planning Constraints				
a Avoid environmental impacts and minimize induced damages	N/A	YES	YES	YES
b. Institutional Acceptability	N/A	YES	YES	YES
3. Response to Evaluation Criteria				
a. Acceptability	N/A	YES	YES	YES
b. Completeness	N/A	YES	Partially	Moderately
c. Effectiveness	N/A	YES	Partially	Moderately
d. Efficiency (Cost-Effectiveness; i.e., most efficient use of Federal and Non-Federal Funds)	N/A	Most efficient of all the plans	Moderately	Moderately

Problem Area: Dantzler Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3	Plan 5
e Integration	N/A	Seamless part of overall system.	Seamless part of overall system.	Seamless part of overall system.
f. Reversibility	N/A	N/A	N/A	N/A
2. Federal and non-Federal Comparison				
a. Federal				
b. Public				
4. Stakeholder Preference Score (From MCDA weightings analysis)				
a. Summary Score	**62.23%**	**43.20%**	**38.59%**	**41.05%**
Cluster Group A	79.63%	26.30%	36.46%	38.06%
Cluster Group B	67.39%	38.70%	40.68%	39 33%
Cluster Group C	61 90%	43.81%	37.71%	40.28%
Cluster Group D	40.00%	64.00%	39.52%	46.54%
b. Stakeholder Preference	No clear stakeholder preference indicated, although no action plan ranked higher than action plans.	All action plans ranked lower than no action by stakeholders.	All action plans ranked lower than no action by stakeholders.	All action plans ranked lower than no action by stakeholders
D. Implementation Responsibility	No implementation responsibilities	Joint Federal/Non-Federal implementation responsibility.	Joint Federal/Non-Federal implementation responsibility	Joint Federal/Non-Federal implementation responsibility.
E. State and other Non-Federal Coordination	No State or other Non-Federal coordination activities	Additional State or other non-Federal coordination required	Additional State or other non-Federal coordination required	Additional State or other non-Federal coordination required

Problem Area: Dantzler Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3	Plan 5
F. Risk Evaluation				
1. Risk and Vulnerabilities				
a. Risk of Failure	N/A	Very low risk of failure	Very low risk of failure.	Very low risk of failure
b. Residual Risk	Residual risk (economic) does not apply, but residual risks (potential damages to ecosystem left unattenuated) would remain very high	Residual risk (economic) does not apply, but residual risks (potential damages to ecosystem left unattenuated) would be reduced more by this plan than any other plan	Residual risk (economic) does not apply, but residual risks (potential damages to ecosystem left unattenuated) would be reduced more than No-Action Plan, but less than any other action plan	Residual risk (economic) does not apply, but residual risks (potential damages to ecosystem left unattenuated) would be reduced more by this plan over plan 3 but less than Plan 1
c. Reliability	No Action would have least reliable outcomes over period of analysis	Plan 1 would be most reliable of all plans including No-Action	Plan 3 would provide least reliability than all action plans, but more than No-Action Plan	Plan 5 would provide less reliability than Plan 1, but more than No-Action Plan or Plan 3

Problem Area: Dantzler Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3	Plan 5
d. Relative Sea Level Rise	Sea level rise would cause continued loss of ecosystem functions and values	Plan would be minimally impacted by an increasing relative rise of sea level over the period of analysis	Plan would be minimally impacted by an increasing relative rise of sea level over the period of analysis	Plan would be minimally impacted by an increasing relative rise of sea level over the period of analysis
e. Risk of Ecosystem Damage	There would remain considerable risk of damage to ecosystem from hurricane-induced surge and/or waves and increase in invasive species.	There would be a reduced risk of damage to the ecosystem compared to No-Action Plan and all other action plans. Minimal level of risk as compared to No-action	There would be a reduced risk of damage to the ecosystem compared to No-Action Plan Moderate level of risk as compared to No-Action Plan or Plan 1 or 5.	There would be a reduced risk of damage to the ecosystem compared to No-Action Plan and Plan 3 Moderate level of risk as compared to No-Action and Plan 3
f. Risk to Life and Safety	N/A	Increased stormwater storage will reduce risk to adjacent areas.	Increased stormwater storage will reduce risk to adjacent areas.	Increased stormwater storage will reduce risk to adjacent areas.
g. Risk to Mental and Physical Health	N/A	Increased stormwater storage will	Increased stormwater storage will	Increased stormwater storage will

Problem Area: Dantzler Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3	Plan 5
		reduce risk to adjacent areas.	reduce risk to adjacent areas.	reduce risk to adjacent areas.
2. Recommendations and Preferences				
a. Federal Recommendation		Plan 1 achieves greater functional improvement and greater reliability of outcomes when compared to all other plans, and is a cost-effective means of achieving goals and objectives.		
b. Stakeholder Preference	Initial stakeholder preference indicated for No-Action Plan	Even though the initial stakeholder preference scores pointed towards the No-Action Plan, additional		

Problem Area: Dantzler Ecosystem Restoration, Hancock County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3	Plan 5
		coordination among local & state support entities expressed strong support for Plan 1.		

Table 3-18
System of Accounts table for Franklin Creek Alternatives

Problem Area: Franklin Creek Ecosystem Restoration, Jackson County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3
A. PLAN DESCRIPTION	No Federal Action	Restoration of 149 Acres North and South of Railroad Maintain by Burning and Mowing	Restoration of 56 Acres South of Railroad and Maintain by Burning and Mowing
B. IMPACT ASSESSMENT			
1. National Economic Development			
a. Beneficial Impacts			
(1) Damages Prevented	$0	Would provide a modest level of damage reduction due to increase in flood storage compared to existing condition.	Would provide a modest level of damage reduction due to increase in flood storage compared to existing condition
(2) Emergency Costs Avoided	$0	$0	$0
(3) Recreation	No significant change in recreation benefits	Possible increase in ecotourism	Possible increase in ecotourism
(4) Total Beneficial Impacts	None.	None.	None.
b. Adverse Impacts			
(1) Project Cost	$0	$1,630,000	$550,000
(2) Interest During Construction	$0	$36,000	$12,000
(3) Average Annual First Cost	N/A	$90,000	$30,000
(4) Annual O&M	$0	$11,000	$4,000
(5) Total Avg Annual Costs	$0	$101,000	$34,000
2. Environmental Quality (EQ)			
(1) Ecosystem Restoration	No ecosystem restoration benefits.	Average Annual Functional Units (AAFU) increase of **516**.	Average Annual Functional Units (AAFU) increase of **194**.

Problem Area: Franklin Creek Ecosystem Restoration, Jackson County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3
(2) Water Circulation	No effect on water circulation.	No effect on water circulation.	No effect on water circulation.
(3) Noise Level Changes	No change in noise levels	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction
(4) Public Facilities	N/A	N/A	N/A
(5) Aesthetic Values	No significant change in aesthetic values	Would result in aesthetic improvement to the overall environmental setting	Would result in aesthetic improvement to the overall environmental setting
(6) Natural Resources	Existing natural resources would remain in degraded state	Restoration of wet pine savannah resources.	Restoration of wet pine savannah resources
(7) Biological Resources	Continued degradation of biological resources.	Biological resources would be improved versus the no-action alternative.	Biological resources would be improved versus the no-action alternative
(8) Air Quality	No anticipated effect on air quality	Temporary negative impacts during construction and intermittently during burning.	Temporary negative impacts during construction and intermittently during burning.
(9) Water Quality	No anticipated effect on water quality	Temporary negative impacts to water quality due to construction but is anticipated to improve future water quality.	Temporary negative impacts to water quality due to construction but is anticipated to improve future water quality.
(10) Public Services	N/A	N/A	N/A
(11) Cultural and Historical Preservation	N/A	N/A	N/A

Problem Area: Franklin Creek Ecosystem Restoration, Jackson County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3
(12) Total Quality of the Environment	Continued degraded state	Environmental quality would be improved versus the no-action alternative; thus, restoring the historical environmental setting.	Environmental quality would be improved versus the no-action alternative; thus, restoring the historical environmental setting.
3. Regional Economic Development (RED)			
(1) Impact on Sales Volume	No impact to the local economy.	**Increase of $3,879,600** in additional sales volume.	Increase of **$1,378,000** in additional sales volume.
(2) Impact on Income	No impact to the local economy.	Increase of **$756,621** in additional local income.	Increase of **$268,745** in additional local income.
(3) Impact on Employment	No impact to the local economy	Increase of **22** new jobs	Increase of **8** new jobs.
(4) Tax Changes	N/A	N/A	N/A
4. Other Social Effects (OSE)			
a. Beneficial Impacts			
(1) Security of Life, Health, and Safety	Residents relocated as part of interim.	Decrease in risks to life, health and safety in adjacent areas, due to re-establishment of stormwater conveyance.	Decrease in risks to life, health and safety in adjacent areas, due to re-establishment of stormwater conveyance.
(2) Community Cohesion	N/A	N/A	N/A

Problem Area: Franklin Creek Ecosystem Restoration, Jackson County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3
(3) Tax Values	N/A	N/A	N/A
(4) Community Growth	N/A	N/A	N/A
(5) Property Values	N/A	N/A	N/A
(6) Displacement of Businesses	N/A	N/A	N/A
(7) Public Facilities	N/A	N/A	N/A
(8) Injurious Displacement of Farms	N/A	N/A	N/A
b. Preservation of loss of life	N/A	Alternative will result in minor increase in safety to lives provided by restoration of stormwater conveyance.	Alternative will result in minor increase in safety to lives provided by restoration of stormwater conveyance.
C. PLAN EVALUATION			
1. Contributions to Planning Objectives			
a Flood, Hurricane and/or Storm Damage Reduction	N/A	YES	YES
b. Recovery of lost environmental resources	N/A	YES	YES
2. Response to Planning Constraints			
a. Avoid environmental impacts and minimize induced damages	N/A	YES	YES
b. Institutional Acceptability	N/A	YES	YES
3. Response to Evaluation Criteria			
a. Acceptability	N/A	YES	YES
b Completeness	N/A	YES	YES
c. Effectiveness	N/A	YES	YES
d. Efficiency (Cost-Effectiveness; i.e , most efficient use of Federal and Non-Federal Funds)	N/A	YES, most effective	YES

Problem Area: Franklin Creek Ecosystem Restoration, Jackson County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3
e. Integration	N/A	Seamless part of overall system.	Seamless part of overall system.
f Reversibility	N/A	N/A	N/A
4. Stakeholder Preference Score (From MCDA weightings analysis)			
a. Summary Score	**62.23%**	**41.16%**	**37.40%**
Cluster Group A	79.63%	24.07%	35.76%
Cluster Group B	67.39%	36.41%	39.91%
Cluster Group C	61 90%	41.67%	36.29%
Cluster Group D	40 00%	62.50%	37.65%
b. Stakeholder Preference	Stakeholder preference weighted to no action plan	All action plans ranked lower than no action by stakeholders.	All action plans ranked lower than no action by stakeholders
D. Implementation Responsibility	No implementation responsibilities	Joint Federal/Non-Federal implementation responsibility.	Joint Federal/Non-Federal implementation responsibility.
E. State and other Non-Federal Coordination	No State or other Non-Federal coordination activities	State or other non-Federal coordination required	State or other non-Federal coordination required
F. Risk Evaluation			
1. Risk and Vulnerabilities			
a. Risk of Failure	N/A	Very low risk of failure	Very low risk of failure.

Problem Area: Franklin Creek Ecosystem Restoration, Jackson County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3
b. Residual Risk	Residual risk (economic) does not apply, but residual risks to ecosystem would remain very high	Residual risk (economic) does not apply, but residual risks to ecosystem would be less than all other plans	Residual risk (economic) does not apply, but residual risks to ecosystem would be less than No-Action but higher than Plan 1
c. Reliability	N/A	This plan would provide a significant degree of reliability,	This plan would provide a moderate degree of reliability,
d. Relative Sea Level Rise	Habitat degradation will be substantially exacerbated by an increasing relative rise of sea level	This Plan would be less impacted by increasing relative rise of sea level over the period of analysis than all other plans	This Plan would be less impacted by increasing relative rise of sea level over the period of analysis than No-Action, but more so than Plan 1
e. Risk of Ecosystem Damage	Lack of restoration would encourage risk of invasion by exotics.	Risk of ecosystem damage would be less than all other plans.	Risk of ecosystem damage would be less than No-Action Plan, but more than Plan 1.
f. Risk to Life and Safety	N/A	N/A	N/A
g. Risk to Mental and Physical Health	N/A	N/A	N/A

Problem Area: Franklin Creek Ecosystem Restoration, Jackson County, Mississippi

Problems ID: Environmental damages suffered by hurricane-induced surge and wave attack; Potential future environmental damages from storm and hurricane events.

Item	No Action	Plan 1	Plan 3
2. Recommendations and Preferences			
a. Federal Recommendation		Plan 1 achieves greater functional improvement and greater reliability of outcomes when compared to all other plans, and is cost-effective means of achieving goals and objectives.	
b. Stakeholder Preference	Initial stakeholder preference for No action plan.	Even though the initial stakeholder preference scores pointed towards the No-Action Plan, additional coordination with state and local entities express strong support for Plan 1	

Table 3-19
System of Accounts table for Forest Heights Alternatives

Problem Area: Forrest Heights Project Area, Harrison County, Mississippi			
Problems ID: Damages suffered by hurricane-induced flooding; Potential future damages from flooding.			
Item **A. PLAN DESCRIPTION**	**No Action** No Federal Action	**Plan 1** Elevation 17FT NAVD88 Levee with limited clearing and snagging of turkey Creek	**Plan 2** Elevation 21FT NAVD88 Levee with limited clearing and snagging of turkey Creek
B. IMPACT ASSESSMENT			
1. National Economic Development			
a. Beneficial Impacts			
(1) Damages Prevented	$0	$11,580	$100,540
(2) Emergency Costs Avoided	$0	$1,926	$1,928
(3) Recreation	No change in recreation benefits	No change in recreation benefits	No change in recreation benefits
(4) Total Beneficial Impacts	None	$13,506	$102,468
b. Adverse Impacts			
(1) Project Cost	$0	$6,100,000	$11,400,000
(2) Interest During Construction	$0	$135,000	$252,000
(3) Average Annual First Cost	N/A	$335,000	$626,000
(4) Annual O&M	$0	$42,000	$114,000
(5) Total Avg. Annual Costs	$0	$377,000	$740,000

Problem Area: Forrest Heights Project Area, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced flooding; Potential future damages from flooding.

Item	No Action	Plan 1	Plan 2
2. Environmental Quality (EQ)			
(1) Ecosystem Restoration	No Change	Clearing & snagging will improve Turkey Creek & adjacent habitats	Clearing & snagging will improve Turkey Creek & adjacent habitats
(2) Water Circulation	No Change	Improvement in Turkey Creek flow	Improvement in Turkey Creek flow
(3) Noise Level Changes	No change in noise levels	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction
(4) Public Facilities	No change in public facilities.	Moderate improvement to public facilities by reduction in flooding	Significant improvement to public facilities by reduction in flooding
(5) Aesthetic Values	No significant change in aesthetic values	No significant change in aesthetic values	No significant change in aesthetic values
(6) Natural Resources	No change to natural resources.	Existing natural resources would be slightly degraded due to enlarged footprint of levee Turkey Cheek and bank side resources would be improved	Existing natural resources would be slightly degraded due to enlarged footprint of levee. Turkey Cheek and bank side resources would be improved
(7) Biological Resources	No change to biological resources.	Slight degradation of existing biological resources due to enlarged footprint of levee Resources of creek would be improved.	Slight degradation of existing biological resources due to enlarged footprint of levee. Resources of creek would be improvad.
(8) Air Quality	No anticipated effect on air quality	Air emission would be *de minimus*	Air emission would be *de minimus*
(9) Water Quality	No anticipated effect on water quality	Clearing and snagging within Turkey Creek would improve overall water quality	Clearing and snagging within Turkey Creek would improve overall water quality

Problem Area: Forrest Heights Project Area, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced flooding; Potential future damages from flooding.

Item	No Action	Plan 1	Plan 2
(10) Public Services	Continued interruption of public services during storm events	Moderate increase protection for public services	Significant increase protection for public services.
(11) Cultural and Historical Preservation	Continued negative impacts during storm events	Moderate positive impact on the cultural and historical significance of the minority community	Significant positive impact on the cultural and historical significance of the minority community.
(12) Total Quality of the Environment	Continued negative impacts during storm events	Moderate improvement in overall environmental quality of the Forrest Heights community.	Significant improvement in overall quality the environmental of the Forrest Heights community.
3. Regional Economic Development (RED)			
(1) Impact on Sales Volume	No impact to the local economy.	Increase of **$15,484,500** in additional sales volume	Increase of **$32,77,687** in additional sales volume.
(2) Impact on Income	No impact to the local economy.	Increase of **$3,277,687** in additional local income.	Increase of **$6,440,117** in additional local income.
(3) Impact on Employment	No impact to the local economy	Increase of **98** new jobs.	Increase of **193** new jobs.
(4) Tax Changes	N/A	N/A	N/A
4. Other Social Effects (OSE)			
a. Beneficial Impacts			
(1) Security of Life, Health, and Safety	Continued risks to life, health and safety	Moderate decrease in risks to life, health and safety.	Significant decrease in risks to life, health and safety.

Problem Area: Forrest Heights Project Area, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced flooding; Potential future damages from flooding.

Item	No Action	Plan 1	Plan 2
(2) Community Cohesion	Community Cohesion will be significantly challenged due to the inability of residents to rebuild and/or comply with new building codes and flood regulations	Provides a measured reduction of risk and defense against most storms. Preserves the integrity of the historic and culturally rich minority community	Provides a higher reduction of risk and defense against extreme storms. Preserves the integrity of the historic and culturally rich minority community.
(3) Tax Values	Tax values could decrease with future damages and inability of the community to rebuild.	Tax values would remain the same	Tax values would remain the same
(4) Community Growth	Area is fully developed	area is fully developed	area is fully developed
(5) Property Values	Property values could decrease with future damages and inability of the community to rebuild	No increase	No increase
(6) Displacement of Businesses	N/A	N/A	N/A
(7) Public Facilities	Continued risks and incurred costs to public facilities	Moderately reduced risks and incurred costs to public facilities	Significantly reduced risks and incurred costs to public facilities
(8) Injurious Displacement of Farms	N/A	N/A	N/A
b. Preservation of loss of life	Continued risk of loss of life.	Reduced risk to loss of life in major events.	Reduced risk to loss of life in major events.

C. PLAN EVALUATION

Problem Area: Forrest Heights Project Area, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced flooding; Potential future damages from flooding.

Item	No Action	Plan 1	Plan 2
1. Contributions to Planning Objectives			
a. Flood, Hurricane and/or Storm Damage Reduction	NO	Yes	Yes
2. Response to Planning Constraints			
a. Avoid environmental impacts and minimize induced damages	YES	YES	YES
b. Institutional Acceptability	NO	YES	YES
3. Response to Evaluation Criteria			
a Acceptability	NO	YES	YES
b. Completeness	N/A	YES, but moderate level of risk remains	YES, but minor level of risk remains
c. Effectiveness	N/A	YES	YES
d. Efficiency (Cost-Effectiveness, i.e., most efficient use of Federal and Non-Federal Funds)	N/A	YES	YES
e. Integration	N/A	Seamless part of overall system.	Seamless part of overall system.
f. Reversibility	N/A	Alternative could be reversible, given means to remove structural features	Alternative could be reversible, given means to remove structural features
4. Stakeholder Preference Score (From MCDA weightings analysis)			
a. Summary Score	56.89%	52.89%	47.46%

Problem Area: Forrest Heights Project Area, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced flooding; Potential future damages from flooding.

Item	No Action	Plan 1	Plan 2
Cluster Group A	51.72%	50.70%	52.87%
Cluster Group B	48.68%	55.56%	55.92%
Cluster Group C	63.33%	48.88%	41.67%
Cluster Group D	63.83%	56.40%	39.36%
b. Stakeholder Preference	All groups ranked this plan highest.	Plan ranked very high, but less than No Action	Plan ranked the lowest of all plans.
D. Implementation Responsibility	No implementation responsibilities	Joint Federal/Non-Federal implementation responsibility	Joint Federal/Non-Federal implementation responsibility.
E. State and other Non-Federal Coordination	No State or other Non-Federal coordination activities	Minor State or other Non-Federal coordination activities	Minor State or other Non-Federal coordination activities
F. Risk Evaluation			
1. Risk and Vulnerabilities			
a. Risk of Failure	N/A	Very low risk of failure	Extremely low risk of failure.
b. Residual Risk	Residual risk of all actions will remain substantial due to flooding.	Residual risks associated with this plan would be fairly low	Residual risks associated with this plan would be very low
c. Reliability	N/A	This plan would provide a high degree of reliability, would be unlikely to receive damage from storm events, but would require significant maintenance commitment over long-term.	This plan would provide a very high degree of reliability, would be unlikely to receive damage from storm events, but would require significant maintenance commitment over long-term.

Problem Area: Forrest Heights Project Area, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced flooding; Potential future damages from flooding.

Item	No Action	Plan 1	Plan 2
d. Relative Sea Level Rise	Problems will be exacerbated by an increasing relative rise of sea level	This Plan would be somewhat impacted by an increasing relative rise of sea level over the period of analysis due to relatively lower crest relative to potential flood heights	This Plan would be only minimally impacted by an increasing relative rise of sea level over the period of analysis due to slightly lower crest relative to potential flood heights
e. Risk of Ecosystem Damage	N/A	Risk of ecosystem damage will be minimal throughout the period of analysis.	Risk of ecosystem damage will be minimal throughout the period of analysis.
f. Risk to Life and Safety	Significant threats to Life and Safety from flooding will continue.	Some threats to Life and Safety from flooding will continue, in the event that residents do not evacuate and levee is overtopped.	.Some threats to Life and Safety from flooding will continue, in the event that residents do not evacuate and levee is overtopped, but less risks than No-Action or Plan 1
g. Risk to Mental and Physical Health	Continued significant risks to mental and physical health would remain, from even modest flood events	Some risks to mental and physical health would remain, but only in event that levee is overtopped	Some risks to mental and physical health would remain, but only in event that levee is overtopped. Fewer risks than all other plans
2. Recommendations and Preferences			
a. Federal Recommendation			Plan 2 achieves greater functional improvement and greater reliability of outcomes when compared to all other plans.

Problem Area: Forrest Heights Project Area, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced flooding; Potential future damages from flooding.

Item	No Action	Plan 1	Plan 2
b. Stakeholder Preference	Initial stakeholder preference indicated for No-Action Plan, but preferences are inconsistent between sub-groups. Stakeholders from the community were not available at the initial meetings.		Subsequent meetings with State, local and community leaders expressed strong support for Plan 2.

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Table 3-20
System of Accounts table for Nonstructural Alternatives

Problem Area: High-Risk Zone (High Hazard Area Risk Reduction Plans and High-Risk Structural Application Area)				
Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events in the Highest-Risk Area of the Coastal Zone. Note: There are no reasonable coast-wide structural alternatives to the HARP, which were advanced beyond preliminary screening. Therefore the 30' HRZ Levee is presented for simple comparison purposes only.				
Item	**No Action**	**30' HRZ Levee**	**Long-Term HARP**	**High Risk HARP**
A. PLAN DESCRIPTION	No Federal Action	Comparative Beachfront Levee at Elevation 30 feet for High Risk Zone (HRZ)	Provides acquisition opportunities after next devastating storm event	Provides immediate acquisition opportunities for the most high risk areas
B. IMPACT ASSESSMENT				
1. National Economic Development				
a. Beneficial Impacts				
(1) Damages Prevented	$0	≤$209,000,000 *	$209,665,350	$22,000,000 to $33,000,000
(2) Emergency Costs Avoided	$0	$0	$0	$0
(3) Recreation	No change in recreation benefits	Adverse on existing benefits	Very significant opportunity for increase in benefits but not evaluated at this stage	Significant opportunity for increase in benefits but not evaluated at this stage
(4) Total Beneficial Impacts	None.	≤$209,000,000	$209,665,350	$22,000,000 to $33,000,000
b Adverse Impacts				
(1) Project Cost	$0	>$5,000,000,000 *	$7,999,019,430	$397,000,000**
(2) Interest During Construction	$0		$11,930,890,500	$23,744,000 to $50,274,000**
(3) Average Annual First Cost	N/A		$979,978,085	$8,752,000 to $18,532,000**
(4) Annual O&M	$0	>$60,000,000	$476,850	$10,000
(5) Total Avg. Annual Costs	$0	>$300,000,000	$980,454,935	$8,762,000 to $18, 542,000**

Problem Area: High-Risk Zone (High Hazard Area Risk Reduction Plans and High-Risk Structural Application Area)

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events in the Highest-Risk Area of the Coastal Zone.
Note: There are no reasonable coast-wide structural alternatives to the HARP, which were advanced beyond preliminary screening. Therefore the 30' HRZ Levee is presented for simple comparison purposes only.

Item	No Action	30' HRZ Levee	Long-Term HARP	High Risk HARP
2. Environmental Quality (EQ)				
(1) Ecosystem Restoration	No Change	No opportunity for restoration presented	Very significant opportunity for ecosystem restoration but not evaluated at this stage	Significant opportunity for ecosystem restoration but not evaluated at this stage
(2) Water Circulation	No Change	Plan may alter water circulation in impounded areas	No Change	No Change
(3) Noise Level Changes	No change in noise levels	Significant increase in noise levels during construction	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction
(4) Public Facilities	Continued risk of damage during future storm events	Potential adverse impacts to public facilities due to relocation required for embankment construction contrasted with reduction of level of risk landward of embankment.	Improvement to public facilities through relocation to lower risk zones & opportunity to increase public facilities related to recreation	Improvement to public facilities through relocation to lower risk zones & opportunity to increase public facilities related to recreation
(5) Aesthetic Values	No significant change in aesthetic values	Aesthetic of coastal environment dramatically affected due to presence of large, intrusive embankment, displacement of residences and businesses and negative alteration of visual environment; breaking-up of once cohesive neighborhoods with barrier to movement	Conversion to greenspace could significantly improve the aesthetic values of the coastal area.	Conversion to greenspace could significantly improve the aesthetic values of the coastal area.

Problem Area: High-Risk Zone (High Hazard Area Risk Reduction Plans and High-Risk Structural Application Area)

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events in the Highest-Risk Area of the Coastal Zone.
Note: There are no reasonable coast-wide structural alternatives to the HARP, which were advanced beyond preliminary screening. Therefore the 30' HRZ Levee is presented for simple comparison purposes only.

Item	No Action	30' HRZ Levee	Long-Term HARP	High Risk HARP
(6) Natural Resources	No change to natural resources.	Existing natural resources would be significantly degraded due to large footprint of levee and alteration of traditional flow paths, wildlife corridors, and loss of habitat. Mitigation would be required to minimize damages	Long-term natural resources would be improved due to removal of select high-risk development, and its potential replacement with coastal wetlands, public parks	Long-term natural resources would be improved due to removal of select high-risk development, and its potential replacement with coastal wetlands, public parks
(7) Biological Resources	No change to biological resources.	Existing biological resources would be impacted during construction due to destruction of habitat during removal activities and construction of embankments and access roads and ramps. Long-term biological resources would be impacted due to presence of large barrier to wildlife movement, fragmentation of habitats, and elimination of habitat on site of embankment.	In the long-term biological resources, including threatened and endangered species, would be significantly improved due to removal of development, and its potential replacement with coastal wetlands or green space.	In the long-term biological resources, including threatened and endangered species, would be significantly improved due to removal of development, and its potential replacement with coastal wetlands or green space.
(8) Air Quality	No anticipated effect on air quality	Air emission during construction would be *de minimus*. Barrier could impact land / sea breeze interaction long term.	Air emission would be *de minimus*	Air emission would be *de minimus*

Problem Area: High-Risk Zone (High Hazard Area Risk Reduction Plans and High-Risk Structural Application Area)

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events in the Highest-Risk Area of the Coastal Zone.
Note: There are no reasonable coast-wide structural alternatives to the HARP, which were advanced beyond preliminary screening. Therefore the 30' HRZ Levee is presented for simple comparison purposes only.

Item	No Action	30' HRZ Levee	Long-Term HARP	High Risk HARP
(9) Water Quality	No anticipated effect on water quality	Temporary negative impacts to water quality due to construction. Potential long-term negative effects on WQ due to alteration of traditional flow paths, elimination of natural streambeds and adjacent uplands containing natural filtering areas	Long-term positive improvement expected due to increased flood storage capacity and removal of septic systems	Long-term positive improvement expected due to increased flood storage capacity and removal of septic systems.
(10) Public Services	Public services would continue to be disrupted during future storms.	Significant adverse impact on public services during construction, long-term Increased protection for public services.	Reduced need for public services.	Reduced need for public services
(11) Cultural and Historical Preservation	Cultural and historical resources would continue to be at risk from damage from future storm events	Cultural or Historical sites would either be avoided or mitigated as required by NHPA.	Alternative would have no anticipated effect on cultural and historical preservation	Alternative would have no anticipated effect on cultural and historical preservation
(12) Total Quality of the Environment	Environmental resources would continue to be at risk	Significant negative impacts on the overall total quality of the environment	Significant opportunity for improvement of the coastal environment	Significant opportunity for improvement of the coastal environment
3. Regional Economic Development (RED)				
(1) Impact on Sales Volume	Periodic impacts to sales due to hurricane aftermath	$13,374,321,000 **	Increase of **$19,461,185,520** in additional sales volume.	Increase of **$3,238,601,800** in additional sales volume.
(2) Impact on Income	Periodic loss of income due to hurricanes and aftermath	$6,720,736,400 **	Increase of **$4,088,379,614** in additional local income.	Increase of **$706,330,000** in additional local income.

Problem Area: High-Risk Zone (High Hazard Area Risk Reduction Plans and High-Risk Structural Application Area)

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events in the Highest-Risk Area of the Coastal Zone.
Note: There are no reasonable coast-wide structural alternatives to the HARP, which were advanced beyond preliminary screening. Therefore the 30' HRZ Levee is presented for simple comparison purposes only.

Item	No Action	30' HRZ Levee	Long-Term HARP	High Risk HARP
(3) Impact on Employment	Continued destruction of local economy due to periodic elimination of job base due to hurricanes and aftermath	Increase of 93,332 new jobs **	Increase of **119,847** new jobs	Increase of **19,452** new jobs
(4) Tax Changes	Continued periodic loss of some to virtually all tax revenues due to destruction of residential and commercial tax base	Possible loss of casino revenues could significantly impact tax revenues. Could impact taxes by lessening of aesthetic value (being behind levee), thus lower desirability of high-value residential	Moderate decreases in taxes due to land use and ownership changes. Could exceed 10% of residential tax base Could be offset by eco-tourism and alternate business taxes	Some decreases in taxes due to land use and ownership changes, but anticipated to be considerably less than 10% of residential tax base. Could be offset by eco-tourism and alternate business taxes
4. Other Social Effects (OSE)				
a. Beneficial Impacts				
(1) Security of Life, Health, and Safety	Continued significant risks to life, health and safety	Moderate decrease in risks to life, health and safety. Implied "protection" of levee may cause people to remain behind during hurricanes, with potential negative outcomes	Significant decrease in risks to life, health and safety, due to elimination of higher risk residential housing from higher risk surge/floodplain.	Significant decrease in risks to life, health and safety, due to elimination of highest risk residential and commercial from highest risk surge/floodplain .

Problem Area: High-Risk Zone (High Hazard Area Risk Reduction Plans and High-Risk Structural Application Area)

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events in the Highest-Risk Area of the Coastal Zone.
Note: There are no reasonable coast-wide structural alternatives to the HARP, which were advanced beyond preliminary screening. Therefore the 30' HRZ Levee is presented for simple comparison purposes only.

Item	No Action	30' HRZ Levee	Long-Term HARP	High Risk HARP
(2) Community Cohesion	Community Cohesion will be periodically disrupted due to continued impacts from hurricane surge and waves on communities, and due to the inability of residents to rebuild and/or comply with new building codes and flood regulations.	Provides a measured reduction of risk and defense against most storms. Preserves a small portion of integrity of the historic and culturally rich community, but may create fragmentation of certain communities due to presence of large embankment	Provides a higher reduction of risk and defense against most storms, which may enhance community cohesion, but would create significantly changed community in near-term after construction.	Provides a measured reduction of risk and defense against extreme storms, which may enhance community cohesion, but would create changed community in near-term after construction.. Would provide fewer impacts than Long-Term HARP
(3) Tax Values	N/A	Likely to decrease commensurate with property values	Possible increase as property values increase with addition of adjacent greenspace	Possible increase as property values increase with addition of adjacent greenspace
(4) Community Growth	N/A	Growth would be restricted to areas landward of the levee	Growth would be restricted to lower risk zones along the coast	Growth would be restricted to lower risk zones along the coast
(5) Property Values	Property values could decrease with the inability of people to rebuild in the high risk zones and the lack of affordable insurance.	Could be a significant decrease in property values with loss of waterfront views contrasted with possible increase due to reduction of risk provided by the levee	Potential increase due to improved aesthetics and provision of greenspace	Potential increase due to improved aesthetics and provision of greenspace
(6) Displacement of Businesses	N/A	Significant displacement of businesses within the levee footprint. Possible loss of casino operations.	Some displacement of businesses within high risk zones. Could be relocated within community. Casino operations would not be impacted.	Some displacement of businesses within high risk zones. Could be relocated within community. Casino operations would not be impacted.

Problem Area: High-Risk Zone (High Hazard Area Risk Reduction Plans and High-Risk Structural Application Area)

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events in the Highest-Risk Area of the Coastal Zone.
Note: There are no reasonable coast-wide structural alternatives to the HARP, which were advanced beyond preliminary screening. Therefore the 30' HRZ Levee is presented for simple comparison purposes only.

Item	No Action	30' HRZ Levee	Long-Term HARP	High Risk HARP
(7) Public Facilities	Continued risks and incurred costs to public facilities	Displacement within footprint of embankment. Reduced risk to facilities within embankment.	Reduced risks and incurred costs to public facilities due to relocation from high risk zones	Reduced risks and incurred costs to public facilities due to relocation from high risk zones
(8) Injurious Displacement of Farms	N/A	N/A	N/A	N/A
b. Preservation of loss of life	Not anticipated to increase possibility of loss of life over that existing today.	Reduced risk to loss of life in major events, but may still incur major loss of life during above-design events in the event of over-topping, due to false sense of security	Elimination of risks to life within high risk surge/floodplain. Overall greatest reduction is risk of loss of life in major events of all plans.	Elimination of risks to life within highest risk surge/floodplain. Overall reduced risk to loss of life in major events.
C. PLAN EVALUATION				
1. Contributions to Planning Objectives				
a. Flood, Hurricane and/or Storm Damage Reduction	No damage reduction.	Moderate to major improvement in damage reduction.	Major improvement in damage reduction.	Significantly improved level of flood damage reduction, but less than other action plans.
2. Response to Planning Constraints				
a. Avoid environmental impacts and minimize induced damages	YES	NO	YES	YES
b. Institutional Acceptability	NO	NO	YES	YES
3. Response to Evaluation Criteria				
a. Acceptability	NO	NO	Possibly - will require additional public coordination	Possibly - will require additional public coordination
b. Completeness	N/A	NO, as areas outside embankment remain at high risk of future damage	YES, but minor level of risk remains	YES, but moderate level of risk remains
c. Effectiveness	N/A	Partial	YES	YES, but less than long-term plan

Problem Area: High-Risk Zone (High Hazard Area Risk Reduction Plans and High-Risk Structural Application Area)

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events in the Highest-Risk Area of the Coastal Zone.
Note: There are no reasonable coast-wide structural alternatives to the HARP, which were advanced beyond preliminary screening. Therefore the 30' HRZ Levee is presented for simple comparison purposes only.

Item	No Action	30' HRZ Levee	Long-Term HARP	High Risk HARP
d. Efficiency (Cost-Effectiveness, i.e., most efficient use of Federal and Non-Federal Funds)	N/A	NO	YES	YES
e. Integration	N/A	Does not necessarily integrate with local plans, or other measures, particularly non-structural plans	Does not necessarily integrate smoothly with local plans.	Does not necessarily integrate smoothly with local plans.
f. Reversibility	N/A	Reversibility would be extremely limited, due to large size and investment in plan	Plan is physically reversible, but once land is acquired it cannot be resold for development	Plan is physically reversible, but once land is acquired it cannot be resold for development
4. Stakeholder Preference Score (From MCDA weightings analysis)				
a. Summary Score	**41.27%**	*	**46.83%**	**45.26%**
Cluster Group A	47.79%	*	49.65%	50.22%
Cluster Group B	40.79%	*	53 95%	48.13%
Cluster Group C	46.57%	*	36.57%	47.32%
Cluster Group D	29.92%	*	47.15%	35.37%
b. Stakeholder Preference	All groups ranked this plan lowest	Plan not ranked by stakeholders due to initial opposition to large structural measure. Just included for comparison.	Plan ranked marginally higher than high risk area plan and higher than no action Note that Group C ranked LT Harp less than No Action.	Plan ranked marginally lower than large long term plan, except by Group C which ranked High Risk HARP highest. Each group ranked higher than no action.
D. Implementation Responsibility	N/A	Joint Federal/Non-Federal implementation responsibility.	Joint Federal/Non-Federal implementation responsibility.	Joint Federal/Non-Federal implementation responsibility.
E. State and other Non-Federal Coordination	N/A	Significant State or other Non-Federal coordination activities required	Significant State or other Non-Federal coordination activities required	Moderate State or other Non-Federal coordination activities

Problem Area: High-Risk Zone (High Hazard Area Risk Reduction Plans and High-Risk Structural Application Area)

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events in the Highest-Risk Area of the Coastal Zone.
Note: There are no reasonable coast-wide structural alternatives to the HARP, which were advanced beyond preliminary screening. Therefore the 30' HRZ Levee is presented for simple comparison purposes only.

Item	No Action	30' HRZ Levee	Long-Term HARP	High Risk HARP
F. Risk Evaluation				
1. Risk and Vulnerabilities				
a. Risk of Failure	N/A	Moderate risk of failure due to possibility of catastrophic overtopping and/or lack of long term maintenance.	Extremely low risk of failure of plan outcomes (none of structural failure) due to elimination of potential damageable properties from surge zone.	Very low risk of failure of plan outcomes (none of structural failure) due to elimination of potential damageable properties from surge zone.
b. Residual Risk	Residual risk would remain extremely high due to failure to address surge and waves in developed areas.	Significant level of residual risk with plan in place would remain due to possibility of overtopping during large hurricane events, and areas remaining outside levee.	Residual risk would be extremely low due to elimination of damageable property from surge zone.	Residual risk would be very low due to elimination of damageable property from surge zone.
c. Reliability	N/A	Plan would provide less reliable means of damage reduction than long term or high risk HARP plans due to need for periodic re-evaluation and could become unreliable in the event of failure to conduct maintenance and repairs on embankment over long-term	Plan would provide highly reliable means of reducing damage to structures and contents, through removal of most risky development and relocation to sites outside of high-risk zones, but only for that area targeted for relocation. Extremely minimal reliability issues over long-term.	Plan would provide highly reliable means of reducing damage to structures and contents, through removal of most risky development and relocation to sites outside of high-risk zones, but only for that area targeted for relocation. Extremely minimal reliability issues over long-term.

Problem Area: High-Risk Zone (High Hazard Area Risk Reduction Plans and High-Risk Structural Application Area)

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events in the Highest-Risk Area of the Coastal Zone.

Note: There are no reasonable coast-wide structural alternatives to the HARP, which were advanced beyond preliminary screening. Therefore the 30' HRZ Levee is presented for simple comparison purposes only.

Item	No Action	30' HRZ Levee	Long-Term HARP	High Risk HARP
d. Relative Sea Level Rise	No-Action would result in gradually increasing mean sea level effects and increasing damage to structures due to higher surge levels for a given frequency events.	Plan would result in gradually decreasing level of damage reduction due to rise in mean sea level, with subsequent effects on all properties within area encompassed by levees.	Plan would result in slightly diminishing level of damage reduction due to rise in mean sea level, with subsequent effects on development and natural resources, but at lesser level than structural plans due to minimal increases in periphery of floodplain	Plan would result in slightly diminishing level of damage reduction due to rise in mean sea level, with subsequent effects on development and natural resources, but at lesser level than structural plans due to minimal increases in periphery of floodplain
e. Risk of Ecosystem Damage	Risks of ecosystem damage within footprint of other plans would continue to increase due to failure to address problem set	Risk of ecosystem damage would remain higher than non-structural plans, due to destruction of resources within embankment footprint, and negative effects created by embankment on natural environment	Risks of ecosystem damage within footprint of other plans would be less than No-Action and structural plans due to ability to increase ecosystem value within footprint of plan	Risks of ecosystem damage within footprint of other plans would be less than No-Action and structural plans due to ability to increase ecosystem value within footprint of plan
f. Risk to Life and Safety	Continued extreme risks to life and safety due to failure to address development within surge zone, particularly over long-term.	Significant risk to Life and Safety will remain due to implied "protection" of residents behind barrier and subsequent potential failure to evacuate during hurricane event.	Minimal threat to life and safety from storm surge would exist due to evacuation of storm surge zone and removal of threatened properties.	Minimal to moderate threat to life and safety from storm surge would exist due to evacuation of high risk storm surge zone and removal of threatened properties. Threat would still exist in area outside high risk zone during large hurricane events if failure to evacuate.

Problem Area: High-Risk Zone (High Hazard Area Risk Reduction Plans and High-Risk Structural Application Area)

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events in the Highest-Risk Area of the Coastal Zone.
Note: There are no reasonable coast-wide structural alternatives to the HARP, which were advanced beyond preliminary screening. Therefore the 30' HRZ Levee is presented for simple comparison purposes only.

Item	No Action	30' HRZ Levee	Long-Term HARP	High Risk HARP
g. Risk to Mental and Physical Health	Significant threats to Mental and Physical Health from storm surge will continue to rise due to continued threats from hurricanes and storms.	Significant threats to Mental and Physical Health from storm surge will still exist, but this plan will provide less risk to Mental and Physical Health than no action plan.	Minimal threats to Mental and Physical Health from storm surge will still exist, but this plan will provide less risk to Mental and Physical Health than the No Action Plan or any levee plan.	Some threats to Mental and Physical Health from storm surge will still exist, and this plan will provide less risk to Mental and Physical Health than the No Action Plan and levee plans.
2. Recommendations and Preferences				
a. Federal Recommendation				High risk Harp Plan is best balanced achievement of publicly acceptable outcomes, is most complete, effective, efficient, and acceptable means of addressing problem set and reduction of damages to property, of those evaluated, but also only within footprint of plan. Plan is also least costly plan of those evaluated, that effectively deals with highest risk surge zone problems, and achieves highest net benefit of all plans evaluated including No-Action. Although plan does not achieve highest level of damage reduction,

Problem Area: High-Risk Zone (High Hazard Area Risk Reduction Plans and High-Risk Structural Application Area)

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events in the Highest-Risk Area of the Coastal Zone.
Note: There are no reasonable coast-wide structural alternatives to the HARP, which were advanced beyond preliminary screening. Therefore the 30' HRZ Levee is presented for simple comparison purposes only.

Item	No Action	30' HRZ Levee	Long-Term HARP	High Risk HARP
				this plan is also the only action plan addressing this area that is likely to prove publicly acceptable to entire community, and thus, would be implemented.
b. Stakeholder Preference			Large Long-Term HARP non-structural plan achieved marginally highest Stakeholder preference, compared to High Risk Area HARP Plan. Community remains highly divided on plan preferences, but actually appear least bothered by High Risk HARP when discussed with residents of area. Widely varied stakeholder views will require continued discussion and coordination	

NOTES: * Did not fully estimate damages prevented nor total costs of 30-foot levee due to engineering & environmental constraints. Plan shown for comparative purposes only **The High Risk Harp is presented with a range of benefits and costs which depend on the ultimate number of parcels acquired and range of benefits provided under P.L. 91-646.
*** Does not include any negative impacts due to interference with casino operations, model only looks at cash flow from construction.

Table 3-21
System of Accounts table for Nonstructural Alternatives

Problem Area: Deer Island, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

Item	No Action	Seaward Shoreline	Restore Containment Area	Breakwater Protection	Restore Eastern Marsh	Combination Restoration Plan
A. PLAN DESCRIPTION	No Federal Action	Restore 30 acres of dune, 78 acres of emergent tidal marsh, 78 acres of coastal maritime forests, and 86 acres of beach habitats along the southern shoreline.	Placement of dredged material into the existing containment site and planting 30 acres of emergent tidal marsh.	Extend both the southern and northeastern breakwaters to form a solid line of protection.	Restore 20 acres of emergent tidal marsh via beneficial use of dredged material adjacent to the existing containment site project.	Extend both existing breakwaters, restore 128 acres of emergent tidal marsh habitat, 78 acres coastal maritime forest, 86 acres of beach habitat, and 30 acres of dune habitat.
B. IMPACT ASSESSMENT						
1. National Economic Development						
a. Beneficial Impacts						
(1) Damages Prevented	N/A	N/A	N/A	N/A	N/A	N/A
(2) Emergency Costs Avoided	$0	$0	$0	$0	$0	$0
(3) Recreation	$0	Significant increase in recreation	Possible increase in ecotourism	Moderate increase in recreation	Possible increase in ecotourism	Most significant increase to recreation and ecotourism

Problem Area: Deer Island, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

Item	No Action	Seaward Shoreline	Restore Containment Area	Breakwater Protection	Restore Eastern Marsh	Combination Restoration Plan
(4) Total Beneficial Impacts	None	Significant increase in recreation	Possible increase in ecotourism	Moderate increase in recreation	Possible increase in ecotourism	Most significant increase to recreation and ecotourism
b Adverse Impacts						
(1) Project Cost	$0	$8,360,000	$4,004,000	$2,910,000	$4,707,000	$14,964,000
(2) Interest During Construction	N/A	N/A	N/A	N/A	N/A	N/A
(3) Average Annual First Cost	N/A	N/A	N/A	N/A	N/A	N/A
(4) Annual O&M	$0	$0	$0	$0	$0	$0
(5) Total Avg. Annual Costs	N/A	N/A	N/A	N/A	N/A	N/A
2. Environmental Quality (EQ)						
(1) Ecosystem Restoration	No Federal Action	Restore 30 acres of dune, 78 acres of emergent tidal marsh, 78 acres of coastal maritime forests, and 86 acres of beach habitats along the southern shoreline	Placement of dredged material into the existing Section 204 containment site and planting 30 acres of emergent tidal marsh.	Extend both the southern and northeastern breakwaters to form a solid line of protection.	Restore 20 acres of emergent tidal marsh via beneficial use of dredged material adjacent to the existing containment site project.	Extend both existing breakwaters, restore 128 acres of emergent tidal marsh habitat, 78 acres coastal maritime forest, 86 acres of beach habitat, and 30 acres of dune habitat.
(2) Water Circulation	No anticipated effect on water circulation.	No anticipated effect on water circulation.	No anticipated effect on water circulation.	No anticipated effect on water circulation.	No anticipated effect on water circulation.	No anticipated effect on water circulation.

Problem Area: Deer Island,
Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced surge and wave attack;
Potential future damages from storm and hurricane events.

Item	No Action	Seaward Shoreline	Restore Containment Area	Breakwater Protection	Restore Eastern Marsh	Combination Restoration Plan
(3) Noise Level Changes	No change in noise levels	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction	Temporary increase in noise levels during construction
(4) Public Facilities	N/A	N/A	N/A	N/A	N/A	N/A
(5) Aesthetic Values	No significant change in aesthetic values	Significant increase to aesthetic improvement	Moderate increase to aesthetic improvement	Significant increase to aesthetic improvement	Moderate increase to aesthetic improvement	Most significant increase to aesthetic improvement
(6) Natural Resources	No impact.	Alternative would result in restoration of coastal maritime forests, beach and dune, and emergent marsh habitat resources.	Alternative would result in restoration of emergent tidal marsh resources.	Alternative would result in protection of coastal maritime forests, beach and dune, and emergent marsh habitat resources	Alternative would result in restoration of emergent tidal marsh resources	Alternative would result in protection and restoration of coastal maritime forests, beach and dune, and emergent marsh habitat resources.
(7) Biological Resources	No impact.	Alternative would moderately improve the Biological resources.	Alternative would moderately improve the Biological resources.	Alternative would moderately improve the Biological resources	Alternative would moderately improve the Biological resources.	Alternative would most improve the Biological resources.
(8) Air Quality	Alternative would have no anticipated effect on air quality	Air emission would be *de minimus*	Air emission would be *de minimus*	Air emission would be *de minimus*	Air emission would be *de minimus*	Air emission would be *de minimus*

Problem Area: Deer Island, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

Item	No Action	Seaward Shoreline	Restore Containment Area	Breakwater Protection	Restore Eastern Marsh	Combination Restoration Plan
(9) Water Quality	No impact	Temporary negative impacts to water quality due to construction , significant long-term improvements.	Temporary negative impacts to water quality due to construction , significant long-term improvements	Temporary negative impacts to water quality due to construction , significant long-term improvements.	Temporary negative impacts to water quality due to construction , significant long-term improvements	Temporary negative impacts to water quality due to construction , significant long-term improvements.
(10) Public Services	No impact.	No impact.	No impact	No impact.	No impact	No impact.
(11) Cultural and Historical Preservation	Cultural resource sites would be lost.	Cultural resource sites would be protected	No impact.	Cultural resource sites would be protected.	No impact	Cultural resource sites would be most protected.
(12) Total Quality of the Environment	Total Quality would degrade	Environmental quality of the environment would be improved	Environmental quality would be improved.	Environmental quality would be improved	Environmental quality would be improved.	Environmental quality would be most improved.
3. Regional Economic Development (RED)						
(1) Impact on Sales Volume	No impact.	Increase of **$19,896,800** in additional sales volume.	Increase of **$9,529,521** in additional sales volume.	Increase of **$6,925,800** in additional sales volume	Increase of **$11,202,660** in additional sales volume.	Increase of **$35,614,320** in additional sales volume.
(2) Impact on Income	No impact.	Increase of **$4,122,761** in additional local income.	Increase of **$1,974,585** in additional local income.	Increase of **$1,435,076** in additional local income	Increase of **$2,321,272** in additional local income.	Increase of **$7,379,544** in additional local income.

Problem Area: Deer Island, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

Item	No Action	Seaward Shoreline	Restore Containment Area	Breakwater Protection	Restore Eastern Marsh	Combination Restoration Plan
(3) Impact on Employment	No impact	Increase of **123** new jobs.	Increase of **59** new jobs.	Increase of **43** new jobs.	Increase of **69** new jobs	Increase of **220** new jobs.
(4) Tax Changes	No impact.	Would result in some local tax revenue gain due to recreation and construction.	Would result in some local tax revenue gain due to recreation and construction	Would result in some local tax revenue gain due to recreation and construction.	Would result in some local tax revenue gain due to recreation and construction.	Would result in some local tax revenue gain due to recreation and construction.
4. Other Social Effects (OSE)						
a. Beneficial Impacts						
(1) Security of Life, Health, and Safety	Continued risks to life, health and safety	Not a significant reduction in potential loss	Not a significant reduction in potential loss	Not a significant reduction in potential loss	Not a significant reduction in potential loss	Not a significant reduction in potential loss
(2) Community Cohesion	Some negative impact on community cohesion due to loss of recreation and ecotourism opportunities.	Some positive impact on community cohesion due to increased recreation and ecotourism opportunities.	Some positive impact on community cohesion due to increased recreation and ecotourism opportunities.	Some positive impact on community cohesion due to increased recreation and ecotourism opportunities	Some positive impact on community cohesion due to increased recreation and ecotourism opportunities	Some positive impact on community cohesion due to increased recreation and ecotourism opportunities.

Problem Area: Deer Island, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

Item	No Action	Seaward Shoreline	Restore Containment Area	Breakwater Protection	Restore Eastern Marsh	Combination Restoration Plan
(3) Tax Values	No Impact.	Minor impact on tax values due to added recreational and ecotourism resource for the region.	Minor impact on tax values due to added recreational and ecotourism resource for the region.	Minor impact on tax values due to added recreational and ecotourism resource for the region.	Minor impact on tax values due to added recreational and ecotourism resource for the region.	Minor impact on tax values due to added recreational and ecotourism resource for the region.
(4) Community Growth	No Impact	Minor impact due to added recreational and ecotourism resource for the region.	Minor impact due to added recreational and ecotourism resource for the region.	Minor impact due to added recreational and ecotourism resource for the region.	Minor impact due to added recreational and ecotourism resource for the region.	Minor impact due to added recreational and ecotourism resource for the region.
(5) Property Values	No impact.	N/A	N/A	N/A	N/A	N/A
(6) Displacement of Businesses	N/A	N/A	N/A	N/A	N/A	N/A
(7) Public Facilities	N/A	Enhances opportunities for additional public facilities for recreation / ecotourism	Enhances opportunities for additional public facilities for recreation / ecotourism	Enhances opportunities for additional public facilities for recreation / ecotourism	Enhances opportunities for additional public facilities for recreation / ecotourism	Enhances opportunities for additional public facilities for recreation / ecotourism
(8) Injurious Displacement of Farms	N/A	N/A	N/A	N/A	N/A	N/A

Problem Area: Deer Island, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

Item	No Action	Seaward Shoreline	Restore Containment Area	Breakwater Protection	Restore Eastern Marsh	Combination Restoration Plan
b. Preservation of loss of life	No Impact.	Some reduction in potential loss of life	Some reduction in potential loss of life.	Some reduction in potential loss of life	Some reduction in potential loss of life.	Some reduction in potential loss of life.
C. PLAN EVALUATION						
1. Contributions to Planning Objectives						
a Flood, Hurricane and/or Storm Damage Reduction	No Improvement	Minor reduction in damages at project site due to reduction in wave energy.	Minor reduction in damages at project site due to reduction in wave energy.	Minor reduction in damages at project site due to reduction in wave energy.	Minor reduction in damages at project site due to reduction in wave energy	Minor reduction in damages at project site due to reduction in wave energy.
b Recovery of lost environmental resources	Continued loss of environmental resources	Significant opportunity to recover environmental resources negatively impacted in past	Moderate opportunity to recover environmental resources negatively impacted in past	Some opportunity to recover environmental resources negatively impacted in past	Moderate opportunity to recover environmental resources negatively impacted in past	Significant opportunity to recover environmental resources negatively impacted in past
2. Response to Planning Constraints						
a Avoid environmental impacts and minimize induced damages	Continued loss of pre-Katrina environmental resources	Positive effect on environmental resources.	Positive effect on environmental resources.	Positive effect on environmental resources.	Positive effect on environmental resources.	Positive effect on environmental resources.

Problem Area: Deer Island, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

Item	No Action	Seaward Shoreline	Restore Containment Area	Breakwater Protection	Restore Eastern Marsh	Combination Restoration Plan
b. Institutional Acceptability	Not supported by state or local government	Is supported by local and state governments	Is supported by local and state governments	Is supported by local and state governments	Is supported by local and state governments	Is supported by local and state governments
3. Response to Evaluation Criteria						
a. Acceptability	NO	YES	YES	YES	YES	YES
b. Completeness	NO	YES, but continued degradation of environmental resources.	YES, but continued degradation of environmental resources.	YES, but continued degradation of environmental resources.	YES, but continued degradation of environmental resources.	YES, most significant reduction in degradation of environmental resources
c Effectiveness	NO	YES, moderately effective	YES, moderately effective	YES, moderately effective	YES, moderately effective	YES, significantly effective
d Efficiency (Cost-Effectiveness; i.e., most efficient use of Federal and Non-Federal Funds)	NO	YES, but continued degradation of other environmental resources	YES, but continued degradation of other environmental resources.	YES, but continued degradation of other environmental resources.	YES, but continued degradation of other environmental resources.	YES, most cost effective plan
e. Integration	N/A	Part of overall system.	Part of overall system	Part of overall system.	Part of overall system.	Seamless part of overall system.
f. Reversibility	N/A	N/A	N/A	YES - but at significant cost and degradation to the environment	N/A	N/A

Problem Area: Deer Island, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

Item	No Action	Seaward Shoreline	Restore Containment Area	Breakwater Protection	Restore Eastern Marsh	Combination Restoration Plan
4. Stakeholder Preference Score (From MCDA weightings analysis)						
a. Summary Score	These alternatives were not available for the Stakeholder Preference Workshops.					
D. Implementation Responsibility	No implementation responsibilities	Joint Federal/Non-Federal implementation responsibility.	Joint Federal/Non-Federal implementation responsibility	Joint Federal/Non-Federal implementation responsibility.	Joint Federal/Non-Federal implementation responsibility.	Joint Federal/Non-Federal implementation responsibility.
E. State and other Non-Federal Coordination	No State or other Non-Federal coordination activities	Would require State or other Non-Federal coordination activities	Would require State or other Non-Federal coordination activities	Would require State or other Non-Federal coordination activities	Would require State or other Non-Federal coordination activities	Would require State or other Non-Federal coordination activities
F. Risk Evaluation						
1. Risk and Vulnerabilities						
a. Risk of Failure	N/A	Low	Moderate	Moderate	Moderate	Low

Problem Area: Deer Island, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

Item	No Action	Seaward Shoreline	Restore Containment Area	Breakwater Protection	Restore Eastern Marsh	Combination Restoration Plan
b. Residual Risk	Residual risks (economic) will remain high due to failure to address erosion of island. Island will overtop during large surge events, and will not provide significant reduction of wave energy.	Residual risks (economic) will remain high, but may be slightly reduced for area in shadow of island. Alternative will reduce wave energy for small to moderate surge events, but not large hurricane events. Although moderate, would provide for a greater reduction in residual risk than all others but Combination Plan, particularly due to wave impact	Residual risks (economic) will remain high. Alternative will not significantly reduce wave energy during large hurricane events.	Residual risks (economic) will remain high, but may be very slightly reduced for area in shadow of island. Alternative will reduce wave energy for small to moderate surge events, but not large hurricane events. May provide a very small reduction, and much smaller than either Seaward shoreline or combination plans	Residual risks (economic) will remain high. Alternative will not significantly reduce wave energy during large hurricane events.	Residual risks (economic) will remain high, but would be reduced for area in shadow of island. Alternative will reduce wave energy for small to moderate surge events, but not large Katrina-like events. Although moderate, would provide for a greater reduction in residual risk than all other plans, particularly due to wave impact

Problem Area: Deer Island, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

Item	No Action	Seaward Shoreline	Restore Containment Area	Breakwater Protection	Restore Eastern Marsh	Combination Restoration Plan
c. Reliability	N/A	This plan would provide a moderate level of reliability, would be resistant to damage from storm events, but would also require some periodic maintenance, particularly after damaging storm events.	This plan would provide a low level of reliability, would receive damage from storm events, and would require significant maintenance, particularly after damaging storm events..	This plan would provide a moderate level of reliability, would be resistant to damage from storm events, and would not require significant maintenance, particularly after damaging storm events..	This plan would provide a lesser level of reliability, would receive damage from storm events, and would require significant maintenance.	This plan would provide the highest level of reliability of any plan, would be most resistant to damage from storm events, and would require less maintenance, but still some, after damaging storm events..
d. Relative Sea Level Rise	Problems will be substantially exacerbated by an increasing relative rise of sea level	This Plan will be minimally impacted by an increasing relative rise of sea level over the period of analysis	This Plan will be minimally impacted by an increasing relative rise of sea level over the period of analysis	This Plan will be minimally impacted by an increasing relative rise of sea level over the period of analysis	This Plan will be minimally impacted by an increasing relative rise of sea level over the period of analysis	This Plan will be minimally impacted by an increasing relative rise of sea level over the period of analysis

Problem Area: Deer Island, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

Item	No Action	Seaward Shoreline	Restore Containment Area	Breakwater Protection	Restore Eastern Marsh	Combination Restoration Plan
e. Risk of Ecosystem Damage	Ecosystem damage will continue to accrue at a rate at least that of recent history with substantial negative outcomes.	Some risk of ecosystem damage throughout the period of analysis.	Risk of ecosystem damage will be moderate throughout the period of analysis.	Some risk of ecosystem damage throughout the period of analysis.	Risk of ecosystem damage will be moderate throughout the period of analysis.	Risk of ecosystem damage will be minimal throughout the period of analysis.
f. Risk to Life and Safety	Significant threats to Life and Safety from storm surge will continue to rise due to continued deterioration of the Island.	Significant threats to Life and Safety from storm surge will still exist, but this plan will provide a lesser risk to life and safety than the no action plan, for those living in shadow of island..	Significant threats to Life and Safety from storm surge will still exist, but this plan will provide a lesser risk to life and safety than the no action plan, for those living in shadow of island..	Significant threats to Life and Safety from storm surge will still exist, but this plan will provide a lesser risk to life and safety than the no action plan, for those living in shadow of island..	Significant threats to Life and Safety from storm surge will still exist, but this plan will provide a lesser risk to life and safety than the no action plan, for those living in shadow of island.	Significant threats to Life and Safety from storm surge will still exist, but this plan will provide greatest reduction in risk to those living in shadow of island of any plan.

Problem Area: Deer Island, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

Item	No Action	Seaward Shoreline	Restore Containment Area	Breakwater Protection	Restore Eastern Marsh	Combination Restoration Plan
g. Risk to Mental and Physical Health	Significant threats to Mental and Physical Health from storm surge will continue to rise due to continued deterioration of the Island.	Significant threats to Mental and Physical Health from storm surge will still exist, but this plan will provide a lesser risk to Mental and Physical Health than the no action plan, for those living in shadow of island..	Significant threats to Mental and Physical Health from storm surge will still exist, but this plan will provide a lesser risk to Mental and Physical Health than the no action plan, for those living in shadow of island..	Significant threats to Mental and Physical Health from storm surge will still exist, but this plan will provide a lesser risk to Mental and Physical Health than the no action plan, for those living in shadow of island..	Significant threats to Mental and Physical Health from storm surge will still exist, but this plan will provide a lesser risk to Mental and Physical Health than the no action plan, for those living in shadow of island..	Significant threats to Mental and Physical Health from storm surge will still exist, but this plan will provide the least risk to Mental and Physical Health of all plans, for those living in shadow of island..

Problem Area: Deer Island, Harrison County, Mississippi

Problems ID: Damages suffered by hurricane-induced surge and wave attack; Potential future damages from storm and hurricane events.

Item	No Action	Seaward Shoreline	Restore Containment Area	Breakwater Protection	Restore Eastern Marsh	Combination Restoration Plan
2. Recommendations and Preferences						
a. Federal Recommendation						This Plan produces the most NER benefits, the greatest achievement of OSE outcomes, does not violate any local, state, or Federal statues, laws, and regulations, and is the most cost effective and efficient plan.
b. Stakeholder Preference						Though not scored, this plan has the highest (non-scored; verbal) stakeholder preference, and creates a low risk environment.

1

3.19 Risk Assessment and Education in Plan Formulation

3.19.1 Intro to Risk

The Corps Twelve Action Points for Change (date) identify risk as an important component of the Corps planning process. The Twelve Points specifically charge CORPS to:

- Employ risk based concepts in planning, design, construction, and major maintenance;
- Effectively communicate risk; and
- Establish public involvement risk reduction strategies.

The fulfillment of these risk-related action points in the MsCIP planning process is discussed below.

3.19.2 Risk in Identification in Technical Analyses

In a technical analysis, risk is defined as the reliability of an estimated value. In this sense, risk is typically identified through probability and confidence intervals. Selection of the parameters used in the technical analyses, which would be appropriate for risk identification, was conducted by the study team, technical experts, and Corps Engineering Research and Development Center (ERDC) staff. Risk was initially identified for stage (the depth to which water could rise during a surge event), frequency, wave height, first floor elevation of structures, structure value, and content value.

Some technical parameters, which may be important to the outcome of the technical analysis, are not estimated in a way that allows for the calculation of probabilities and confidence intervals. The uncertainty that these parameters bring to the analysis is typically addressed by using alternative parameter values in sensitivity or scenario analyses. In this study, this type of uncertainty was addressed by the evaluation of multiple storm tracks (paths), magnitudes (strength), and alignments, to ensure that the appropriate range of potential conditions was incorporated into the assumptions that went into defining future without-, and with-project conditions.

3.19.3 Risk Identification in the Planning Process

In public meetings conducted for this study, attendees raised concerns about potential negative or unwanted impacts on the outcome of planning recommendations. Such negative impacts include damage to culture and historical properties, public service disruption, reduction in the long-term sustainability of measures, potential consequences to individuals and families, and other societal issues.

Public workshops were conducted to get input on the factors the public viewed as the most important. The workshops established *which factors* were important, and also provided input on which factors were of *highest* importance to the public. A full discussion on the identification of risk factors by the public is contained in the appendix on the Risk appendix.

3.19.4 The Risk-Informed Decision Framework (RIDF) Process

The information obtained from the public workshops was used to develop a set of evaluation metrics. These evaluation metrics, which are based on Corps developed technical information and public input, were used to evaluate and compare alternative planning measures.

Evaluation metrics were developed to compare the performance of each measure in an economic context (e.g., cost effectiveness), an environmental context (e.g., preservation of fish and wildlife habitat for ecological stability), and a social context (e.g., societal displacement). The metrics were used to calculate performance scores and rank the measures during the evaluation and comparison steps of the planning process. If a measure did not score well, it would either be screened out (dropped from further consideration) or taken back to the "drawing board" for refinement. The next section provides additional detail concerning development of the evaluation metrics.

3.19.5 Evaluation Metric Development

A preliminary set of evaluation metrics was developed by the study team and shared with several stakeholder groups. The preliminary set of evaluation metrics was scored (or weighted) and ranked by these stakeholder groups. This stakeholder group input was used to shape the final list of 15 evaluation metrics.

Evaluating measures by a large set of metrics can be complex and very time consuming. With this in mind, the study team sought to develop an efficient set of metrics that would represent the best available information and public input, but would not be so large as to hinder the evaluation process. Metric values depend upon either model estimates, empirical data from a study, or expert opinion. Each of these sources include varying degrees of uncertainty therefore, it was necessary to provide the stakeholder groups with the underlying assumptions that went into calculating each metric value. Estimates of the uncertainty for a metric were quantified where possible (e.g., in terms of the variance or range associated with the estimate).

The following criteria were used in developing metrics:

- Scientifically verifiable. Meaning that two independent assessments would yield similar results.
- Cost-effective. The technology required to generate data for the metrics is economically feasible and does not require an intensive deployment of labor.
- Communicable. Are easy to communicate to a wide audience. The public would understand the scale and context, and be able to interpret the metric with little additional explanation.
- Changeable by human intervention. The metric would describe a dependent relationship between the outcome of the measure and those things that are under a decision-maker's control. Metrics that are independent of human action do little to help evaluate a measure.
- Credible. It would be perceived by most stakeholders as accurately measuring what it is intended to measure.
- Scalable. It would be directional in nature, whether qualitative (best, good, worst) or quantitative (dollars, acres, percent damaged), as appropriate.
- Relevant. It would reflect the priorities of the public and other stakeholders and enhance their ability to execute their stewardship responsibilities. There is no point assembling a metric no one cares about.
- Sensitive. The metric must be able to capture the minimum meaningful level of change, make the smallest distinctions that are still significant, and any uncertainty about the metric is easy to communicate.
- Minimally redundant. What the metric measures is not essentially reflected by another metric.
- Transparent. The use and development of the metric is readily apparent.

It is important to acknowledge here that there will be "conflicts" among metrics, resulting in the need to make tradeoffs. For example, a tradeoff may exist between achieving the maximum benefit from a project and minimizing project cost. As a consequence of such "conflicts", a measure may not take clear precedence over other measures with respect to every evaluation metric. This may present a dilemma to decision-makers, who are trying to choose a single measure. It is important to place development of metrics prior to the development of measures because the "hard thinking" that goes into developing the metrics can create an improved set of measures. Development of evaluation metrics prior to developing alternative measures permits stakeholders to focus on thinking about the objectives rather than anchoring themselves to their "favorite" measures.

The final set of 15 evaluation metrics, presented below, reflect the combination of technical input from Corps and public input provided by stakeholder groups. The evaluation metrics are grouped according to placement in the four accounts.

3.19.5.1 Environmental Quality (EQ) Metrics

Metric 1) Tidal Habitat Restored - This metric measures (in acres) positive changes to the tidally-influenced wetlands that results from the implementation of a measure or plan. These are positive benefits from implementing a restoration plan or a combination of plans. Ecosystem components included in this metric are tidal wetlands (i.e., tidal fringes), associated threatened and endangered (T&E) and other species, associated essential fish and other tidal habitats (i.e. oysters, submerged aquatic vegetation), and related losses that require mitigation due from implementation of structural plans. There are 5 tidal wetland functions measured: wave energy attenuation (wave energy absorbed by wetland through landscape position, marsh width, and vegetation cover), biogeochemical cycling (receive, transform, and export nutrients through a wetland), nekton (swimming organisms) utilization potential (whether wetland contains suitable habitat for nekton), provide habitat for tidal marsh dependent vertebrate wildlife, and maintain a characteristic tidal marsh plant community. Units for this metric are the percentage increase of quality fish and wildlife habitat in functional habitat units (FHI).

Metric 2) Tidal Habitat Lost - This metric measures adverse impacts to the tidally-influenced wetlands that results from the implementation of a measure or plan. Ecosystem components included in this metric are tidal wetlands (i.e., tidal fringes), associated threatened and endangered (T&E) and other species, associated essential fish and other tidal habitats (i.e. oysters, submerged aquatic vegetation), and related losses that require mitigation due from implementation of structural plans. There are 5 tidal wetland functions measured: wave energy attenuation (wave energy absorbed by wetland through landscape position, marsh width, and vegetation cover), biogeochemical cycling (receive, transform, and export nutrients through a wetland), nekton (swimming organisms) utilization potential (whether wetland contains suitable habitat for nekton), provide habitat for tidal marsh dependent vertebrate wildlife, and maintain a characteristic tidal marsh plant community. Units for this metric are also in acres.

Metric 3) Non-tidal Habitat Restored - This metric measures (as functional units) positive changes to the non-tidal ecosystem that would result from the implementation of a measure or plan. These are positive benefits from implementing a restoration plan or a combination of plans. Ecosystem components included in this metric are maritime forests, beach nourishment, dune restoration and vegetation, and associated threatened, endangered and other species in non-tidal habitats. There are numerous functions provided by upland habitat: wildlife and birds (includes threatened and endangered species) roosting, nesting, and foraging utilization potential, wildlife corridors, sustainability of the Mississippi Flyway, restoration of the natural ecology and aesthetics of the area, and maintenance of plant community composition. Units for this metric are the percentage increase of quality fish and wildlife habitat in acres.

Metric 4) Non-tidal Habitat Lost - This metric measures (as functional units) adverse impacts to the non-tidal ecosystem that results from the implementation of a measure or plan. This has a negative impact of implementation of an array of alternatives as part of the comprehensive plan. Ecosystem components included in this metric are maritime forests, beach and dunes, threatened, endangered and other species and their non-tidal habitats, and related losses that require mitigation due to implementation of structural plans. There are numerous functions provided that will be evaluated and include: breaks in natural wildlife corridors, fragmentation of habitat, loss of critical habitat for threatened and endangered species, loss of foraging and roosting areas, loss of vegetation resulting in increased erosion, reduction in water quality and air quality. Units for this metric are the percentage decrease of quality fish and wildlife habitat in acres.

3.19.5.2 National Economic Development (NED) Metrics

Metric 5) Monetary Damages Reduced/Avoided (Equivalent Annual Damages) - The amount of storm damages reduced/avoided by a plan expressed as annualized dollars. Annualized dollars are calculated by comparing a future without a project in place versus a future with a project in place. Damages are calculated by using the Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA) model. This metric has become standard practice in the evaluation of the value of measures with respect to estimating damages to assets (i.e., residential, commercial, and industrial infrastructure and their contents) over the period of analysis. For more detail about the HEC-FDA model see Economics Appendix.

Metric 6) Residual Damage – Residual damage is defined as the storm damage that is not prevented with the implemented plan in place (expressed as annualized dollars). This metric describes what a plan does not account for (or what happens if a plan is exceeded).

Metric 7) Cost to Implement Plan – The amount of money in dollars needed to implement the plan. This metric measures the cost in today's dollars to local and Federal governments to implement the recommended plan.

3.19.5.3 Other Social Effects (OSE) Metrics

These metrics focus on the preservation of people's quality of life. OSE metrics were developed to address impacts to cultural heritage and preservation of historical structures, disruptions to public service and infrastructure and impacts to personal effects.

Metric 8) Cultural and historical heritage impacts – This metric addresses impacts to social groups, church congregations, and groups with common heritages. This metric also includes impacts to aesthetics and the destruction of the human-created landscape such as historical structures. The units for this metric will be a unit less quantitative scale (0-10). A score of 10 is best, 1 is bad.

Metric 9) Public service and infrastructure disruptions – This metric includes disruptions to schools, fire and police service, access to hospitals, libraries and community centers, and use of roads, bridges, and utilities. The units for this metric will be a unit less quantitative scale (0-10). A score of 10 is best, 1 is bad.

Metric 10) Personal impacts – This metric includes loss of family possessions, photographs, and impacts to people's emotional and mental health. The units for this metric will be a unit less quantitative scale (0-10). A score of 10 is best, 1 is bad.

3.19.5.4 Regional Economic Development (RED) Metrics

The RED metrics measure both positive and negative impacts to the regional economy. Positive impacts are captured by impacts to sales volume, personal income and employment and negative impacts by local cost burdens. Sales volume, income and employment will be sub-metrics under RED, and will be equally weighted. This metric is termed Positive regional economic benefits and will combine these 3 sub-metrics. The local cost burdens metric is also a sub-metric under RED and will receive a weight equal to combined weighting of the positive metrics under regional economic benefits.

Metric 11) Local Cost Burdens – This metric represents the costs and burdens to the local governments due to implementing a measure. This includes cost-sharing requirements with the Federal government to implement the plan and local costs for ongoing operations and maintenance (O&M) related to the implemented plan. The local cost burdens may also include those associated with additional workforce needed to maintain features of an implemented plan. This metric will be based on a unit-less quantitative scale (0-10). A score of 10 is best, 1 is bad.

Metric 12) Positive regional economic benefits – Economic benefits to the region with regards to sales volume, income and employment. This metric was evaluated using the economic impact forecasting system (EIFS) model. This model is an economic analysis tool that given the inputs for a particular plan will assess potential impacts of sales volume change and personal income in dollars and regional employment change in number of jobs to the local economy. Uncertainty will be based on several factors such as population, implementation cost, and social behavior of people in the region. This metric will be based on a unit-less quantitative scale (0-10). A score of 10 is best, 1 is bad.

3.19.5.5 Risk Metrics

The following risk metrics serve as additional information to decision makers. They are a way to address extreme cases of uncertainty.

Metric 13) Long-term Sustainability of Plan – The qualitative likelihood that features associated with the recommended plan will not perform as intended (over time) due to factors such as cost, human behavior, technical level of maintenance required, political concerns, resource availability, local funding per year, and operational reliability. The units for this metric will be a unit-less quantitative scale (0-10). A score of 10 is best, 1 is bad.

Metric 14) Residual Risk – This metric considers potential damages which would occur even with the implemented plan in place. It accounts for the following factors: erosion, wildlife species, wildlife habitat, salt water intrusion, surge damages, drainage, wind, maximum probable intensity (MPI) plan (accounts for more intense storm), cultural heritage, and infrastructure. The units for this metric will be a unit-less quantitative scale (0-10). A score of 10 is best, 1 is bad.

Metric 15) Consequences of Plan Failing – This metric considers the consequences of a plan not functioning as intended. In other words, it describes consequences to humans and the environment due to a catastrophic failure of an implemented plan under design conditions or other sets of circumstances from a storm event. The greatest consequences would result from failure to structural measures, such as levees, flood gates, etc. Consequences and likelihood of failure vary depending on the line of defense. For example, risk of Line 2 failure is more likely, but consequences are relatively low; risk of Line 4 failure is highly unlikely, but consequences are very high. It includes the following factors: injuries to population, loss of infrastructure, loss of habitat, and loss of wildlife species. The units for this metric will be a unit less quantitative scale (0-10). A score of 10 is best, 1 is bad.

Once the 15 metrics were described, the study team developed the values associated with each measure. The team calculated the acres associated with each measure for the metrics within the Environmental Quality Account as discussed above. The NED metrics were developed through the use of the Corps' HEC-FDA program (further described in the Economics Appendix) and are expressed in dollars.

As mentioned above, the RED, OSE, and Risk metrics are based on a scale from 1-10. Guidelines for these metrics were given to the team to help provide consistency amongst the different measures and are defined in the following tables.

3.19.6 "Weighting" of Evaluation Metrics by Stakeholders of Coastal Mississippi

Three sequential "risk weighting" workshops were held in July, September, and December of 2007 with various stakeholder groups. The first workshop was used primarily to make sure that the stakeholders understood the RIDF process and that the metric definitions were sound and easily understood. At this workshop, the stakeholders were subjected to two different weighting (or scoring) techniques and their feedback helped to refine the process. This process was repeated at the September workshop, where the stakeholders used example metric data to aid their understanding of the measures. Again, feedback from this workshop allowed the team to finalize the weighting process and in the December, the stakeholders were able to see the actual data for the metrics associated with the final list of alternatives. The MsCIP weight elicitation workshops yielded 45 complete sets of weights on fifteen metrics. These initial weights were used to establish the importance of each factor as determined by the stakeholders, and are shown in Table 3-22. Weights are based on 100 points distributed among the 15 categories.

Table 3-22
Point Allocation to Metrics

Cluster	Session	Tidal Habitat Restored	Tidal Habitat Lost	Non-Tidal Restored	Non-Tidal Lost	Damage Reduced	Residual Damage	Implementation Cost	Local Cost Burdens	Regional Benefits	Cultural Heritage	Disruptions	Personal Impacts	Sustainability	Consequences	Residual Risk
A	Business	1	1	1	1	35	3	5	5	5	4	2	2	15	16	4
A	Business	5	3	5	3	5	4	9	10	10	6	8	8	15	3	6
A	Federal	2	1	2	1	20	4	10	4	10	1	10	4	17	10	4
A	Local	2	2	2	2	7	7	12	24	10	5	10	5	5	2	5
A	Local	1	1	1	1	3	3	25	25	10	10	5	1	7	3	4
A	Local	1	2	1	2	13	8	1	12	13	1	8	5	12	12	9
A	Local	3	4	1	2	15	5	5	3	4	3	12	8	18	13	4
A	Local	1	1	1	1	20	8	12	9	10	6	7	2	15	5	2
A	Local	1	1	1	1	10	10	10	16	3	7	7	7	15	10	1
B	Business	8	6	6	2	15	6	10	8	8	8	5	7	4	3	4
B	Business	10	8	1	1	7	10	10	12	5	3	8	5	9	6	5
B	Corps	12	12	10	10	12	7	2	2	2	5	5	2	7	7	5
B	Corps	10	12	10	14	10	9	8	5	7	3	2	4	2	3	1
B	Corps	5	5	5	5	10	5	10	10	5	5	5	5	7	15	3
B	Federal	6	6	5	5	20	6	6	4	7	4	5	3	9	8	6
B	Federal	5	5	5	5	10	10	10	5	5	5	5	5	10	10	5
B	Federal	10	10	5	5	10	1	10	7	5	1	5	1	5	5	20
B	Local	1	10	1	10	10	12	18	1	8	4	8	3	1	12	1
B	Local	15	9	5	2	8	5	6	8	3	8	5	5	8	5	8
B	NGO	5	10	5	10	17	1	10	5	2	3	3	3	18	7	1
B	State	5	5	5	5	10	10	10	10	10	5	10	5	10	0	0
B	State	7	12	7	12	6	3	11	6	3	3	2	2	16	5	5
B	State	5	4	5	3	9	5	5	7	6	5	10	10	8	6	12
B	State	3	15	2	2	8	10	8	8	7	1	5	12	5	6	8
C	Business	8	30	1	1	5	1	10	10	9	5	5	3	10	1	1
C	Corps	11	12	11	12	5	7	6	6	4	2	3	2	9	8	2
C	Federal	12	12	12	12	5	5	3	3	2	5	5	5	10	5	4
C	Federal	10	10	12	15	4	4	1	1	1	15	1	1	5	15	5
C	NGO	16	16	11	11	4	3	3	1	1	2	1	1	18	8	4
C	NGO	10	20	5	20	6	3	5	3	5	2	5	2	5	8	1
C	State	12	15	11	13	9	1	10	9	2	2	1	2	10	2	1
C	State	8	15	8	16	5	5	5	10	2	5	4	4	8	3	2
C	State	15	20	10	10	5	0	10	0	3	2	3	2	10	10	0
C	State	15	15	5	5	5	5	5	5	5	5	10	10	4	4	2
D	Federal	15	20	15	15	10	5	1	2	3	4	2	4	1	1	2
D	Federal	30	25	12	8	1	1	1	1	1	1	1	1	7	5	5
D	Federal	50	1	20	2	6	5	2	2	1	2	2	2	2	1	2
D	NGO	14	20	14	20	1	1	1	3	7	2	1	1	5	8	2
D	NGO	14	25	15	24	2	1	3	2	1	2	2	3	2	3	1
D	State	5	15	2	40	1	10	5	1	1	2	1	1	10	1	5

An exploratory data reduction technique called a cluster analysis was used to group stakeholders with similar preference patterns expressed through their allocation of weights to metrics. These results, as shown in Figure 3-15, enabled the MsCIP team to compare the different stakeholder preferences that exist for potential solutions. This stakeholder preference information was used in the systems of accounts analysis and is included in the Systems of Accounts tables as the "stakeholder risk score". A more detailed description of how the weights of these metrics were developed can be found in the RIDF Appendix.

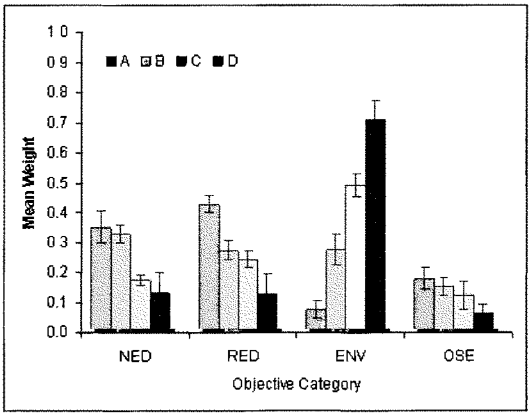

Figure 3-15
Stakeholder Weights for Clusters by Planning Objective

The stakeholder preferences were included as part of the System of Accounts' "trade-off" analysis. While these preferences to not determine the actual recommended plan, they are taken into consideration, and would make a difference especially where plans' other benefits are nearly equal. Table 3-23 illustrates that the preference pattern groups agree on several plans, but care must be taken not to discount those with differing opinions. The MsCIP team continued communicating with the stakeholder groups to make sure their concerns and ideas were considered during the comparison step and are reflected in the System of Accounts tables.

Table 3-23
System of Accounts - Summary of Stakeholder Preferences

	Preference Pattern			
Location	**A**	**B**	**C**	**D**
Barrier Islands	Barrier Island Plan H	Barrier Island Plan H	Barrier Island Option A	Barrier Island Option A
LOD2	LOD2 Option K	LOD2 Option K	LOD2 Option K	LOD2 Option K
Turkey Creek	Turkey Creek No Action	Turkey Creek No Action	Turkey Creek No Action	Turkey Creek Ecosystem Plan 1
Bayou Cumbest	Bayou Cumbest Acquisition	Bayou Cumbest Acquisition	Bayou Cumbest Acquisition	Bayou Cumbest Ecosystem Plan 1
Admiral Island	Admiral Island No Action	Admiral Island No Action	Admiral Island No Action	Admiral Island Ecosystem Plan 1
Dantzler	Dantzler No Action	Dantzler No Action	Dantzler No Action	Dantzler Ecosystem Plan 1
Franklin Creek	Franklin Creek No Action	Franklin Creek No Action	Franklin Creek No Action	Franklin Creek Ecosystem Plan 1
Forrest (Forest) Heights	Forrest (Forest) Heights Plan 2	Forrest (Forest) Heights Plan 2	Forrest (Forest) Heights No Action	Forrest (Forest) Heights No Action
Non-Structural	Phase I High Hazard Risk Reduction Plan	Long-term High Hazard Risk Reduction Plan	Phase I High Hazard Risk Reduction Plan	Long-term High Hazard Risk Reduction Plan

3.20 Selection of Recommended Alternatives

The final phase of the plan formulation and selection process involved the use of the more refined information on each of the final array of alternatives, in side-by-side comparison of no-action and final alternative plans, in a presentation of plan benefits, impacts, potential outcomes, stakeholder input, and potential inherent and residual risks, by display in the "System of Accounts" tables. The objective of the final phase was to generate a complimentary and comprehensive package of recommended plan features, which would act as the system-wide Comprehensive Plan for improvement for coastal Mississippi.

The initial part of this final phase had two parallel efforts. The first of these was the effort to solicit public and stakeholder input, through the presentation of measures and preliminary alternatives, to all stakeholder groups, at a series of public workshops. This was the second part of the "Risk-Informed Decision Framework" (RIDF) process. The workshops were designed to elicit "stakeholder preferences" on potential solutions to each identified problem area. Stakeholders were asked to "score" measures and preliminary alternatives, in comparison to one another. Scores were then placed into the Multi-Criteria Decision

Analysis (MCDA) model, and sub-group and summary scores were derived. This process is discussed in greater detail in Attachment 1 to the Risk Appendix. The results of this process were presented in the System of Accounts tables, as both "Stakeholder Preference" scores, and a summary of stakeholder preferences (the final row in each problem area's account summary). This information both informed the larger plan selection process, provided support for selection of some plan features, and may also be used by decision-makers outside the Corps to inform further development of Locally-Preferred Plan alternatives, should those be desired at a later phase of study.

The second parallel effort involved the comparison of the entire array of detailed plan information presented in the System of Accounts tables, and the consideration of all apparent risks, uncertainties, potential consequences and outcomes, of each final array directed at a specific problem area, to determine the plan that provided the best balance of positive outcomes. The screening and selection process involved the multi-agency study team, expert elicitation, and vertical team input; comparison and identification of the most cost-effective plans that achieved plan objectives; and full consideration of all of the criteria presented in the System of Accounts tables. The plan that provided the best balance of all these factors was selected for Federal recommendation as a recommended plan feature. This process ultimately led to determination of the "Federally-recommended" package of "recommended plan features", each of which is an integral element of the comprehensive package of recommended plans, directed at achieving a lower-risk, higher sustainability environment for coastal Mississippi.

The Accounts displayed and used in this final part of the process, included the standard four accounts identified in Federal plan formulation guidance: "National Economic Development" (NED), "Regional Economic Development" (RED), "Environmental Quality" (EQ), "Other Social Effects" (OSE). In addition a "Risk" (RISK) account, directed at public safety issues, was added to fully identify the inherent risks associated with No-Action or the implementation of any one of the alternatives. The System of Accounts tables also display the "Stakeholder Preference "scores resulting from the public and agency RIDF process, as well as a final discussion of the selection result, based on those factors of greatest importance in that selection, for both "Stakeholder", and "Federally-recommended" actions. In the case of the "Stakeholder Preference "scores, the number presented rates each alternative, in concept, as a percentage of a theoretical "perfect plan" (in the eyes of the stakeholder group). The higher the score reflects the stakeholder belief that the alternative provides the best fit to their value judgments of the metrics. In other words, the higher the score, the more acceptable the alternative should be to that stakeholder group.

In no case was the recommended plan feature determined solely by stakeholder preference scores. These scores were used to inform that process, but consideration of risks to life and public safety, uncertainties, and cost-effectiveness, were in some cases, over-riding considerations in the selection of a particular plan element. It should be noted that even though the initial stakeholder preference scores pointed towards the No-Action Plan for several of the ecosystem restoration plans, additional consultation with local and state authorities also showed strong support for the recommended plans. The goal of the entire process was to generate a full range of tiered, implementable plans for further action aimed at achievement of the study objectives, and identification of those measures for immediate or longer-term action as a result of the decision document being acted upon by Congress.

Ultimately, because the stakeholders may possess very different life experiences and also may not have possessed full information on the nature and magnitude of potential risks associated with any plan of action, the process required that the study team have ultimate responsibility for a Federally-recommended "recommended plan feature" selection, based on full consideration of risk factors and potential consequences of plan implementation. This was determined to be especially important in the consideration of alternatives that had potentially hazardous outcomes under various future scenarios.

3.20.1 Phase I Alternatives Recommended for Construction Authorization

The following components of the Comprehensive Plan, which are described in this report, are ready for advanced design and implementation. These projects are presented in support of a recommendation for construction:

- Turkey Creek Ecosystem Restoration– An essential component necessary when selecting the recommended plan at Turkey Creek was the need for burning. Burning allows the wet pine savannah environment to continue naturally as a functioning system. Although mowing does effectively keep understory plants from over colonizing the area, it does not simulate the natural conditions (i.e. seed germination, heating the pine bark, etc.) Therefore, the environmental PDT ranked the burning measure higher than that of the mowing. Plan 5 was not determined cost effective due to its small size of only 190 acres. When evaluating between Plan 1 and 3, the AAFU units were very different. The acreages were also very different due to Plan 1 including both the north and south parcels while Plan 3 included only the south parcel. The team noted that the man-made barrier within the project site produced hydrology constraints. Dominant flora species in wet pine savannah habitats are dependent upon burning; thus, the MsCIP environmental team selected the following plan knowing that most of these plant species would colonize the area upon establishment of routine burning and hydrology. The Environmental PDT then noted that the desired environmental restoration outputs (i.e. a functioning wet pine savannah) could be achieved by selecting Plan 3 which would also provide a cost-effective plan. Plan 3 (Restoration of 689 Acres South of the Railroad and Maintained by Burning) was selected as the federal recommendation, because it achieves best balance of plan outcomes, at lower costs than Plan 1, and it achieves the objectives for problem solving at this site with much higher benefits than either Plan 5 or the No-Action Plan. Even though the stakeholder preference scores pointed towards the No-Action Plan, follow up communication with stakeholders determined there is strong local and state support for Plan 3.
- Bayou Cumbest Ecosystem Restoration – The environmental MsCIP team selected the 1.0 meter spacing based on field experience by the Corps, universities, NGOs, State, and other Federal agencies with restoration of emergent marsh habitats. Past experience in Coastal Mississippi has proven that spacing, elevation, and hydrology are the three key essential components to obtain a successful emergent marsh site. The three spacing scenarios (i.e. 0.5, 1.0, 2.0 meters) have been used at a local Coastal Mississippi project (i.e. Deer Island, Harrison County). Upon assessing the propagation of those different spacings, the environmental PDT determined that although the 0.5 meter spacing is the desired planting technique, the overall goal of the restoration project can be achieved by spacing the tidal emergent plants out to 1.0 meters per plant. The 2.0 meter spacing was determined to leave the site too vulnerable to storms and/or hurricanes; thus, this spacing technique proofed to be rather risky. Marsh restoration along Coastal Mississippi will provide nursery habitat for various vertebrates and invertebrates while also providing a natural storm protection buffer from future storms. Plan 2 (Restoration of 110 acres by excavating filled in areas, removing exotic species, planting native species at a 1.0 meter density, filling in ditches, and acquisition of properties) was selected as the federal recommendation because it achieves the best balance of outcomes at a similar cost to Plans 1, 3, and 6, but with substantially greater functional improvement and greater reliability when compared to all other plans. Even though the stakeholder preference scores pointed towards the No-Action Plan, follow up communication with stakeholders determined there is strong local and state support for Plan 2.
- Dantzler Ecosystem Restoration – Reasoning for selecting Plan 1 for Dantzler was based upon similar Turkey Creek reasoning described above. In order to restore this area to a wet pine savannah habitat, the higher areas will be designated as wet pine savannah. These areas have depression areas within them which will enable water to flow downward to the depression areas; thus, holding water. The wet pine savannah habitat will be restored with wet pine flatwoods, such as *P. elliotti, M. cerifera, L. glabra, S. patens and P. virgatum.* Plan 1 (Restoration of 385 acres and maintained by burning) Plan 1 was selected as the federal

recommendation because it achieves greater functional improvement and greater reliability of outcomes when compared to all other plans. Even though the stakeholder preference scores pointed towards the No-Action Plan, follow up communication with stakeholders determined there is strong local and state support for Plan 1.

- Admiral Island Ecosystem Restoration – Plan 2 (Restoration of 123 acres by excavating filled in areas, removing exotic species, planting native species at a 1.0 meter density, filling in ditches, and acquisition of properties) Plan 2 was selected as the federal recommendation for the same reasons as described above in Bayou Cumbest, and at similar cost to Plans 1,3, and 6, but with substantially greater functional improvement and greater reliability outcomes when compared to all other plans. Even though the stakeholder preference scores pointed towards the No-Action Plan, follow up communication with stakeholders determined there is strong local and state support for Plan 2.
- Franklin Creek Ecosystem Restoration – Reasoning for selecting Franklin Creek Plan 1 was based upon similar burning benefits as described in Turkey Creek and furthermore, the MsCIP Interim Project already incorporated the 194 acre site; therefore, Plan 1's large contiguous area provided additional benefits while those costs associated with property purchasing were included in the MsCIP Interim Project. Plan 1 (Restoration of 149 Acres North and South of the Railroad and maintained by burning) was selected as the federal recommendation because it achieves greater functional improvement and greater reliability of outcomes when compared to all other plans. Even though the stakeholder preference scores pointed towards the No-Action Plan, follow up communication with stakeholders determined there is strong local and state support for Plan 1.
- Submerged Aquatic Vegetation Restoration – For the SAV effort, limited knowledge of the functional restoration prohibited the team in developing cost effective alternatives; thus, a pilot project was identified at Bayou Cumbest to obtain the much needed described data. The federal recommendation is to construct a pilot project which would restore the SAV beds lost in Bayou Cumbest. The information gained from this pilot study could then be used to develop a plan to implement larger scale SAV restoration.
- Coast-wide Beach and Dune Restoration – Plan K (Construction of a 2' high x 60' wide dune through the existing berm expansion, and placing sand fencing and plantings) was selected as the federal recommendation because it provides the best balance of ecosystem and damage reduction benefits at a considerably lower cost than Plans I & J, and at similar risk. It also provides considerable benefits compared to No-Action Plan. The stakeholder preference scores for Plan K were also higher than any of the other plans.
- Deer Island Restoration – The existing Deer Island FHI evaluation from the Section 204 and WRDA Section 528 were used to develop the cost effective alternatives. Combination Plan (Restoration of Extend both existing breakwaters, restore 128 acres of emergent tidal marsh habitat, 78 acres coastal maritime forest, 86 acres of beach habitat, and 30 acres of dune habitat.) was selected as the federal recommendation because it produces the most NER benefits, the greatest achievement of OSE outcomes, does not violate any local, state, or Federal statues, laws, and regulations, and is the most cost effective and efficient of all other plans. Though not scored by preference groups, communication with stakeholder on this plan showed strong support, and creates a low risk environment.
- Barrier Island Restoration – Early coordination with the NPS narrowed potential restoration measure at the barrier islands, such as the reshaping/constructing dunes. Plan H (the restoration of Ship Island, littoral zone sand additions at the east ends of Petit Bois and East Ship Island, changes in maintenance dredging practices that meet the requirements of the Regional Sediment Management Practice, and a study to define the best restoration option

for Cat Island) was selected as the federal recommendation because it has the highest NED benefits, substantial RED benefits, substantial EQ benefits, the greatest achievement of OSE outcomes, does not violate any local, state, or Federal statues, laws, and regulations, and is the most cost effective and efficient recommendation of the Barrier Island component of the Comprehensive Plan. This Plan also has the highest stakeholder preference score, and creates a low risk environment.

- Forrest (Forest) Heights Hurricane and Storm Damage Reduction – Plan 2 (Construction of a levee at an elevation of 21 feet (NAVD88) with clearing and snagging of channel) was selected as the federal recommendation because it achieves greater functional improvement and greater reliability of outcomes when compared to all other plans. Even though the stakeholder preference scores pointed towards the No-Action Plan, follow up communication with stakeholders determined there is strong local and state support for Plan 2.
- High Hazard Area Risk Reduction Plan Phase I (provides immediate buyout opportunities for the most high risk areas for approximately 2000 parcels) was selected as the federal recommendation because it is the best balanced achievement of publicly acceptable outcomes, the most complete, effective, efficient, and acceptable means of addressing the problem set, and provides long-term reduction of damages to property. This plan is also the least costly of those evaluated, it effectively deals with highest risk surge zone problems, it achieves highest net benefit of all plans evaluated including No-Action and is considered to be compliant with Corps policy.
    - Moss Point Municipal Structure Relocation – The federal recommendation is to relocate municipal services to higher ground within Moss Point.
- Waveland Flood Proofing - The federal recommendation is to construct a pilot project involving new methods for elevating structures in the hardest hit areas of Waveland. The information gained from this effort could help other communities in elevating structures using FEMA's new 550 guidelines, thereby reducing their risk from future storm surge.
- Freshwater Diversion at Violet, Louisiana – A critical element of the Comprehensive Plan includes the diversion of fresh water from the Mississippi River to the Mississippi Sound. To that end, the plan supports a recommendation for initiating studies to accomplish the intent of Section 3083 of the Water Resources Development Act of 2007 to design a freshwater diversion project to be located in the vicinity of Violet, LA. The comprehensive goal to be attained through the initiation of these studies would provide sufficient inflows to the western Mississippi Sound area to support oyster reef health and productivity in coastal Mississippi.

3.20.2 Alternatives Recommended for Further Study Prior to Implementation

During early partnering efforts with the State of Mississippi, the MsCIP team identified several State Initiatives required environmental restoration efforts. These sites were owned by the State which would enable them to be restored with no upfront real estate costs, thus, providing immediate accessibility. Environmental restoration by restoring the hydrology and natural landscape of the coastal counties with incidental risk reduction benefits would be achieve through these State Initiative projects as part of the Coastal Preserves Program. Hydrology would be restored by the removing fill material that was historically placed within these sites for development. Removal of this fill material is necessary in order to allow the water to naturally move through these areas. The natural landscape needs to be recontoured to shape the land to its historical setting. In addition, some man-made ditches need to be filled. The overall effort would restore the natural landscape and provide historical tidal creeks to enhance the natural edge between the water interface and emergent tidal marsh habitat. The Comprehensive Plan recommends Phase II detail studies that would be needed but the overall benefit from restoration would provide approximately 14,068 acres of emergent tidal marsh and 1,285 acres of wet pine savannah habitat.

Phase III includes other site-specific and system-wide components of the Comprehensive Plan, which have been developed in this feasibility study, are not presented in support of a specific project construction recommendation at this time. However, they are addressed as reasonably foreseeable actions for the consideration of cumulative effects. Additional engineering and design investigations have to be completed in order to complete feasibility level designs and accurately quantify the benefits, costs, and impacts of these alternatives. As a result, these site-specific and system-wide elements of the Comprehensive Plan are not yet ripe for decision-making.

There are four system-wide elements of the Comprehensive Plan which require additional investigation and evaluation prior to the recommendation of site-specific plans for construction or implementation. These system-wide elements of the Comprehensive Plan include:

- Long-term High Hazard Risk Reduction Plan (HARP)
- Additional Damage Reduction Alternatives
- Coastal Mississippi Ecosystem Restoration Program
- Escatawpa River Freshwater Diversion.

3.20.3 Additional Comprehensive Plan Elements

While not compared in a system of accounts analysis, there are other areas that warrant either additional feasibility study or implementation by others. These include:

- education on hurricane risk,
- hurricane and storm warning,
- evacuation plans,
- flood insurance,
- zoning changes, and
- saltwater intrusion plans.

4 ENVIRONMENTAL EFFECTS*

The Mississippi Coastal Improvements Program Comprehensive Plan, as developed in this feasibility analysis, consists of system-wide elements and site-specific elements. Phase I site-specific components of the Comprehensive Plan have been developed sufficiently for a construction authorization recommendation. These components of the Comprehensive Plan are ready for advanced design and implementation.

- Turkey Creek Ecosystem Restoration;
- Bayou Cumbest Ecosystem Restoration;
- Dantzler Ecosystem Restoration;
- Admiral Island Ecosystem Restoration;
- Franklin Creek Ecosystem Restoration;
- Deer Island Ecosystem Restoration;
- Submerged Aquatic Vegetation Ecosystem Restoration;
- Coast-wide Beach and Dune Restoration;
- Moss Point Municipal Structure Relocation
- Waveland Flood Proofing;
- Forrest (Forest) Heights Hurricane and Storm Damage Reduction
- High Hazard Area Risk Reduction Plan (HARP); and
- Barrier Island Risk Reduction Plan.

The restoration project at Deer Island also has been developed sufficiently for a construction authorization recommendation and is presented in support of a Record of Decision for construction. Should the Corps proceed with this action, additional decisions may be made with regard to additional Deer Island project components at a later date (such as a breakwater and westward expansion of the former Section 204 wetland site). Each of these future decisions will be subject to appropriate documentation to comply with NEPA.

Additionally, other site-specific and system-wide components of the Comprehensive Plan (Phase II and Phase III), which are developed in this feasibility study, are not presented in support of a Record of Decision for construction, but are addressed as reasonably foreseeable actions for the consideration of cumulative effects. Because additional engineering and design investigations have yet to be completed, these site-specific and system-wide elements of the Comprehensive Plan are not yet ripe for decision-making. Supplemental NEPA information will be presented as necessary to ensure compliance with the appropriate environmental laws and regulations:

- High Hazard Area Risk Reduction Plan
- Freshwater Diversion at Violet, Louisiana
- Additional Damage Reduction Alternatives
- Barrier Island Restoration
- Coastal Mississippi Ecosystem Restoration Program.

During early partnering efforts with the State of Mississippi, the MsCIP team identified several State Initiatives required environmental restoration efforts. These sites were owned by the State which would enable them to be restored with no upfront real estate costs, thus, providing immediate accessibility. Environmental restoration by restoring the hydrology and natural landscape of the coastal counties with incidental risk reduction benefits would be achieve through these State Initiative projects as part of the Coastal Preserves Program. Additional detail studies of these Phase

II sites would be needed but the overall benefit from restoration would provide approximately 14,068 acres of emergent tidal marsh and 1,285 acres of wet pine savannah habitat. Phase II studies are recommended for the following locations:

- Pascagoula River Marsh;
- Dantzler Coastal Preserve;
- Dupont Coastal Preserve;
- La Francis Coastal Preserve Camp Trenaisse;
- Ansley Coastal Preserve;
- Wachovia Coastal Preserve

Figure 4-1 provides a geographic representation of all Mississippi Comprehensive Plan elements.

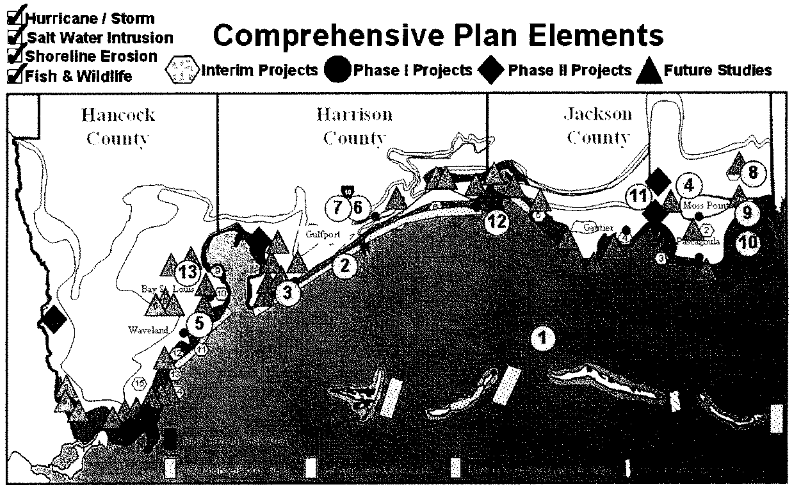

Figure 4-1
Mississippi Comprehensive Plan Elements

The analysis of environmental effects section of the report first presents a broad qualitative overview of potential environmental effects of the overall Comprehensive Plan. The presentation of broad program-wide impacts is followed by a more detailed and quantitative discussion of the impacts of projects presented in support of a Record of Decision for construction.

4.1 Comprehensive Plan

There are three system-wide elements of the Comprehensive Plan which require additional investigation and evaluation prior to the recommendation of site-specific plans for construction or implementation. These system-wide elements of the Comprehensive Plan include:

- High Hazard Area Risk Reduction Plan (HARP);
- Additional Damage Reduction Alternatives,
- Coastal Mississippi Ecosystem Restoration Program.

A Record of Decision for construction is not being requested for these Comprehensive Plan components, but their potential environmental effects are presented as reasonably foreseeable actions for the consideration of cumulative effects. The environmental effects of the Additional Damage Reduction Alternatives and Coastal Mississippi Ecosystem Restoration Program are presented in this section. The Environmental effects of the HARP are presented separately in Section 4.2.

The environmental effects analysis is conducted on three different levels, which provide various details based on the information available. A more qualitative analysis is conducted for those components of the Comprehensive Plan that require Advanced Study and Design for further project development. Two projects are being recommended for Advanced Engineering and Design and an environmental analysis is conducted using the most information that is available. Supplemental environmental documentation will be prepared for the barrier islands effort and will provide a greater level of detail at that time.

As a result of the diversity of potential projects that have come forth as a part of the Comprehensive Plan, further environmental considerations and analyses will be required prior to projects being implemented. There could be supplemental environmental impact statements to evaluate projects that would result in significant impacts and further environmental assessments for projects that are less complex in nature and do not have significant impacts. During development of NEPA documentation, detailed discussions of potential impacts and subsequent mitigation will be incorporated as measures and alternatives are being developed.

Provisions for "tiering" of EISs are found in 40 CFR 1502.20 whenever a broad environmental impact statement has been prepared (such as a program or policy statement) and a subsequent statement or environmental assessment would then be prepared on an action included within the entire program or policy. This EIS will serve as the basis from which further required environmental analyses and documentation could be tiered from.

A third level of detailed analyses has been conducted to determine the impacts associated with projects being recommended for construction. It is expected that no further environmental analysis is required prior to the projects being constructed. The following table depicts potential projects and their analyses.

4.1.1 Comprehensive Plan - No Action Alternative

Hurricanes are a way of life along the Mississippi Gulf coast region. From 1715 to 1985, approximately forty hurricanes struck the Gulf Coast region stretching from Texas to the Florida Keys. Though differing in size, strength and intensity, those hurricanes greatly affected the environment and its inhabitants on the Gulf of Mexico. The hurricane season of 2005 was the most devastating in recent times, when Hurricane Katrina struck.

Unfortunately, coastal lands are typically places where higher population densities are concentrated. Typically, there is a higher influx of population than that leaving the coastal areas. In fact, many of these residents have only recently settled this vital coastal environment. Thus, developmental pressures are typically found in coastal environments, which was also true of coastal Mississippi. Wet pine savannah and emergent tidal marsh habitats were increasingly having development encroach upon them in Mississippi; thus, causing unnatural stresses upon those vital environmental features. Bulkheads, such as those at Belle Fontaine, and other man-made navigational features along the Mississippi coast were actually altering natural littoral drift systems along the only natural Mississippi beach. Such stresses like these on this thin vital coastal environment were affecting the area and when Hurricane Katrina made landfall it just accelerated environmental degradation. In mere hours, some 100 square miles of marshes along the Gulf coast were converted into open water as a consequence of erosion during storm surges.

Following the hurricane season of 2005, those already stressed environmental habitats are now experiencing even more accelerated degradation. Prior to the hurricane season of 2005, the barrier islands had been adversely impacted by numerous continual storms and hurricanes - without a period of time for recovery. These coastal systems provide an array of habitats – coastal maritime forests, beaches/dunes, and emergent tidal marshes – for various fish and wildlife and also important migratory birds. These islands and adjacent coastal systems are also essential habitats for some T&E species, such as piping plover, sea turtles, and the Gulf sturgeon. In addition, they create the fertile Mississippi Sound that is one of the most productive fishery grounds in the world. Implementation of the No Action plan would result in the continual erosion of the barrier islands; thus, increasing Mississippi Sound's salinity and eventually losing the Sound all together.

Undesirable exotic species, such as Chinese Tallow and Phragmites, are provided an excellent opportunity to out-compete native species by the newly opened spaces in habitats, such as wet pine savannah and emergent marsh habitats. These exotic species out-compete native, more productive flora and eventually become the primary, if not the only species, found in these vital habitats. These exotic species do not provide the sources of food benefiting Mississippi Flyway's migratory birds and associated wildlife as those native species do. Without intervention, coastal areas in Mississippi, such as wet pine savannahs, beaches and dunes, coastal maritime forests, and emergent tidal marsh habitats, would continue accelerated degradation. Without project - the No Action plan – for future development scenarios are provided in Table 4-1.

Table 4-1
Overview of Future Scenarios

Future Scenario	Redevelopment Type	Relative Sea Level Rise	Description
Future Scenario 1	Residential	None	Rebuild structures as existed pre-Hurricane Katrina with no relative sea level rise over the period of analysis. This future scenario applies to all three planning units (counties).
Future Scenario 2	Mixed Residential & Commercial	None	Rebuild structures as existed pre-Hurricane Katrina except at water front where condo/casino rebuild will occur. Also, no relative sea level rise over the period of analysis. This future scenario applies only to planning units one and two. Planning unit three would not allow commercial type redevelopment based on local ordinances.
Future Scenario 3	Residential	Expected	Rebuild structures as existed pre-Hurricane Katrina with up to 2.4-feet relative sea level rise over the 100-year period of analysis. This future scenario applies to all three planning units.
Future Scenario 4	Mixed Residential & Commercial	Expected	Rebuild structures as existed pre-Hurricane Katrina except at water front where condo/casino rebuild will occur. Also, an up to 2.4-feet relative sea level rise over the period of analysis. This future scenario applies only to planning units one and two. Planning unit three would not allow commercial type redevelopment based on local ordinances.
Future Scenario 5	Residential	High	Rebuild structures as existed pre-Hurricane Katrina with up to 3.4-feet of relative sea level rise over the period of analysis. This future scenario applies to all three planning units.
Future Scenario 6	Mixed Residential & Commercial	High	Rebuild structures as existed pre-Hurricane Katrina except at water front where condo/casino rebuild will occur. Also, up to 3.4-feet of relative sea level rise over the period of analysis. This future scenario applies only to planning units one and two. Planning unit three would not allow commercial type redevelopment based on local ordinances.

Future Scenarios One and Two are included only to evaluate the effects of relative sea level rise These Future scenarios will not be used in the evaluation of potential measures. Futures Three, Four, Five, and Six will be the future scenarios by which potential measures will be evaluated depending on the planning unit.

4.1.2 Comprehensive Plan Description

The MsCIP Comprehensive Plan presents a very complex challenge to identify Mississippi coast recovery plans. The investigation was focused on 3 components – environmental, non-structural and structural plans – to achieve an array of protection and restoration measures. While developing these components, the team ensured that the specific measure or a compilation of measures addressed the 2005 congressional authorization of:

a) future hurricane storm and flood damage reduction;

b) prevention of saltwater intrusion;

c) prevention of coastal erosion;

d) preservation of fish and wildlife; and

e) other water related resources (reduction of flooding).

Ultimately, several hundred measures were identified ranging from restoring the barrier islands at varying levels, raising existing structures' elevation, constructing ring levees around communities, building surge gates across water bodies, restoring dune and beaches, developing housing assistance and relocation programs, and restoring wet pine savannah, emergent tidal marsh, and scrub shrub habitats. These measures were screened throughout the plan formulation process in order to develop alternatives. The comprehensive nature of the MsCIP effort resulted in the ability to implement certain alternatives while others required additional study.

Large structural components of the comprehensive plan, such as surge gate barriers and ring levees, were evaluated; however, additional details and further study will be required prior to making a determination of their feasibility as effective measures to reduce damages from future hurricane and storm surge events. Additionally, smaller viable alternatives, such as smaller ring levees, have the potential of providing cost effective solutions. Several options being recommended for future study include environmental restoration of barrier islands for increased biodiversity within existing habitats. Potential projects being considered include marsh restoration, re-planting of maritime forests, and large scale beach/dune and seagrass restoration projects. Other structural options that are being considered include elevated roadways across the mainland shoreline, interior drainage projects, and construction of a continuous levee crossing the mainland near the shoreline and surge barriers crossing Bay of St. Louis and Biloxi Bay. Various smaller levees around various coastal communities and cities that include Belle Fontaine, Gulf Park Estates, Pascagoula and Moss Point, Pearlington, Gautier, Ocean Springs, and Bay St. Louis are being considered. Projects for reduction of saltwater intrusion are being considered that would consist of freshwater diversion within the eastern portion of coastal Mississippi in the Grand Bay Savannah and Wetland and the western portion of the state in conjunction with a recently authorized project near Violet, Louisiana. Various non-structural projects are being considered that include relocations of residences, businesses, communities, municipal buildings, etc. Additional non-structural options include flood-proofing structures within communities, educational programs and evacuation planning. These measures will be evaluated further and developed into cost-effective solutions in coordination with Federal, State, and local governments as well as interested members of the public.

4.1.3 Comprehensive Plan Soils Impact

Alteration of soils would occur under levee footprints and within environmental restoration projects; however, in some instances, old fill material would be removed for reestablishment of more native types soils generally found in the natural system. In cases where fill material for levee construction is obtained onsite, impacts to soils could be significant. Further environmental studies during project development and implementation of measures will determine specific impacts.

4.1.4 Comprehensive Plan Sediments Impact

Re-suspension of sediments would likely occur within specific project sites. Containment structures, silt curtains, and other Best Management Practices (BMP) would be used to contain sediment deposition at construction and environmental restoration sites in order to minimize adverse impacts during construction activities. Projects that are located within or adjacent to Mississippi Sound might cause sediments to remain suspended in the water column; however, it is anticipated they would eventually settle out or migrate via littoral drift. The use of BMPs should ensure any impacts that might occur would be isolated to each construction site, minor and of short duration.

4.1.5 Comprehensive Plan Geology Impact

No geological changes are anticipated to occur by implementation of these type projects. Potential projects have been or would be designed to avoid impacts to current geological formations.

4.1.6 Comprehensive Plan Climate Impact

There should be no effects to the existing climate.

4.1.7 Comprehensive Plan Air Quality Impact

Currently all areas within coastal Mississippi are in attainment with the National Ambient Air Quality Standards (NAAQS). Air quality in the immediate vicinity of project construction would be slightly affected for a period of time by the fuel combustion and resulting engine exhausts. The standards would not be violated by the implementation of the proposed project.

4.1.8 Comprehensive Plan Noise Impact

Noise from construction type equipment is expected to increase during the proposed operations in project vicinities. Noise levels will resume to existing conditions as construction activities are completed. It is anticipated there would be no significant impacts to noise levels during implementation of these measures.

4.1.9 Comprehensive Plan Vegetation Impact

Upland Vegetation

Vegetation within coastal Mississippi would be altered as projects are constructed as a result of implementing components of the Comprehensive Plan. Measures were developed to address congressional authorization of storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife habitats, and prevention of coastal erosion. Restoration of the barrier islands would provide a benefit to vegetation. Generally, removal of existing vegetation would occur under footprints of structures or within restoration sites. Exotic and invasive species would be removed as applicable and replaced with native vegetation. Re-vegetation of damaged habitats would be part of the overall environmental effort. Further studies during project development would determine specific impacts to vegetation.

Wetlands

Environmental restoration of historical wetlands that have been previously filled would benefit wetlands as the restoration plans would restore hydrology and remove exotics allowing native plants to become better established. Exotic and invasive species would be removed and replaced with native wetland species. Reforestation of lost or damaged wetland habitats would be part of the overall environmental effort. The environmental restoration effort was tailored to create the most effective path forward for this comprehensive effort. Initial efforts yielded numerous sites that were then reviewed by the team. It was necessary to develop a phasing plan to accomplish the comprehensive effort. The sites were divided into phases with Turkey Creek, Bayou Cumbest, Admiral Island, Dantzler and Franklin Creek being recommended for immediate construction. Details analyses of these initial phased projects were conducted in Section 4.4. During early partnering efforts with the State of Mississippi, the MsCIP team identified several State Initiatives required environmental restoration efforts. These sites were owned by the State which would enable them to be restored with no upfront real estate costs, thus, providing immediate accessibility. Environmental restoration by restoring the hydrology and natural landscape of the coastal counties with incidental risk reduction benefits would be achieve through these State Initiative projects as part of the Coastal Preserves Program. Hydrology would be restored by the removing fill material that was historically placed within these sites for development. Removal of this fill material is necessary in order to allow the water to naturally move through these areas. The natural landscape needs to be recontoured to shape the land to its historical setting. In addition, some man-made ditches need to be filled. The overall effort would restore the natural landscape and provide historical tidal creeks to enhance the natural edge between the water interface and emergent tidal marsh habitat. Additional detail studies would be needed but the overall benefit from restoration would provide approximately 14,068 acres of emergent tidal marsh and 1,285 acres of wet pine savannah habitat.

A component of the comprehensive ecosystem restoration would improve wetland functions and restoration of tidal emergent marsh wetlands. Approximately 21,407 acres of emergent tidal marsh, of which, 13,945 acres are owned by the State of Mississippi in their Coastal Preserves Program, would be restored.

A component of the comprehensive ecosystem restoration would provide wetland functions and restoration of lost wet pine savannah wetlands. Approximately 3,579 acres of wet pine savannah would be restored, of which, 900 acres are owned by the State of Mississippi in their Coastal Preserves Program. The Deer Island ecosystem restoration – owned by the State of Mississippi - would provide approximately 78 acres of emergent tidal marsh.

Diversion of freshwater into Mississippi Sound would possibly alter salinity regimes which in turn would result in a gradual change in wetland habitats to fresher types. Further studies during project development would determine the specific benefits and any adverse impacts associated with barrier island restoration.

LOD 3 would require the loss of approximately 15.7 acres of coastal wetlands, including some open-water habitats, of the approximate 85 mile overall length. Additionally, up to approximately 265 acres of wetland vegetation could be lost based on the initial alignments of potential ring levees. Further avoidance and minimization would be investigated to determine specific losses. This would be field verified prior to construction and during project development to determine functions of wetlands lost.

LOD 4 could result in approximately 344 acres of wetland vegetation lost based on potential alignments. Specific losses and potential secondary and indirect impacts would be field verified prior to construction and during project development to determine the extent of wetland functions lost.

Implementation of the non-structural alternatives could result in impacts to wetland habitats throughout coastal Mississippi as emergency and critical facilities are relocated and constructed in the northern portions of the counties. As buildings are relocated, however, adverse impacts to wetlands could occur within newly developed areas that are currently more natural undeveloped land located nearby. It is anticipated properties to be purchased as part of a HARP program would be restored to historical conditions, which would actually provide a benefit to vegetation. Future studies during project development would determine specific impacts associated with implementation of these type measures.

4.1.10 Comprehensive Plan Fish and Wildlife Impact

Fish and wildlife would be altered by implementation of potential measures associated with the Comprehensive Plan. Generally, important habitat for fish and wildlife species would be lost and altered as a result of the structure footprints. Fragmentation of habitat would occur as a result of levee and/or surge gate construction. Environmental restoration along the barrier islands and the mainland would result in vital habitat being restored that would benefit species found within coastal Mississippi. Several measures have been developed, which would allow for storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife habitats, and prevention of coastal erosion. Additional study would determine the extent of adverse or beneficial impacts to fish and wildlife resources.

Generally, restoration of barrier islands would entail filling of existing water bottoms to pre-Hurricane Camille conditions, restoring dunes along beaches, and limited dune re-vegetation. The barrier islands and adjacent coastal systems currently provide EFH for managed fisheries under the Magnuson Fishery Conservation and Management Act and critical habitats for the Gulf sturgeon and piping plover under ESA. Several sea turtle species utilize the islands and adjacent water bottoms for nesting and foraging. It is anticipated additional sand along the shoreline would provide additional opportunities for nesting for sea turtles. Additionally, barrier island restoration would provide additional over wintering critical habitat for the piping plover. Many other shorebird species use the barrier islands for nesting and foraging while migratory birds use the islands as stopovers and temporary feeding grounds. Filling of water bottoms would remove foraging areas for sea turtles and other marine species, such as the Gulf sturgeon and EFH species. Restoration of seagrasses once prevalent throughout the barrier islands would benefit numerous marine species for foraging opportunities and cover. Establishment of a comprehensive program would provide further educational opportunities as to the importance of this disappearing resource.

The sand would be obtained from an offshore source, St. Bernard Shoals, approximately 45 miles south of the islands. Dredging to obtain the material source will impact epibenthic crustaceans and infaunal polychaetes within the immediate area. However, impacts are primarily short-term in nature and consist of a temporary loss of benthic invertebrate populations in the areas of dredging. Adjacent benthic communities are anticipated to move into the dredged site and begin recolonization. The area is characterized as a relic sand shoal at approximate elevation -60 NAVD88 and once dredging is complete, will remain similar in character as dredged depths would not exceed an additional 10 feet in depth. Therefore, because similar habitat, in terms of both sediment composition and depth, will be present pre- and post dredging, it is anticipated the benthic biota in the dredging areas will recover and recolonize. Further study during project development would determine the extent of impacts and benefits associated with implementation of this measure.

Existing beachfront roadways present hazards to shorebird species utilizing corridors to and from beach habitat and adjacent upland habitat. Elevating the roadways could pose an increased risk of bird strikes by vehicles; however it also would help sustain beach habitat by preventing sand from migrating into the adjacent roadway. In fact, the roadway could be an indirect benefit to the shorebirds by the hindering northward movement of sand. Modification and repairs to existing seawalls should have minimal impacts to fish and wildlife resources.

Overall, construction of ring levees would result in fragmentation of fish and wildlife habitat, which would limit availability of travel corridors for a variety of wildlife species. This could result in geographic isolation of populations. Continued maintenance of the levee reduces natural habitats that are currently available for numerous wildlife species. Unnatural crossings of water bodies by culverts, etc., reduces in-stream habitat for various life stages of fish. Impacts to wetland crossings remove essential lifecycle requirements for numerous fish and wildlife species. It is anticipated that construction of the levees could result in significant changes to existing hydrology and possibly impact the water table. Subterranean species that use the area would then abandon the habitat as these changes occur. This would result in less habitat available to species. Implementation of this measure would require further study during project development to determine the full extent of impacts to fish and wildlife and their habitat. Various alignments could reduce or avoid impacts to fish and wildlife.

Construction of inland barriers could result in alterations to current runoff and sheet flow drainage patterns resulting in altered hydrology. Overall, construction of the inland barrier would result in fragmentation of fish and wildlife habitat, which would limit availability of travel corridors for a variety of wildlife species. This could result in geographic isolation of populations. Continued maintenance of the levee would reduce natural habitats that are currently available for numerous wildlife species. Unnatural crossings of water bodies by culverts, etc., reduces in-stream habitat for various life stages of fish. Impacts to wetland crossings remove essential lifecycle requirements for numerous fish and wildlife species. It is anticipated that construction of these structures could result in changes to existing hydrology and could impact the water table. Subterranean species that use the area would then abandon the habitat as these changes occur. This would result in less habitat that is available to species. Implementation of this measure would require further study during project development to determine the full extent of impacts to fish and wildlife and their habitat. Various alignments could reduce or avoid impacts to fish and wildlife.

Construction of the surge barriers across bays would alter circulation and flow patterns at the confluence of the bay and Mississippi Sound. Constricting the mouth of the bay would create a bottleneck for any species utilizing the area. Tidal flows would be changed as freshwater input is reduced, which could cause impacts to many species of shellfish. Limiting freshwater inflows into the estuary could result in further saltwater intrusion. EFH would be lost during construction as well as permanent losses to EFH by installation of the structure. Filling of water bottoms by construction of abutments on either end would result in permanent losses to EFH. Installation of the structure would disturb bottom substrate releasing possible contaminants into the water column. There would be impacts to the natural flushing actions that occur within existing tidal marshes. Implementation of this measure would require further study during project development to determine the full extent of impacts to fish and wildlife and their habitat.

Overall, implementation of non-structural measures would have minimal impacts to fish and wildlife; however, as properties would be bought out and existing development relocated, additional impacts to fish and wildlife and their habitat would be felt in other area. Existing habitats that could be affected by implementation of this measure currently remain intact. They are in rural areas and predominantly natural. The main threat that exists today is by increased development and this planning guide would heighten this threat. Valuable habitat could be lost, which could result in losses to the species themselves. Additionally, as development occurs within this natural habitat, potential conflict between wildlife and human population increases. Although impacts to valuable habitat in the existing rural areas would occur, the bought out properties would be restored back to its natural condition resulting in a benefit to fish and wildlife. However, it is anticipated that secondary development in the newly relocated areas could offset benefits gained by restoration of the bought out property.

Environmental restoration is expected to result in a benefit to fish and wildlife resources. Overall, environmental restoration projects would help to correct problems within the natural system, such as restoration of historical wetlands that have been filled during prior development and introduction of freshwater into areas suffering from saltwater intrusion. It is important to establish a program to investigate all impacts associated with such actions to ensure no further degradation would occur to other habitats and resources, such as impacts to SAVs by the introduction of freshwater into a saline environment. Further study would be needed during specific project development.

4.1.11 Comprehensive Plan Threatened and Endangered Species Impact

Close coordination with resource agencies has allowed for better planning and development of alternatives in order to further avoid potential significant impacts to listed species. The comprehensive plan provides numerous benefits to a variety of threatened and endangered species, such as piping plover, sea turtles, Gulf sturgeon, Mississippi gopher frog, Mississippi sandhill crane, manatees, Louisiana quillwort, etc. Without the continued existence of most of this vital habitat many of these species would continue to be adversely impacted by increased developmental encroachment. A more detailed assessment of these T&E species issues can be found in the Environmental Appendix. Benefits and adverse impacts to T&E species were part of an initial screening process used during early planning. Further consultation with appropriate resource agencies would occur during future project development and subsequent biological opinions are anticipated to be issued prior to construction activities.

Restoration of the barrier islands would benefit piping plover and its critical habitat by the increased amount of over wintering foraging areas. Temporary impacts could occur during construction but could be avoided during the times the piping plover are on the over wintering grounds. Brown pelicans could utilize the project areas; however, it is anticipated these species would avoid the construction area due to noise and activity. This species nests mostly on offshore islands, but has been known to nest in onshore estuaries; however, based on surveys by FWS biologist, there is no known nesting in Mississippi. Should nesting brown pelicans be discovered, the area would be avoided to ensure no impacts occur. Barrier islands provide adjacent critical habitat essential for the continued existence of the Gulf sturgeon. Primary constituent elements, such as feeding, water quality, and sediment quality, are vital to the Gulf sturgeon species' continued existence. In addition, sea turtles only use those barrier island beaches for nesting in Mississippi. Replenishment of sand within the system allows the continued persistence of the barrier island system to continue supporting vital threatened and endangered species. Manatees, Gulf sturgeon and sea turtles could be in the project area and there is potential for temporary adverse impacts to occur. It is anticipated these species would primarily avoid the construction areas due to noise and activity resulting in less risk for harm or harassment. Methods of dredging would be utilized to avoid adverse impacts to listed species. Placement activities would be accomplished using appropriate BMPs to reduce turbidity and other potential adverse impacts to species and its critical habitat. Further consultation would be required to determine adverse impacts to critical habitat for the Gulf sturgeon. It is anticipated whale species would avoid the project area during construction activities due to noise and activity and no collisions should occur.

Elevated Roadways

Elevating existing beachfront roads throughout coastal Mississippi for use as structural barriers or in combination with an associated seawall defines a portion of LOD 3. These structures would be the first hard engineered structure that would not be affected by erosion from storm events. There is potential for the brown pelican and piping plover to be present within the project area; however, these species should avoid the area during construction activities due to noise and equipment activity. It is anticipated minimal impacts would occur during construction. Once the project is completed, the elevated roadways would present hazards to shorebird species utilizing corridors to and from beach habitat and adjacent upland habitat. Elevated roadways could pose an increased risk of bird strikes by vehicles.

Seawalls

There is potential for the brown pelican and piping plover to be present within the project area; however, these species should avoid the area during construction activities due to noise and activity. It is anticipated minimal impacts would occur during construction.

Ring Levees

Pearlington

Louisiana quillwort is known to be present within the project area and can be found in flowing streams or other wet habitats. Surveys would be conducted during project development to determine its presence. Alternate levee alignments could reduce or avoid impacts to Louisiana quillwort; however, should it be present within the levee alignment, further consultation would be required and adverse impacts could occur. Louisiana black bears and gopher tortoises could be present within the project area. The Louisiana black bear is a transient species within the area and should avoid the project area during construction activities due to noise and activity. There is a potential for gopher tortoises to be found within the immediate vicinity uplands. Surveys could be conducted to determine the presence of gopher tortoises or burrows. If evidence of gopher tortoises is found to be within the project area, further consultation would be required. Relocation of gopher tortoises may be necessary. Alternate levee alignments could reduce adverse impacts to listed species. Further study during project development would determine the full extent of adverse impacts to species.

Bay St. Louis

Louisiana quillwort is known to be present within the project area and can be found in flowing streams or other wet habitats. Surveys could be conducted during project development to determine its presence. Alternate levee alignments could reduce or avoid impacts to Louisiana quillwort; however, should it be present within the levee alignment, further consultation would be required and adverse impacts could occur. Brown pelicans could be found within the project area; however, it is anticipated the species would avoid the project area during construction activities due to noise and activity. There should be no adverse impacts to the brown pelicans associated with implementation of this measure. Alternate levee alignments could reduce adverse impacts to listed species. Further study during project development would determine the full extent of adverse impacts to species.

Ocean Springs

Louisiana quillwort is known to be present within the project area and can be found in flowing streams or other wet habitats. Surveys could be conducted during project development to determine its presence. Alternate levee alignments could reduce or avoid impacts to Louisiana quillwort; however, should it be present within the levee alignment, further consultation would be required and adverse impacts could occur. Brown pelicans could be found within the project area; however, it is anticipated the species would avoid the project area during construction activities due to noise and activity. There should be no adverse impacts to the brown pelicans associated with implementation of this measure. Alternate levee alignments could reduce adverse impacts to listed species. Further study during project development would determine the full extent of adverse impacts to species.

Gulf Park Estates

Louisiana quillwort is known to be present within the project area and can be found in flowing streams or other wet habitats. Surveys could be conducted during project development to determine its presence. Alternate levee alignments could reduce or avoid impacts to Louisiana quillwort; however, should it be present within the levee alignment, further consultation would be required and adverse impacts could occur. Brown pelicans could be found within the project area; however, it is anticipated the species would avoid the project area during construction activities due to noise and activity. There should be no adverse impacts to the brown pelicans associated with implementation of this measure. Alternate levee alignments could reduce adverse impacts to listed species. Further study during project development would determine the full extent of adverse impacts to species.

Belle Fontaine

Louisiana quillwort is known to be present within the project area and can be found in flowing streams or other wet habitats. Surveys could be conducted during project development to determine its presence. Alternate levee alignments could reduce or avoid impacts to Louisiana quillwort; however, should it be present within the levee alignment, further consultation would be required and adverse impacts could occur. Brown pelicans could be found within the project area; however, it is anticipated the species would avoid the project area during construction activities due to noise and activity. There should be no adverse impacts to the brown pelicans associated with implementation of this measure. Alternate levee alignments could reduce adverse impacts to listed species. Further study during project development would determine the full extent of adverse impacts to species.

Gautier

Louisiana quillwort is known to be present within the project area and can be found in flowing streams or other wet habitats. Surveys could be conducted during project development to determine its presence. Alternate levee alignments could reduce or avoid impacts to Louisiana quillwort; however, should it be present within the levee alignment, further consultation would be required and adverse impacts could occur. Brown pelicans could be found within the project area; however, it is anticipated the species would avoid the project area during construction activities due to noise and activity. There should be no adverse impacts to the brown pelicans associated with implementation of this measure. The Mississippi Sandhill crane could be found within the project vicinity; however, it is anticipated the species would avoid the area during project construction due to noise and activity.

Alternate levee alignments could reduce adverse impacts to listed species. Further study during project development would determine the full extent of adverse impacts to species.

Pascagoula

Louisiana quillwort is known to be present within the project area and can be found in flowing streams or other wet habitats. Surveys could be conducted during project development to determine its presence. Alternate levee alignments could reduce or avoid impacts to Louisiana quillwort; however, should it be present within the levee alignment, further consultation would be required and adverse impacts could occur. Louisiana black bears and gopher tortoises could be present within the project area. The Louisiana black bear is a transient species within the area and should avoid the project area during construction activities due to noise and activity. There is a potential for gopher tortoises to be found within the immediate vicinity uplands. Surveys could be conducted to determine the presence of gopher tortoises or burrows. If evidence of gopher tortoises is found to be within the project area, further consultation would be required. Relocation of gopher tortoises may be necessary. Brown pelicans and bald eagles could be found within the project area; however, it is anticipated the species would avoid the project area during construction activities due to noise and activity. There should be no adverse impacts to the brown pelicans associated with implementation of this measure. The Mississippi Sandhill crane could be found within the project vicinity; however, it is anticipated the species would avoid the area during project construction due to noise and activity. Alternate levee alignments could reduce adverse impacts to listed species. Further study during project development would determine the full extent of adverse impacts to species.

The general alignment of the inland barrier would be along the path of the existing railway that crosses the coast of Mississippi. This railway is located atop of a constructed berm. In order to protect much of the developed areas around Biloxi and St. Louis Bays, the inland barrier would need to cross the mouths of these bays, which would necessitate construction of structural surge barriers.

Hancock County Inland Barrier

Louisiana quillwort is known to be present within the project area and can be found in flowing streams or other wet habitats. Surveys could be conducted during project development to determine its presence. Alternate levee alignments could reduce or avoid impacts to Louisiana quillwort; however, should it be present within the levee alignment, further consultation would be required and adverse impacts could occur. Louisiana black bears and gopher tortoises could be present within the project area. The Louisiana black bear is a transient species within the area and should avoid the project area during construction activities due to noise and activity. There is a potential for gopher tortoises to be found within the immediate vicinity uplands. Surveys could be conducted to determine the presence of gopher tortoises or burrows. If evidence of gopher tortoises is found to be within the project area, further consultation would be required. Relocation of gopher tortoises may be necessary. Brown pelicans could be found within the project area; however, it is anticipated the species would avoid the project area during construction activities due to noise and activity. There should be no adverse impacts to the brown pelicans associated with implementation of this measure. Alternate levee alignments could reduce adverse impacts to listed species. Further study during project development would determine the full extent of adverse impacts to species.

Bay of St. Louis Surge Barrier

Gulf sturgeon, manatee, and various sea turtles could be found within the project vicinity. Additionally, brown pelicans could be found within the project vicinity. It is anticipated that adverse impacts during construction is unlikely as the species would avoid the project area due to noise and activity. Further consultation would be necessary during project development to determine the full extent of adverse impacts to species.

Harrison County Inland Barrier

Louisiana quillwort is known to be present within the project area and can be found in flowing streams or other wet habitats. Surveys could be conducted during project development to determine its presence. Alternate levee alignments could reduce or avoid impacts to Louisiana quillwort; however, should it be present within the levee alignment, further consultation would be required and adverse impacts could occur. Brown pelicans could be found within the project area; however, it is anticipated the species would avoid the project area during construction activities due to noise and activity. There should be no adverse impacts to the brown pelicans associated with implementation of this measure. Alternate levee alignments could reduce adverse impacts to listed species. Further study during project development would determine the full extent of adverse impacts to species.

Back Bay of Biloxi Surge Barrier

Gulf sturgeon, manatee, various sea turtles, and brown pelicans could be found within areas considered for surge barrier crossings. It is anticipated that adverse impacts during construction is unlikely as the species would avoid the project area due to noise and activity. The Alabama red-bellied turtle could be found within the project or its immediate vicinity. Implementation of this measure could result in destruction of nesting areas along the banks, feeding areas among SAVs, and result in reduced water quality within the project site. Surveys could determine the presence of the species and BMPs during construction could reduce adverse impacts to water quality within and around the construction site. Further consultation would be necessary during project development to determine the full extent of adverse impacts to listed species.

Louisiana quillwort is known to be present within the project area and can be found in flowing streams or other wet habitats. Surveys could be conducted during project development to determine its presence. Alternate levee alignments could reduce or avoid impacts to Louisiana quillwort; however, should it be present within the levee alignment, further consultation would be required and adverse impacts could occur. Louisiana black bears and gopher tortoises could be present within the project area. The Louisiana black bear is a transient species within the area and should avoid the project area during construction activities due to noise and activity. There is a potential for gopher tortoises to be found within the immediate vicinity uplands. Surveys could be conducted to determine the presence of gopher tortoises or burrows. If evidence of gopher tortoises is found to be within the project area, further consultation would be required. Relocation of gopher tortoises may be necessary. Brown pelicans could be found within the project area; however, it is anticipated the species would avoid the project area during construction activities due to noise and activity. There should be no adverse impacts to the brown pelicans associated with implementation of this measure. The Mississippi Sandhill crane could be found within the project vicinity; however, it is anticipated the species would avoid the area during project construction due to noise and activity. Alternate levee alignments could reduce adverse impacts to listed species. Further consultation would occur to determine potential impacts to listed species. Biological Assessments of particular project components would determine the extent of impacts under future programmatic consultations.

Overall, implementation of non-structural and environmental restoration measures would provide benefits while having minimal impacts to listed species during construction activities. It is anticipated that purchasing of property would require relocation and possibly further development of rural properties. This could result in additional impacts to listed species and their habitat. An example of concern would be the gopher tortoise and Louisiana quillwort. Existing habitats that could be affected by implementation of this measure currently remain intact. They are in rural areas and predominantly natural. The main threat that exists today is by increased development resulting in valuable habitat losses, which could result in losses to the species themselves. Additionally, as development occurs within this natural habitat, potential conflict between wildlife and human population increases. Although development of valuable habitat in the existing rural areas would occur, the bought out properties would be restored back to its natural condition resulting in a benefit to fish and wildlife. However, it is anticipated that secondary development in the newly relocated areas could offset the benefits gained by restoration of the bought out property. It would be necessary to conduct surveys to determine the presence of listed species prior to construction during project development. Programmatic consultation would address impacts to listed species in association with implementation of this measure.

4.1.12 Comprehensive Plan Water Quality Impact

Water quality within coastal Mississippi being evaluated as part of their ongoing program and monitoring data are compared to the *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters* in order to make decisions on whether a water body is supporting or not supporting its designated uses, such as aquatic life support, water contact recreation, fish/shellfish consumption, and drinking water. A more detailed assessment pertaining to water quality issues in coastal Mississippi can be found in the Environmental Appendix. There are specific problems in certain water bodies throughout the study area; however, many are isolated, associated with certain conditions due to industrial discharge, historical problems, and increased run-off in conjunction with development.

Restoration of the barrier islands would require a large amount of high quality sand being placed on or around the sandy string of barrier islands. Overall, this should not cause significant impacts to existing water quality within Mississippi Sound. Restoration of the barrier islands would actually ensure estuarine conditions within Mississippi Sound remain. This is essential for the continual existence of Mississippi Sound and its vital importance (i.e. productive estuarine fishery ground). The sand found at St. Bernard Shoals is of a quality similar to what is found in the present day Mississippi barrier islands and sufficient quantity to meet the need. There should be no problems associated with turbidity at the borrow site in association with the dredging. The sandy material should pose no turbidity problems during placement activities as sand settles quickly. BMPs would be utilized in order to decrease any impacts associated with water quality. It is expected no impacts to water quality would result from implementation of this measure.

Environmental restoration and construction of a dune feature on islands and mainland beaches would provide indirect positive impacts to water quality due to increased functions of wetlands and marshes on the islands (i.e. continual existence). It is anticipated there would be a benefit to water quality as a result of this measure. Although there may be a slight increase in turbidity during construction, it is anticipated this would be localized and short in duration. Improved water quality within Mississippi Sound would help to establish sea grasses.

Elevating existing beachfront roads throughout coastal Mississippi for use as structural barriers or in combination with an associated seawall defines a portion of the LOD 3. These structures would be the first hard engineered structure that would not be affected by erosion from storm events. Prevention of coastal erosion would result in positive impacts to overall water quality. Modification and necessary repairs to existing seawalls would result in positive benefits in overall water quality by prevention of coastal erosion. The use of BMPs would ensure stabilization of bare soils during construction of ring levees. Interior drainage would be accomplished by the removal of stored water through culverted crossings of small water bodies and by the use of pump stations where necessary. BMPs would be utilized during all construction activities and no run-off material would be allowed to enter adjacent waters. It is anticipated there would be no significant impacts to water quality as a result of implementation of this measure. Environmental restoration of properties purchased as part of non-structural implementation would result in positive impacts to water quality as lost wetland functions would be replaced.

4.1.13 Comprehensive Plan Water Supply Impact

There should be no effect on water supply. Potential projects have been or would be designed to avoid impacts to existing public water supply infra-structure and operating facilities.

4.1.14 Comprehensive Plan Socio-Economic Impact

The socio-economic impacts that result from the MsCIP Comprehensive Plan are several fold and have been fully discussed and evaluated in the Economic Appendix. They include impacts to populations, sales-volume, income, and employment as represented in Table 4-2. Recognizing that the Comprehensive Plan for coastal Mississippi has multiple tiers of features, project impacts to socio-economics are as follows: for all of the recommended projects, except for the HARP, positive RED benefits would be anticipated and include sales, income, and employment. For the HARP, all of the four above RED benefits would possibly be impacted; however, further NEPA documentation would be required before construction of this project. For the ecosystem restoration and ring levee areas in Pearlington, Bay St. Louis, Ocean Springs, Gautier, Gulf Park Estates, Belle Fontaine, and Pascagoula/Moss Point, which are being recommended for further study, further data collection and coordination through the NEPA and the Corps evaluation processes would need to be conducted, and socio-economic impacts would be addressed and evaluated in much greater detail at that time.

4.1.15 Comprehensive Plan Land Use Impact

Over the last several decades, coastal Mississippi has experienced large development and, as a result, the environmental landscape has undergone significant changes. High-density urban land in coastal Mississippi has increased twice as much as the population has between 1992 and 2000. Impervious surfaces have increased about 50 percent more than developed land but less than population. Hurricane Katrina devastated coastal Mississippi, which could result in potential changes in land uses. Rebuilding is currently underway at moderate levels. Potential components of the Comprehensive Plan could dramatically alter current land uses.

Barrier Island Restoration

Alteration of land use is expected due to the change from filling in of water bottoms being converted to sandy barrier islands resulting in expanded acreage. It is anticipated this change in land use would be insignificant as the islands would be expanded to historical sizes and the relative size of the project to the surrounding land use. Environmental restoration and construction of a dune feature would provide a benefit to current land use as restoration would provide enhancement to the existing environment. Restoration of sea grasses would result in an enhancement of the water bottoms and existing seagrass beds as a result of implementation of this measure. The project would result in a positive benefit to land use.

Table 4-2
Summaries of Benefits and Costs for Measures Recommended for Implementation

	Equivalent annual damages Reduced Future 3 (Annual $)	Recreation (Annual $)	Environmental Impacts	Changes in Sales Volume ($)	Changes in Income ($)	Changes in Employment	Total First Cost with IDC[2] ($)	Average Annual Cost (Annual $)
Barrier Island Restoration	$18,028,000	$466,000	$43,618,000 Fishery Losses Avoided	$798,984,000	$167,850,000	4,920	$551,134,800	$29,608,000
Beach and Dune Placement	Moderate Reduction	N/A	736 Functional Habitat Index (FHI) Score	$33,413,200	$7,307,000	208	$25,192,300	$1,353,000
Acquisition in High Risk Areas	$22,000,000 to $33,000,000	Potential Recreational Opportunities	Potential Restoration Opportunities	$3,238,602,000	$706,330,000	19,452	$459,442,100	$24,682,000
Waveland Pilot	Reduced risk to 25 Homes	N/A	N/A	$8,850,000	$2,130,000	50	$4,864,000	$261,000
SAV Pilot	N/A	N/A	5 acres submerged aquatic vegetation	$1,800,000	$434,000	10	$957,600	$51,000
Forrest Heights 21-FT Ring Levee	$89,000	N/A	3 6 Acres Impacted	$30,425,000	$6,440,000	193	$14,482,500	$778,000
Admiral Island Ecosystem Rest.	Increased Surge Storage	N/A	60 Average Annual Functional Units (AAFU)	$49,750,000	$ 11,996,000	301	$22,997,000	$1,235,000
Turkey Creek Ecosystem Rest.	Increased Surge Storage	N/A	1,565 Average Annual Functional Units (AAFU)	$15,237,000	$3,226,000	97	$7,206,300	$387,000
Bayou Cumbest Ecosystem Rest.	Increased Surge Storage	N/A	188 Average Annual Functional Units (AAFU)	$54,073,000	$ 10,546,000	306	$26,917,800	$1,446,000
Dantzler Ecosystem Rest	Increased Surge Storage	N/A	1,244 Average Annual Functional Units (AAFU)	$ 5,054,000	$ 986,000	29	$2,331,800	$125,000
Franklin Creek Ecosystem	Increased Surge Storage	N/A	516 Average Annual Functional Units (AAFU)	$3,890,000	$ 759,000	22	$1,960,500	$105,000

1/ These measures were analyzed for economic benefits and do not represent the entire recommended plan features for implementation. See the main report for more detail.
2/ Implementation costs are based on ROM cost estimates and an FY 08 price level and do not include escalation. See the engineering appendix for more details on the

Elevated Roadways and Seawalls

There should be no significant changes to current land use as the potential measure would modify existing beachfront roadways. The existing roadways are within developed areas and impacts from expanding the footprint to gain in elevation should be minimal due to the highly developed nature of the site. Within Hancock County, existing crossings of marsh areas create opportunities for expansion of existing bridged areas, which would result in more natural conditions. This would result in slight changes to existing land use as old fill material could be removed resulting in enhanced natural marsh systems. Within Harrison County, it is expected current land use would remain unchanged as the project site is currently comprised of a 4-lane U.S. Highway throughout the length of the beachfront. No significant impacts to current land use are anticipated. Modification to existing seawalls, if necessary, would not result in changes to current land use as the entire beachfront consists of previously constructed seawalls along the southern edge of existing roadways.

Ring Levees

Implementation of this measure could result in changes in land use under the footprint and outside the levee construction. Impacts could be avoided or minimized by alternate alignments resulting in less linear footage of levee constructed. There could be impacts to developed areas, such as established residential neighborhoods, as well as more natural areas, such as drainage ways and wetlands. Current land use within the boundary of the ring levee could remain the same or potentially improve. Construction of the ring levee would provide additional protection for citizens and would allow the community to rebuild inside the ring levee rather than relocate. Further studies during project development would determine the full extent of impacts associated with this measure.

Inland Barriers

The inland barrier would involve construction of a continuous levee aligned atop the existing elevated railroad berm. Changes in land use would occur in areas where the proposed levee would align over existing neighborhoods, which may result in fracture of communities; however, much of the residential areas within this portion of coastal Mississippi experienced catastrophic destruction resulting from the storm surge associate with Hurricane Katrina and remain in a state of disrepair. Construction of this measure would allow neighborhoods to safely rebuild landward of the levee which would help repair existing devastated neighborhoods. Further studies prior to project development and design would determine the extent of damage to current land use.

Surge Barriers

Construction of surge barriers would require the direct filling and construction of surge gates on water bottoms across the Bay of St. Louis and Biloxi Bay. This would result in losses to productive water bottoms. This measure would have adverse impacts to current land use. Further studies prior to project development and design would determine the extent of damage to current land use.

Non-Structural

The non-structural approach takes into account existing conditions within different areas of coastal Mississippi. The measure recommended within an area is very site specific based on existing conditions, objectives of the non-structural approach, and expectant public benefits. Elevation of buildings would result in a benefit to current land use by increased elevations above flood levels as appropriate. Flood-proofing measures would not have a significant impact to current land use as the projects would occur on existing structures. Potential purchases of properties could have a significant impact to current land use as large areas would be purchased and existing residential or businesses would be relocated elsewhere outside of high hazard areas. Implementation of this measure could result in fractured communities, relocation of central areas that hold public sentiment, etc. Further consideration is warranted in conjunction with development of this program, in order to identify specific impacts to each small intricate part of larger communities. Although the measure would provide these benefits, there would be adverse impacts associated with relocation construction and secondary development. Further studies would determine the extent of impacts and benefits to current land use.

Environmental Restoration

The environmental restoration approach identifies problems within the natural system and recommends several measures that could be implemented based on existing conditions and objectives. Restoration of historical wetlands could cause a significant impact to current land use by the purchase of areas that have been developed. Impacts could involve relocation of neighborhoods, businesses, etc., which could impact the overall character of small nuances within communities. Positive impacts would include restoration of primary land use that once existed naturally prior to development. Freshwater diversion projects would enhance existing degraded estuarine habitats by introduction of freshwater into areas suffering from saltwater intrusion. This would provide a benefit to current land use. Further studies would warrant specific impacts as potential projects are being developed.

4.1.16 Comprehensive Plan Aesthetic Resources Impact

As projects would be constructed, aesthetics would be temporarily reduced in the immediate vicinity of the proposed project sites. Many recreational vessels utilize Mississippi Sound within the project vicinities and it is believed some residents and visitors may be disturbed by the presence of required heavy equipment during any construction phases. However, construction activities would be temporary in nature so the disturbance would be anticipated to be minimal at each potential project site. There could be times when numerous projects throughout coastal Mississippi would be occurring at once or potential project phases could be scheduled upon completion of requisite projects which would take extended amounts of time. The completed projects should provide residents and visitors with an overall more aesthetically pleasing view as projects are completed. Environmental restoration projects would provide additional fish and wildlife habitat to numerous shore birds and various wildlife species which would enhance coastal Mississippi and its diverse aquatic habitats while providing future sustainability of the natural system.

4.1.17 Comprehensive Plan Cultural Resources Impact

Cultural building and site assessments began almost immediately after the storm in early September 2005. The NPS and the Mississippi Department of Archives and History have led efforts in damage assessments to cultural properties and still have much work ahead of them. Additionally, the Mississippi Heritage Trust, and the National Trust for Historic Preservation have been working closely with assessment teams. The National Center for Preservation Training and Technology (NCPTT), a branch of the NPS, developed a series of checklists designed to be used by Federal Emergency Management Agency (FEMA) volunteers and professional preservationists to compile uniform data on the post-storm condition of cultural properties. The checklists, known as a "Rapid Building and Site Condition Assessment" and a "Detailed Building and Site Condition Assessment" incorporate information including the property description, potential safety hazards that would prevent someone from getting near the property, basic evaluations of structural integrity or the presence of exposed archaeological material, recommendations, and graphs for a field sketch of the site. These forms made it possible for a task force to gather enough data to create an initial status report for Hancock, Harrison, and Jackson counties as well as several other counties to the north. Although the report released by the NPS Task Force is general in nature, the extreme extent of the damage recorded is readily noticeable (Table 4-3). Most efforts have been directed at studying the architectural rather than archaeological resources, but the amount of damage suffered by both types is staggering. The efforts documented in Table 4-3 below are some of the earliest accounts, and much more work remains to be done to fully account for and assess the damage sustained to Mississippi's coastal cultural properties.

1 **Table 4-3**
2 **General Cultural Property Assessment for the Mississippi Coast**

STATE OF MISSISSIPPI	INSTITUTION OR SITE	STATUS
Hancock County		
Bay St. Louis	Multiple properties	Two of 5 National Register Districts destroyed. 90% of remaining properties that were assessed are judged salvageable.
Harrison County		
Biloxi	Beauvoir, The Jefferson Davis Home and Presidential Library	Home: Aerial photo shows holes torn in slate roof and galleries (porches) missing. Library: Built to withstand category 5 hurricane; first floor washed out by storm surge. Portraits salvaged after event additional recovery of artifacts begun. Archeologist assisting in recovering artifacts from debris scattered over 60-acre site. Historic library pavilion, Hayes cottage, Soldier's Home Barracks replica, Confederate Soldier's Museum, Gift shop, and director's home destroyed. Replicas of destroyed buildings will be built after restoration of Beauvoir and Presidential Library. Sewage contamination to pond behind Beauvoir to be addressed (as of 11/14).
Biloxi	Breilmaier House (c. 1895)	Destroyed.
Biloxi	Biloxi Cemetery	Many trees uprooted; markers broken.
Biloxi	Dantzler House	Destroyed.
Biloxi	Maritime and Seafood Industry Museum	A portion of the building remains. Some artifacts salvaged, including lens from Ship Island lighthouse.
Biloxi	Ohr-O'Keefe Museum of Art	Aerial photo shows two of five buildings in new museum complex left (JLH). Pleasant Reed House destroyed (DP).
Biloxi	Tullis-Toledano Manor	Aerial photo shows Tullis-Toledano House (c. 1860) destroyed (under the displaced casino barge); Tullis Slave Quarters (c. 1860) destroyed; Crawford House (c. 1850) destroyed
East Ship Island	Gulf Islands National Seashore, French Warehouse and associated cemetery, Quarantine Station	Quarantine Station site submerged, under 5-6 feet of water; French Warehouse site and cemetery sustained damage but are accessible.
Jackson County		
Ocean Springs	Gulf Coast Research Laboratory	Coast Guard permitted access to collections on 9/15/05. Collections flooded. NPS Incident Management Team assisting with recovery of herbarium and hazardous tree and debris removal.
Ocean Springs	Gulf Islands National Seashore	Storm surge flooded exhibits and museum collections at Davis Bayou Visitor Center. Museum Emergency Response Team is stabilizing collections. Collections moved to NPS Southeast Archeological Center and Timucuan Ecological and Historic Preserve. Frozen archives to be shipped and treated off-site. See report for Gulf Coast Research Laboratory where some park herbarium specimens are stored.
Ocean Springs	Shearwater	Most of the work of Anderson Family potters destroyed;

STATE OF MISSISSIPPI	INSTITUTION OR SITE	STATUS
		12 of 15 buildings destroyed
West Ship Island	Gulf Islands National Seashore Ft. Massachusetts; reconstructed Ship Island Lighthouse	Storm surge flooded and damaged fort: earthen berm damaged, large granite blocks dislodged and in moat, interior filled with mud and debris several inches thick. Most of the mud removed by 10/13/05. Extent of damage to Rodman cannon, artifacts and exhibits unknown. Conservator visit scheduled. Reconstructed lighthouse destroyed. Archeologist surveyed 9/19. Parts of the fort's rampart were breached by storm surge. Domed surface of casements exposed when earthen berm removed by storm. Sally Port damaged, extensive beach erosion. Cannon carriage flooded by salt water, but not cannon. Brick foundation and scattered brick, probably associated with archeological remains of lighthouse, identified.

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4.1.17.1 Expected Impacts to Resources

Once a full assessment of damage is complete, we can expect to see the destructive impacts to cultural properties caused by Hurricane Katrina to fall under two categories: direct and indirect. Direct impacts should include damage directly caused during the storm by surging water, wind and flying debris, while indirect impacts would be those caused largely by the effects of standing water, exposure to the elements, or mold and decay due to water saturation. These impacts will differ slightly between archaeological and architectural resources.

4.1.17.2 Direct Impacts

Properties directly in the path of the storm surge appear to have suffered the most damage. Many of the historic homes and mansions that lined the shoreline highways were completely demolished. Some of the more well known historic properties along Beach Boulevard in Biloxi that are now completely gone include the Dantzler House, the Breilmaier House, the Pleasant Reed House, and the Tullis-Toledano mansion.

The Dantzler House lay in splinters behind the bronze statue of Pierre Le Moyne d'Iberville. The Breilmaier House, built in 1895, was reported missing and may have been sighted "floating down the street during the storm" (Williams 2005). The only remaining evidence of the Pleasant Reed House, a shotgun style house built in 1887, is the chimney (ibid). Also, the Tullis-Toledano mansion was found flattened under a casino barge (ibid). Reassuringly, the Beauvoir Mansion, Jefferson Davis's home designated as a National Historic Landmark is substantially damaged, but the main portion of the house remains standing. The first floor of the presidential library is destroyed as well as several cottages on the grounds, but many of the most valuable artifacts were removed prior to Katrina's landfall and survive. Additionally, because of Beauvoir's status as a National Historic Landmark, funds will be set aside eventually for its refurbishment.

Because archaeological sites are unique resources in that they cannot be recreated or restored, the damage many have sustained is irreparable. Several have had huge chunks gouged out by wayward fishing vessels beached on top of the remains of ancient American Indian coastal settlements. Wave scour, and giant uprooted trees have cleared 2,000 year old mounds immediately along the coastline of vegetation and exposed them for further erosion and looting. Shipwrecks that were once buried under several feet of sand have been exposed, and will suffer accelerated degradation as the wooden hull timbers dry into dust. The full extent of the loss is yet to be fully documented, and the work and funding required to salvage any remaining information is yet to be fully estimated.

4.1.17.3 Indirect Impacts

Archaeological resources where most of the resources lie below the ground or on the ground surface can be expected to suffer indirect effects from exposure of materials to sunlight that previously were kept in the dark moist earth. Materials, such as bone, oxidized metal, and organic remains, will dry and become brittle or may disintegrate. Also, the loss of vegetation that once held a site in place and obscured artifacts from view will cause site erosion. Other issues will occur as a result of materials becoming exposed that may be attractive to looters. Alternately, archaeological resources that were close to the shore and located on dry ground before the storm may now be permanently inundated, or in a surf zone and subject to constant erosion by sand and tidal action. Conversely, architectural resources where most of the resource lies above the ground can be expected to suffer from mold and mildew, and the rotting of wood and other materials. Additionally, sunlight and air can access portions of the structure and allow vegetation to take over and cause damage with the roots. Wood and cellulose eating insects will cause a loss of structural integrity and irreversible damage to furnishings that otherwise made it through the storm intact. As with archaeological resources, the threat of theft is present when objects of value are exposed to the outside or left unattended.

Mobile District archaeologists are closely coordinating with the State of Mississippi Department of Archives and History regarding potential impacts associated with potential measures being considered in the Comprehensive Plan. Additionally, FEMA and the Mississippi Development Authority are conducting individual cultural resources analyses in conjunction with their identified projects. Mobile District archaeologists will be given access to other agency's findings and reports and will be informed as additional projects are being analyzed regarding cultural resources. Once specific projects become funded, cultural resources analysis would occur on an individual project basis to ensure compliance.

Many of the current analyses that might be needed could actually be in duplication of what is currently being conducted by other agencies. Ongoing coordination with SHPO and other agency representatives will help to prevent duplication of efforts for cultural resources compliance.

4.1.18 Comprehensive Plan Hazardous, Toxic, and Radioactive Wastes Impact

Quickly after Hurricane Katrina, the EPA working with the National Strike Team and other national search and rescue teams began identification and cleanup of the HTRW and other hazardous type debris. The EPA established partnerships with various national and local teams involved with debris cleanup. The Corps team coordinated with them regularly and provided coordinates/locations of HTRW that were located during vegetative and construction type debris cleanup. The EPA working with others were charged with the responsibility of final cleanup of this type debris after the storm event.

Site inspections would be conducted at and adjacent to the various components of the Comprehensive Plan during development of specific plans and specifications in accordance with the requirements of ER 1165-2-132 entitled, HTRW Guidance for Civil Works Projects, and the American Society of Testing and Materials Standard E 1527. Inspections would be accomplished to determine the presence or evidence of landfills, surface areas unable to support vegetation, visible sheens of petroleum product, nearby contaminated industrial facilities, or any type of visible indication that HTRW concerns exist that may impact any component of the recommended plans during specific project development. Site inspections of adjacent properties, reviews of historic aerial photographs, on site interviews, and environmental database record searches would be conducted to determine any evidence of HTRW concerns that may impact any component of the recommended plans during specific project development.

Based on the findings of the HTRW site assessments, specific or unusual environmental concerns that are identified that could affect construction of any proposed projects would be addressed appropriately. Additional supplemental environmental impacts statements or environmental analyses may be necessary once specific projects have been identified and development of project plans has begun. HTRW issues and concerns would be addressed during the required NEPA compliance and documentation.

4.1.19 Comprehensive Plan Unavoidable Adverse Environmental Effects

Initial screening criteria were established and applied to potential projects based on their technical and environmentally feasibility. This initial screening resulted in certain measures not being considered further, for example, surge gates crossing of Pascagoula and Pearl Rivers and across expanse marshes on the eastern and western boundaries of the state. Additional screening criteria were applied to potential projects which further still eliminated potential projects early on. Additional study would be needed in order to further develop potential projects identified in the Comprehensive Plan and a multi-disciplined project delivery team would analyze alternatives in order to further reduce adverse impacts associated with specific project components. Every reasonable effort will be made to ensure that unavoidable adverse environmental effects that could not be avoided would be temporary and localized, minor and short term in nature, or fully mitigated as necessary to reduce impacts.

4.1.20 Comprehensive Plan Irreversible and Irretrievable Commitments of Resources

The potential for significant irreversible or irretrievable commitments of resources involved in all of the proposed projects have been considered and are unanticipated at this time. Further evaluation will be conducted to determine if any of the proposed plans would present minor impacts in this area.

4.1.21 Comprehensive Plan Environmental Justice Impact

On February 11, 1994, President Clinton issued EO 12898, *Federal Actions to Address Environmental Justice in Minority and Low-Income Populations.* The EO is designed to focus attention of Federal agencies on the human health and environmental conditions in minority communities and low-income communities. Environmental Justice analyses are performed to identify potential disproportionately high and adverse impacts to these communities and to identify alternatives that might mitigate these impacts. EO 12898 requires that Federal agencies conduct their programs, policies, and activities that substantially affect human health or the environment in a manner that ensures that such programs, policies, and activities do not have the effect of excluding persons (including populations) from participation in, denying persons (including populations) the benefits of, or subjecting persons (including populations) to discrimination under such programs, policies, and activities because of their race, color, or national origin.

On February 11, 1994, the President also issued a memorandum for heads of all departments and agencies, directing that EPA, whenever reviewing environmental effects of proposed actions pursuant to its authority under Section 309 of the CAA, ensure that the involved agency has fully analyzed environmental laws, regulations, and policies.

The MsCIP Comprehensive Plan is not designed to create a benefit for any specific group or individual. Any potential measures would not create disproportionately high or adverse human health or environmental impacts on minority or low-income populations within the study area. Review and evaluation of the overall comprehensive plan have not disclosed the existence of identifiable minority or low-income communities that would be adversely impacted by proposed measures. Further studies during project development would determine specific impacts associated with implementation of potential measures. The following analysis will serve as a beginning point from which further analyses can be built upon during the comprehensive plan components.

Data from the U.S. Department of Commerce, Census of Population and Housing were used for the Environmental Justice analysis. The population in 2005 for Mississippi was 2,908,456. Minority populations included in the census are identified as Black or African American, American Indian and Alaska Native, Asian, Native Hawaiian and other Pacific Islander, Hispanic, of two or more races, and other. Mississippi is second to the District of Columbia as having the largest Black or African American population. In 2005, Mississippi ranked number one out of the 50 states for individuals living below the poverty level in the past 12 months. Mississippi had 21.3% of its population living in poverty in 2005.

Coastal Mississippi has a lower percentage of minority residents than the State of Mississippi and the U.S. In 2000 (the most up-to-date data available), 79.6 percent of the population was white and 16.3 percent was black. All other racial groups combined totaled approximately 4.1 percent of the population, while 2.2 percent were of Hispanic origin. In Mississippi, 61.4 percent of the population was white, 36.3 percent was black, 2.3 percent was of another minority racial group, and 1.4 percent was of Hispanic origin. For the U.S., 75.1 percent of the population was white, 12.3 percent was black, and 12.6 percent was of other minority racial groups. Approximately 12.5 percent of the U.S. population was Hispanic.

The Census Bureau bases the poverty status of families and individuals on 48 threshold variables, including income, family size, number of family members under the age of 18 and over the age of 65, and amount spent on food. In 1997, approximately 14.6 percent of the residents were classified as living in poverty, lower than the State of Mississippi but slightly higher than the poverty rate for the U.S. as a whole.

As of 2006, the population in Mississippi was 2,910,540 – of this 135,940 individuals live in Jackson County, 193,810 live in Harrison County, and at this time a population count for Hancock County was not available. Hurricane Katrina drew focus on the number of residents unable to flee the Gulf coast due to lack of funds. There is a longstanding legacy of unfair and disproportionate harmful exposures to low income, predominantly African American communities in much of Mississippi. Predominantly in the Biloxi area but also in other coastal Mississippi communities, there was a large population of Asian Americans that depended upon fishing for their livelihood. Adverse impacts from Hurricane Katrina have resulted in a large number of these individuals leaving the area.

Environmental Justice concerns in coastal Mississippi have arisen from years of industrial activity and waste disposal practices that hit these vulnerable communities harder than higher income, predominantly white communities. Impacted areas, such as superfund facilities, are found more often in low-income areas and therefore are at greater risk to post-Katrina exposure. As clean-up proceeds and rebuilding begins, every effort must be made to remedy these environmental injustice inequities through full clean-up, fair rebuilding practices, and full partnership with affected communities. Over 30,000 families are being helped through Administration on Children and Families Temporary Assistance for Needy Families (TANF) program by the provision of short term, non-recurrent cash benefits to families who traveled to another State from the disaster designated States. The hurricane-damaged States of Mississippi, Louisiana, and Alabama also received additional funding for the TANF program to provide assistance and work opportunities to needy families ($69 million for loan forgiveness and $25 million in contingency funds for State Welfare Programs.) Counties along the Mississippi Gulf coast lost a sizeable share of their white residents and homeowners immediately following Hurricane Katrina, while other Gulf Coast metropolitan areas, especially those that gained residents, experienced little overall shifts in their demographic profiles. Coastal counties of Mississippi, which include Gulfport-Biloxi and Pascagoula metropolitan areas, in contrast to New Orleans, were left with a population that had a larger share of minority residents, a lower level of homeownership, and no significant decline in poverty. In essence, while the poor and less well-off residents of New Orleans bore the greatest brunt of Katrina, the storm had a more egalitarian effect on the population of coastal Mississippi. Examination of the data for other hurricane impacted areas in the Gulf Coast region reveals that while a great deal of population shifting had occurred, only minor changes have taken place in the race and ethnic, economic and socio-demographic profiles for most of these areas.

Every measure or alternative (e.g., Forrest (Forest) Heights) examined in the MsCIP study was evaluated for its potential for adverse impacts to minority and/or low-income populations, in adherence with EO 12898. In no case was there any identified negative impact to any of these communities in regards to human health and environmental conditions, from any proposed actions or projects. However, because no plans for structural or non-structural protection of residences or businesses have been vetted by community leaders or the public at more than a concept level, it is impossible to say at this time whether or not any of these measures, as ultimately acted on over the long-term, would have a significant effect, either positive or negative, on low-income or minority populations.

In fact, the realities of living in a high hazard area, which grows more hazardous as one approaches the shoreline, will supersede the effect of any plans or projects pursued under any outside authority. The reality is that most low-income populations, some of whom are also minorities, will have a hard time rebuilding in high hazard areas simply due to the cost of homeowners or business insurance, which will be a requirement of the vast majority of lending institutions. In the more than three years since the hurricanes of 2005, the majority of rebuilding has been undertaken by those that can self-insure their homes or businesses, and also can afford to rebuild with their own resources, something the vast majority of the population, in addition, to the low income families cannot do. Therefore, the economic nature of communities along the coast of Mississippi is changing largely due to the economic status of those that can afford to rebuild and insure their properties, versus those that cannot.

And, while some structural measures might protect areas in which low-income residents might rebuild, those measures would only provide damage reduction for surge events, and not wind. The cost of insurance against wind damage, which would continue to be a requirement of lending institutions, may continue to drive the economics of whether one can or cannot afford to rebuild traditional residences or businesses within the highest hazard zones.

Non-structural measures intended for acquisition and removal of the most risky structures would tend to affect all residents or businesses located in those zones, low-income and high-income alike. However, well-armored structures, such as high-rise concrete complexes, would likely be the most survivable structures in highest hazard zones. The income levels required to live in those complexes will also likely drive a change in the socioeconomic and racial mix of residents in these zones. A question remains whether any of the complexes would contain apartments that have low / subsidized rental rates. This is a decision that would be made by local governments, who are responsible for zoning ordnances, land-use and development decisions. This is outside of the MsCIP study team's authority or ability; therefore, it will not be affected by the Comprehensive Plan. Ultimately, the plan adopted for the Mississippi coast will not be a plan forced on them by the Corps or other Federal agencies, but a plan coordinated, discussed, and finally adopted by the numerous entities and individuals that will live with that plan, the residents and local government of coastal Mississippi.

4.1.22 Comprehensive Plan Protection of Children Impact

The EO 13045, Protection of Children from Environmental Health Risks and Safety Risks (April 21, 1997), recognizes a growing body of scientific knowledge that demonstrates that children may suffer disproportionately from environmental health risks and safety risks. These risks arise because children's bodily systems are not fully developed; because children eat, drink, and breathe more in proportion to their body weight; because their behavior patterns may make them more susceptible to accidents. Based on these factors, the President directed each Federal agency to make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children. The President also directed each Federal agency to ensure that its policies, programs activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.

It is anticipated that no disproportionate risks to children would occur as a result of implementation of the Comprehensive Plan. Further studies during project development phase would determine any activities that might pose any disproportionate environmental health risks or safety risks to children and would be conducted during project development.

4.1.23 Comprehensive Plan Cumulative Effects

Council on Environmental Quality (CEQ) regulations stipulate that the cumulative effects analysis within an environmental document should consider the potential environmental impacts resulting from "the incremental impacts of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions" (40 Code of Federal Regulations [CFR] 1508.7). CEQ guidance in *Considering Cumulative Effects under the National Environmental Policy Act* (CEQ 1997) affirms this requirement, stating that the first steps in assessing cumulative effects involve defining the scope of the other actions and their interrelationship with the proposed action. The scope must consider geographic and temporal overlaps among the proposed action and other actions. It must also evaluate the nature of interactions among these actions. Cumulative effects are most likely to arise when a relationship or synergism exists between a proposed action and other actions expected to occur in a similar location or during a similar time period. Actions overlapping with or in close proximity to the proposed action would be expected to have more potential for a relationship than those more geographically separated. Similarly, actions that coincide, even partially, in time would tend to offer a higher potential for cumulative effects.

To identify cumulative effects, the analysis needs to address three fundamental questions:

1. Does a relationship exist such that affected resource areas of the proposed action might interact with the affected resource areas of past, present, or reasonably foreseeable actions?

2. If one or more of the affected resource areas of the proposed action and another action could be expected to interact, would the proposed action affect or be affected by impacts of the other action?

3. If such a relationship exists, then does an assessment reveal any potentially significant impacts not identified when the proposed action is considered alone?

The scope of the cumulative effects analysis involves both the geographic extent of the effects and the timeframe in which the effects could be expected to occur. For this Integrated EIS, the region of influence (ROI) consists of all of coastal Mississippi, also into the adjacent states, such as Alabama and Louisiana, and extending southward into Mississippi Sound and the Gulf of Mexico. Numerous other activities exist in the ROI. The activities described here are not completely inclusive, but they do serve to highlight some major influences in the region and to provide perspective on the contribution to any impacts generated by the proposed action.

Within coastal Mississippi, recovery work to clean up and rebuild following the landfall of Hurricane Katrina in August 2005 would continue to occur. The majority of this work would occur onshore, where there would be potential for interaction with the proposed action. The MsCIP PDT has been coordinating with the responsible entities to ensure that no significant adverse direct cumulative impacts would result.

Plans are in place to increase the size of the Gulfport and Pascagoula Federal Navigation Channels, within the Mississippi Sound to their authorized dimensions. These Federal navigation channels were excluded from Gulf sturgeon critical habitat (FR Vol. 68, No. 53). The Gulfport Harbor project plans to utilize beneficial use sites for a portion of new work material (Chandeleur Islands) and the ODMDS site offshore. The proposed Pascagoula River Harbor Dredged Material Management Plan involves raising the existing dike height of Triple Barrel, constructing the 425-acre site adjacent to SRI, using the revised open-water disposal site #5, continuing utilization of existing open-water disposal sites, and where feasible, utilizing beneficial use sites. Based on this and the fact that the construction of these projects would improve the economic benefits to the ROI, no significant direct cumulative impacts are expected to result.

Plans under the MsCIP Interim Projects are in place to beneficially utilize material from maintenance dredging of a segment of navigation channels and/or approved upland sites to create beaches and/or emergent tidal marsh habitats, such as Bayou Caddy, Pascagoula Beach, Harrison County dunes/beaches. In addition, other MsCIP Interim Projects restore channels that meander through communities in order to increase flushing of those streams. Other projects still repair and/or purchase damaged structures, such as Franklin Creek and Bay St. Louis. It is possible that construction of these projects would occur close in time to the MsCIP Comprehensive effort; however, no significant adverse direct cumulative impacts are expected to result. Table 4-4 provides an overview of the cumulative effects associated with components of the Comprehensive Plan being recommended for construction.

Table 4-4
MsCIP Comprehensive Plan Phase I Cumulative Effects

Proposed Restoration Project	Portion of the Ecotone to be Addressed	Ecological/Societal Functions to be Addressed	Acres of Habitat to be Restored
High Hazard Risk Reduction Program	Restore natural buffers	Relocation of human development out of the coastal ecotone for public safety zone	TBD
Moss Point Municipal Relocation Component	Restore natural flooding buffer	Restore natural buffer zone, relocation of human development out of the coastal ecotone for public safety	NA
Waveland Floodproofing	Restore natural flooding buffer	Restore natural buffer, elevation of human development within the coastal ecotone for public safety zone	NA
Forest Heights Hurricane and Storm Damage Reduction Component	Reduces flooding	Adds protection to human development out of the coastal ecotone for public safety zone	NA
Turkey Creek Ecosystem Restoration	Wet Pine Savannah Wetlands	Enhanced productivity of wetlands Removes structures from project area	689 acres of wet pine savannah
Dantzler Restoration Area Ansley	Wet Pine Savannah Wetlands	Enhanced productivity of wetlands	385 acres of wet pine savannah
Franklin Creek Ecosystem	Wet Pine Savannah	Moves Residents out of Harms Way (MsCIP Interim Project)	149 acres of wet pine savannah

Proposed Restoration Project	Portion of the Ecotone to be Addressed	Ecological/Societal Functions to be Addressed	Acres of Habitat to be Restored
Restoration	Wetlands	Enhanced productivity of wetlands	
Bayou Cumbest Ecosystem Restoration	Emergent Tidal Marsh Scrub/Shrub	Enhanced productivity of emergent tidal wetland, habitat enhancement, relocation of human development out of the coastal ecotone for public safety	110 acres of emergent tidal 38 acres of scrub/shrub
Admiral Island Ecosystem Restoration	Emergent Tidal Marsh Scrub/Shrub	Enhanced productivity of emergent tidal wetland, habitat enhancement, relocation of human development out of the coastal ecotone for public safety	62 acres of emergent tidal marsh 61 acres of scrub shrub habitats
SAV Pilot Project at Bayou Cumbest	SAV – *Ruppia maritime*	Enhance fishery production	5 acres of SAVs
Beach and Dune Ecosystem Restoration	Coastal Dune Habitat	Buffer mainland from storm surge and waves energy	105 acres of dune
Barrier Island Restoration	Littoral zones, beach, dunes, emergent tidal marsh	Buffer mainland from storm surge and waves energy, enhanced productivity of emergent tidal marsh, enhance productivity of SAVs in littoral areas, enhance fisheries production	456 acres of tidal habitat 694 acres of nontidal habitat
Deer Island Ecosystem Restoration	Coastal Forests, Emergent Tidal Marsh	Enhanced productivity of wetlands	50 acres of emergent tidal marsh 116 acres of dune and beach habitat 78 acres of coastal maritime forest

4.2 High Hazard Area Risk Reduction Plan

The HARP would provide an effective means to induce and assist devastated and displaced property owners in relocating outside of high hazard surge-plain throughout coastal Mississippi. Acquisition of those properties where the residential owners have not yet rebuilt and continue to be displaced presents a unique window of opportunity to assist landowners while minimizing cost to the U.S. Government. The HARP, an acquisition strategy, would provide a non-structural alternative for reducing future property damage resulting from hurricanes, storm surge and flooding, and by extension, reducing threats to lives in those areas, in the most hazardous areas throughout coastal Mississippi.

A Record of Decision for construction is not being requested for the HARP, but the potential environmental effects are presented as reasonably foreseeable actions for the consideration of cumulative effects

4.2.1 No Action

Houses will either be rebuilt in place or the people will relocate to other areas for various personal or financial reasons. This would likely impact undeveloped lands in the Mississippi area. Should the residences not be rebuilt by original owners, it is believed the land would be sold and redeveloped by other people moving into the area. Thus, it is anticipated that coastal Mississippi would be rebuilt to pre-Hurricane Katrina conditions with more possible condominium development.

4.2.2 HARP Soils Impact

Alteration of soils is anticipated as relocation of properties spurs new development within rural undeveloped areas and fill material is brought in; however, the extent of impacts remain unclear but could be insignificant should small acreages be involved.

4.2.3 HARP Sediments Impact

Silt fences and other BMPs would be used to minimize adverse impacts to the environment during construction activities to the maximum extent practicable. Containment structures, silt curtains, and other BMPs would be used to contain sediment deposition at construction sites. Overall, the physical sediment will not be altered and it is anticipated impacts to sediments would be insignificant.

4.2.4 HARP Geology Impact

There should be no effects to geology. Projects have been designed to avoid impacts to current geological formations.

4.2.5 HARP Climate Impact

There should be no effects to the existing climate.

4.2.6 HARP Air Quality Impact

There should be no change in the existing air quality conditions. Currently all areas within coastal Mississippi are in attainment with the NAAQS. Air quality in the immediate vicinity of project construction would be slightly affected for a period of time by the fuel combustion and resulting engine exhausts. The standards would not be violated by the implementation of the proposed projects.

4.2.7 HARP Noise Impact

Noise from the construction type equipment is expected to increase during the proposed operations in the project vicinities. Noise levels will resume to existing conditions as construction activities are completed. It is anticipated there would be no significant impacts to noise levels during implementation of these measures.

4.2.8 HARP Vegetation Impact

Temporary and minimal effects to vegetation could occur during implementation of this measure; however, properties that would be purchased as part of a HARP program could be restored to historical environmental conditions. This would provide a more natural setting to the coastal environment via planting of native species. It is anticipated that this measure could provide benefits to vegetation. As buildings are relocated, however, adverse impacts could be felt within newly developed areas that are proposed for more natural undeveloped land located nearby. An assessment of potential locations would be conducted prior to redevelopment of those areas in order to minimize adverse impacts.

4.2.9 HARP Fish and Wildlife Impact

Overall, implementation of this measure would have minimal impacts initially to fish and wildlife; however, as properties would be purchased and existing development would be relocated, additional impacts to fish and wildlife and their habitat would be felt in nearby areas in Mississippi. Existing natural habitats that could be affected by implementation of this measure currently remain intact. They are in rural areas and predominantly natural. The main threat that exists today is by increased development and this planning guide would heighten this threat. Valuable habitat could be lost, which could result in losses to the species themselves. Additionally, as development occurs within this natural habitat, potential conflict between wildlife and human population increases. Although impacts to valuable habitat in the existing rural areas would occur, the purchased properties would be restored back to its natural condition resulting in a benefit to fish and wildlife. However, it is anticipated that secondary development in the newly relocated areas could offset benefits gained by restoration of the purchased property. It is expected that environmental measures would result in positive impacts to fish and wildlife and their habitat.

4.2.10 HARP Threatened and Endangered Species Impact

Overall, implementation of this measure would have minimal impacts to listed species; however, as properties would be purchased and existing development relocated, additional impacts to listed species and their habitat would be felt in adjacent areas. An example of concern would be the gopher tortoise. Existing habitats that could be affected by implementation of this measure currently remain intact. They are in rural areas and predominantly natural. There are several other T&E species that could possibly be adversely impacted by implementation of this measure. Initial alternatives will be developed to avoid and minimize impacts to any T&E species. In addition, assessment surveys, in close coordination with the.USFWS, of the proposed relocation areas would be conducted prior to implementation to further reduce potential impacts.

The main threat that exists today is encroachment of development on these valuable T&E habitats and this planning guide would heighten this threat. Valuable habitat could be lost, which could result adverse impacts to the species. Valuable habitat would be restored along the coastal areas where the properties are purchased but possible impacts are still anticipated in adjacent areas. Programmatic consultation would address impacts to listed species in association with implementation of this measure.

4.2.11 HARP Water Quality Impact

BMPs would be utilized during construction activities to ensure stabilization of bare soils in order to reduce run off in adjacent water bodies. The purchase of properties and subsequent environmental restoration, where appropriate, would result in positive impacts to water quality within coastal Mississippi. Emergent tidal marsh, wet pine savannah, and other wetland habitats would be restored in this vital ecotone. A direct positive correlation exists between increased water quality benefits and the presence of wetlands as a result of natural filtering of the runoff prior to entering the coastal water bodies. It is anticipated no significant impacts to water quality would occur as a result of implementation of this measure.

4.2.12 HARP Water Supply Impact

There should be no effect on water supply. Potential projects have been or would be designed to avoid impacts to existing public water supply infra-structure and operating facilities.

4.2.13 HARP Socio-Economic Impact

The HARP will look at the acquisition of 2,000 structures within the high risk area. The implementation cost is estimated to be $407,860,000. It is estimated that the 2,000 structures would take 5 years to acquire, or about 400 structures per year. Based on an FY 08 federal discount rate of 4.875% and a 50-year period of analysis, interest during construction (IDC) would be approximately $50,274,000 for a total first cost plus interest during construction of $459,442,100. This equates to an average annual cost of $24,682,000. The benefits of the HARP were calculated using the HEC-FDA program. The program uses a Monte Carlo simulation to estimate average annual damages. The 2,000 structures were evaluated using a moderate relative sea level rise scenario and were determined to be between $22,000,000 and $33,000,000, or between $11,000 and $16,500 average annual damages per structure. Further, the implementation of this measure would not only move property from these high risk areas, but would also reduce the risk to human health and safety as well as reduce Federal and non-Federal emergency costs resulting from future storm events, and opportunities for recreation or ecosystem restoration exist as alternate uses of the lands.

4.2.14 HARP Land Use Impact

Non-structural projects would result in a positive benefit to current land use by raising buildings above flood elevations where appropriate. Implementation of this measure could have a significant impact to current land use as large areas would be purchased and existing residential or businesses would be relocated elsewhere outside of high hazard areas. Implementation of this measure could result in fractured communities, relocation of central areas that hold public sentiment, etc. Further consideration is warranted in conjunction with development of this program, in order, to identify specific impacts to each small intricate part of larger communities. Although the measure would provide these benefits, there would be adverse impacts associated with relocation construction and secondary development.

4.2.15 HARP Aesthetic Resources Impact

As projects would be constructed, aesthetics would be temporarily reduced in the immediate vicinity of the proposed project sites. It is believed those few residents and visitors still located in the vicinity may be disturbed by the presence of required heavy equipment during any construction phases. However, construction activities would be temporary in nature so the disturbance would be anticipated to be minimal at each potential project site. There could be times when numerous projects throughout coastal Mississippi would be occurring at once or potential project phases could be scheduled upon completion of requisite projects, which would take extended amounts of time. The projects should provide residents and visitors with an overall more aesthetically pleasing view as projects are completed.

4.2.16 HARP Cultural Resources Impact

Significant cultural resources as defined by the NHPA are those sites that are considered eligible for or are included in the National Register. These sites are known as historic properties. Historic properties can include buildings or other standing structures; historic or prehistoric districts (such as the historic districts in Biloxi and Ocean Springs); archaeological sites such as Indian mounds or other remains of prehistoric life; objects such as statues or paintings; or sunken vessels. Traditional cultural properties can also be considered significant cultural resources because of their traditional religious or cultural importance to an Indian tribe or other traditional community.

Properties such as cemeteries or buildings that are less than 50 years old are usually not considered eligible for the National Register, but there are exceptions. For example, certain buildings associated with the Cold War are considered so important to our history that they are eligible for the National Register.

Along the Mississippi Gulf Coast, historic properties can be roughly defined within two categories. The categories are the built environment (standing structures) and archaeological sites. The vast majority of historic properties listed on the National Register are those of the built environment. To date 62 standing structures, 14 historic districts, and one ship have been listed. Many more standing structures are considered eligible for the National Register, but have not been formally nominated. These are also considered potential historic properties. Historic districts have been designated in Biloxi, Ocean Springs, and Bay St. Louis.

In contrast, very few archaeological sites have been formally nominated to the National Register. However, numerous sites still meet the criterion of definition as historic properties. These include prehistoric earthworks and mounds, shell middens, village sites, and historic occupation areas including extinct town sites. Currently over 200 recorded archaeological sites are considered potential historic properties.

In addition to National Register eligible properties, the Mississippi Coast also contains several National Historic Landmarks and designated Mississippi Landmarks. These include Beauvoir and the Mullato Bayou prehistoric earthworks.

The vast majority of historic and prehistoric sites are found along the immediate coastal strand and adjacent to estuarine systems. Preference for well drained, sandy soils adjacent to water sources is apparent. Coast wide survey work performed by both state (Giliberti n.d.) and private researchers (Blitz and Mann 2000) have found a distinctive focus on the immediate coastal and estuarine locations. Unfortunately, the geographic placement of these resources has made them extremely vulnerable to destruction from continued occupation and development, as well as vulnerable to the effects of tropical storms and hurricanes.

Modern development along the Mississippi coast has affected both archaeological sites and standing structures, including individual structures and historic districts in the project area. Key issues are soil disturbance and construction. Soil disturbance affects archaeological sites, and construction of new buildings and associated infrastructure can affect the view shed and "feel" of a historic building or district or cause demolition or alteration of historic buildings.

From the early 1970s to the present, construction in the project area has greatly increased. In fact, more development and construction has occurred in the three counties that are part of the project area than anywhere else in the state. Land use studies show that between 1972 and 2000 both medium-density and high-density urban land use areas increased by more than 90 percent in the study area; overall, developed land use increased by almost 70 percent during that period (MARIS, 1992, 2000; USGS, 1972; USGS and USEPA, 1992). This sizeable increase in developed land is caused in part by the casinos and related infrastructure, residential, and commercial construction. The development involves large areas of soil disturbance, which destroys archaeological sites.

Previous archaeological and architectural studies along the Mississippi Gulf Coast have documented the destruction caused by natural forces, most notably hurricanes. Standing structures are often the most dramatic and visible witnesses to this destruction. However, prehistoric and historic archaeological sites are also extremely vulnerable. Shell middens, found along the immediate shoreline and within coastal marshes and estuaries, often are flipped and re-deposited by the storm surge and wave action of hurricanes. This effectively destroys much of the value of the sites. Sites such as Indian villages and historic town sites such as those along the bluff on Bay St. Louis can also be destroyed by such wave action. In addition, post storm activities offer many more mechanisms for site destruction. These include clearing of timber by use of skidders and other heavy equipment, debris removal, and reconstruction. The destructiveness of these activities is well documented from the years following hurricane Camille which struck the area in 1969.

Mobile District Archaeologists, through long standing coordination relationships developed throughout the years, coordinated closely with the Mississippi Department of Archives and History staff in determining effects of the storm event. Hurricane Katrina has been documented to have destroyed a vast majority of the standing historic properties within Hancock County, and a large number of those within Harrison and Jackson Counties. The size and strength of the storm surge has also undoubtedly had as much destruction on archaeological sites. Post hurricane activities have further impacted the remaining historic properties.

Protection from the immediate and post-effects of hurricanes should be considered as beneficial to cultural resources. While some historic properties may be adversely affected by protection plans, long term prevention of damage should be considered a positive measure for historic properties, in particular standing structures. Mobile District archaeologists are closely coordinating with the State of Mississippi Department of Archives and History regarding potential impacts associated with implementation of the various components of the Comprehensive Plan. Plans are underway to develop an overall process through which potential impacts to cultural and historic resources would be addressed during specific project development. Specific projects would be closely coordinated with the State of Mississippi Department of Archives and History prior to beginning of construction activities.

4.2.17 HARP Hazardous, Toxic, and Radioactive Wastes Impact

Site inspections would be conducted at and adjacent to the various components of the MsCIP Comprehensive Plan during development of specific plans and specifications in accordance with the requirements of ER 1165-2-132 entitled, HTRW Guidance for Civil Works Projects, and the American Society of Testing and Materials Standard E 1527.

Inspections would be accomplished to determine the presence or evidence of landfills, surface areas unable to support vegetation, visible sheens of petroleum product, nearby contaminated industrial facilities, or any type of visible indication that HTRW concerns exist that may impact any component of the recommended plans during specific project development. Site inspections of adjacent properties, reviews of historic aerial photographs, on site interviews, and environmental database record searches would be conducted to determine any evidence of HTRW concerns that may impact any component of the recommended plans during specific project development.

Based on the findings of the HTRW site assessments, specific or unusual environmental concerns that are identified that could affect construction of any proposed projects would be addressed appropriately. Additional supplemental environmental impacts statements or environmental analyses may be necessary once specific projects have been identified and development of project plans has begun. HTRW issues and concerns would be addressed during the required NEPA compliance and documentation.

4.2.18 HARP Unavoidable Adverse Environmental Effects

Although BMPs would be utilized during construction activities, some adverse environmental effects could result during implementation of projects; however, it is anticipated any effects that cannot be avoided should be temporary and localized and would be minor and short-term in nature.

4.2.19 HARP Irreversible and Irretrievable Commitments of Resources

Any irreversible or irretrievable commitments of resources involved in any potential proposed projects have been considered and are either unanticipated at this time or will be considered to determine if any would present minor impacts.

4.2.20 HARP Environmental Justice Impact

EO 12898, Federal Actions to address Environmental Justice in Minority and Low-Income Populations (February 11, 1994) requires that Federal agencies conduct their programs, policies, and activities that substantially affect human health or the environment in a manner that ensures that such programs, policies, and activities do not have the effect of excluding persons (including populations) from participation in, denying persons (including populations) the benefits of, or subjecting persons (including populations) to discrimination under such programs, policies, and activities because of their race, color, or national origin. On February 11, 1994, the President also issued a memorandum for heads of all departments and agencies, directing that EPA, whenever reviewing environmental effects of proposed actions pursuant to its authority under Section 309 of the CAA, ensure that the involved agency has fully analyzed environmental laws, regulations, and policies.

A detailed assessment of the historical and existing conditions from the U.S. Department of Commerce, Census of Population and Housing was presented in Section 4.1.21. Non-structural measures intended for acquisition and removal of the most risky structures would tend to affect all residents or businesses located in those zones, low-income and high-income alike. However, well-armored structures, such as high-rise concrete complexes, would advisedly be the most survivable of those that might exist in the most high hazard zones. But, the choice of income level of those that would be able to afford to live in those complexes will also likely be driven by economics of those that can or cannot afford to do so. A question remains whether any of the complexes would contain apartments that have low rental rates. This is a decision that would be made by local governments, whose responsibility it is to control zoning ordnances, land-use and development decisions. This is outside of the MsCIP study team's authority or ability; therefore, it will not be affected by the Comprehensive Plan Report. Ultimately, the plan adopted for the Mississippi coast will not be a plan forced on them by the Corps or other Federal agencies, but a plan coordinated, discussed, and finally adopted by the numerous entities and individuals that will live with that plan, the residents and local government of coastal Mississippi.

The HARP is not designed to create a benefit for any specific group or individual. In fact, it would help many individuals, including minorities and low-income, that are currently unable to rebuild their homes finding housing. Any potential HARP efforts would not create disproportionately high or adverse human health or environmental impacts on minority or low-income populations within the study area. Review and evaluation of the overall MsCIP Comprehensive Plan have not disclosed the existence of identifiable minority or low-income communities that would be adversely impacted by proposed measures. Further studies during project development would determine specific impacts associated with implementation of potential measures.

4.2.21 HARP Protection of Children Impact

The EO 13045, Protection of Children from Environmental Health Risks and Safety Risks (April 21, 1997), recognizes a growing body of scientific knowledge that demonstrates that children may suffer disproportionately from environmental health risks and safety risks. These risks arise because children's bodily systems are not fully developed; because children eat, drink, and breathe more in proportion to their body weight; because their behavior patterns may make them more susceptible to accidents. Based on these factors, the President directed each Federal agency to make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children. The President also directed each Federal agency to ensure that its policies, programs activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.

It is anticipated that no disproportionate risks to children would occur as a result of implementation of the HARP. Further studies during project development phase would determine any activities that might pose any disproportionate environmental health risks or safety risks to children.

4.3 Site-Specific Components of the Comprehensive Plan

Two very large site-specific components of the Comprehensive Plan were developed in this feasibility study, which are not presented in support of a Record of Decision for construction. These very large site-specific Comprehensive plan components are:

- Freshwater Diversion at Violet, Louisiana; and
- Barrier Island Restoration.

These Comprehensive Plan components are addressed as reasonably foreseeable actions for the consideration of cumulative effects. Because additional engineering and design investigations have yet to be completed, these projects and programs are not yet ripe for decision-making. Supplemental NEPA information will be presented as necessary to ensure compliance with the appropriate environmental laws and regulations:

4.3.1 Freshwater Diversion at Violet, La.

Increased salinity problems originated as a result of the Mississippi River being contained in levees and not allowed to migrate back and forth across southeast Louisiana. As the river naturally migrated, it deposited sediment in the form of deltaic marshes. The river overflowed its banks every spring, flooding and supplying the area with nutrients and sediments to sustain the deltas and maintain the marshes and their vegetative characteristics. Since the river's channelization, the only freshwater flowing into the western Mississippi Sound has been from the opening of the Bonnet Carre Spillway during flood conditions, and from rainfall runoff from the uplands adjoining the project area. It is unknown the effects of various channels, canals and diversion projects have had on salinities within western Mississippi Sound.

A detailed discussion regarding the diversion of freshwater into Mississippi Sound has been presented in the Environmental Appendix. It will be necessary to supplement this Integrated EIS with additional NEPA documentation during project development and design to determine the range of benefits and adverse impacts associated with a project of this magnitude.

4.3.1.1 No Action

Upon implementing the No Action plan, the problems are anticipated to continue within western Mississippi Sound. The area would be deprived of the annual freshwater from the river. The natural processes of subsidence, compaction, erosion, and saltwater intrusion along with manmade actions, such as channel dredging and levee building activities, would result in further losses to coastal marshes, annual harvestings of oysters, and various other adverse impacts to habitats for commercially important fisheries. The No Action plan would result in the continual degradation of the oyster habitat, which many of the residents of Mississippi and Louisiana depend their livelihood upon.

4.3.1.2 Freshwater Diversion Description

Changing freshwater contributions to Mississippi Sound caused the western area of coastal Mississippi to suffer greatly from increased saltwater intrusion; especially hit hard are oyster resources. Hancock County marshes, located within the western portion of coastal Mississippi, have suffered increased saltwater intrusion as well as lack of sediment. Furthermore, the State of Louisiana's marshes experience continual erosion from the lack of sediment influx. Additionally, historic oyster reefs located within western Mississippi Sound have declined from lack of freshwater flows resulting from increased saltwater intrusion. Oyster predators, thriving in salty waters, destroy the beds.

A detailed description of the freshwater diversion has been presented in the Environmental Appendix. Diversion of Mississippi River freshwater and sediments in the vicinity of Violet, Louisiana has strongly been considered because of a number of positive environmental benefits – oysters, marsh, water quality, etc. In addition, these include proximity of the river to target coastal wetlands, public support, and high confidence in potential environmental benefits. MDMR has been working with the Mississippi congressional delegation in order to address the increased saltwater intrusion within this portion of Mississippi Sound. Joint efforts between the States of Mississippi and Louisiana congressional delegates resulted in the identification of potential freshwater diversion projects from the Mississippi River as a mechanism for reversing historic high salinity concentrations in the western portion of coastal Mississippi. A freshwater diversion project near Violet, Louisiana, was identified as an authorized project. Preliminary results from modeling a simulated diversion of 7,500 cubic feet per second of freshwater near Violet, Louisiana, suggest salinities were lowered in Western Mississippi Sound sufficiently to warrant additional examination (Dortch et al 2007). Further refinement of the models should address current limitations and must be made to estimate potential beneficial or deleterious effects on oysters, sea grasses, marsh systems, and other coastal resources. Further engineering and design is needed prior to project development.

4.3.1.3 Freshwater Diversion Soils Impact

Alteration of soils is anticipated within the footprint of the diversion structure. Fill material would be introduced during construction in order to ensure a solid foundation for the construction of the diversion structure. Further analysis would be required during project development to determine the associated impacts.

4.3.1.4 Freshwater Diversion Sediments Impact

Silt fences and other BMPs would be used to minimize the adverse impacts to the environment during construction activities to the maximum extent practicable. Containment structures, silt curtains, and other BMPs would be used to contain sediment deposition at the construction site. The diversion of freshwater would increase sediments and nutrients into areas that have historically suffered as a result of reduced transport via freshwater input. Further analysis would be required during project development to determine the associated impacts.

4.3.1.5 Freshwater Diversion Geology Impact

There should be no effects to geology. Projects have been designed to avoid impacts to current geological formations.

4.3.1.6 Freshwater Diversion Climate Impact

There should be no effects to the existing climate.

4.3.1.7 Freshwater Diversion Air Quality Impact

There should be no change in the existing air quality conditions once construction of the diversion project is complete. Air quality in the immediate vicinity of project construction would be slightly affected for a period of time by the fuel combustion and resulting engine exhausts. Current standards would not be violated by the implementation of the proposed projects.

4.3.1.8 Freshwater Diversion Noise Impact

Noise from the construction type equipment is expected to increase during the proposed operations in the project vicinities. Noise levels will resume to existing conditions as construction activities are completed. It is anticipated there would be no significant impacts to noise levels during implementation of these measures.

4.3.1.9 Freshwater Diversion Vegetation Impact

It is expected vegetation under the footprint of the structure would be lost completely; however, any bare soils would be vegetated to reduce future erosion. The exact location of the structure and waterway is unknown at this time but it is anticipated that emergent tidal marsh habitat would likely be impacted, as indicated by review of aerial photography. The freshwater diversion project would result in increased sediments and nutrients into areas that have suffered losses of marsh. Advanced engineering and design is needed to determine impacts to vegetation. Additionally, potential negative impacts to SAVs could occur as salinities are reduced due to the introduction of freshwater into the system. Further analysis and additional model runs during project development would determine both positive and negative impacts associated with the freshwater diversion project.

4.3.1.10 Freshwater Diversion Fish and Wildlife Impact

The impacts to fish and wildlife habitats associated with the diversion project are unknown at this time. Pre- and post-construction water quality monitoring would be required to inform structure operations and assess the effects of the diverted freshwater on fish and wildlife populations. Monitoring would need to capture hydrological, water quality, chemical, physical, and biological data as a component of the project's regular operation and maintenance. An adaptive operations strategy would be required to ensure flexibility in the operation of diversions, including frequency, duration, time of year, and quantities. One of the project goals is to create salinity conditions favorable for fish and wildlife productivity, especially increased annual oyster production in the State of Mississippi. Productivity of other species, such as white shrimp, blue crab, croaker, and menhaden, should greatly increase. Further analysis and additional model runs during project development would determine impacts associated with the project.

4.3.1.11 Freshwater Diversion Threatened and Endangered Species Impact

The impacts to fish and wildlife habitats associated with the diversion project are unknown at this time. Several species, such as sea turtles and Gulf sturgeon, are known to be present within this portion of Mississippi Sound that could be impacted by the proposed freshwater diversion effort. Impacts could potentially benefit or adversely impact protected species; however, additional information is required to identify those potential impacts. Critical habitat for the Gulf sturgeon has been designated within western Mississippi Sound due to it containing some of the species' primary constituent elements, such as water quality, sediment quality, and prey abundance, essential for its continued existence. Impacts of diverting freshwater at this area need to have further analysis and additional model runs during project development to develop a more detailed assessment, including the primary constituent elements of the Gulf sturgeon, such as sediment, water quality, and prey abundance. There could also be T&E species and/or critical habitat located in the vicinity of the proposed diversion structure, currently location unknown at this time. In addition, a possibility of newly designated species, such as the Pallid sturgeon, could be identified by the USFWS and/or NOAA, PRD during the modeling and design phase. As a result of this assessment, the T&E impacts would be assessed in greater detail and appropriate level of coordination would commence at that time with USFWS and/or NOAA, PRD.

4.3.1.12 Freshwater Diversion Water Quality Impact

The freshwater diversion project could cause an increase in turbidity, coliform counts, nitrate and phosphorous levels, and other types of chemical concentrations. Temperatures could be slightly lowered. The impacts of diverting freshwater into this area are unknown at this time but further analysis and additional model runs would provide the anticipated water quality impacts as a result of the project implementation. Detailed assessment of water quality would occur during the supplemental environmental documentation.

4.3.1.13 Freshwater Diversion Water Supply Impact

There should be no effect on water supply. Potential projects have been or would be designed to avoid impacts to existing public water supply infra-structure and operating facilities.

4.3.1.14 Freshwater Diversion Socio-Economic Impact

Oyster reefs were seriously impacted by Hurricane Katrina and all reefs in Coastal Mississippi were closed immediately following the storm, with some of them still remaining closed almost 2 years later. There are signs the reefs are beginning some of the healing processes on their own; however, much work will be needed to restore the oyster reefs to their former prime condition. Extensive sampling of the reefs is currently being conducted by the MDMR to provide information needed to plan extensive long-term recovery activities. Initial assessments of the reef conditions are underway but at present, are incomplete. Conditions of the reefs are highly variable. Generally, offshore areas were heavily scoured. Recent very heavy oyster spat set (less than one inch in length) was found in some of these areas with no spat set in other areas. Inshore reefs generally had moderate to very low numbers of live oysters in some areas with other areas revealing no live oysters. The preservation of the Mississippi Sound habitat that is vital to both local fisheries and economies, but also a large source of national oyster production, and the continued use of the barrier islands as a recreational resource. Many of the Mississippi and Louisiana residents depend their livelihood upon oyster harvesting. Diverting water into Mississippi would enhance that production.

4.3.1.15 Freshwater Diversion Land Use Impact

The freshwater diversion project would take place at or near Violet, Louisiana; however, the exact location is unknown at this time. It is expected that a significant change in current land use would occur as the area presently consists of a small town, associated homes and businesses, and rural lands. Further analysis during project development would determine the impacts to land use associated with the project.

4.3.1.16 Freshwater Diversion Aesthetic Resources Impact

The freshwater diversion project would cause a change in aesthetic resources within the area at or near Violet, Louisiana. Further analysis during project development would determine the extent of impacts to aesthetics within the surrounding area.

4.3.1.17 Freshwater Diversion Cultural Resources Impact

Potential impacts to cultural resources are unknown. A phase one archaeological survey would need to be conducted during project development and design to determine if any cultural resources are located within the project area and then further analysis would determine the impacts associated with the project.

4.3.1.18 Freshwater Diversion Hazardous, Toxic, and Radioactive Wastes Impact

Site inspections would be accomplished in accordance with the requirements of ER 1165-2-132 entitled, HTRW Guidance for Civil Works Projects, and the American Society of Testing and Materials Standard E 1527 during project development. The inspections would be conducted to determine the presence or evidence of landfills, surface areas unable to support vegetation, visible sheens of petroleum product, nearby contaminated industrial facilities, or any type of visible indication that HTRW concerns exist that may impact the relocations and subsequent restoration of the site. Based on the findings of the HTRW site assessments, specific or unusual environmental concerns that are identified that could affect construction of any proposed projects would be addressed appropriately. Additional supplemental environmental impacts statements or environmental analyses may be necessary once specific projects have been identified and development of project plans has begun. HTRW issues and concerns would be addressed during the required supplementation NEPA compliance and documentation.

4.3.1.19 Freshwater Diversion Unavoidable Adverse Environmental Effects

Initial screening of alternatives based on environmental acceptability would help avoid adverse environmental effects. Further analysis during project development and design would determine if any unavoidable adverse environmental effects would occur as a result of the project.

4.3.1.20 Freshwater Diversion Irreversible and Irretrievable Commitments of Resources

Any irreversible or irretrievable commitments of resources involved in any potential proposed projects have been considered and are either unanticipated at this time or will be considered to determine if any would present minor impacts.

4.3.1.21 Freshwater Diversion Environmental Justice Impact

A detailed description of Environmental Justice has been provided in Section 4.1.21. Potential impacts to Environmental Justice issues are unknown at this time. A detailed assessment would be conducted in the supplemental environmental documentation during project development and design to determine if any impacts are anticipated.

4.3.1.22 Freshwater Diversion Protection of Children Impact

A detailed description of Protection of Children has been provided in Section 4.1.22. Potential impacts to Protection of Children issues are unknown at this time. A detailed assessment would be conducted in the supplemental environmental documentation during project development and design to determine if any impacts are anticipated.

4.3.2 Restoration of Barrier Islands

Several measures have been developed, which would allow for storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife habitats, and prevention of coastal erosion. Screening criteria were based on comprehensive goals and objectives, technical feasibility, and environmental effectiveness. Measures considered include restoration of the island footprints to pre-Hurricane Camille conditions, replenishment of sand within the littoral zone, environmental restoration consisting of dune construction and planting of native species, seagrass restoration, and repair of the Ship Island breach. A detailed explanation of these measures is presented in the Environmental Appendix. After screening, the PDT developed the following alternatives for further analysis.

The Proposed Action recommended for construction will consist of the combination of two options – filling of Ship Island breach and littoral placement of sand - combined with recommended changes in the local RSM practices. This alternative is recommended to help prevent the accelerated erosion of the barrier islands, especially what is now considered West and East Ship Island (a single island prior to Hurricane Camille) as well as Petit Bois Island to the east.

To provide needed data on some aspects of completing this plan, additional studies will be conducted during the Engineering and Design (E&D) phase of this project. It is generally understood that the loss of these islands will change the entire ecosystem of Mississippi Sound as well as having affects on the amount of storm damage incurred along the mainland coast. Since the islands form the southern boundary of the Mississippi Sound estuary, continued loss of the islands will allow a different salinity interface as freshwater from the mainland river systems and the saltwater from the Gulf of Mexico adjust to new tidal and littoral currents. Under E&D, additional storm surge, wave, water quality, and sediment transport modeling will be conducted to predict the affects of not having West and East Ship Island in place during future hurricanes. Initial modeling indicates that taking Ship Island(s) out of the system will not have a great effect on surge, but will have a major impact on waves that affect the mainland. The additional sediment transport modeling will also be used to optimize the placement of sand in the littoral zone under this plan. Water quality models will also be conducted to predict the changes to salinity levels in the Sound without Ship Island.

The proposed action consists of placement of 22 million cubic yards of sand: 9 million cubic yards within the littoral zone and 13 million cubic yards to be directly placed for restoration of the breach at Ship Island. The sand to be placed in the littoral zone would be obtained from dredging sand from an offshore site located at the St. Bernard Shoals. Sand used for the repair of the Ship Island breach would be obtained from St. Bernard Shoals offshore site.

4.3.2.1 No Action

The No Action alternative involves the continuation of existing conditions and no new solutions for existing problems. This alternative avoids both the monetary investment and potential adverse impacts associated with improvements. Future conditions associated with not restoring the barrier islands would result in the continued degradation of the valuable beach ecosystem and loss of these types of habitats. The immediate area would remain particularly vulnerable to wave and storm activity that continually threaten and prevent the re-establishment of this vital natural resource. The No Action Plan would result in continued erosion to the barrier islands, increased saltwater intrusion, continued degradation and possible lack of suitable fish and wildlife habitats including numerous federally protected species and their critical habitat.. It is unclear as to the extent and rate of degradation the natural resources would suffer as a result of implementation of the No Action Plan.

4.3.2.2 Barrier Island Restoration Vegetation Impact

It is anticipated that placement of sandy material within the littoral zone would cause no adverse impacts to vegetation because the site would be identified to minimize impacts. Filling in the breach at Ship Island could provide a benefit to vegetation because it is believed that natural recolonization of the beach and dune system would occur. Additionally, it is believed the adjacent areas would consist of sandy shallows that could support sea grasses. It is anticipated that implementation of this project would provide a benefit to vegetation. The vegetation impacts resulting from each of the alternative plans evaluated varied only in the level of benefits due to the amount and type of planning used in each alternative.

4.3.2.3 Barrier Island Restoration Fish and Wildlife Impact

Option A: Restore Island Footprint Fish and Wildlife Impact

Generally, restoration of the island footprint would entail filling of existing water bottoms to pre-Hurricane Camille conditions. The barrier islands currently provide essential fish habitat for managed fisheries, designated critical habitat for the threatened Gulf sturgeon, and designated critical habitat for piping plover. Several sea turtle species utilize the islands and adjacent water bottoms for nesting and foraging. It is anticipated additional sand along the shoreline would provide additional opportunities for nesting for sea turtles. Additionally, the potential measure would provide additional over wintering critical habitat for the piping plover. Many other shorebird species use the barrier islands for nesting and foraging. Filling of water bottoms would remove foraging areas for sea turtles and other marine species.

The sand would be obtained from an offshore source, St. Bernard Shoals, approximately 45 miles south of the islands. Dredging will impact epibenthic crustaceans and infaunal polychaetes within the immediate area. However, the impacts are primarily short-term in nature and consist of a temporary loss of benthic invertebrate populations in the areas of dredging. Adjacent benthic communities are anticipated to move into the dredged site and begin recolonization. The area is characterized as a relic sand shoal approximately at elevation -60 NAVD88 and once dredging is complete, will remain similar in character as dredged depths would not exceed 10 feet in depth. Therefore, because similar habitat, in terms of both sediment composition and depth will be present pre- and post dredging, it is anticipated the benthic biota in the dredging areas will recover and recolonize. Further study during project development would determine the extent of impacts and benefits associated with implementation of this measure.

Option B: Replenish Sand in Littoral Zone, Inland Source Fish and Wildlife Impact

This measure would result in less direct impacts to the islands themselves by introduction of sand into the littoral zone where the islands are located. A large amount of water bottoms would be filled as a result. These areas currently provide essential fish habitat for managed fisheries and designated critical habitat for the threatened Gulf sturgeon. Several sea turtle species utilize the islands and adjacent water bottoms for nesting and foraging. Filling of water bottoms would remove foraging areas for sea turtles and other marine species including the Gulf sturgeon. Sand would be obtained from inland sources comprised of previous dredged river sands. Past analyses and comparisons have found the river sands are typically a finer grain size than native beach sands, which are mostly medium-sized. Additionally, these comparisons determined the beach sands are slightly more rounded than river sands. One factor that would warrant further analysis is the differences in color of the two sands with the river sands having a slight brown tint compared to the beach sand samples which are described as white or light grey. It is believed the river sands would undergo bleaching from the ultraviolet radiation from the sun if the color variation was caused by a mineral staining. Adding this sand into the littoral system would diminish the differences between the natural sands by spreading it over large areas with shallow thicknesses. The natural sediment transport process would blend the two sands together while removing staining from the sand grains and rounding the individual particles through abrasion. Further study during project development would determine the extent of impacts of incorporating river sands into the marine system and filling of water bottoms.

Option C: Replenish Sand in Littoral Zone, Offshore Source Fish and Wildlife Impact

This measure would result in less direct impacts to the islands themselves by introduction of sand into the littoral zone where the islands are located. A large amount of water bottoms would be filled as a result. These areas currently provide essential fish habitat for managed fisheries and designated critical habitat for the threatened Gulf sturgeon. Several sea turtle species utilize the islands and adjacent water bottoms for nesting and foraging. Filling of water bottoms would remove foraging areas for sea turtles and other marine species including the Gulf sturgeon. Sand would be obtained from an offshore source and would consist of high quality beach sands. The natural sediment transport process would blend this sand into the existing littoral system. Further study during project development would determine the extent of impacts of filling of water bottoms and incorporation of the offshore sands.

The sand would be obtained from an offshore source, St. Bernard Shoals, approximately 45 miles south of the islands. Dredging will impact epibenthic crustaceans and infaunal polychaetes within the immediate area. However, the impacts are primarily short-term in nature and consist of a temporary loss of benthic invertebrate populations in the areas of dredging. Adjacent benthic communities are anticipated to move into the dredged site and begin recolonization. The area is characterized as a relic sand shoal approximately at elevation -60 NAVD88 and once dredging is complete, will remain similar in character as dredged depths would not exceed 10 feet in depth. Therefore, because similar habitat, in terms of both sediment composition and depth will be present pre- and post dredging, it is anticipated the benthic biota in the dredging areas will recover and recolonize. Further study during project development would determine the extent of impacts and benefits associated with implementation of this measure.

Option D: Environmental Restoration With 2-Foot Dune Fish and Wildlife Impact

It is anticipated that implementation of this measure would provide significant benefits to fish and wildlife by restoration of existing damaged and lost habitat. Dunes provide natural island habitat and by restoration, the island dwelling species gain lost habitat. The barrier islands provide important stopover habitat for many species of migratory birds. The barrier islands currently provide essential fish habitat for managed fisheries, designated critical habitat for the threatened Gulf sturgeon, and designated critical habitat for piping plover. Several sea turtle species utilize the islands and adjacent water bottoms for nesting and foraging. It is anticipated additional sand along the shoreline would provide additional opportunities for nesting for sea turtles. Additionally, the potential measure would provide additional over wintering critical habitat for the piping plover. Many other shorebird species use the barrier islands for nesting and foraging. Further studies during project development would determine specific benefits resulting from implementation of this measure.

Option E: Environmental Restoration With 6-Foot Dune Fish and Wildlife Impact

It is anticipated that implementation of this measure would provide significant benefits to fish and wildlife by restoration of existing damaged and lost habitat. Dunes provide natural island habitat and by restoration, the island dwelling species gain lost habitat. The barrier islands provide important stopover habitat for many species of migratory birds. The barrier islands currently provide essential fish habitat for managed fisheries, designated critical habitat for the threatened Gulf sturgeon, and designated critical habitat for piping plover. Several sea turtle species utilize the islands and adjacent water bottoms for nesting and foraging. It is anticipated additional sand along the shoreline would provide additional opportunities for nesting for sea turtles. Additionally, the potential measure would provide additional over wintering critical habitat for the piping plover. Many other shorebird species use the barrier islands for nesting and foraging. Further studies during project development would determine specific benefits resulting from implementation of this measure.

Option F: Environmental Restoration of Sea Grass Beds Fish and Wildlife Impact

Many marine species depend on sea grass beds for foraging opportunities and cover. Restoration of this vital habitat would provide significant benefits to fish and wildlife and their habitats. Establishment of a comprehensive program would allow for further education regarding the sustainability of the resource.

Option G: Restoration of Ship Island Breach Fish and Wildlife Impact

Generally, restoration of the island footprint would entail filling of existing water bottoms to circa 1916-17 geomorphic conditions. These areas currently provide essential fish habitat for managed fisheries, designated critical habitat for the threatened Gulf sturgeon, and designated critical habitat for piping plover. Several sea turtle species utilize the islands and adjacent water bottoms for nesting and foraging. It is anticipated additional sand along the shoreline would provide additional opportunities for nesting for sea turtles. Additionally, the potential measure would provide additional over wintering critical habitat for the piping plover. Filling of water bottoms would remove foraging areas for sea turtles and other marine species. Further study during project development would determine the extent of impacts and benefits associated with implementation of this measure.

The sand would be obtained from an offshore source, St. Bernard Shoals, approximately 45 miles south of the islands. Dredging will impact epibenthic crustaceans and infaunal polychaetes within the immediate area. However, the impacts are primarily short-term in nature and consist of a temporary loss of benthic invertebrate populations in the areas of dredging. Adjacent benthic communities are anticipated to move into the dredged site and begin recolonization. The area is characterized as a relic sand shoal approximately at elevation -60 NAVD88 and once dredging is complete, will remain similar in character as dredged depths would not exceed 10 feet in depth. Therefore, because similar habitat, in terms of both sediment composition and depth will be present pre- and post dredging, it is anticipated the benthic biota in the dredging areas will recover and recolonize. Further study during project development would determine the extent of impacts and benefits associated with implementation of this measure.

4.3.2.4 Barrier Island Restoration Proposed Actions Fish and Wildlife Impact

The Proposed Action would result in less direct impacts to the islands themselves by introduction of sand into the littoral zone where the islands are located; however, a large amount of water bottoms would be filled as a result. These areas currently provide EFH for managed fisheries and designated critical habitat for the threatened Gulf sturgeon. Several sea turtle species utilize the islands and adjacent water bottoms for nesting and foraging. Filling of water bottoms would remove foraging areas for sea turtles and other marine species including the Gulf sturgeon. Sand could be obtained from inland sources comprised of previous dredged river sands. Past analyses and comparisons have found the river sands are typically a finer grain size than native beach sands, which are mostly medium sized. However, there may be some large gravel intermixed within the river sands. Additionally, these comparisons determined the beach sands are slightly more rounded than river sands. One factor that would warrant further analysis is the differences in color of the two sands with the river sands having a slight brown tint compared to the beach sand samples, which are described as white or light grey. It is believed the river sands would undergo bleaching from the ultraviolet radiation from the sun if the color variation was caused by a mineral staining. Adding this sand into the littoral system would diminish the differences between the natural sands by spreading it over large areas with shallow thicknesses. The natural sediment transport process would blend the two sands together while removing staining from the sand grains and rounding the individual particles through abrasion. Further study during project development would determine the extent of impacts of incorporating river sands into the marine system and filling of water bottoms.

Sand could be obtained from an offshore source and would consist of high quality beach sands. The natural sediment transport process would blend this sand into the existing littoral system. Further study during project development would determine the extent of impacts of filling of water bottoms and incorporation of the offshore sands.

The sand would be obtained from an offshore source, St. Bernard Shoals, approximately 45 miles south of the islands. Dredging will impact epibenthic crustaceans and infaunal polychaetes within the immediate area. Adjacent benthic communities are anticipated to move into the dredged site and begin recolonization. The area is characterized as a relic sand shoal approximately at elevation -60 NAVD88 and once dredging is complete, will remain similar in character as dredged depths would not exceed 10 feet in depth. Therefore, because similar habitat, in terms of both sediment composition and depth will be present pre- and post-dredging, it is anticipated the benthic biota in the dredging areas will recover and recolonize. Further study during project development would determine the extent of impacts and benefits associated with implementation of this measure.

Generally, restoration of the island footprint would entail filling of existing water bottoms to circa 1916-17 geomorphic conditions. It is anticipated that barrier island restoration would provide significant benefits to fish and wildlife by restoration of existing damaged and lost habitat. Dunes provide natural island habitat and by restoration, the island dwelling species gain lost habitat. The barrier islands provide important stopover habitat for many species of migratory birds.

4.3.2.5 Barrier Island Restoration Threatened and Endangered Species Impact

Overall barrier island restoration would benefit piping plover and its critical habitat (refer to the Environmental Appendix) by the increased amount of over wintering foraging areas. There are no substantive differences in impacts to threatened and endangered species among the alternative plans evaluated. Temporary impacts could occur during construction but could be avoided during the times the piping plover are on the over wintering grounds. Impacts associated with construction activities should be temporary and isolated to actual construction limits. Brown pelicans could potentially utilize the project areas due to the increase in habitat, however, it is anticipated these species would avoid the construction area due to noise and activity. These impacts would be temporary and isolated to actual construction limits. Surveys to determine if nesting brown pelicans are present could be conducted to avoid any impacts. Manatees could possibly be in the project area also. Restoration activities could possibly provide suitable water quality conditions to support additional submerged aquatic vegetation habitat which could provide potential feeding grounds to the manatee. Construction activities could potentially result in adverse impacts but it is anticipated these species would primarily avoid the construction areas due to noise and activity resulting in less risk for harm or harassment. Methods of dredging and operations would be utilized to avoid adverse impacts to listed species. Placement activities would be accomplished using appropriate BMPs to reduce turbidity and other potential adverse impacts to species. Further consultation would be required to determine adverse impacts to critical habitat for the Gulf sturgeon. It is anticipated whale species would avoid the project area during construction activities due to noise and activity and no collisions should occur

Potential beneficial and negative impacts to listed sea turtles and Gulf sturgeon and its critical habitat could occur during dredging of sand and placement activities. Placement of sand would provide additional nesting areas for sea turtles which are only known to nest primarily on the barrier islands in Mississippi. To reduce the possibility of protected species interactions, the dredge drag heads would be equipped with sea turtle deflectors devices. In addition, 100% of the material dredged would pass through 4-inch screening boxes for screening by approved observers for evidence of protected species interactions. The precautionary steps taken when utilizing hopper dredges will ensure restoration of the barrier islands will not jeopardize the continued existence of listed species.

Alteration of Gulf sturgeon critical habitat is likely. Unit 8 is listed due to its containing four of the primary constituent elements that identify critical habitat. These constituent elements consist of the following: "abundant prey items", "sediment quality", "water quality", and "migration habitat." The non-motile benthic community within the project area would be temporarily, adversely impacted as a result of the dredging and disposal operations. However, these impacts will not result in permanent habitat alteration due to the fact that the areas will re-colonize with similar benthic species within a few months upon completion of the project remaining functionally identical to the existing habitat. The project area constitutes a fraction of one percent of the total available forage habitat for the species in that area. The sandy dredged material will be of the same composition as that of the adjacent sandy placement areas since the material is characterized as sand. Therefore, no long-term change in community structure is expected to occur. In fact, with the restoration effort at the barrier islands, those critical habitat's vital primary constituents - "abundant prey items", "sediment quality", "water quality", and "migration habitat", would continue to exist in Mississippi Sound for the Gulf sturgeon. Barrier islands would continue to support the estuarine habitat in Mississippi Sound that provide those essential feeding grounds between the island passes while also sustaining the water and sediment quality to that of when the primary constituents were first designated back in 2003 – pre-hurricane season of 2005. Long-term benefits to Gulf sturgeon and its critical habitat would be achieved.

Prey Abundance: Activities associated with placement cover epibenthic crustaceans and infaunal polychaetes within the littoral zones and breach areas that serve as potential prey items for the Gulf sturgeon. The impacts are considered short-term in nature and consist of a temporary loss of benthic invertebrate populations where the shoreline extends seaward. It is believed that this will not alter critical habitat. The beach placement area has suffered erosion due to highly dynamic wind and wave action within the area, especially during recent hurricane and storm events. The area was above mean high water and was not contributing to the benthic productivity of the coastal system.

Past observances have recorded subpopulations found within the Pearl and Pascagoula Rivers utilize the project area located within and around Ship Island. NOAA, PRD, in previous biological opinions for projects within Mississippi Sound, concluded the actual number of the species utilizing the project area for foraging is likely few based on the small population sizes.

Some data are available to describe what the Gulf sturgeon may feed on in the nearshore zone of the Gulf of Mexico. Studies supporting the critical habitat rule indicate that the Gulf sturgeon's diet includes amphipods, lancelets, polychaetes, gastropods, shrimp, isopods, mollusks, and crustaceans.

The direct placement sandy material into the littoral zone would result in the temporary mortality of some percentage of the existing benthic assemblages. The indirect placement within the littoral zone from localized turbidity increases may also result in temporary benthic mortality; however, the impact from this is expected to be minimal. The non-motile benthic community within the project area would be temporarily, adversely impacted as a result of the dredging and disposal operations. This area within Ship Island would be converted to upland habitat but it would help maintain the integrity of one of Mississippi Sound's primary constituent elements for the Gulf sturgeon (i.e. prey abundance, water quality, and sediment quality).

Past monitoring studies associated with placement activities have indicated that the benthic communities showed a high degree of variability through the site. The area exhibited a high degree of resilience and rapid recovery over the study period. Results from the samplings show that there is a general increase in the number of individuals per species as well as an increase in the percentage of prey species out of all species represented. This is particularly true for *Branchiostoma* (lancelet), which has been identified as primary Gulf sturgeon prey. Based on past benthic studies, it is concluded that the placement activities associated with barrier island restoration will not cause a significant impact on possible feeding of the Gulf Sturgeon and it is believed the project would not result in an adverse modification to the designated Gulf sturgeon critical habitat. The project is anticipated to sustain Mississippi Sound resulting in the continued existence of these primary constituent elements.

Migratory passage: The primary migration pattern through the area would be parallel to the shoreline in Mississippi Sound, near the islands and within the island passes. The proposed action is occurring primarily in an open-water environment and will not restrict fish migration. The remaining area surrounding the islands would be available for the sturgeon's migration. The proposed action would sustain the barrier islands system; thus, allowing for the migration patterns along and within the passes of the island system to continue. Furthermore, the migration pathways along the mainland would also be protected by the restoration efforts due to it remaining an estuarine system with limited wave action. Restoration activities would benefit the migratory pathways essential to the species.

Sediment quality: Sediment quality and texture of the material are expected to be similar to the existing conditions at the placement areas. It is expected this constituent element will not be significantly affected by the proposed activity. The proposed action would sustain the essential barrier islands system; thus, allowing for the physical parameters – sediment – within the Mississippi Sound and the island system to continue. Restoration activities would benefit the sediment quality essential to the species.

Water quality: Impacts from sediment disturbance during construction are expected to be temporary and minimal, with suspended particles settling out within a short time frame, with no measurable effects on water quality. No changes in temperature, salinity, pH, hardness, oxygen content, and other chemical characteristics are expected.

Further consultation with resource agencies will ensure that alteration of Gulf sturgeon critical habitat will not result in adverse modification of the habitat. Evaluation of potential impacts to the four primary constituent elements of critical habitat present in Mississippi Sound follows.

4.3.2.6 Barrier Island Restoration Water Quality Impact

BMPs would be utilized to reduce turbidity associated with placement activities. There are no substantive differences among the water quality impacts of the alternatives evaluated. It is anticipated there would be minimal impacts to water quality in association with activities. This measure would result in less direct impacts to the islands themselves by introduction of sand into the littoral zone where the islands are located. The sand would not be placed on the islands, but in areas between the islands where the currents that make up the littoral drift zone could transport the sand to the islands. It is anticipated there would be minimal impacts to water quality due to the sandy material quickly settling out of the water column.

4.3.2.7 Barrier Island Restoration Land Use Impact

There are no substantive differences among the land use impacts of the alternatives considered. Water bottoms at the littoral site and breach would be filled at shallow depths in association with barrier island restoration. Alteration of land use is expected due to the changes associated with filling in of water bottoms and their conversion to sandy barrier island resulting in expanded acreage. It is anticipated this change in land use would be insignificant as islands would be expanded to historical sizes; thus, benefiting the Mississippi Sound's ecological persistence.

4.3.2.8 Barrier Island Restoration Cumulative Effects

Tables 4-5 and 4-6 provide the Functional Habitat Index (FHI) benefits that would be achieved by implementation of this proposed construction compared to the no action. The FHI tool was used to quantify the environmental outputs generated from various measures/alternatives. Potential benefits associated with restored habitat types were assessed using past scientific studies and best professional judgment. This environmental output unit (i.e., number) generated from the FHI tables was used to assess the cost-effectiveness of various ecosystem restoration alternatives at the barrier islands.

Table 4-5
Littoral Zone Placement & Fill of Breach Between West & East Ship Islands

	Habitat Units									
Assessment Variables	*Shorebirds*	*Waterfowl*	*Migratory Birds*	*Raptor*	*Beach Fauna*	*Dune Flora and Fauna*	*Oysters*	*Estuarine Fish*	*T&E Species*	*FHI Unit*
Island Persistence	10	8	10	8	10	10	10	10	10	86
Shoreline Stabilization	10	8	8	8	10	10	10	6	10	80
Reproduction Habitat	10	0	0	0	8	10	10	10	10	58
Feeding Habitat	10	6	10	8	8	10	10	10	10	82
Roosting Habitat	10	6	8	6	10	10	10	10	10	80
Wintering Habitat	10	6	8	6	10	10	10	10	10	80
Dune Habitat	10	10	10	10	10	10	10	10	10	90
Beach Habitat	10	10	10	10	10	10	10	10	10	90
Water Column Habitat	8	8	8	8	8	8	10	10	10	78
Water-Land Interface Habitat	10	10	10	10	10	10	10	10	10	90
Fishery Habitat	10	10	10	10	10	10	10	10	10	90
Oyster Habitat	6	6	6	6	6	8	10	8	8	64
									TOTAL FHI	968

Table 4-6
No Action – Barrier Islands

	Habitat Units									
Assessment Variables	*Shorebirds*	*Waterfowl*	*Migratory Birds*	*Raptors*	*Beach Fauna*	*Dune Flora and Fauna*	*Oysters*	*Estuarine Fish*	*T&E Species*	*FHI Unit*
Island Persistence	0	0	0	0	0	0	0	0	0	*0*
Shoreline Stabilization	0	0	0	0	0	0	0	0	0	0
Reproduction Habitat	0	0	0	0	0	0	0	0	0	0
Feeding Habitat	0	0	0	0	0	0	0	0	0	0
Roosting Habitat	0	0	0	0	0	0	0	0	0	0
Wintering Habitat	0	0	0	0	0	0	0	0	0	0
Dune Habitat	0	0	0	0	0	0	0	0	0	0
Beach Habitat	0	0	0	0	0	0	0	0	0	0
Water Column Habitat	2	2	2	2	2	2	2	2	2	18
Water-Land Interface Habitat	0	0	0	0	0	0	0	0	0	0
Fishery Habitat	2	2	2	2	2	2	2	2	2	18
Oyster Habitat	2	2	2	2	2	2	2	2	2	18
									TOTAL FHI	**54**

4.4 Comprehensive Plan Components Recommended for Construction

The following components of the Comprehensive Plan are ready for advanced design and implementation. These projects are presented in support of a Record of Decision for construction:

- Coastal Wetland and Forest Restoration:
  - Turkey Creek
  - Bayou Cumbest
  - Dantzler
  - Admiral Island
  - Franklin Creek
- Submerged Aquatic Vegetation Restoration;
- Coast-wide Beach and Dune Restoration;
- Moss Point Municipal Structure Relocation
- Waveland Flood Proofing; and
- Forrest (Forest) Heights Hurricane and Storm Damage Reduction.

The potential project impacts on some parameters are similar and are presented jointly for the projects recommended for construction. Impacts to other parameters are presented separately for each recommended project. The jointly presented impact parameters include:

- Soils
- Sediments
- Geology
- Climate
- Air Quality
- Noise
- Cultural Resources
- Aesthetic Resources
- Hazardous, Toxic, and Radioactive Wastes
- Environmental Justice
- Protection of Children
- Unavoidable Adverse Environmental Effects
- Irreversible and Irretrievable Commitments of Resources

4.4.1 Recommended Plans - Soils Impacts

Alteration of soils is anticipated within environmental restoration projects – also in conjunction with the HARP; however, in some instances, old fill material would be removed for reestablishment of more native types of soils generally found in the natural system. Alteration of soils could occur as a result of barrier island restoration as sand is introduced onto existing water bottoms. Soils could also be altered at the levees via use of fill material.

4.4.2 Recommended Plans - Sediments Impacts

Re-suspension of sediments would likely occur within specific project sites. Silt fences and other BMPs would be used to minimize the adverse impacts to the environment during construction activities to the maximum extent practicable. Containment structures, silt curtains, and other BMPs would be used to contain sediment deposition at construction and environmental restoration sites. It is expected that solids that remain suspended in the water column would migrate by littoral drift. Any impacts that might occur would typically be isolated to each construction site, minor and of short duration. The freshwater diversion project would result in increased nutrients and sediment being released; however, it is anticipated the amount of sediment actually transferred would be relatively limited.

4.4.3 Recommended Plans - Geology Impacts

There should be no effects to geology. Potential projects have been or would be designed to avoid impacts to current geological formations.

4.4.4 Recommended Plans - Climate Impacts

There should be no effects to the existing climate.

4.4.5 Recommended Plans - Air Quality Impacts

Currently, all areas within coastal Mississippi are in attainment with the NAAQS. Air quality in the immediate vicinity of project construction would be slightly affected for a period of time by the fuel combustion and resulting engine exhausts. At those environmental restoration sites requiring burning, such as Turkey Creek, a temporary degradation of air quality is anticipated. Burning the restoration sites would cause emissions of many different chemical compounds, such as small particles, NO, CO, and organic compounds. The compounds and quantity of emissions depends in part on the types of fuel burned, its moisture content, and the temperature of combustions. Visibility conditions are affected by scattering and absorption of light by particles and gases. The fine particles most responsible for visibility impairment are sulfates, nitrates, organic compounds, soot and soil dust. Fine particles are more efficient per unit mass than coarse particles at scattering light. Light scattering efficiencies also go up as humidity rises, due to water adsorption on fine particles, which allow the particles to grow to sizes comparable to the wavelength of light. This is anticipated to be a temporary impact. The standards would not be violated by the implementation of the proposed project.

4.4.6 Recommended Plans - Noise Impacts

Noise from the construction type equipment is expected to increase during the proposed operations in the project vicinities. Noise levels will resume to existing conditions as construction activities are completed. It is anticipated there would be no significant impacts to noise levels during implementation of these measures.

4.4.7 Recommended Plans - Water Supply Impacts

There should be no effect on water supply. Potential projects have been or would be designed to avoid impacts to existing public water supply infra-structure and operating facilities.

4.4.8 Recommended Plans - Socio-Economic Impacts

Refer to the Economic Appendix for more specific details regarding the direct and indirect socio-economic impacts of the recommended projects throughout coastal Mississippi.

Population - It is expected that non-structural projects would benefit the population of the study area. Relocation of homes outside of the high-hazard surge-plain would relocate at risk populations into safer areas that are not vulnerable to storm surges and associated flooding. Flood-proofing of homes would help reduce damages from future flooding events. Environmental restoration would enhance fish and wildlife; thus, potentially benefiting the population of coastal Mississippi.

Employment and Income - Implementation of these Recommended plans could result in a positive increase to employment and income of the area and its residents. This effort could also result in the creation of jobs due to project related expenditures.

Housing – Environmental restoration projects would not directly impact housing within coastal Mississippi because no habitable properties would be acquired to implement restoration alternatives. Non-structural and structural projects would benefit current housing stock by reducing damages from future storm and flood events and increasing the quality and value of housing within project implementation areas.

Quality of Life - Implementation of these recommended plans could improve quality of life within coastal Mississippi. Additional wetland restoration would enhance water quality, wildlife habitat, and various natural resource functions as a result of restoration activities. Non-structural and flood damage reduction projects would enhance current living conditions.

Schools - Implementation of this measure would not impact schools within coastal Mississippi.

Public Safety - It is anticipated there could be positive effects to public safety by implementation of the potential measures. Wetland restoration would benefit water quality, wildlife habitat, and various natural resource functions. Non-structural and storm damage reduction projects would improve public safety by the relocation of people outside of the high-hazard areas and reduced damages from flood events.

Recreation - It is anticipated there would be minimal benefits to recreation associated with implementation of the projects.

Transportation and Traffic - It is anticipated there would be no transportation impacts associated with implementation of the projects.

4.4.9 Recommended Plans - Aesthetics Impacts

During construction aesthetics would be temporarily reduced in the immediate vicinity of the proposed project sites. Many recreational vessels utilize Mississippi Sound within the project vicinities and it is believed some residents and visitors may be disturbed by the presence of required heavy equipment during any construction phases. However, construction activities would be temporary in nature so the disturbance would be anticipated to be minimal at each potential restoration project site. There could be times when numerous projects throughout coastal Mississippi would be under construction simultaneously. The restoration projects should provide residents and visitors with an overall more aesthetically pleasing view as projects are completed.

The environmental restoration projects would provide additional fish and wildlife habitat to numerous shorebirds and various wildlife species, which would enhance coastal Mississippi and its diverse aquatic habitats while providing future sustainability of the natural system.

4.4.10 Recommended Plans -Cultural Resources Impacts

The vast majority of historic and prehistoric sites are found along the immediate coastal strand and adjacent to estuarine systems. Preference for well-drained, sandy soils adjacent to water sources is apparent. Coast wide survey work performed by both state (Giliberti n.d.) and private researchers (Blitz and Mann 2000) have found a distinctive focus on the immediate coastal and estuarine locations. Unfortunately, the geographic placement of these resources has made them extremely vulnerable to destruction from continued occupation and development, as well as vulnerable to the effects of tropical storms and hurricanes.

Modern development along the Mississippi coast has affected both archaeological sites and standing structures, including individual structures and historic districts in the project area. Key issues are soil disturbance and construction. Soil disturbance affects archaeological sites, and construction of new buildings and associated infrastructure can affect the view shed and "feel" of a historic building or district or cause demolition or alteration of historic buildings.

From the early 1970s to the present, construction in the project area has greatly increased. In fact, more development and construction has occurred in the three counties that are part of the project area than anywhere else in the state. Land use studies show that between 1972 and 2000 both medium-density and high-density urban land use areas increased by more than 90 percent in the study area; overall, developed land use increased by almost 70 percent during that period (MARIS 1992, 2000; USGS 1972; USGS and USEPA 1992). This sizeable increase in developed land is caused in part by the casinos and related infrastructure, residential, and commercial construction. The development involves large areas of soil disturbance, which destroys archaeological sites.

Previous archaeological and architectural studies along the Mississippi Gulf Coast have documented the destruction caused by natural forces, most notably hurricanes. Standing structures are often the most dramatic and visible witnesses to this destruction. However, prehistoric and historic archaeological sites are also extremely vulnerable. Shell middens, found along the immediate shoreline and within coastal marshes and estuaries, often are flipped and re-deposited by the storm surge and wave action of hurricanes. This effectively destroys much of the value of the sites. Sites such as Indian villages and historic town sites such as those along the bluff on Bay St. Louis can also be destroyed by such wave action. In addition, post storm activities offer many more mechanisms for site destruction. These include clearing of timber by use of skidders and other heavy equipment, debris removal, and reconstruction. The destructiveness of these activities is well documented from the years following hurricane Camille which struck the area in 1969.

Corps, Mobile District Archaeologists, through long standing coordination relationships developed throughout the years, coordinated closely with the Mississippi Department of Archives and History staff in determining effects of the storm event. Hurricane Katrina has been documented to have destroyed a vast majority of the standing historic properties within Hancock County, and a large number of those within Harrison and Jackson Counties. The size and strength of the storm surge has also undoubtedly had as much destruction on archaeological sites. Post hurricane activities have further impacted the remaining historic properties.

Protection from the immediate and post-effects of hurricanes should be considered as beneficial to cultural resources. While some historic properties may be adversely affected by protection plans, long term prevention of damage should be considered a positive measure for historic properties, in particular standing structures.

Mobile District archaeologists are closely coordinating with the State of Mississippi Department of Archives and History regarding potential impacts associated with potential measures being considered in the Comprehensive Plan. Additionally, FEMA and the Mississippi Development Authority are conducting individual cultural resources analyses in conjunction with their identified projects. Mobile District archaeologists will be given access to other agency's findings and reports and will be informed as additional projects are being analyzed regarding cultural resources. Once specific projects become funded, cultural resources analysis would occur on an individual project basis to ensure compliance.

Many of the current analyses that might be needed could actually be in duplication of what is currently being conducted by other agencies. Ongoing coordination with SHPO and other agency representatives will help to prevent duplication of efforts for cultural resources compliance.

4.4.11 Recommended Plans - HTRW Impacts

Quickly after Hurricane Katrina, the EPA working with the National Strike Team and other national search and rescue teams began identification and cleanup of the Household Hazardous Wastes and other hazardous type debris. The EPA established partnerships with other national and local teams involved with debris cleanup. The Corps team coordinated with them regularly and provided coordinates/locations of HHW and HTRW that were located during vegetative and construction type debris cleanup. The EPA working with others were charged with the responsibility of final cleanup of this type debris after the storm event.

Site inspections would be conducted at and adjacent to the various components of the proposed projects during development of specific plans and specifications in accordance with the requirements of ER 1165-2-132 entitled, HTRW Guidance for Civil Works Projects, and the American Society of Testing and Materials Standard E 1527.

Inspections would be accomplished to determine the presence or evidence of landfills, surface areas unable to support vegetation, visible sheens of petroleum product, nearby contaminated industrial facilities, or any type of visible indication that HTRW concerns exist that may impact any component of the recommended plans during specific project development. Site inspections of adjacent properties, reviews of historic aerial photographs, on site interviews, and environmental database record searches would be conducted to determine any evidence of HTRW concerns that may impact any component of the recommended plans during specific project development.

Based on the findings of the HTRW site assessments, specific or unusual environmental concerns that are identified that could affect construction of any proposed projects would be addressed appropriately. Additional supplemental environmental impacts statements or environmental analyses may be necessary once specific projects have been identified and development of project plans has begun. HTRW issues and concerns would be addressed during the required NEPA compliance and documentation.

4.4.12 Recommended Plans - Environmental Justice Impacts

EO 12898, Federal Actions to address Environmental Justice in Minority and Low-Income Populations (February 11, 1994) requires that Federal agencies conduct their programs, policies, and activities that substantially affect human health or the environment in a manner that ensures that such programs, policies, and activities do not have the effect of excluding persons (including populations) from participation in, denying persons (including populations) the benefits of, or subjecting persons (including populations) to discrimination under such programs, policies, and activities because of their race, color, or national origin. On February 11, 1994, the President also issued a memorandum for heads of all departments and agencies, directing that EPA, whenever reviewing environmental effects of proposed actions pursuant to its authority under Section 309 of the CAA, ensure that the involved agency has fully analyzed environmental laws, regulations, and policies.

The projects being recommended for construction are not designed to create a benefit for any specific group or individual. Any potential measures would not create disproportionately high or adverse human health or environmental impacts on minority or low-income populations within the study area. Since the establishment of the Turkey Creek Community, which includes Forrest (Forest) Heights within its vicinity, by freed slaves and their descendants, federally funded construction programs including the Gulfport Regional Airport, U.S. Highway 49, and Interstate-10 have impacted the Turkey Creek watershed. In addition, numerous other constructions including hotels, shopping centers and housing developments have been federally permitted to fill wetlands and construct within the Turkey Creek watershed. Review and evaluation of the overall comprehensive plan have not disclosed the existence of identifiable minority or low-income communities that would be adversely impacted by proposed measures.

A detailed discussion on the *Historic and Existing Conditions Data from the U.S. Department of Commerce, Census of Population and* Housing has been provided in Section 4.2.1.21. This analysis will serve as a beginning point from which further analyses can be built upon during the comprehensive plan components. Ultimately, the plan adopted for the Mississippi coast will not be a plan forced on them by the Corps or other Federal agencies, but a plan coordinated, discussed, and finally adopted by the numerous entities and individuals that will live with that plan, the residents and local government of coastal Mississippi.

4.4.13 Recommended Plans - Protection of Children Impacts

The EO 13045, Protection of Children from Environmental Health Risks and Safety Risks (April 21, 1997), recognizes a growing body of scientific knowledge that demonstrates that children may suffer disproportionately from environmental health risks and safety risks. These risks arise because children's bodily systems are not fully developed; because children eat, drink, and breathe more in proportion to their body weight; because their behavior patterns may make them more susceptible to accidents. Based on these factors, the President directed each Federal agency to make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children. The President also directed each Federal agency to ensure that its policies, programs activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.

It is anticipated that no disproportionate risks to children would occur as a result of the projects being recommended for construction. Further studies during project development phase would determine any activities that might pose any disproportionate environmental health risks or safety risks to children.

4.4.14 Recommended Plans - Unavoidable Adverse Environmental Effects

It is anticipated that any adverse environmental effects, which could not be avoided should potential projects be implemented, should be temporary and localized and would be minor individually and cumulatively.

4.4.15 Recommended Plans - Irreversible and Irretrievable Commitments of Resources

Any irreversible or irretrievable commitments of resources involved in any potential proposed projects have been considered and are either unanticipated at this time or will be considered to determine if any would present minor impacts.

The following section provides a thorough detailed analysis of the No Action and Recommended Plans. The detailed analysis for alternatives considered for each restoration project can be found in the Environmental Appendix.

4.5 Beach and Dune Restoration

In addition to the no action alternative, three alternative actions were evaluated. Each proposed action is comprised of a stand alone dune at alternative heights with alternative berm widths as presented below:

- Alternative I: dune elevation 10 ft with 50 ft crest, extended berm to match and sand fence;
- Alternative J: dune elevation 10 ft with 50 ft crest, extended berm to match and sand fence, plus planting dune/fence area; and
- Alternative K: dune elevation 2ft, 60 ft berm, sand fence with planting.

The higher dune elevation alternatives (Alternative I and J) were projected to disrupt highway traffic due to wind blown sand and were therefore not carried forward for full evaluation. The effects of the no action plan and the recommended plan (Alternative K) are discussed below. Only the parameters which have discernable differences between the no action plan and the recommended plan are presented in the discussion below.

4.5.1 Beach and Dune No Action Plan and Impacts

The No Action alternative involves the continuation of existing conditions and no new solutions for existing problems. This alternative avoids both the monetary investment and potential temporary adverse impacts associated with improvements. This alternative however does not allow for the beneficial effects of the proposed action. Future conditions associated with not restoring the dune feature would result in the continued absence of a valuable ecosystem, including critical habitat for the piping plover, various shorebirds including the least tern, and numerous fish and wildlife species. The immediate area would remain particularly vulnerable to wave and storm activity that continually threaten the mainland shoreline and prevent the re-establishment of the dune system. Maintenance of existing beaches occurs approximately every 12 years by hydraulic placement of sand obtained from within near offshore area. In some instances, particularly in Hancock and Jackson Counties, maintenance of existing beaches occurs annually with sand being obtained from commercial sources and trucked to the site. The No Action Plan would result in continuing current maintenance practices with the potential for increased volumes of sand associated with intensities and frequencies of future storm events.

4.5.1.1 Beach and Dune Restoration No Action Vegetation Impacts

Implementation of the No Action Plan would result in eroded beaches and dunes. The loss of dune vegetation would occur as erosion occurs.

4.5.1.2 Beach and Dune Restoration No Action Fish and Wildlife Impacts

The No Action Plan would allow the beach to become unstable due to erosion and the loss of habitat for nesting and foraging shorebirds and migratory birds would occur.

4.5.1.3 Beach and Dune Restoration No Action Threatened and Endangered Species Impacts

Loss of valuable over-wintering foraging areas for the piping plover would occur.

4.5.1.4 Beach and Dune Restoration No Action Water Quality Impacts

No impact is anticipated to water quality.

4.5.1.5 Beach and Dune Restoration No Action Land Use Impacts

The No Action Plan would not cause a change in land use impacts since these areas are maintained for public benefit.

4.5.1.6 Beach and Dune Proposed Actions and Impacts

Existing beaches, located along approximately one-half of coastal Mississippi mainland shoreline, are situated seaward of existing concrete seawalls. Dune restoration would provide additional protection against erosion during small storm events as well as provide feeding grounds and nesting areas for various birds, crabs, and other fauna.

The Proposed Action would consist of creation of a dune field that would be constructed approximately 50 feet seaward of the existing seawall and about 2 feet above the existing berm with a width of approximately 60 feet running the length of the three coastal counties. The project would include planting of dune vegetation and sand fencing to enhance establishment and survival of the dune vegetation. Sand would be obtained from borrow areas historically used located offshore of the mainland or from upland commercial sources brought in by trucks.

4.5.1.7 Proposed Beach and Dune Restoration Vegetation Impacts

It is anticipated there would be no adverse impacts to vegetation as a result of the proposed action. Actually, the project would provide a benefit to vegetation as native dune plantings occur.

4.5.1.8 Proposed Beach and Dune Restoration Fish and Wildlife Impacts

It is anticipated that implementation of the proposed action would provide significant benefits to fish and wildlife by nourishment of the beaches and reconstruction of damaged or lost dunes. Dunes provide natural habitat and by restoration, the beach dwelling species gain lost habitat. These beaches provide important stopover habitat for species of migratory birds. In fact, these dunes and beaches are essential stopover areas for migratory birds to rest and feed prior to making their continued flight and without them many may not continue to their final destination. The beaches are currently designated critical habitat for piping plover. Enhancement of this habitat would benefit piping plover and other shorebirds. The beaches have existed since the mid-fifties and have experienced erosion and nourishment throughout the years. Nourishment activities would not result in significant impacts to the benthic community within the project vicinity.

4.5.1.9 Proposed Beach and Dune Restoration Threatened and Endangered Species Impacts

Overall implementation of the proposed action would benefit piping plover and its critical habitat by an increased amount of over wintering foraging areas. Only minor temporary impacts could occur during construction but could be avoided during the times the piping plover are on the over wintering grounds. Impacts associated with construction activities should be temporary and isolated to actual construction limits. Brown pelicans could utilize the project areas; however, it is anticipated these species would avoid the construction area due to noise and activity. These impacts would be temporary and isolated to actual construction limits. Surveys to determine if nesting brown pelicans are present could be conducted to avoid any impacts. Manatees, Gulf sturgeon and sea turtles could be in the project borrow area. It is anticipated these species would primarily avoid the construction areas due to noise and activity resulting in less risk for harm or harassment. Methods of dredging would be utilized to avoid adverse impacts to listed species. Placement activities would be accomplished using appropriate best management practices to reduce turbidity and other potential adverse impacts to species and its critical habitat. Further consultation would be required to determine adverse impacts to critical habitat for the Gulf sturgeon. It is anticipated Whale species would not be present within the project area. Further consultation would determine potential impacts to listed species. Biological Assessments of particular project components would need to be evaluated under future programmatic consultations.

4.5.1.10 Proposed Beach and Dune Restoration Water Quality Impacts

BMPs would be used to minimize impacts to water quality during placement and construction activities. It is anticipated there would be minimal impacts to water quality resulting from the proposed action. Turbidity should be localized to the placement activities and short term in nature.

4.5.1.11 Proposed Beach and Dune Restoration Land Use Impacts

Beach nourishment and construction of the dune feature would help sustain current land use along the existing beach front.

4.6 Admiral Island

Six alternatives plus a no action alternative were considered for ecosystem restoration at Admiral Island. Ecosystem restoration at Admiral Island falls within the Congressional authorization for fish and wildlife preservation on the Mississippi coast.

- No Action
- Plan 1 – Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at .5 meter spacing.
- Plan 2 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.
- Plan 3 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 2 meter spacing.
- Plan 4 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at .5 meter spacing.
- Plan 5 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.
- Plan 6 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at 2 meter spacing.

4.6.1 Admiral Island No Action Plan and Impacts

Implementation of the No Action Plan would allow degraded conditions to continue on the existing state-owned property. Tidal marshes in this area were ditched in the 1960s causing changes in the natural hydrology and subsequent changes in the species composition. Hurricane Katrina left extensive debris fields and sedimentation in the area destroying many native trees and vegetation. Due to the loss of native species and the subsequent open spaces, this area has a severe infestation of the invasive Chinese Tallow Tree, which is invading the marshes and adjacent flatwoods.

4.6.1.1 Admiral Island No Action Vegetation Impacts

The invasive species would continue to thrive threatening to take over the site. Persistence of the exotic species would diminish the native food supply to migratory birds and the associated wildlife found in the area. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition.

4.6.1.2 Admiral Island No Action Fish and Wildlife Impacts

The invasive species would continue to thrive threatening to take over the site reducing available native forage for fish and wildlife species to use the area. Lack of available habitat could cause fish and wildlife species to move from the area seeking more suitable habitat.

4.6.1.3 Admiral Island No Action Threatened and Endangered Species Impacts

It is anticipated there will be no impacts to T&E species as the project area does not offer suitable habitat for any of the listed species.

4.6.1.4 Admiral Island No Action Water Quality Impacts

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. Continued degradation of the site would further reduce any water quality functions that currently exist.

4.6.1.5 Admiral Island No Action Land Use Impacts

The invasive species would continue to thrive threatening to take over the site; thus, eventually outcompeting the native species and ultimately changing land use. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition; however there should be no change to current land use as the site is currently owned by the State of Mississippi and consists of a degraded wetland.

4.6.2 Admiral Island Proposed Actions and Impacts

The restoration site contains 62 acres of emergent tidal marsh to be restored. The remaining 61 acres of scrub shrub wetland habitat would remain. The tidal marshes in this area were ditched during the 1960s causing changes in the natural hydrology and subsequent changes in the species composition. Hurricane Katrina left extensive debris fields and sedimentation in the area and destroyed many native trees and vegetation. Due to the loss of native species this area has a severe infestation of the invasive Chinese Tallow tree, which is invading the marshes and the adjacent flatwoods. For increased habitat diversity, higher elevations containing shrub/scrub wetland plant species would remain in order to enhance diversity within the restoration site. The following measures were developed:

1. Excavation of old fill material (includes 90-95% removal of existing exotic species in excavated areas) (Mandatory).

This measure, in conjunction with measure 3, affects the hydrologic regime variable, which under existing conditions receives a score 0.25, on the assumption that greater than half the site has been filled above the normal tidal flooding zone. This measure by itself would raise the hydrologic regime variable to a 0.75.

2. 100% removal of exotics from non-excavated areas and maintain removal of exotic plant species in all areas over project lifetime. (Mandatory in all plans).

This measure affects the "percent cover by invasive or exotic species" variable, and would raise the variable score to 1.0 under all plans

3. Filling in 100% of existing artificial ditches/channels.

If this measure is performed in addition to the mandatory measure 1, the hydrologic regime variable score would increase to 1.0 as there would be no more hydrologic alterations to the site.

4. Native Vegetation Planting

Alternatives:

a) 0.5 meter spacing

b) 1 meter spacing

c) 2 meter spacing

This measure affects the "percent cover by woody plant species", "wildlife habitat diversity", "vegetation height", "wetland indicator status" and "mean percent cover emergent plant species" variables. The relevant vegetation variables are assumed to reach their highest potential score at year 5 under 0.5 meter spacing, year 7 with 1.0 meter spacing, and year 10 with 2.0 meter spacing, and then sustained at that level for the project life (50 years). Variable sub index scores are treated as increasing linearly from their value under the no-action plan up to their highest potential value obtained at year 5, 7, or 10, depending on the planting spacing, and then remaining constant thereafter.

A combination of measures resulted in the following plan combinations and a summary of functional unit benefits are shown in the Tables 4-7 and 4-8 below:

Table 4-7
Admiral Island Measures

Plan 1. 1,2,3,4a	Plan 2. 1,2,3,4b	Plan 3. 1,2,3,4c
Plan 4. 1,2,4a	Plan 5. 1,2,4b	Plan 6. 1,2,4c

Table 4-8
Admiral Island Restoration Plans - Summary of AAFU Benefits

Site	Restoration Acres	Plan	AAFU Benefit
Admiral Island	62	No-action plan	0
Admiral Island	62	Plan 1	61
Admiral Island	62	Plan 2	60
Admiral Island	62	Plan 3	59
Admiral Island	62	Plan 4	51
Admiral Island	62	Plan 5	50.5
Admiral Island	62	Plan 6	49

The PDT selected Plan 2 as the best buy plan using the IWR planning suite, based on cost estimates and benefits gained by each alternative. The following analysis is based on Plan 2 being recommended for construction.

4.6.2.1 Admiral Island Restoration Alternative Vegetation Impacts

There will be a benefit to vegetation as the recommended plan will restore hydrology and remove exotics allowing native plants to become better established. The planting density is not at optimum level for expedited reestablishment of native species; however, it is the most cost-effective method. This will reduce the percent cover which could allow for exotics to reestablish in the future but with future plantings/management this would be minimized. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return. Vegetation would support the vital migratory bird population moving through Mississippi.

4.6.2.2 Admiral Island Restoration Alternative Fish and Wildlife Impacts

There will be a benefit to fish and wildlife species, including the migratory bird population, as this plan will restore hydrology, and remove exotics allowing native plants to become better established. Native species would provide potential food sources to many fish and wildlife species found in coastal Mississippi. The planting density is not at optimum level for expedited reestablishment of native species; however, it is the most cost-effective method. This will reduce the percent cover which could allow for exotics to reestablish in the future; however, it is the most cost-effective method but with future plantings/management this would be minimized. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return and to provide necessary habitat for fish and wildlife species. Fish and wildlife species would benefit from the restoration of Admiral Island because it provides essential feeding, breeding, staging and resting areas for many ARNI species and are essential areas to EFH.

4.6.2.3 Admiral Island Restoration Alternative Threatened and Endangered Species Impacts

It is anticipated there will be no impacts to T&E species as the project area does not offer suitable habitat for any of the listed species.

4.6.2.4 Admiral Island Restoration Alternative Water Quality Impacts

There will be a benefit to water quality as this plan will restore hydrology, and remove exotics allowing native plants to become better established. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return. Once complete, the project would mature over a longer period of time; however, the project would provide for improved water quality functions. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

4.6.2.5 Admiral Island Restoration Alternative Land Use Impacts

There would be no impacts to current land use as a result of construction of this alternative as the site is currently owned by the State of Mississippi and consists of a degraded wetland.

4.7 Dantzler

Two alternative actions and a no action alternative were considered for ecosystem restoration at Dantzler. Variations on the two alternative action plans were also considered. Ecosystem restoration at Dantzler falls within the Congressional authorization for fish and wildlife preservation on the Mississippi coast.

- No Action
- Plan 1 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, 100% Removal of exotics and plantation pines over the project life, Fill in 100% artificial ditches.
- Plan 2 – Maintain Savannah Vegetation by Mowing Annually, 100% Removal of exotics and plantation pines over the project life, Fill in 100% artificial ditches.

4.7.1 Dantzler No Action Plan and Impacts

Implementation of the No Action Plan would allow degraded conditions to continue on the existing state-owned property. The area was planted in plantation pines during the 1960s and ditches and stormwater lines were constructed in the 1970s in anticipation of residential development of the site. Long term exclusion of fire and the invasion of non-native species, cogongrass and Chinese Tallow Trees have severely degraded the site.

4.7.1.1 Dantzler No Action Plan Vegetation Impacts

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession and create a mixed pine/hardwood community.

4.7.1.2 Dantzler No Action Plan Fish and Wildlife Impacts

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession, creating a mixed pine/hardwood forest community thus shifting the fish and wildlife species that would normally use the historical pine savannah habitat.

4.7.1.3 Dantzler No Action Plan Threatened and Endangered Species Impacts

The invasive species would continue to thrive threatening to take over the site further degrading available habitat for use by the Mississippi Sandhill Crane.

4.7.1.4 Dantzler No Action Plan Water Quality Impacts

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession and create a mixed pine/hardwood community.

4.7.1.5 Dantzler No Action Plan Land Use Impacts

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession and creating a mixed pine and hardwood community. There would be no impacts to current land use as a result of construction of this alternative as the site is currently owned by the State of Mississippi and consists of a degraded wetland.

4.7.2 Dantzler Proposed Alternatives and Impacts

The restoration site contains 385 acres to be restored to wet pine savanna. This area was planted in plantation pine during the 1960s and ditches and stormwater lines were constructed in the early 1970s in anticipation of residential development of the site. The long-term exclusion of fire and the invasion of non-native species such as Cogongrass and Chinese have severely degraded the site. The following measures were developed:

1. Maintain native savanna vegetation. (Mandatory)

    Alternative:

    a. prescribed burning on a 3-5 year cycle.

    b. mowing annually.

This measure affects the "area of contiguous fire-maintained landscape", as well as all plant related variables used in the model. It is assumed that these variables will recover to a score of 1.0 under the burn alternative. Under the mowing alternative, the "area of contiguous fire-maintained" landscape variable will score a 0.0 but the plant related variables will still score a 1.0, similar to burning.

2. 100% removal of exotics and plantation pine; maintain removal of exotic plant species in all areas over project lifetime. (Mandatory in all plans).

This measure affects the "percent cover by invasive or exotic species" variable, and would raise the variable score to 1.0 under all plans

3. Filling in 100% of existing artificial ditches. (Mandatory)

If this measure is performed in addition to the mandatory measure 1, the hydrologic regime variable score would increase to 1.0 as there would be no more hydrologic alterations to the site.

A combination of measures resulted in the following plan combinations and a summary of functional unit benefits are shown in Tables 4-9 and 4-10 below.

Table 4-9
Dantzler Restoration Measures

Plans 1-2.	Restoring areas both north and south of road (areas A and B)	
	Plan 1. 1a,2,3	Plan 2. 1b,2,3
Plans 3-4.	Restoring only area north of road (Area A)	

	Plan 3. 1a,2,3	Plan 4. 1b,2,3
Plans 5-6.	Restoring only area south of road (Area B)	
	Plan 5. 1a,2,3	Plan 6. 1b,2,3

Table 4-10
Dantzler Restoration Plans - Summary of AAFU Benefits

Site	Restoration Acres	Plan	AAFU Benefit
Dantzler	385	No-action plan	0
Dantzler	385	Plan 1	1,244
Dantzler	385	Plan 2	943
Dantzler	151	Plan 3	488
Dantzler	151	Plan 4	370
Dantzler	234	Plan 5	756
Dantzler	234	Plan 6	573

The PDT using the IWR planning suite, selected Plan 1 as the best buy plan based on cost estimates and benefits gained by each alternative. The following analysis is based on Plan 1 being recommended for construction.

4.7.2.1 Dantzler Proposed Alternatives Vegetation Impacts

Implementation of this plan will benefit vegetation. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. The only difference in vegetation impacts among the alternatives is the extent of restoration.

4.7.2.2 Dantzler Proposed Alternatives Fish and Wildlife Impacts

Implementation of this plan will benefit fish and wildlife species. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. Many fish and wildlife species depend on these disappearing habitats. Adequate restoration and fire management is necessary to ensure continued existence of species dependent on pine savannah habitats. Mowing may have more of an impact to nesting birds than the fire regime. Many species of wildlife are indigenous to the wet pine savannah habitat. Understory plant communities may contain wiregrass, sedges, orchids, American chaffseed and rough-leaved loosestrife. Insectivorous plants that may be found include pitcher plants, bladderworts, Venus flytrap, and sundews.

4.7.2.3 Dantzler Proposed Alternatives Threatened and Endangered Species Impacts

Implementation of this plan will benefit the Mississippi sandhill crane by restoration of the wet pine savannah, the main habitat used by the species for nesting and foraging. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. The Alabama red-bellied turtle has been documented in using channels within Mary Walker Bayou, adjacent to the project site. It is anticipated the species could use the project site for nesting. The Mississippi sandhill crane depends on this type habitat for its continued existence which has experienced declines due to development within coastal Mississippi. Rare, threatened or endangered birds that may occur in these areas include Henslowe's sparrow, Bachman's sparrow, red-cockaded woodpecker in addition to the Mississippi sandhill crane. This ecosystem may also benefit the Mississippi gopher frog and in drier areas along ridges, the black pine snake and the gopher tortoise. There is no substantive difference in threatened and endangered species impact among the two alternatives.

4.7.2.4 Dantzler Proposed Alternatives Water Quality Impacts

Implementation of this plan will benefit water quality. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. It is anticipated that burning activities could have short term impacts to water quality due to runoff during rain events. This should be localized and short term in nature. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi. There is no difference between the alternatives concerning water quality impacts.

4.7.2.5 Dantzler Proposed Action Land Use Impacts

There would be no impacts to current land use as a result of construction of this alternative as the site is currently owned by the State of Mississippi and consists of a degraded wetland.

4.8 Turkey Creek

Six alternative actions and a no action alternative were considered for ecosystem restoration at Turkey Creek. Ecosystem restoration at Turkey Creek falls within the Congressional authorization for fish and wildlife preservation on the Mississippi coast.

- No Action
- Plan 1 – Acquire lands and maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site.
- Plan 2 – Acquire lands and maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site.
- Plan 3 – Acquire lands and maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area south of the railway berm.
- Plan 4 – Acquire lands and maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area south of the railway berm.
- Plan 5 – Acquire lands and maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area north of the railway berm.
- Plan 6 – Acquire lands and maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area north of the railway berm.

4.8.1 Turkey Creek No Action Plan Impacts

Implementation of the No Action Plan could result in two different scenarios occurring on the privately owned property. The site is primarily comprised of a pine savannah wetland. Several miles of ditches have been excavated throughout the site. Additionally, an elevated railway berm fragments the wetland habitat substantially altering hydrology of the wetlands located to the north. The project site could continue to degrade or the current landowner could obtain a wetland fill permit in order to develop the site into a commercial development resulting in almost the complete site being paved with impervious surfaces.

4.8.1.1 Turkey Creek No Action Vegetation Impacts

The invasive species would continue to thrive threatening to completely colonize the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession and create a mixed pine/hardwood community. Development of the site into a commercial site would result in a complete loss of existing vegetation. It is anticipated that any bare soils that would not be covered by paving materials would be vegetated with grass or other ornamental landscaping to reduce erosion.

4.8.1.2 Turkey Creek No Action Fish and Wildlife Impacts

The invasive species would continue to thrive threatening to completely colonize the site; thus, eliminating the valuable. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession, creating a mixed pine/hardwood forest community thus shifting the fish and wildlife species that would normally use the historical pine savannah habitat.

4.8.1.3 Turkey Creek No Action Threatened and Endangered Species Impacts

Without action, it is anticipated that this already degraded wet pine savannah habitat, which exists within the impaired Turkey Creek watershed, would likely become developed given the history of the area. Assuming development, it is anticipated that the loss of wet pine savannah habitat would indirectly adversely impacts T&E species, such as the Mississippi sandhill crane and Mississippi gopher frog.

4.8.1.4 Turkey Creek No Action Water Quality Impacts

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession and create a mixed pine/hardwood community.

4.8.1.5 Turkey Creek No Action Land Use Impacts

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area undergoes succession and creating a mixed pine and hardwood community. The No Action alternative being implemented would not preclude future development from occurring on the site as the site is owned by a private citizen.

4.8.2 Turkey Creek Proposed Alternatives and Impacts

The restoration site is primarily comprised of a degraded wet pine savannah wetland. Several miles of ditches have been excavated throughout the site. Additionally, an elevated railway berm fragments the wetland habitat substantially altering hydrology of the wetlands located to the north. All alternatives require the acquisition of the undeveloped property. The following restoration and management measures were developed:

1. Filling in ditches (Mandatory to achieve overall restoration project).

This measure affects the "Outflow of Water" variable, which measures the removal of water by ditches or drains. The variable score would increase from 0.0 to 1.0 under this measure.

2. Maintain vegetation (Mandatory to achieve overall restoration project).

Alternatives:

a. Burn (3-year cycle).

b. Mow (annual).

This measure affects the "area of contiguous fire-maintained landscape", as well as all plant related variables used in the model. It is assumed that these variables will recover to a score of 1.0 under the burn alternative. Under the mowing alternative, the "area of contiguous fire-maintained" landscape variable will score a 0.0 but the plant related variables will still score a 1.0, similar to burning.

3. Excavate and remove existing roadbeds and any additional fill (Mandatory to achieve overall restoration project).

This measure affects the "surface water storage" variable, which measures the presence of excavation or fill at the site. This variable score would increase from 0.0 to 1.0 in areas with existing roadbeds/fill.

A combination of the measures resulted in the following plan combinations and a summary of functional unit benefits are shown in Tables 4-11 and 4-12 below:

Table 4-11
Turkey Creek Restoration Measures

Plans 1-2.	Restoring areas north and south of railroad	
	Plan 1. 1, 2a, 3	Plan 2. 1, 2b, 3
Plans 3-4.	Restoring just areas south of railroad	
	Plan 3. 1, 2a, 3	Plan 4. 1, 2b, 3
Plans 5-6.	Restoring just areas north of railroad	
	Plan 5. 1, 2a, 3	Plan 6. 1, 2b, 3

Table 4-12
Turkey Creek Restoration Plans - Summary of Functional Unit Benefits

Site	Restoration Acres	Plan	Average Annual Functional Unit Benefit
Turkey Creek	879	Existing Condition (plans 1-2)	-
Turkey Creek	689	Existing Condition (plans 3-4)	-
Turkey Creek	190	Existing Condition (plans 5-6)	-
Turkey Creek	879	No-action plan (plans 1-2)	0
Turkey Creek	689	No-action plan (plans 3-4)	0
Turkey Creek	190	No-action plan (plans 5-6)	0
Turkey Creek	879	Plan 1	2,046
Turkey Creek	879	Plan 2	1,352
Turkey Creek	689	Plan 3	1,565
Turkey Creek	689	Plan 4	815
Turkey Creek	190	Plan 5	481
Turkey Creek	190	Plan 6	327

The PDT using the IWR planning suite selected Plan 3 as the best buy plan based on cost estimates and benefits gained by each alternative. The following analysis is based on Plan 3 being recommended for construction.

4.8.2.1 Turkey Creek Proposed Alternatives Vegetation Impact

Implementation of this plan will benefit vegetation. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories more effectively than the mowing alternatives, which will allow native grasses to become established. Removal of exotic species will allow for native species to remain.

4.8.2.2 Turkey Creek Proposed Plan Fish and Wildlife Impact

Pine savannah wetlands found in coastal Mississippi provide for diverse habitat for a number of plants and animals including many T&E species found only in these unique habitats. Pine savannah wetlands are commonly referred to as sponges that provide floodwater retention, groundwater recharge, and water purification. This wetland habitat is under increased developmental pressures due to the extreme and urgent housing need faced by Mississippians as they are trying to rebuild. This habitat is becoming fragmented and with the increased development, fire maintenance is increasingly harder to perform. Due to the nature of the flat coastal plains with little relief, these lands are some of the first to be considered for housing development. Urbanization and developmental pressure have created what are commonly referred to as forested wetlands. Fragmentation causes loss of wildlife corridors and contiguous expanses of habitat necessary for continued species existence. Coastal Mississippi has lost over half of its wet pine savannahs due to urbanization throughout the area; thus, creating a threatened ecosystem that in turn is home to many T&E species. Because of the loss of these habitats, the species dependent upon them are increasingly becoming diminished.

Implementation of this plan will benefit fish and wildlife species. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Mowing activities could impact ground nesting birds as well as other terrestrial mammals. Mowing creates additional ground litter that could inhibit daily activities of some species although maintenance of early successional habitat will benefit most species. Removal of exotic species will allow for native species to remain. Many fish and wildlife species depend on these disappearing habitats. Many species of wildlife are indigenous to the wet pine savannah habitat. Understory plant communities may contain wiregrass, sedges, orchids, American chaffseed and rough-leaved loosestrife. Insectivorous plants that may be found include pitcher plants, bladderworts, Venus flytrap, and sundews. Adequate restoration and fire management is necessary to ensure continued existence of species dependent on pine savannah habitats. This plan would only restore the area south of the railroad berm which would provide a contiguous fire maintained landscape. Larger blocks of habitat are more easily managed using fire and less fragmented landscapes provide more benefits to fish and wildlife species.

4.8.2.3 Turkey Creek Proposed Plan Threatened and Endangered Species Impact

Implementation of this plan would benefit some threatened and endangered species, such as the Mississippi sandhill crane, by restoration of the wet pine savannah, the main habitat used by the species for nesting and foraging. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. Even though the species is more likely to be found to the east, the Mississippi sandhill crane depends on this type habitat for its continued existence which has experienced declines due to development within coastal Mississippi. Rare, threatened or endangered birds that may occur in these areas include Henslow's sparrow, Bachman's sparrow, red-cockaded woodpecker in addition to the Mississippi sandhill crane. This ecosystem may also benefit the Mississippi gopher frog and in drier areas along ridges, the black pine snake and the gopher tortoise.

4.8.2.4 Turkey Creek Proposed Plan Water Quality Impact

Implementation of any of the proposed alternatives will benefit water quality. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. It is anticipated that burning activities could have short term impacts to water quality due to runoff during rain events. This should be localized and short term in nature. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

4.8.2.5 Turkey Creek Proposed Plan Land Use Impact

Implementation of this plan would result in slight changes to current land use due to restoration efforts. The site would continue to exist as a wetland with increased functions. The main change in land use would be that the lands would be restricted from future development with the required acquisition and subsequent inclusion in the Mississippi Coastal Preserves Program.

4.9 Bayou Cumbest

Six alternative actions and a no action alternative were considered for ecosystem restoration at Bayou Cumbest. Ecosystem restoration at Bayou Cumbest falls within the Congressional authorization for fish and wildlife preservation on the Mississippi coast.

- No Action
- Plan 1 – Acquisition of lands, Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at .5 meter spacing.
- Plan 2 - Acquisition of lands, Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.
- Plan 3 - Acquisition of lands, Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 2 meter spacing.
- Plan 4 - Acquisition of lands, Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at .5 meter spacing.
- Plan 5 - Acquisition of lands, Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.
- Plan 6 - Acquisition of lands, Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at 2 meter spacing.

4.9.1 Bayou Cumbest No Action Plan and Impacts

The project site consists of existing tidal marsh as well as filled and developed residential areas causing changes in the natural hydrology and subsequent losses and fragmentation to marsh. The developed areas were significantly destroyed by Katrina. Jackson County via a FEMA Hazard Mitigation Grant is purchasing repetitively flooded properties within the Bayou Cumbest area. In total Jackson County will purchase approximately 230 acres (126 parcels). Future development of these parcels will be prohibited. Within the project site, 8.6 acres (9 parcels) fall within the County / FEMA program and of these approximately 4 acres fall within the proposed restoration area.

Hurricane Katrina left extensive debris fields and sedimentation in the area destroying many native trees and vegetation. Due to the loss of native species this area has a severe infestation of the invasive Chinese Tallow Tree, cogongrass, and Phragmites, which are invading the marshes and adjacent flatwoods. The endangered Alabama Red-bellied turtle has been documented with using Bayou Cumbest north of the project site. There is potential this species could be found within Bayou Cumbest near or adjacent to the project site. There are no other documented occurrences of any T&E species within the project vicinity. Implementation of the No Action Plan would result in residents rebuilding their damaged homes in an area vulnerable to future hurricanes, smaller storm events, and potential flooding.

4.9.1.1 Bayou Cumbest No Action Plan Vegetation Impacts

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition.

4.9.1.2 Bayou Cumbest No Action Plan Fish and Wildlife Impacts

The invasive species would continue to thrive threatening to take over the site reducing available native forage for fish and wildlife species to use the area. Lack of available habitat could cause fish and wildlife species to move from the area seeking more suitable habitat.

4.9.1.3 Bayou Cumbest No Action Plan Threatened and Endangered Species Impacts

It is anticipated there will be no impacts to T&E species as the project area does not offer suitable habitat for any of the listed species, except for the Alabama Red-bellied Turtle as noted above.

4.9.1.4 Bayou Cumbest No Action Plan Water Quality Impacts

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition.

4.9.1.5 Bayou Cumbest No Action Plan Land Use Impacts

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The site would remain a severely damaged residential community which may experience moderate rebuilding efforts in the future dependent on the need for and availability of insurance by the proposed developers.

4.9.2 Bayou Cumbest Proposed Actions and Impacts

Of the total 148-acre restoration site, approximately 110 acres would be restored to tidal marsh while the remaining 38 acres would remain scrub/shrub wetland habitat. The area presently consists of previously filled marsh areas that were developed into a residential community. The proposed project requires the acquisition of approximately 144 acres of developed and undeveloped properties in addition to the use of 4 acres of land being acquired via the County / FEMA process. Portions of approximately 7 parcels of previously developed land fall within the restoration area (20 acres) with the remaining being undeveloped. The recommended project would require the acquisition of the subject properties according the Corps regulations. The majority of the residences were severely damaged or completely destroyed during the hurricanes of 2005. The following management measures were developed:

1. Excavation of old fill material (includes 90-95% removal of existing exotic species in excavated areas) (Mandatory)

This measure, in conjunction with measure 3, affects the hydrologic regime variable, which under existing conditions receives a score 0.50, on the assumption that approximately half the site has been filled above the normal tidal flooding zone. This measure by itself would raise the hydrologic regime variable to a 0.75.

2. 100% removal of exotics from non-excavated areas and maintain removal of exotic species (Chinese Tallow, Phragmites, Cogon Grass) in all areas over project lifetime. (Mandatory in all plans).

This measure affects the "percent cover by invasive or exotic species" variable, and would raise the variable score to 1.0 under all plans

3. Filling in 100% of existing artificial ditches/channels

If this measure is performed in addition to the mandatory measure 1, the hydrologic regime variable score would increase to 1.0 as there would be no more hydrologic alterations to the site.

4. Native Vegetation Planting

Alternatives

a) 0.5 meter spacing

b) 1 meter spacing

c) 2 meter spacing

This measure affects the "percent cover by woody plant species", "wildlife habitat diversity", "vegetation height", "wetland indicator status" and "mean percent cover emergent plant species" variables. The relevant vegetation variables are assumed to reach their highest potential score at year 5 under 0.5 meter spacing, year 7 with 1.0 meter spacing, and year 10 with 2.0 meter spacing, and then sustained at that level for the project life (50 years). Variable sub index scores are treated as increasing linearly from their value under the no-action plan up to their highest potential value obtained at year 5, 7, or 10, depending on the planting spacing, and then remaining constant thereafter.

A combination of measures resulted in the following plan combinations and a summary of functional unit benefits are shown in the Tables 4-13 and 4-14 below:

Table 4-13
Bayou Cumbest Restoration Measures

Plan 1. 1,2,3,4a	Plan 2. 1,2,3,4b	Plan 3. 1,2,3,4c
Plan 4. 1,2,4a	Plan 5. 1,2,4b	Plan 6. 1,2,4c

Table 4-14
Bayou Cumbest Restoration Plans - Summary of AAFU Benefits

Site	Restoration Acres	Plan	AAFU Benefit[1]
Bayou Cumbest	110	No-action plan	0
Bayou Cumbest	110	Plan 1	191
Bayou Cumbest	110	Plan 2	188
Bayou Cumbest	110	Plan 3	184
Bayou Cumbest	110	Plan 4	172
Bayou Cumbest	110	Plan 5	169
Bayou Cumbest	110	Plan 6	164

(1) AAFU's are based on a 50-year period of analysis
(2) See economic appendix for cost-effective analysis

The PDT using the IWR planning suite selected Plan 2 as the best buy plan based on cost estimates and benefits gained by each alternative. The following analysis is based on Plan 2 being recommended for construction.

4.9.2.1 Bayou Cumbest Restoration Alternatives Vegetation Impact

There will be a benefit to vegetation as this plan will restore hydrology, and remove exotics allowing native plants to become better established. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return. The differences in vegetation impacts among the alternatives are based on differing levels of planting density.

4.9.2.2 Bayou Cumbest Restoration Alternatives Fish and Wildlife Impact

There will be a benefit to fish and wildlife species as this plan will restore hydrology, and remove exotics allowing native plants to become better established. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return and to provide necessary habitat for fish and wildlife species. There are no substantive differences among the fish and wildlife impacts of the alternatives. Fish and wildlife species would benefit from the restoration of Bayou Cumbest because it provides essential feeding, breeding, staging and resting areas for many ARNI species and are essential areas to EFH.

4.9.2.3 Bayou Cumbest Restoration Alternatives Threatened and Endangered Species Impact

It is anticipated the alternatives will have no impact to T&E species as the project area does not offer suitable habitat for any of the listed species.

4.9.2.4 Bayou Cumbest Restoration Alternatives Water Quality Impact

There will be a benefit to water quality as each of the plans would restore hydrology, and remove exotics allowing native plants to become better established. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return. Once complete, the project would mature over a longer period of time; however, the project would provide for improved water quality functions. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

4.9.2.5 Bayou Cumbest Restoration Alternatives Land Use Impact

There would be a significant change in current land use as the existing site consists of a severely damaged residential community. Construction of any of the alternatives would result in the removal of the residences and restoration of the area into a fully functional wetland. In addition the area would be afforded the protections contained within the Mississippi Coastal Preserves Program into the future.

4.10 Franklin Creek

Acquisition of properties and relocation of homeowners within the Franklin Creek Floodway was authorized as a flood damage reduction measure in response to the MsCIP Interim Report dated 30 December 2006 (P.L. 110-28). Fifty nine parcels (29 unimproved, 30 residential) totaling 149 acres of degraded wet pine savannah are currently being purchased. Four alternative management actions and a no action alternative were considered for ecosystem restoration at Franklin Creek. Ecosystem restoration at Franklin Creek falls within the Congressional authorization for fish and wildlife preservation on the Mississippi coast.

- No Action
- Plan 1 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site, Add culverts under existing railroad berm.
- Plan 2 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site, Add culverts under existing railroad berm.
- Plan 3 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area southeast of railroad berm.
- Plan 4 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area southeast of railroad berm.

4.10.1 Franklin Creek No Action Plan and Impacts

The site currently consists of degraded pine flatwoods with numerous areas of fill as a result of residential development and the existing railroad which creates a hydrologic barrier between two separate areas. Implementation of the No Action Plan would result in the historical wetland area remaining a partially filled degraded pine savannah wetland.

4.10.1.1 Franklin Creek No Action Plan Vegetation Impacts

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession and create a mixed pine/hardwood community.

4.10.1.2 Franklin Creek No Action Plan Fish and Wildlife Impacts

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession, creating a mixed pine/hardwood forest community thus shifting the fish and wildlife species that would normally use the historical pine savannah habitat.

4.10.1.3 Franklin Creek No Action Plan Threatened and Endangered Species Impact

The invasive species would continue to thrive threatening to take over the site further degrading available habitat for use by threatened and endangered species, such as the Mississippi sandhill crane.

4.10.1.4 Franklin Creek No Action Plan Water Quality Impact

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession and create a mixed pine/hardwood community.

4.10.1.5 Franklin Creek No Action Plan Land Use Impact

Implementation of the flood damage reduction project will remove all structures, slabs, utilities, and some of the roadways in the area. This land will then be entered into the Mississippi Coastal Preserves Program. However, the invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition.

4.10.2 Franklin Creek Proposed Actions and Impacts

The restoration site including removal of utilities, building slabs, and roadways is a MsCIP interim buy-out project currently being implemented. The site consists of 149 acres bisected by an elevated railroad atop an earthen berm. The site received severe flood damages during the hurricanes of 2005 and previous storm events. Historically, the site consisted of wet pine savannah wetlands. It is assumed that removal of utilities, building slabs, and roadways would be completed as part of the ongoing interim project. The following restoration measures were developed:

1. Filling in ditches (Mandatory)

This measure affects the "Outflow of Water" variable, which measures the removal of water by ditches or drains. The variable score would increase from 0.1 to 1.0 under this measure.

2. Maintain vegetation (Mandatory)

Alternatives

a. Burn (3 year cycle)

b. Mow (annual)

This measure affects the "area of contiguous fire-maintained landscape", as well as all plant related variables used in the model. It is assumed that these variables will recover to a score of 1.0 under the burn alternative. Under the mowing alternative, the "area of contiguous fire-maintained landscape variable will score a 0.05 but the plant related variables will still score a 1.0, similar to burning.

3. Excavate and remove existing roadbeds and any additional fill (Mandatory)

This measure affects the "surface water storage" variable, which measures the presence of excavation or fill at the site. This variable score would increase from 0.1 to 1.0 in areas with existing roadbeds/fill.

4. Add culverts (Mandatory)

This measure increases the hydrologic connection between the two existing wetland areas separated by an elevated railway. The wetlands are primarily precipitation driven resulting in sheet flow drainage. Additional culverts will result in increased sheet flow drainage reducing standing surface water in the northern wetland area.

A combination of measures resulted in the following plan combinations and a summary of functional unit benefits are shown in Tables 4-15 and 4-16 below:

Table 4-15
Franklin Creek Measures

Plan 1. 1,2a,3,4	Plan 2. 1,2b,3,4
Plan 3. 1,2a,3	Plan 4. 1,2b, 3

Table 4-16
Franklin Creek Restoration Plans - Summary of AAFU Benefits

Site	Restoration Acres	Plan	Average Annual Functional Unit Benefit
Franklin Creek	149	No-action plan (plans 1-2)	0
Franklin Creek	56	No-action plan (plans 3-4)	0
Franklin Creek	149	Plan 1	516
Franklin Creek	149	Plan 2	399
Franklin Creek	56	Plan 3	194
Franklin Creek	56	Plan 4	150

The PDT using the IWR planning suite selected Plan 1 as the best buy plan based on cost estimates and benefits gained by each alternative. The following analysis is based on Plan 1 being recommended for construction.

4.10.2.1 Franklin Creek Alternative Plans Vegetation Impact

Pine savannah wetlands provide diverse habitat for a number of plants and animals including some species, such as carnivorous pitcher plants, found only in these unique habitats. These areas found primarily in the southeastern region of the U.S. are under increased developmental pressures and are becoming fragmented because fire maintenance is increasingly harder to perform. Due to the nature of the flat coastal plains with little relief, these lands are some of the first to be considered for housing development. Fragmentation causes loss of wildlife corridors and contiguous expanses of habitat necessary for continued species existence. Coastal Mississippi has lost over half of its wet pine savannahs due to urbanization throughout the area; thus, creating a threatened ecosystem that in turn is home to many T&E species. Because of the loss of these habitats, the species dependent upon them are increasingly becoming diminished.

Implementation of this plan will benefit vegetation. Restoration of hydrology by excavation of old roadbeds and any additional fill will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will allow for native species to remain. Installation of culverts increases hydrologic connections between the two separate areas which will improve native vegetation.

4.10.2.2 Franklin Creek Alternative Plans Fish and Wildlife Impact

Implementation of this plan will benefit fish and wildlife species. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. Many fish and wildlife species depend on these disappearing habitats. The mowing alternatives could impact ground nesting birds as well as other terrestrial mammals. Mowing creates additional ground litter that could inhibit daily activities of some species although maintenance of early successional habitat will benefit most species. Adequate restoration and fire management is necessary to ensure continued existence of species dependent on pine savannah habitats. This plan would restore the entire area north and south of the railroad berm which would provide a contiguous fire maintained landscape. Larger blocks of habitat are more easily managed using fire and less fragmented landscapes provide more benefits to fish and wildlife species. Unfortunately the railroad berm presents a barrier to hydrology, fire, and fish and wildlife species. To accommodate the barrier, additional culverts would be required as well as additional fire breaks for prevention of damages to the railroad berm by fire. Wildlife crossings would aid in dispersal of fish and wildlife species and would reduce train/wildlife collisions.

4.10.2.3 Franklin Creek Alternative Plans Threatened and Endangered Species Impact

Implementation of this plan would benefit some T&E species, such as the Mississippi sandhill crane, by restoration of the wet pine savannah, the main habitat used by the species for nesting and foraging. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. The Mississippi sandhill crane depends on this type habitat for its continued existence which has experienced declines due to development within coastal Mississippi. Rare, threatened or endangered birds that may occur in these areas include Henslow's sparrow, Bachman's sparrow, red-cockaded woodpecker in addition to the Mississippi sandhill crane. This ecosystem may also benefit the Mississippi gopher frog and in drier areas along ridges, the black pine snake and the gopher tortoise.

4.10.2.4 Franklin Creek Alternative Plans Water Quality Impact

Implementation of any of the alternative plans will benefit water quality. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. It is anticipated that burning activities could have short term impacts to water quality due to runoff during rain events. This should be localized and short term in nature. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

4.10.2.5 Franklin Creek Alternative Plans Land Use Impact

Implementation of any of the alternative plans would not result in significant changes to current land use as the land will be part of the Mississippi Coastal Preserves. The value of the land use by wildlife however will be significantly improved with the implementation of any of the alternative management measures.

4.11 SAV Pilot Project

4.11.1 SAV No Action Plan and Impacts

The No Action Plan would result in the continued loss of 5 acres of sea grasses that existed prior to Hurricane Katrina. No new techniques could be identified to aid in future larger seagrass restoration projects in brackish and saltwater systems.

4.11.1.1 SAV No Action Plan Vegetation Impacts

The SAVs will not be restored. SAVs are being lost regularly and successful restoration techniques remain unproven and difficult to quantify. Without this project, the lack of much needed research could lead to continued losses of SAVs throughout coastal Mississippi, especially within brackish water systems.

4.11.1.2 SAV No Action Plan Fish and Wildlife Impacts

The SAVs will not be restored. SAVs are being lost regularly and successful restoration techniques remain unproven and difficult to quantify. A high density of juvenile fish utilizes SAV beds and without its restoration, benefits to fish would be lost. Without this project, the lack of much needed research could lead to continued losses of SAVs throughout coastal Mississippi, especially within brackish water systems.

4.11.1.3 SAV No Action Plan Threatened and Endangered Species Impacts

The SAVs will not be restored. SAVs are being lost regularly and successful restoration techniques remain unproven and difficult to quantify. Without this project, the lack of much needed research could lead to continued losses of SAVs throughout coastal Mississippi, especially within brackish water systems. The endangered Alabama red-bellied turtle feeds on SAVs within fresh and brackish water bodies. Destruction of nesting areas along river banks, feeding areas of SAV, and reduced water quality has impacted this species.

4.11.1.4 SAV No Action Plan Water Quality Impact

The SAVs will not be restored. SAVs are being lost regularly and successful restoration techniques remain unproven and difficult to quantify. Without this project, the lack of much needed research could lead to continued losses of SAVs throughout coastal Mississippi, especially within brackish water systems.

4.11.1.5 SAV No Action Plan Land Use Impact

The SAVs will not be restored. SAVs are being lost regularly and successful restoration techniques remain unproven and difficult to quantify. Without this project, the lack of much needed research could lead to continued losses of SAVs throughout coastal Mississippi, especially within brackish water systems and recovery of the once existent land use would not be accomplished.

4.11.2 SAV Proposed Actions and Impacts

The project site is located within Bayou Cumbest and would consist of re-planting approximately 5 acres of destroyed sea grasses as a result of Hurricane Katrina. The pilot project would evaluate three restoration techniques to demonstrate their feasibility for larger restoration projects. Although it is unclear how to quantify benefits associated with restoration of sea grasses, the following information provides additional benefits associated with implementation of this type pilot project:

Value of SAV to Ecosystems

- Primary production (food for other animals)
- Improves water quality
- Storm protection (dampens waves, currents, and storm surge)
- Value to commercial and recreational fisheries by providing
    - Protection to juveniles from predators
    - Nursery habitat
    - Foraging habitat
- Nutrient cycling (estimated to be $7,700/ac/yr in 1996 USD)
- Sediment filtration and trapping (offset sea-level rise)
- Oxygen production
- Organic-matter production and export (provides materials used in other habitats such as adjacent wetlands and marsh, offsets sea-level rise)
- Prevents/reduces erosion
- Increased species diversity (in both the sediments and SAV beds)

Table 4-17
Fish Species Collected at Grand Bay NERR SAV beds

Scientific Name	Common Name
Anchoa mitchilli	Bay anchovy
Bairdiella chrysoura	Silver perch (drum family)
Brevoortia patronus	Gulf menhaden
Citharichthys spilopterus	Bay whiff (flounder)
Ctenogobius boleosoma	Darter goby
Cynoscion nebulosus	Spotted seatrout
Eucinostomus argenteus	Spot-fin mojarra
Lagodon rhomboides	Pinfish
Leiostomus xanthurus	Spot
Lucania parva	Rainwater killifish
Lutjanus grisues	Grey snapper (mangrove snapper)
Menidia beryllina	Inland silverside
Mugil cephalus	Striped mullet
Oligoplites saurus	Leatherjack
Sphoeroides parvus	Least puffer

Scientific Name	Common Name
Sphyraena guachancho	Guaguanche (barracuda family)
Sygnathus louisianae	Chain pipefish
Sygnathus scovelli	Gulf pipefish
Symphurus plagiusa	Black cheeked toungefish (flounder-like)
Synodus foetens	Inshore lizardfish
Archosargus probatacephalus	Sheepshead
Mycteroperca microlepis	Gag grouper
Chasmodes saburrae	Florida blenny
Orthopristis chrysoptera	Pigfish

In addition, the SAV beds support shrimp and blue crabs, both of which have value as commercial and recreational fisheries along with EFH designation status. SAV beds provide critical nursery areas for many species of fish and shellfish. Menhaden and shrimp, the most important commercial species, depend on estuarine wetlands for protection and food when they are juveniles. The relationship between a fishery and wetlands has been very effectively demonstrated for the shrimp fishery. Research has shown that the productivity of shrimp fisheries is directly related to the amount of vegetated area in an estuary. The more wetlands there are in an estuary, the more shrimp the estuary will produce. Shrimp landings account for more than half of the value of Mississippi commercial fisheries, which is why Mississippi shrimp fishermen, facing declining harvests in some areas, have joined other Gulf of Mexico shrimpers in becoming supporters of efforts to conserve and restore coastal wetlands. Another example of a fisheries dependence on wetlands is found in the menhaden fishery, whose total landings (Atlantic and Gulf of Mexico) have decreased by 26% in the last decade. Menhaden are dependent on wetlands for nursery habitat and the detrital food chain. The regional management plan for Gulf menhaden cites the loss of coastal wetlands as one of the principle threats to that fishery.

4.11.2.1 SAV Alternative Plans Vegetation Impact

Implementation of this pilot project would allow experimental techniques to provide much needed research to restore SAVs and determine the effectiveness of subsequent restoration projects. Additionally, the project will replace lost SAVs as a result of Hurricane Katrina. The functions and resultant values will help sustain productive foraging and refuge habitat for various life stages of numerous aquatic species.

4.11.2.2 SAV Alternative Plans Fish and Wildlife Impact

Experimental techniques associated with this pilot project would provide much needed research and information to restore SAVs and determine the effectiveness of subsequent restoration projects. Additionally, the project will replace loss SAVs as a result of Hurricane Katrina. The functions and resultant values help to sustain productive foraging and refuge habitat for various life stages of numerous aquatic species.

4.11.2.3 SAV Alternative Plans Threatened and Endangered Species Impact

The knowledge gained from implementing this pilot project has direct and indirect benefits to T&E species, such as the Alabama red-bellied turtle. Initially, the project will replace loss SAVs as a result of Hurricane Katrina, which would provide a possible food source to this protected species. Furthermore, the knowledge gained from implementing this proposed small restoration project would allow future projects to incorporate that information to ensure successful restoration projects; thus, provide future benefits to the Alabama red-bellied turtle.

4.11.2.4 SAV Alternative Plans Water Quality Impact

Experimental techniques would provide much needed research and information needed to restore SAVs and determine the effectiveness of subsequent restoration projects. Additionally, the project will replace loss SAVs as a result of Hurricane Katrina. The functions and resultant values help to improve and sustain water quality as the SAVs trap fine silty sediments increasing water clarity, reducing nutrient levels, and providing for overall less turbidity.

4.11.2.5 SAV Alternative Plans Land Use Impact

Implementation of this pilot project, experimental techniques would provide much needed research and information needed to restore SAVs and determine the effectiveness of subsequent restoration projects. Additionally, the project will replace loss SAVs as a result of Hurricane Katrina. The functions and resultant values help to sustain productive foraging and refugia habitat for various life stages of numerous aquatic species. Implementation of the recommended plan would allow for recovery of the once existent resource, thereby establishing the land use as it existed prior to Hurricane Katrina.

4.12 Deer Island Restoration

Deer Island is considered a mainland remnant and is not part of the coastal barrier system of islands along the Mississippi coast. It is unique in that it is one of only a few islands along the Northern Gulf of Mexico that are totally surrounded by an estuarine environment. The storms of 2005 have acerbated an already eroding shoreline and degrading interior marshes and coastal maritime forest areas. The island contains a diverse habitat of beach/dunes, emergent tidal marshes, and coastal maritime forests. Currently, the uninhabited island is part of the MDMR Coastal Preserves Program. Restoration efforts have been funded under the Section 528 of WRDA of 2000 for breaches at the west end and near Grand Bayou, and parts of the southern shoreline. Although a substantial restoration effort in its own right, there are significant opportunities to further restore the island and repair hurricane-caused damage to the islands' ecosystems.

4.12.1 Deer Island No Action Plan and Impacts

As a result of implementing the No Action Plan, Deer Island would continue its degradation and ultimately increased wave action would occur along the mainland at the City of Biloxi. The southern shorelines would continue to erode; thus, adversely impacting those dependant species, such as birds and crabs. Wave action from daily occurrences and storm events would eventually erode the beach and then begin eroding the emergent tidal marsh and coastal maritime forests. Furthermore, the Section 204 emergent tidal marsh restoration site would continue to degrade. Ultimately, this unique habitat would continue change from a productive beach/dune, emergent tidal marsh, and coastal maritime forest habitat to stressed and non-functioning habitats.

4.12.1.1 Deer Island No Action Plan Vegetation Impact

Vegetation, emergent tidal marsh, some dune habitat along the southern shoreline, and coastal forest, would be lost due to erosion.

4.12.1.2 Deer Island No Action Plan Fish and Wildlife Impact

Lack of available habitat could cause fish and wildlife species to move from the area seeking more suitable habitat.

4.12.1.3 Deer Island No Action Plan Threatened and Endangered Species Impact

It is anticipated there will be adverse impacts to T&E species, such as piping plover and Gulf sturgeon, as the project area and its adjacent areas offers suitable habitat for listed species.

4.12.1.4 Deer Island No Action Plan Water Quality Impact

The area would continue to experience changes in hydrology due to erosion of the island and changes in native species composition.

4.12.1.5 Deer Island No Action Plan Land Use Impact

Upon implementation of the No Action Plan, the island could possibly eventually erode away.

4.12.2 Deer Island Proposed Actions and Impacts

Comprehensive Deer Island restoration consists of a combination of the following alternatives to form the recommended plan:

- Repair/Replace the Section 204 containment dike;
- Add/Replace material in the Section 204 containment dike;
- Analyze new stone training dikes on the northern and southern ends of the islands as a result of Section 204;
- Lengthen stone containment dikes on northern and southern ends as a result of Section 204; and
- Create additional marsh habitat area adjacent to the existing created marsh area.

The following table provides an overview of benefits associated with implementation of the proposed project.

Table 4-18
Functional Habitat Index Restoration of Grand Bayou, the West End Breach and Entire Southern Shoreline

Functions	Shoreline Birds	Migratory Birds	Native Fish	Sport Fish	Macro Invertebrates & Primary Producers	Bivalves	Proposed Alternative		Future Without	
							Functional Habitat Index (FHI)	FHI 525 acres	Future w/o FHI	FHI 0 acres
Restoration of Emergent Beach and Dune System	0.10	0.10	0.05	0.05	0.05	-	0.35	183.75	-	0.0
Restoration of Maritime Forest Habitat	0.10	0.10	-	-	0.05	-	0.25	131.25	-	0.0
Soft Substrate	0.05	0.05	0.10	0.10	0.05	0.05	0.40	210	-	0.0
Reestablishment of pre-disturbance shoreline	0 05	0.05	-	-	-	-	0.10	52 5	-	0.0
Reduced Wave Energy along Grand Bayou and the Southern Shoreline	0.10	0 10	0.05	0.05	0.05	0 05	0.40	210	-	0.0
Shoreline Stabilization	0.05	0.05	0.05	0.05	-	-	0.20	105	-	0.0
Roosting Habitat	0.10	0.10	-	-	-	-	0.20	105	-	0.0
Nesting Habitat	0.10	0.10	-	-	-	-	0.20	105	-	0.0
Native Vegetation Propagation	0 10	0.10	0.05	0 05	0.10	-	0.40	210	0.10	0.0
Shoreline Foraging Habitat	0 10	0.10	0 10	0.10	0 05	0.05	0.50	262.5	0 10	0.0
Erosion Control	0.05	0.05	0.05	0.05	0.05	0.10	0.35	183.75	-	0.0
Sediment Stabilization	0 05	0 05	0 05	0.05	0.05	0.10	0.35	183.75	-	0 0
Water Quality	-	-	0.05	0.05	0.05	0.05	0 20	105	-	0.0
Hard Substrate-ocean bottom or submerged rip-rap	-	-	0.05	0.05	-	0.10	0.20	105	-	0.0
					Total FHI =		4.1	2152 5	0.20	0.0

Direct Benefit = 0.10
Indirect Benefit = 0 05

4.12.2.1 Deer Island Alternative Plans Vegetation Impact

It is anticipated there would be no adverse impacts to vegetation. The alternative actions would provide a benefit to vegetation as the project would help stabilize the island ensuring its future sustainability. The marsh creation would help offset losses that have occurred during the past. In some cases, native wetland vegetation would be replanted in place of invasive exotic species.

4.12.2.2 Deer Island Alternative Plans Fish and Wildlife Impact

It is expected that restoration of Deer Island would result in positive impacts to fish and wildlife and their habitat. Overall, the environmental restoration would reduce and assist in the restoration of past losses to habitats.

Construction might cause temporary adverse impacts to fish and wildlife during construction phases; however, lost functions would be returned. Restoration of natural habitats allows for displaced fish and wildlife to re-inhabit these areas. Restoration would result in creation of contiguous blocks of habitat and would result in reduction of fragmentation. Additionally, restoration of these lost habitats would result in an increase to essential lifecycle requirements to numerous species. Hydrology would be restored in areas resulting in increased flushing activities which would help sustain and increase resources of national importance. Valuable habitat for breeding amphibians would be restored. These habitats are currently experiencing a worldwide decline.

4.12.2.3 Deer Island Alternative Plans Threatened and Endangered Species Impact

. Restoration of Deer Island provides numerous benefits to a variety of T&E species, such as piping plover, sea turtles, Gulf sturgeon, and manatees. Restoration of the island would benefit piping plover and its critical habitat by the increased amount of over wintering foraging areas. Temporary impacts could occur during construction but could be avoided during the times the piping plover are on the over wintering grounds. Brown pelicans could utilize the project areas; however, it is anticipated these species would avoid the construction area due to noise and activity. This species nests mostly on offshore islands, but has been known to nest in onshore estuaries; however, based on surveys by FWS biologist, there is no known nesting in Mississippi. Should nesting brown pelicans be discovered, the area would be avoided to ensure no impacts occur. Deer Island provide adjacent critical habitat essential for the continued existence of the Gulf sturgeon. Primary constituent elements, such as prey abundance, migration, water quality, and sediment quality, are vital to the Gulf sturgeon species' continued existence. Manatees, Gulf sturgeon and sea turtles could be in the project area and there is potential for temporary adverse impacts to occur. It is anticipated these species would primarily avoid the construction areas due to noise and activity resulting in less risk for harm or harassment. Further study and consultation would be required to determine the full extent of impacts to listed species associated with implementation of this measure.

4.12.2.4 Deer Island Alternative Plans Water Quality Impact

BMPs would be utilized during construction activities to ensure stabilization of bare soils in order to reduce run off. Environmental restoration activities would improve overall water quality within coastal Mississippi. It is anticipated that implementation of this measure would result in benefits to overall water quality within the study area.

4.12.2.5 Deer Island Alternative Plans Land Use Impact

It is expected that no significant changes in land use would occur as a result of the proposed project as the island is currently owned by the State of Mississippi and is being preserved as a natural wildlife area.

4.13 Moss Point Relocation

The municipal facilities for the City of Moss Point are located adjacent to the shoreline of the Escatawpa River in a low lying flood prone area. The facilities suffered extensive damage during Hurricane Katrina and municipal services were interrupted for an inordinate length of time.

4.13.1 Moss Point No Action Plan and Impacts

The City's municipal services would not be relocated and the badly damaged or uninhabitable structures would have to be reconstructed in the same area as funding becomes available.

4.13.1.1 Moss Point No Action Plan Vegetation Impact

The City's municipal services would not be relocated and the badly damaged or uninhabitable structures would have to be reconstructed in the same area as funding becomes available. There would be no impacts to vegetation as the relocation project would not occur.

4.13.1.2 Moss Point No Action Plan Fish and Wildlife Impact

The City's municipal services would not be relocated and the badly damaged or uninhabitable structures would have to be reconstructed in the same area as funding becomes available. There would be no impacts to fish and wildlife resources as the relocation project would not occur.

4.13.1.3 Moss Point No Action Plan Threatened and Endangered Species Impact

The City's municipal services would not be relocated and the badly damaged or uninhabitable structures would have to be reconstructed in the same area as funding becomes available. There would be no impacts to T&E species as the relocation project would not occur.

4.13.1.4 Moss Point No Action Plan Water Quality Impact

The City's municipal services would not be relocated and the badly damaged or uninhabitable structures would have to be reconstructed in the same area as funding becomes available. It is anticipated there would be only minor, temporary, and insignificant impacts to water quality as a result of the rebuilding efforts and potential runoff. The use of BMPs should be required to be used on construction sites to reduce runoff during construction activities.

4.13.1.5 Moss Point No Action Plan Land Use Impact

The City's municipal services would not be relocated and the badly damaged or uninhabitable structures would have to be reconstructed in the same area as funding becomes available. There would be no changes to current land use as result of the No Action Plan.

4.13.2 Moss Point Proposed Actions and Impacts

This component consists of relocating the City of Moss Point's municipal buildings to a lower risk site with regards to flooding within the incorporated limits. This will aid the city in providing basic community services in a more timely fashion after future storm events, and further demonstrate the effectiveness of relocations projects as a hurricane and storm damage reduction measure along the Mississippi coast. These buildings include the city hall, police station, fire station and community services building and will be replaced to current standards and based upon the existing community needs. Implementation of this project would allow a demonstration of a relocation project in order to determine the effectiveness of the hurricane and storm damage reduction measure by relocation of the city's municipal services at a lower risk area.

4.13.2.1 Moss Point Alternative Plans Vegetation Impact

Implementation of this project would allow a demonstration of a relocation project in order to determine the effectiveness of the hurricane and storm damage reduction measure by relocation of the city's municipal services at a lower risk area. It is anticipated there could be impacts to vegetation as a result of implementation of this measure as the relocations would require earthwork in the new sites; however, due to the potential sites being located within largely developed areas within the City of Moss Point, it is believed the impacts would be minor in significance.

4.13.2.2 Moss Point Alternative Plans Fish and Wildlife Impact

Implementation of this project would allow a demonstration of a relocation project in order to determine the effectiveness of the hurricane and storm damage reduction measure by relocation of the city's municipal services at a lower risk area. It is anticipated there could be impacts to fish and wildlife resources as a result of implementation of this measure as the relocations would require disturbances at new sites; however, due to the potential sites being located within largely developed areas within the City of Moss Point, it is believed the impacts would be minor in significance.

4.13.2.3 Moss Point Alternative Plans Threatened and Endangered Species Impact

Implementation of this project would allow a demonstration of a relocation project in order to determine the effectiveness of the hurricane and storm damage reduction measure by relocation of the city's municipal services at a lower risk area. It is anticipated there would be no impacts to T&E species as a result of implementation of this measure as the relocations are in areas that do not support the listed species, due to the potential sites being located within largely developed areas within the City of Moss Point.

4.13.2.4 Moss Point Alternative Plans Water Quality Impact

Implementation of this project would allow a demonstration of a relocation project in order to determine the effectiveness of the hurricane and storm damage reduction measure by relocation of the city's municipal services at a lower risk area. It is anticipated there would be only minor, temporary, and insignificants impacts to water quality as a result of this alternative as BMPs would be utilized to reduce runoff during construction activities.

4.13.2.5 Moss Point Alternative Plans Land Use Impact

Implementation of this project would allow a demonstration of a relocation project in order to determine the effectiveness of the hurricane and storm damage reduction measure by relocation of the city's municipal services at a lower risk area. There would be changes in current land use at the relocation sites as well as the current site. The current site would be converted to recreational green space for the citizens of Moss Point.

4.14 Waveland Floodproofing

4.14.1 Waveland No Action Plan and Impacts

The city of Waveland is located in Hancock County, Mississippi and was directly in the path of Hurricane Katrina. Because of the low lying area in which the city is located, the only flood damage reduction measures available to a portion of Waveland are either acquisition or floodproofing the individual structures. Implementation of the No Action Plan would not alleviate the damages which may be suffered by these structures in the future from flooding, and would not afford the opportunity to educate the community on appropriate floodproofing techniques for the coastal area.

4.14.1.1 Waveland No Action Plan Vegetation Impact

There would be no impacts to vegetation as the project would not be constructed. This area of Waveland would be reconstructed without any protection afforded by structural measures.

4.14.1.2 Waveland No Action Plan Fish and Wildlife Impact

There would be no impacts to fish and wildlife resources as the project would not be constructed. This area of Waveland would be reconstructed without any protection afforded by structural measures.

4.14.1.3 Waveland No Action Plan Threatened and Endangered Species Impact

There would be no impacts to T&E species as the project would not be constructed. This area of Waveland would be reconstructed without any protection afforded by structural measures.

4.14.1.4 Waveland No Action Plan Water Quality Impact

It is anticipated there would be only minor, temporary, and insignificant impacts to water quality as a result of the rebuilding efforts and potential runoff. The use of BMPs should be required to be used on construction sites to reduce runoff during construction activities.

4.14.1.5 Waveland No Action Plan Land Use Impact

There should be no change to current land use by implementation of the No Action Plan as the area currently exists as a residential neighborhood.

4.14.2 Waveland Proposed Actions and Impacts

In order to evaluate the different foundation and building types, 25 existing structures would be selected in the Waveland area that could be safely elevated out of the 1% chance storm event, and which could not be protected by any other structural measures evaluated as part of this study.

4.14.2.1 Waveland Alternative Plans Vegetation Impact

There should be only minor insignificant and temporary impacts to vegetation by implementation of the recommended plan as structural components of this plan would only apply to existing houses within a developed area.

4.14.2.2 Waveland Alternative Plans Fish and Wildlife Impact

There should be only minor insignificant and temporary impacts to fish and wildlife resources by implementation of the recommended plan as structural components of this plan would only apply to existing houses within a developed area.

4.14.2.3 Waveland Alternative Plans Threatened and Endangered Species Impact

There should be no impacts to T&E species by implementation of the recommended plan as structural components of this plan would only apply to existing houses within a developed area.

4.14.2.4 Waveland Alternative Plans Water Quality Impact

It is anticipated there would be only minor, temporary, and insignificant impacts to water quality as a result of the floodproofing efforts and potential runoff. The use of BMPs would be required to be used on construction sites to reduce runoff during construction activities.

4.14.2.5 Waveland Alternative Plans Land Use Impact

There should be no change to current land use by implementation of the No Action Plan as the area currently exists as a residential neighborhood.

4.15 Forrest (Forest) Heights Levee

The community of Forrest (Forest) Heights lies on the bank of Turkey Creek about 2.6 miles from the mouth at Bernard Bayou. Ground elevations over most of the residential area are between elevations 10-14 ft NAVD88. Drainage is mostly along streets and through natural drainage ways to Turkey Creek. Impacts from flooding and hurricanes have been devastating. Hurricane Katrina in August, 2005 resulted in significant flood damages to residences in the Forrest (Forest) Heights community. A levee with top width of 6 ft was constructed around the community to elevation 16.5 ft NGVD29 with side slopes of 1 vertical to 1.5 horizontal in 1969, prior to Hurricane Camille. It has not been adequately maintained and is a state of disrepair. There were two alternative actions and a no action alternative evaluated for the Forrest (Forest) Heights Levee Project. This storm damage reduction project falls within the Congressional authorization for storm damage reduction along the Mississippi coast.

- No Action
- Levee Elevation 17 feet NAVD88
- Levee Elevation 21 feet NAVD88

4.15.1 Forrest (Forest) Heights No Action Plan and Impacts

The Natural Resources Conservation Service will restore the existing levee to as-built condition by January of 2009. However, the restored levee will not be sufficient to meet the present day standard for certification according to the existing FEMA flood profiles in the vicinity. The existing condition assumes that the NRCS has reconstructed the levee around the Forest Heights community to a crest elevation of 16.5 feet NAVD88.

4.15.1.1 Forrest (Forest) Heights No Action Plan Vegetation Impact

It is anticipated there would be not be any impacts to vegetation from implementation of this alternative as the project would not be constructed.

4.15.1.2 Forrest (Forest) Heights No Action Plan Fish and Wildlife Impact

It is anticipated there would be no impacts to fish and wildlife species from implementation of this alternative as the project would not be constructed.

4.15.1.3 Forrest (Forest) Heights No Action Plan Threatened and Endangered Species Impact

It is anticipated there would be no impacts to T&E species from implementation of this alternative because the project would not be constructed.

4.15.1.4 Forrest (Forest) Heights No Action Plan Water Quality Impact

It is anticipated there would be no impacts to water quality from implementation of the No Action Plan because construction of the project would not occur.

4.15.1.5 Forrest (Forest) Heights No Action Plan Land Use Impact

It is anticipated there would be no impacts to current land use as a result of this alternative since the existing site consists of an existing residential community. Under the no action plan, however, the residences within the Forrest Heights community will not be able to meet the criteria under the revised Flood Insurance Rate Maps and any future rebuilding following disaster will be severely limited.

4.15.2 Forrest (Forest) Heights Proposed Actions and Impacts

The existing with-project condition assumes clearing and snagging of debris in Turkey Creek will counteract any local water surface profile impact due to flow obstruction by the levee. The selective clearing and snagging would extend for approximately 4.5 miles from the mouth of Turkey Creek at Bernard Bayou to the upstream limits. Selective clearing and snagging would remove obstructions such as debris dams and excessive sedimentation that hinders the flow through the Turkey Creek channel. While the selective clearing and snagging component of the plan does not eliminate flooding along Turkey Creek, the plan does reduce flood damages along the creek and at the upper end of the canals at 28th Street. The main purpose of the selective clearing and snagging is to make sure that induced damages do not occur due to the construction of the levee.

During some hurricane events or high water in Turkey Creek, when the culvert gates are shut, and rainfall exceeds the average 10-yr intensity over the basin, some ponding from rainfall will occur. A detention basin was added to help reduce the size of required pumps. The detention basin would have an area of approximately 3 acres but would not be excavated. The area is the lowest site in the subdivision and is presently is used for recreation facilities such as baseball and tennis. Detailed modeling of the area was not possible for this report, therefore the exact extent of the detention basin is not precisely defined. Designing the pumps for the peak 10-yr flow provides a significant pumping capacity. Further design during construction will refine the requirement for the appropriate detention area and pump sizes to provide protection from 100-yr rainfall.

This option consists of an earthen levee around northern, western, and southern sides of the Forrest (Forest) Heights community. Because of the height of the levee, the eastern side will be constructed with a concrete "T"-wall structure. The "T" wall will take less space than an earthen levee and encroach less into property along the alignment. The alignment of the levee is generally the same as Option A. Closure gates across the two access roads to the subdivision will be required. The lengths of the levee culverts will be slightly longer than those used in Option A. Other features and methods of analysis are the same.

Through modeling results, a levee with a crest elevation of 21 feet NAVD88l was determined to be consistent with the levee certification guidelines with the basis measurement being a storm surge elevation that has a 0.2% probability (500-year event) of occurrence in any given year. The levee is estimated to be 6,500 linear feet and require 93,000 cubic yards of fill. An existing park with a surface elevation of elevation 12 to 14 feet NAVD88 would serve as a water detention area for temporary containment of rainfall during storm events.

4.15.2.1 Forrest (Forest) Heights Alternative Plans Vegetation Impact

Under the 17-foot alternative, there is an expected loss of 1.47 acres of non-tidal wetland vegetation impacted by construction of the levee. Additionally, construction of the levee to 21 feet would cause the loss of 3.62 acres of other vegetation, which consists of mainly mixed pine hardwood forests. Although native vegetation under the levee footprint would be lost, the levee itself would be vegetated with non-native species for stabilization of the structure. Any required mitigation for wetland losses would be accomplished within the same watershed.

4.15.2.2 Forrest (Forest) Heights Alternative Plans Fish and Wildlife Impact

Due to a pre-existing disturbed condition created by the presence of the residential development and partial levee system currently in place, the alternatives would result in increased impacts to fish and wildlife species from the additional height of the levee expansion. Continued maintenance of the levee reduces natural habitats that are currently available for numerous wildlife species. Unnatural crossings of water bodies by culverts, etc, could reduce in-stream habitat for various life stages of fish. Impacts to wetland crossings remove essential lifecycle requirements for numerous fish and wildlife species.

4.15.2.3 Forrest (Forest) Heights Alternative Plans Threatened and Endangered Species Impact

It is anticipated there will be no impacts to T&E species as the project area does not offer suitable habitat for any of the listed species.

4.15.2.4 Forrest (Forest) Heights Alternative Plans Water Quality Impact

BMPs would be utilized during construction to ensure stabilization of bare soils in order to reduce run-off of materials. Interior drainage would be accomplished by the removal of stored water through culverted crossings of small water bodies and by the use of pump stations where necessary. Limited clearing and snagging of Turkey Creek would assist in improving overall water quality through the improvement of tidal flows.

4.15.2.5 Forrest (Forest) Heights Alternative Plans Land Use

Under the preferred alternative, there is an expected loss of 19.85 acres of non-tidal wetland vegetation impacted by construction of the levee and the required buffer zone for maintenance access. Although construction of the levee to this elevation would require additional land for the expanded footprint, impacts to current land use should be minimal as the area currently exists as an established residential community.

5 DESCRIPTION OF RECOMMENDED COMPREHENSIVE PLAN COMPONENTS

5.1 Comprehensive Plan Description

The comprehensive plan provides integrated systems-based solutions and recommended plans that address: ***hurricane and storm damage reduction, ecosystem and restoration and fish and wildlife preservation, reduction of damaging saltwater intrusion, and reduction of coastal erosion.*** The recommended plans also provide measures that aid in: regional economic redevelopment, positive societal effects, and long-term measures to reduce risk to the public and property.

The Mississippi Coastal Improvements Program Comprehensive Plan, as developed in this feasibility analysis, consists of system-wide elements and site-specific elements. Phase I site-specific components of the Comprehensive Plan have been developed sufficiently for a construction authorization recommendation. These components of the Comprehensive Plan are ready for advanced design and implementation.

- Turkey Creek Ecosystem Restoration;
- Bayou Cumbest Ecosystem Restoration;
- Dantzler Ecosystem Restoration;
- Admiral Island Ecosystem Restoration;
- Franklin Creek Ecosystem Restoration;
- Deer Island Ecosystem Restoration;
- Submerged Aquatic Vegetation Ecosystem Restoration;
- Coast-wide Beach and Dune Restoration;
- High Hazard Area Risk Reduction Plan (HARP) including the
    - Moss Point Municipal Structure Relocation
- Waveland Flood Proofing;
- Forrest (Forest) Heights Hurricane and Storm Damage Reduction: and
- Barrier Island Risk Reduction Plan.

The diversion of freshwater from the Mississippi River into the western Mississippi Sound is a critical component of the overall Mississippi Comprehensive Plan as discussed previously. In 2007 Congress authorized such a diversion (Section 3083 of the Water Resources Development Act of 2007) in the vicinity of Violet, Louisiana.

Additionally, other site-specific and system-wide components of the Comprehensive Plan (Phase II and Phase III), which are developed in this feasibility study, are not presented in support of a Record of Decision for construction, but are addressed as reasonably foreseeable actions for the consideration of cumulative effects. Because additional engineering and design investigations have yet to be completed, these site-specific and system-wide elements of the Comprehensive Plan are not yet ripe for decision-making. Supplemental NEPA information will be presented as necessary to ensure compliance with the appropriate environmental laws and regulations:

- High Hazard Area Risk Reduction Plan Phase II
- Additional Damage Reduction Alternatives
- Barrier Island Restoration

- Coastal Mississippi Ecosystem Restoration Program.

During early partnering efforts with the State of Mississippi, the MsCIP team identified several State Initiatives required environmental restoration efforts. These sites were owned by the State which would enable them to be restored with no upfront real estate costs, thus, providing immediate accessibility. Environmental restoration by restoring the hydrology and natural landscape of the coastal counties with incidental risk reduction benefits would be achieve through these State Initiative projects as part of the Coastal Preserves Program. Additional detail studies of these Phase II sites would be needed but the overall benefit from restoration would provide approximately 14,068 acres of emergent tidal marsh and 1,285 acres of wet pine savannah habitat. Phase II studies are recommended for the following locations:

- Pascagoula River Marsh;
- Dantzler Coastal Preserve;
- Dupont Coastal Preserve;
- La Francis Coastal Preserve Camp Trenaisse;
- Ansley Coastal Preserve;
- Wachovia Coastal Preserve

Figure 5-1 provides a geographic representation of all Mississippi Comprehensive Plan elements.

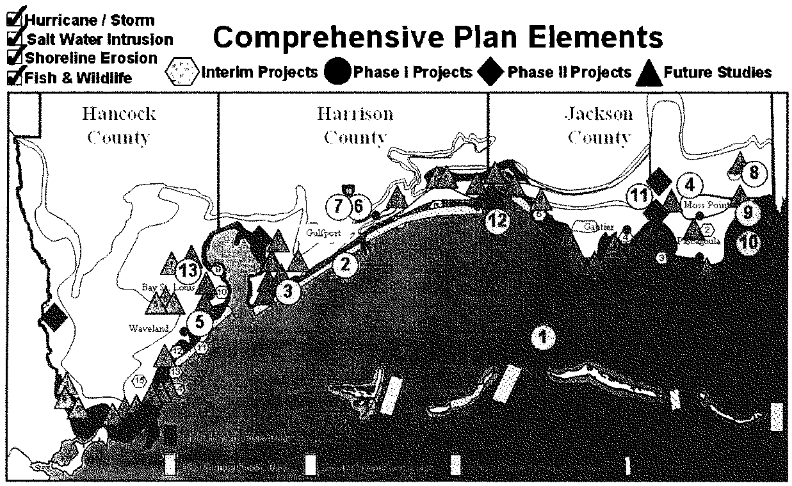

Figure 5-1
Mississippi Comprehensive Plan Elements

The Congressional authorization for this study mandated a comprehensive approach to solutions for water resource problems in coastal Mississippi. The comprehensive nature of the study team's approach included identifying solutions regardless of implementation authority or agency. Hence a number of recommended plan features also include education and hurricane preparedness. These features include:

- Hurricane Risk Reduction Education
- Hurricane and Storm Warning Systems
- Hurricane Evacuation Planning
- Floodplain Management
- Building Codes
- Zoning Codes, and
- Relocation of Critical Infrastructure and Services (Line of Defense 5).

Feasibility level investigations concerning freshwater diversion at Violet, LA are authorized by Congress under WRDA 2007. Section 3083 authorized the design and implementation of a project for diversion of freshwater at or near Violet, Louisiana, for the purposes of reducing salinity in the western Mississippi Sound, enhancing oyster production, and promoting the sustainability of coastal wetlands. The MsCIP supports this action and is a critical element to sustain the ecosystems of coastal Mississippi. This report supports a recommendation to Congress for a freshwater diversion project that is fully coordinated between the States of Mississippi and Louisiana, the appropriate entities within the Corps of Engineers, and other interested stakeholders.

The following table identifies how the recommended components of the Comprehensive Plan address the Congressional concerns identified in the authorization. These comprehensive plan components are 'keystone' pieces of the comprehensive plan on which later recommendations would build. These plan elements have been determined to be engineeringly feasible, environmentally acceptable and beneficial, and cost effective. Each of these recommended comprehensive plan components are designed to be implemented and function as stand alone units should additional time be required to design all plan components or additional plan components be determined to not be cost effective.

Table 5-1
Components of the Comprehensive Plan

	Areas of Concern			
Recommendation	**Storm Damage Reduction**	**Erosion Reduction**	**Salt Water Intrusion**	**Fish and Wildlife**
High Hazard Area Risk Reduction Plan	√			√
Waveland Floodproofing	√			
Additional Damage Reduction Alternatives	√			
Additional Ecosystem Restoration Alternatives	√	√	√	√
Barrier Island Restoration	√	√	√	√
Violet, LA Fresh Water Diversion	√	√	√	√
Escatawpa Fresh Water Diversion			√	√
Beach and Dune Restoration	√	√		√
SAV Restoration				√
Forrest (Forest) Heights Levee	√			
Deer Island Restoration	√	√		√
Turkey Creek Restoration	√			√
Bayou Cumbest Restoration	√		√	√
Dantzler Restoration				√
Admiral Island Restoration	√			√
Franklin Creek Restoration	√			√

All recommended ecosystem restoration plans incorporate monitoring and adaptive management capabilities, where needed. The role of monitoring and adaptive management in the Comprehensive Plan is presented in section 5.5 Monitoring and Adaptive Management.

5.2 Education and Hurricane Preparedness Plan Features

The Mississippi Coast is a complex geographic system which is governed and managed by multiple agencies and entities. No single agency or entity could reasonably be expected to implement the all of the diverse components of a Comprehensive Plan. Implementation of these recommendations will enhance the effectiveness of the comprehensive plan developed by the MsCIP team.

5.2.1 Hurricane Risk Reduction Education

Over 300 persons were confirmed as having perished or were identified as missing in the State of Mississippi as a result of Hurricane Katrina. Any loss of life is tragic, and any number of those deaths may have been prevented. Even one death prevented is sufficient reason to improve our methods of educating the public on hurricane and storm threats, and to ensure that all is done to warn all those in coastal Mississippi as to the extreme hazard to all that reside in the area, from the dual hazards of wind and surge/waves. It is particularly vital to inform the public as to the zones of highest hazard in regards to surge and wave impact, as these can also have extremely destructive impacts to property, in addition to that of its effects on the lives of those that might remain behind during an event. Education needs to include articulation of effects related to the potential magnitude of the threat, the urgency to heed the call to evacuate, and providing the means by which to make wise choices on evacuation methods and route (see recommendations given below under

"Hurricane Evacuation Planning"). The following are suggested guidelines in the interests of good education on hurricane storm threats:

- Provide good science and information to the residents of coastal Mississippi, so they can understand the nature of the threat, and its possibility of happening at any time, even repeatedly within a single year. This information should be provided in both written form, and as maps, in a variety of venues, including:
  - Posting in supermarkets, libraries, public buildings, and schools;
  - Education in schools and at public workshops, at regular intervals (minimum 1 yr.);
  - Providing information on hurricane threat by zone, evacuation routes, and procedures, on publicly-accessible websites, updated regularly (minimum 1 yr.).
- Provide information on hurricane threats within the course of continued study and after the study effort is concluded. The study team held numerous public workshops during the course of the Interim and Comprehensive Plan studies. More workshops on risk will be held in the future, to educate residents to their current and future risks, and to allow them to make better choices in selecting plans for potential implementation.
- Educate members of Congress and other public representation as to the need to continue support for upgrading and maintenance of systems supporting the goals of providing early warning of hurricanes and tropical storms, and support for efforts to provide media dissemination of early warning and evacuation data.

There is nothing humanly possible that can be done to protect the lives and safety of Mississippi residents, if they do not have sufficient warning, and if they then do not use that knowledge to evacuate in a timely manner.

5.2.2 Hurricane and Storm Warning

Residents and visitors to the coast of Mississippi need to recognize that they live in, or are visiting, a high-hazard area. Although certain times of the year pose less risk than others, each year's hurricane season provides a strong possibility of hurricane impact. All residents and visitors need to be made aware of the current hurricane threat, but that threat must be assessed and information passed along, by a system of instruments that pass on information on the location and nature of weather conditions, and for that information to be evaluated and passed on to national and local media, for dissemination. Continued support of the following activities is critical to an adequate warning system:

- On-going efforts to upgrade the existing system of buoys and advanced warning measures that provide date on the location and nature of weather conditions.
- Efforts directed at the interpretation of that data and its dissemination to the media and public, through the National Weather Service.
- Public appreciation for the need to be aware at all times of, and the need to listen to weather reports and advice given on various media. Television weather reports, radio, and the internet all provide excellent up-to-date information on weather conditions, and the development of threatening situations. Simply living in or visiting the Gulf Coast should provide the need to be exceptionally aware of the weather, and its consequences.
- The vital importance of heeding the advice of experts. One should know what needs to be done in the event of an approaching storm. Family members should conduct evacuation drills, keep needed phone numbers and travel supplies on hand, and be prepared to leave on short notice. One should be aware of evacuation routes, keeping a full tank of gas during the hurricane season, and having a plan for where one should go, how to maintain contact

with other family members, and where one will re-locate temporarily, particularly if this turns out to be longer than expected.

5.2.3 Hurricane Evacuation Planning

The critical need for adequate evacuation planning was borne out by Hurricane Katrina. An evacuation plan is an essential component of a comprehensive plan for ensuring the safety of residents of and visitors to the coast of Mississippi. The preservation of life is the single most important goal and objective of the recommended plans. The joint Federal Emergency Management Agency (FEMA)/ NOAA/Corps/Mississippi Emergency Management Agency (MEMA) task force's Mississippi Hurricane Evacuation Study of April 2002 has provided a tremendous amount of value to-date in aiding local government, individual and family readiness, in the face of approaching events. Support for this program is a critical element of the recommended plans for coastal Mississippi. The following are important recommendations in support of efforts to support Hurricane Evacuation Planning:

- There is still much that can be done to update this on-going effort, and to provide new, and more widely-disseminated data and tools for evacuation planning by local county and city governments, and also for use by individuals and families in their preparation for an impending event.
- Evacuation route signage is an important part of a successful evacuation campaign. Replacement of missing or destroyed signage is viewed as a vital link in ensuring the safety of residents and visitors alike. Given recent experience with how many signs were destroyed during Katrina, placing replacements on heavier posts driven a greater distance into the ground, and possessing concrete footings, would be essential in ensuring that signage survives inundation or wind damage, particularly given the possibility that another event might occur in short order.
- The provision of additional signage illustrating surge height achieved during Katrina would be an added and continual link to on-going education efforts. This could take the form of signs placed in locations in which there is significant traffic, such as major thoroughfares, where pedestrians walk, and particularly in those highest hazard zones based on elevation/depth data.

5.2.4 Floodplain Management

Management of the floodplain is a non-Federal responsibility, yet is considered a key component of the Comprehensive Plan. Much of the information needed to make on-going and future decisions about appropriate measures to take in the interest of public safety has only been recently developed as part of this on-going MsCIP study effort. These decisions also dependent on review and finalization of FEMA's Flood Insurance Rate Maps (FIRMs) for the area (released for public review 11 – 13 December 2008). Therefore, it may be some time before a complete revision of local floodplain management plans can be undertaken.

It is hoped that communities within the study area will make use of a number of the products of this study, particularly the RISK ZONE maps developed for the public and government education campaign that are shown below in Figure 5-2.

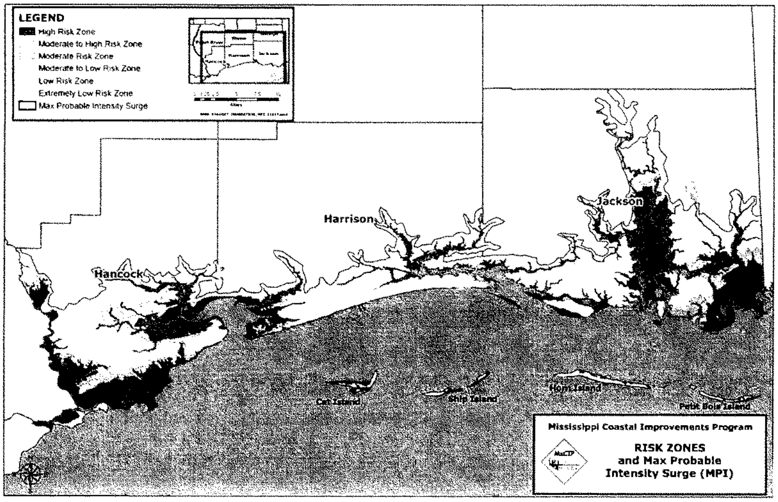

Figure 5-2
Coastal Mississippi Risk Zones

This map, along with the new FEMA Flood Insurance Rate Maps (FIRMs) and accompanying data, provides local government tools to be used in the determination of how to manage development or location of inhabited development, infrastructure, businesses, hazardous waste facilities, sites that contain large, un-anchored structural components such as fuel tanks, lumber and other potentially damaging flood-borne materials, and other sites that require careful consideration of potential surge effects, when developing Master Plans for their communities. The map above provides an assessment of risk based on a frequency framework, in which each area is color-coded according to its potential frequency for surge inundation, as well as its potential for shallow to very deep inundation. The red zone is the highest hazard zone within coastal Mississippi, subject to the most frequent inundation, and during large events, to the greatest depth of surge and waves. Each successive zone is at generally lower risk. It should be noted that virtually all of coastal Mississippi has the equal potential for wind damage due to hurricanes.

Key components of the effort to revise floodplain management guidelines will also be to evaluate and adopt new zoning code-related information for the purposes of re-construction and new construction. This may also take time to develop, but is also considered a critical component of a Comprehensive Plan for the coast.

5.2.5 Building Code Update

The majority of the municipalities and counties have adopted the International Building Code (IBC) to guide the design and construction of residential and commercial structures in the project area. In most cases, these local jurisdictions are using the 2003 version of the IBC. In order to assure that the latest design and construction techniques are being used that apply to hurricane-resistant construction, each of the local jurisdictions should adopt the latest version of the IBC (2007) and ensure enforcement of the codes through diligent building permit processing and on-site inspections of construction. Annual training classes on the use and enforcement of the new IBC should be implemented by the local jurisdictions. In addition, all local jurisdictions should consider appending the published document "FEMA 550 Guidelines for Elevating Residential Structures on the Gulf Coast" as a part of their updated building codes for construction in areas where surge inundation may be present.

5.2.6 Zoning Code Update

Zoning Code updates are similar to the suggestions made under the section on Floodplain Management. This recommendation focuses on continued support of efforts being made by the three counties and their cities in the updating of current zoning codes. These entities are expected to make strong use of the Corps' RISK ZONE maps, shown above, and new FEMA Flood Insurance Rate Maps (FIRMs), as the basis for modification of existing zoning codes to reflect higher to lower hazard zones, and appropriate land uses within those zones. Updated zoning codes are expected to limit development in highest hazard areas to those uses that will incur lesser damage and risks to life and safety, given the relative frequency and magnitude of event occurrence. While a local responsibility, the counties and cities may make full use of the resources provided under this study.

5.2.7 Long-term Critical Infrastructure and Services Relocation (LOD 5)

The Comprehensive Plan recommends relocation of critical infrastructure and services outside the Maximum Probable Intensity (MPI) boundary, which is identified as Line of Defense 5. Infrastructure and services recommended for relocation include the following:

- evacuation centers,
- long-term care facilities,
- school and municipal bus and transportation facilities,
- power plants,
- water treatment plants,
- City and County records,
- hospitals that do not contain emergency care components, and
- other resources critical to rapid response or recovery.

The methodical relocation of these facilities north of this boundary will save untold lives and funds. This program may be instituted under a Capital Improvement Program, where structures reaching the end of their economic life are successively replaced outside the MPI boundary, as funds become available.

Facilities necessary for the conduct of emergency and every day services needed within individual cities should be re-sited, according to funds availability, at the highest elevation possible within that individual community.

Realistically, Police and Fire facilities, which have a need to be located "forward" to adequately address emergency response, may not have the luxury of relocating north of the MPI boundary, but could be re-constructed under this same program, to locate critical components of each facility above the MPI inundation depth, and to re-construct these facilities to withstand the effects of surge, waves, and wind, perhaps at a safer distance from the shoreline than they currently reside. So-called "wet" flood-proofing (in which doors and windows are temporarily sealed from water infiltration) may be one component of that required to create a structure adequate for survival within the surge zone; however, it is critical that these facilities and structures are capable of surviving the event, so that they can quickly respond after recession of the surge, to protect lives and property in their charge.

5.3 Recommendations for Proposed Corps of Engineers Implementation

5.3.1 High Hazard Area Risk Reduction Plan (HARP) and Waveland Floodproofing

This report supports the recommendation for authorization and immediate implementation of the Phase I HARP including implementation of the Moss Point Municipal Facilities Relocation, as described below.

5.3.1.1 Phase I HARP

The most effective alternative for reducing the risk from future hurricane surge events is to remove all structures and relocate population centers from the high risk zones. Formulation of alternatives included those which would provide for minimum level of risk reduction (approximate base flood elevation) up to those that would provide for risk reduction from increasing levels of inundation.

Hurricane Katrina destroyed an estimated 32,446 structures (i.e., damages of 51% to 100% of structure value), and caused significant damage to another 15,000 to 25,000 structures located within the inundation footprint of the three coastal counties in Mississippi. The vast majority of all destroyed homes within the inundation footprint have not yet been rebuilt, nearly three years after the event. The rebuilding rate within the inundated area is much slower than might typically be expected following a hurricane. This is due in part to a significant increase in construction costs since Katrina, higher flood insurance rates and uncertainty resulting from the fact that FEMA has recently released draft Flood Insurance Rate Maps (FIRM) and requirements outlining at what elevation future first-floor construction must adhere to in order to qualify for flood insurance through the NFIP.

Limited rebuilding is occurring within the surge-plain, at a variety of elevations. Those that are rebuilding at former elevations are largely self-insured (or un-insured), while those rebuilt prior to approval of the revised FIRMs at higher elevations are doing so with an assumption as to what the Base Flood Elevations (BFE) may be for their area. Regardless, most of those that would need flood insurance have not rebuilt at the time of this report, due to changes in National Flood Insurance Program (NFIP) requirements relative to BFE or lack of available and affordable hazard insurance. Other reasons include a desire to move from the hazardous areas following flooding as a result of Hurricanes Gustav and Ike in 2007.

The sheer magnitude of the devastation, together with the number of persons still displaced more than two years after Hurricane Katrina presents unprecedented challenges and opportunities. The HARP alternative appears to be the most cost-effective option that provides a non-structural alternative for reducing property damage resulting from hurricanes, storm surge and flooding, and by extension, reducing threats to lives in those areas, in the most hazardous areas along the Mississippi Coast. In the Phase I HARP, acquisition of those properties where the residential owners have not yet rebuilt presents a unique window of opportunity to minimize project costs. This report recommends that the Phase I HARP is specifically structured to capitalize on the current opportunity and encourage relocation outside the high-hazard surge-plain.

The advantages of such a program are numerous including:

- Reduces future property loss and potential loss of life;
- Eliminates costly structural alternatives and associated long term operation and maintenance costs;
- Provides a buffer and aids in reducing storm surge to adjoining properties; and
- Provides a potential opportunity to initiate alternative uses of the acquired land for fish and wildlife, ecosystem restoration and public recreation.

As part of the HARP, this report supports the recommendation for relocating the buildings currently comprising the Moss Point Municipal Services Complex. The City of Moss Point is located north of the City of Pascagoula in Jackson County. All of the City's municipal services were disrupted by Hurricane Katrina, and their structures were either severely damaged or deemed uninhabitable. The MsCIP has formulated alternatives that would aid the city in providing basic community services in a more timely fashion after future storm events, and further demonstrate the effectiveness of relocations projects as a hurricane and storm damage reduction measure along the Mississippi coast. The best means of achieving these goals consists of relocating the city's municipal buildings to a lower risk site with regards to flooding within the incorporated limits. These buildings include the city hall, police station, fire station and community services building. Future use of the existing site of these buildings would be as open space that would provide a buffer between City and the Escatawpa River further reducing the damages from hurricane surge and flooding events.

Based upon the best available FIRM data, the four relocation sites are all at elevation 12.0. The elevation of the 1% annual chance flood at those locations is elevation 11.0 based again upon the FIRM data. The risks of surge inundation (at varying levels) at the four sites would be addressed during the site and building design phase of development. Both the site(s) and building(s) can be designed such that the first floors of the structures can be set at an elevation that reduces any damages by surge inundation. Given the confined urban context of the sites, it is likely that required parking would be accommodated on the ground level beneath the structure and the first and upper stories set well above surge heights. ADA access requirements would be addressed during the design phase to accommodate the differences in elevation.

Phase I HARP Benefits

The recommended plan for immediate application for hurricane and storm damage reduction is a limited acquisition and relocation program, directed at approximately 2,000 of the most high-risk properties along the coastline. Benefits of the program include reduction of future damages and risks to lives within those areas, and incidental recreation and social effects benefits. Select areas within certain acquired areas would be available for ecosystem restoration, and could also produce additional restoration benefits. The average annual average damages avoided for the 2,000 structures were determined to $33,000,000. The relocation of the Moss Point facilities would greatly reduce future damages to the local infrastructure and provide a higher confidence in uninterrupted public service in future events.

Regional economic benefits include an increase in sales volume of $3,288,600,000, a $710,330,000 increase in local income, and a net increase of 5,200 jobs.

Phase I HARP Costs

The estimated cost for implementation of Phase I is $407,860,000, but may be less depending on the ultimate number of parcels acquired and range of benefits provided under P.L. 91-646.

5.3.1.2 Long-term High Hazard Area Risk Reduction Plan Evaluation

Evaluation of long term HARP is warranted to address the relocation of structures from the high to moderately high risk areas of the Mississippi coast. This program which could cover risk reduction opportunities over the next 20 to 40 years could target those properties which have been rebuilt but are still susceptible to significant future damage. A long-term HARP could involve the acquisition of large contiguous properties immediately following any large future hurricane events and be a joint effort between the Corps, FEMA, and the State of Mississippi.

Long Term HARP Benefits

The benefits of an ongoing acquisition and relocation program for coastal Mississippi could be tremendous taken into account the implications of sea level rise, continued development along the coast, and the frequency and magnitude of storms known to affect this area of the northern Gulf of Mexico. The additional study effort aimed at developing the framework and guidelines, detailed benefits, and costs would involve local and State interests as well as FEMA.

Long Term HARP Study Cost

Estimated study cost for development of a long-term HARP program is $5,000,000.

5.3.1.3 Waveland Floodproofing

This report supports the recommendation for authorization to immediately implement the flood proofing at Waveland, MS. The city of Waveland is located in Hancock County and was directly in the path of Hurricane Katrina. Because of the low lying nature of the city, the only flood damage reduction measures available to a portion of Waveland are either acquisition or floodproofing of individual structures. FEMA has released a manual for "Recommended Residential Construction for the Gulf Coast" which is meant to aid residents in rebuilding on strong and safe foundations. The design manual (FEMA 550) provides recommended foundation design and guidance for rebuilding homes destroyed by hurricanes in the Gulf Coast. The Waveland floodproofing alternatives are designed to evaluate the FEMA 550 guidelines with regards to current Corps' floodproofing practices. In addition to showing the application of existing elevation techniques and construction practices to reduce flood damages, this alternative would evaluate the use of possible innovative contracting techniques. These techniques would be designed to improve the Corps – contractor – homeowner relationship, focusing on using more timely and customer focused approaches. The 25 structures selected for floodproofing represent an adjacent group of structures that were not destroyed by Hurricane Katrina.

Waveland Benefits

In order to evaluate the different foundation and building types, 25 structures would be selected in the Waveland area that could be safely elevated out of the 1% chance storm event, and which could not be protected by any other structural measures evaluated as part of this study. Damages to these structures would be significantly reduced and the area would serve as an example of smart growth. Regional economic benefits include an increase in sales volume of $20,250,000, a $4,286,426 increase in local income, and a net increase of 129 jobs.

Waveland Costs

First Costs: $4,450,000
Annual O&M: $0

5.3.2 Forrest (Forest) Heights Hurricane and Storm Damage Reduction Component

This report supports the recommendation for authorization to immediately implement levee construction at Forrest (Forest) Heights in Harrison County Mississippi. The Forrest (Forest) Heights community is located within the city of Gulfport at the lower end of the Turkey Creek floodplain and in a part of the larger historic Turkey creek community. The Harrison County area was over topped and heavily damaged by the hurricanes of 2005. Particularly, the storm surge and winds generated by Hurricane Katrina on August 29, 2005, caused structural damage to the existing levee that provides inland flood protection to this low lying residential community.

Storm surge inundation reached a depth of 2-8 ft over the entire community during Hurricane Katrina. In addition, prior to Hurricane Katrina, Forrest (Forest) Heights was frequently inundated by flood waters due to inland flooding along the lower reach of Turkey Creek that overtopped the existing levee. An economically justified improvement to the existing earthen levee for inland flooding protection was evaluated in July 2005, prior to landfall of Hurricane Katrina. These evaluations included 100-year, 250-year and 500-year protection and elevations up to 19.5 feet above sea level. This plan was put on hold following Katrina in order to evaluate suitable defense of Forrest (Forest) Heights from hurricane storm surge flooding. The proposed levee was evaluated at elevations 17 ft and 21 ft NAVD-88.

All evaluated alternatives were also gauged against the intent of Executive Order 12898, "Federal actions to address environmental justice in minority and low-income populations". Since the establishment of the Turkey Creek Community by freed slaves and their descendants, federally funded construction programs including the Gulfport Regional Airport, US Highway 49 and Interstate Highway - 10 have impacted the Turkey Creek Watershed. In addition, numerous other constructions including hotels, shopping centers and housing developments have been federally permitted to fill wetlands and construct within the Turkey Creek watershed.

Through modeling results, a levee crest elevation of 21 feet NAVD-88l was determined to be consistent with the levee certification guidelines with the basis measure being a storm surge elevation that has a 0.2% probability (500-year event) of occurrence in any given year. The levee is estimated to be 6,500 linear feet and require 93,000 cubic yards of fill. An existing park with a surface elevation of 12 to 14 feet NAVD-88 would serve as a water detention area for temporary containment of rainfall during storm events.

Forrest (Forest) Heights Benefits

Equivalent annual damages reduced by the 21-foot levee are estimated to be $102,000, with residual damages of $41,000. Regional economic benefits include an increase in sales volume of $32,770,000, a $6,440,000 increase in local income, and a net increase of 193 jobs. In addition to these damages reduced, the levee would provide a significant boost to the cohesiveness of the historically significant community, preserve the culture and heritage of it's predominantly minority residential population, and greatly improve their overall quality of life. Residual damages for the Forrest Heights Area are $40,000.

Forrest (Forest) Heights Costs

First Costs: $14,070,000
Annual O&M: $114,000

5.3.3 Potential Local Flood Risk Management Projects

This report supports a recommendation for future feasibility level analyses of local flood risk management components of the Comprehensive Plan. While large structural solutions such as surge gate barriers did not garner much local support, there were smaller scale structural solutions, such as smaller ring levees, local surge barriers, and levee alignments that have the potential to provide cost effective solutions. Possible ring levee alternatives identified as part of this study including ring levees at: Belle Fontaine, Gulf Park Estates, Pascagoula/Moss Point, Pearlington, Gautier, Ocean Springs, and Bay St. Louis. Potential local surge barriers have been identified for St. Louis Bay and Biloxi Bay. Other levees with alternative alignments may also potentially be feasible. The development of cost effective, acceptable structural alternatives however will require additional study and coordination.

Potential Local Flood Risk Management Project Benefits

A very preliminary estimate of annual without-project damages for these potential structural solutions totals well over $60 million. The implementation of ring levees and / or other structural components in these areas would reduce a significant portion of those damages and warrants further feasibility level consideration.

Potential Local Flood Risk Management Project Costs

To complete feasibility level analyses for these potential structural solutions will require a significant amount of additional design. Due to time constraints, the current cost estimates are based significantly less than feasibility level investigations. Also, none of the options requiring further study and additional design have the benefit of geotechnical investigations or preliminary assessments for hazardous, toxic or radiological waste (HTRW) and much of the levee alignment would be in highly developed areas. For this study, most of the structural components such as traffic gates through levees, pumping stations, boat access gates, surge gates and other hard structural components were assigned to groups with a range of capacities.

Table 5-2 shows the cost of studies and additional design for individual projects associated with options that may be grouped into a structural alternative. The cost used as a basis for the design is the higher contract cost (without contingencies) of the group of options that may be included. Cost to complete feasibility level designs was estimated as seven percent of the estimated contract cost for each option. The value of 7% was selected by the PDT based on having completed some preliminary investigations (as included in this report), but not having geotechnical data or HTRW information to provide detailed feasibility level cost estimates.

Table 5-2
Local Flood Risk Management Study and Project Costs

Project	Feasibility Study Cost	Preliminary Construction Cost Estimate w/o Contingency
Pearlington Ring Levee	$5,343,000	$76,319,000
Bay St. Louis Ring Levee	$9,812,000	$140,171,000
Ocean Springs Ring Levee	$8,861,000	$126,584,000
Gulf Park Estates Ring Levee	$8,414,000	$120,191,000
Belle Fontaine Ring Levee	$6,786,000	$96,936,000
Gautier Ring Levee	$17,164,000	$245,194,000
Pascagoula/Moss Point Ring Levee	$29,082,000	$415,449,000
TOTAL COSTS	**$85,462,000**	**$1,020,844,000**

5.3.4 Site Specific Ecosystem Restoration Plan Components

This report recommends Congressional authorization to construct a number of site-specific ecosystem restoration components of the Comprehensive Plan. Attainment of three of the objectives of the MsCIP study effort: fish and wildlife preservation, reduction of coastal erosion, and amelioration of the effects of saltwater intrusion, would significantly restore the ecosystem of coastal Mississippi to pre-hurricane conditions. The proposed restoration efforts would not only enhance the natural habitats of the area but would make the coastal area more resilient to the adverse impacts of future storms. Team members, including staff from the States of Mississippi and Louisiana, U.S. Fish and Wildlife Service, National Park Service, and non-governmental environmental organizations developed a number of options including coastal forest and wetland ecosystem restoration, barrier island / Mississippi Sound ecosystem restoration, and beach and dune ecosystem restoration to achieve these missions. From these options, nine comprehensive plan elements are recommended for construction, one is recommended for continued engineering and design, and several are recommended for additional feasibility level studies.

5.3.4.1 Turkey Creek Ecosystem Restoration

This project site is located in north Gulfport, Mississippi, adjacent to U.S. Highway 49, a major north-west thoroughfare, and within the impaired Turkey Creek watershed. The area is becoming increasingly urbanized and development pressures are resulting in increased wetland degradation and loss by direct filling with the incumbent decrease in flood storage capability. The Turkey Creek site is approximately 880 acres of predominately undeveloped land. The site is divided by an east-west running railroad berm and contains a number of dirt road/paths and several miles of drainage ditches. These drainage ditches were constructed in the past in an effort to drain the site and control the drainage across the site into specified areas in order to make the site more attractive for development. Approximately 689 acres are south, and 190 acres are north, of the existing railway. The railway berm effectively separates the two portions of the site and therefore these areas function separately. The site is primarily comprised of degraded pine savannah wetland habitat. The elevated railway berm, miles of drainage ditches, and undeveloped roads fragment the wetland habitat and substantially alters the hydrology of the wetlands located to the south. Hurricane Katrina damaged and/or destroyed much of the remaining habitat (wind and salt damage to vegetation as well as salinity increases in the soils from the surge) such that the area has been determined to be incapable of unassisted recovery.

Wet (hydric) flats, which comprise as much as 20 – 30 percent of the coastal plain landscape from southeastern Virginia to south-eastern Texas, include wetlands on both organic and mineral soils and in the southeastern U.S. occur on the interfluvial marine terraces of the coastal plain. The hydric conditions contributing to the development of this habitat type include abundant rainfall and slow drainage associated with a landscape of low relief. Historically these habitats have been maintained in their open understory character by periodic fire. Pine savannah wetlands found in coastal Mississippi provide for diverse habitat for a number of plants and animals including many T&E species found only in these unique habitats. Pine savannah wetlands are commonly referred to as sponges that provide floodwater retention, groundwater recharge, and water purification. These habitats have been identified by the U.S. Fish and Wildlife Service as habitats of high value for evaluation species and relatively scarce or becoming scarce on a national basis or in the ecoregion section (Category 2) (Service Mitigation Policy, FR 46(15):7656-7663; dated 23 Jan 1981).

Current national trends show the continued movement of a large portion of the population to the nation's coastal communities and this evident in Mississippi as well. Numerous development plans for this property have been presented and so far have been unsuccessful; however, it is reasonable to assume future action will occur. This would result in loss of valuable habitat within an impaired watershed and subsequent increase in flooding. In addition, development of this property would contribute to the ongoing water quality degradation of this area.

Several plans were evaluated in order to determine the most cost-effective plan for restoration. The Turkey Creek site had an HGM assessment performed in 2000, using the *Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Wet Pine Flats on Mineral Soils in the Atlantic and Gulf Coastal Plains* (Rheinhardt et al 2002). Results from this earlier assessment are used to establish baseline (current) conditions at the site. The site has been divided into 8 separate assessment areas (Figure 8.1.2.1.4-1), as there were different baseline conditions for each area. The same HGM model is also being used to measure functional unit benefits at the site resulting from different restoration plans.

The recommended plan requires the acquisition of 689 acres of predominately undeveloped land, filling the previously constructed draining ditches, excavating and removing existing roadbeds and any additional fill, and maintaining vegetation growth by burning the project area in the initial year of construction as well as maintaining it by mowing and burning every three years over the life of the project as needed (Plan 3).

An essential component necessary when selecting the recommended plan at Turkey Creek was the need for burning. Burning allows the wet pine savannah environment to continue naturally as a functioning system without future intensive maintenance to maintain the required vegetation species. Although mowing does effectively keep understory plants from over colonizing the area, it does not simulate the natural conditions (i.e. seed germination, heating the pine bark, etc.) Dominant flora species in wet pine savannah habitats are dependent upon burning; thus, the following plan was selected knowing that most of these plant species would colonize the area upon establishment of routine burning and hydrology.

In addition, selection of the most cost effective plan was aided by the fact that the site is effectively divided into two functional units by the railroad berm. To make the entire site a functional unit would have required significant modification to this berm to restore the hydrology of the northern area. The additional cost was not supported by the additional benefits that would be gained.

Turkey Creek Ecosystem Restoration Benefits

Higher areas within the site will be designated as wet pine savannah. These areas have depressional areas within them which will enable water to flow down into the depression thus, holding water. Following the initial burning there would be a natural re-growth of wet pine savannah habitat, including species such as *Pinus elliotti, Morella cerifera, Ilex glabra, Spartina patens, and Panicum virgatum.*

Many species of wildlife are indigenous to the wet pine savannah habitat and are expected to thrive in the restored area. Understory plant communities including wiregrass, sedges, orchids, American Chaffseed and rough-leaved loosestrife as well as the insectivorous plants (pitcher plants, bladderworts, venus flytrap, and sundews) would be expected. Rare and threatened and endangered birds that are expected to utilize the areas following burning and regrowth include Henslow's sparrow, Bachman's sparrow, red-cockaded woodpecker, and Mississippi Sandhill Crane. This ecosystem may also benefit the Mississippi Gopher frog and in drier areas along ridges, the black pine snake and the gopher tortoise.

The HGM approach was used to assess wetland function. Benefits are measured in terms of average annual functional units (AAFU). Results from this assessment were used to establish baseline (current) conditions and, ultimately, to measure the functional unit benefits resulting from different restoration plans. Table 5-3 shows the total functional units under the recommended plan and the AAFU net benefit. It is assumed that functional units will remain the same under existing conditions and the no action plan even though it is likely that under the no action plan the functional value of the habitat would degrade over time. For this reason the calculation of the environmental benefits of the proposed restoration are considered conservative in nature.

The AAFU net benefit was calculated as the difference between the total functional units for the ecosystem restoration plan and the total functional units for the no action plan. The selection of Plan 3 would result in a net benefit of over 1500 average annual functional habit units at a minimum of high value scarce habitat on an ecoregional or national basis.

Table 5-3
Turkey Creek Ecosystem Summary of Benefits

Plan	Plan Description	Total Functional Units	AAFU Net Benefit
Existing Condition	Existing Condition	-	-
No Action	No Action	1,012	0
Recommended Plan – Plan 3	689 Acre Restoration Maintain by Burning	2,577	1,565

Turkey Creek Ecosystem Restoration Costs

First Costs: $6,840,000
Annual O&M: $47,000.

5.3.4.2 Dantzler Restoration Area

The 385-acre State-owned site is located in central Jackson County near the Pascagoula River. The site was planted in plantation pine during the 1960s and drainage ditches and stormwater lines were constructed in the early 1970s in anticipation of residential development of the site. The restorable area is split by a road, 151 of the acres are north of the road and the remaining 234 acres are south of the road. The long-term exclusion of fire and the invasion of non-native species, such as Cogon grass and Chinese tallow tree, have also severely degraded the site. These exotic species out compete the native vegetation, which provides food sources to the many fish and wildlife important species, including T&E species. Without any native competing species, these exotic species eventually become the only species in the area and result in a continuing degradation of the functional value of the wetlands. The importance of the wet pine savannah has been previously been discussed in the Turkey Creek ecosystem restoration project above.

Winds from Hurricane Katrina destroyed most if not all of the plantation pine leaving massive amounts of tree litter on the ground. In addition, debris and sedimentation resulting from the storm surge added even more litter. The exotics that were present in the site prior to the storm thrive in this type environment and it is likely that without restoration of the site they will become the dominant species inhabiting the site. Six alternative plans were developed to address the ecosystem restoration of the area.

The recommended plan requires filling ditches, excavating and removing existing roadbeds and any additional fill, and maintaining vegetation growth by mowing and burning the project area in the initial year of construction as well as maintaining it by burning every three years over the life of the project as needed (Plan 1). As with the Turkey Creek ecosystem restoration, periodic burning of the site is a critical element to the success of the restoration.

Dantzler Restoration Benefits

Benefits are measured in terms of AAFU. The HGM approach was used to assess wetland function similar to Turkey Creek. Table 5-4 shows the AAFU net benefit under the recommended plan. The AAFU net benefit was calculated as the difference between the total functional units for the ecosystem restoration plan and the total functional units for the no action plan. For the analysis, it is assumed that functional units would remain the same under existing conditions and the no action plan even though it is likely that under the no action plan the functional value of the habitat would degrade significantly as exotic species became the dominant vegetation. For this reason the calculation of the environmental benefits of the proposed restoration are underestimated.

Table 5-4
Dantzler Ecosystem Summary of Benefits

Plan	Plan Description	Total Functional Units	AAFU Net Benefit
Existing Condition	Existing Condition	-	-
No Action	No Action	116	0
Plan 1	385 Acre Restoration Maintain by Burning	604	1,244

Dantzler Restoration Costs

First Costs: $2,210,000
Annual O&M: $26,000

5.3.4.3 Franklin Creek Ecosystem Restoration

The Franklin Creek ecosystem restoration area is located near the communities of Orange Grove and Pecan, Mississippi in eastern Jackson County, near the Mississippi - Alabama state line. This area has already been funded for acquisition and demolition of 30 structures as part of the MsCIP Interim Report (P.L. 110-28). The restoration area consists of 149 acres located north and south of U.S. Highway 90, a major thoroughfare through the community and the CSX railway alignment. This area routinely floods with only a slight rainfall; thus, this would also provide additional flood storage capacity by restoring the natural habitat. Pine savannah wetlands are commonly referred to as sponges that provide floodwater retention, groundwater recharge, and water purification. This wetland habitat is under increased developmental pressures due to the extreme and urgent housing need faced by Mississippians as they are trying to rebuild. This habitat is becoming fragmented and with the increased development, fire maintenance is increasingly harder to perform.

The recommended plan requires filling ditches, excavating and removing existing roadbeds and any additional fill, installing culverts under the highway, and maintaining vegetation growth by burning and mowing the project area in the initial year of construction as well as maintaining it by burning every three years over the life of the project as needed (Plan 1).

Franklin Creek Restoration Benefits

Benefits are measured in terms of AAFU. The HGM approach was used to assess wetland function similar to Turkey Creek discussed above. Table 5-5 shows the AAFU net benefit under the recommended plan. The AAFU net benefit was calculated as the difference between the total functional units for the ecosystem restoration plan and the total functional units for the no action plan. For the analysis, it is assumed that functional units would remain the same under existing conditions and the no action plan even though it is likely that under the no action plan the functional value of the habitat would degrade significantly as exotic species became the dominant vegetation. For this reason the calculation of the environmental benefits of the proposed restoration are underestimated.

Table 5-5
Franklin Creek Ecosystem Summary of Benefits

Plan	Plan Description	Total Functional Units	AAFU Net Benefit
Existing	Existing	-	-
No Action	No Action (149 acres)	80	0
Recommended Plan – Plan 1	149 Acre Restoration Maintain by Burning & Restore Hydrology	596	516

Franklin Creek Restoration Costs

First Costs: $1,860,000
Annual O&M: $11,000

5.3.4.4 Bayou Cumbest Ecosystem Restoration

This area is located in the extreme southeastern portion of Jackson County adjacent to Bayou Cumbest and the Mississippi Sound. The Bayou Cumbest restoration area contains approximately 148 acres to be restored to emergent tidal marsh and scrub shrub habitat. The area currently consists of a degraded tidal marsh, as well as filled and developed areas (Figure 8.1.2.4.4-1). Due to the severity of Hurricane Katrina, most of the residential development was severely damaged or destroyed. The area contains low elevations and since most residential structures have been destroyed, the opportunity exists reduce the risk of future hurricane and storm damage and to restore the once existent tidal marsh. Of the total 148-acre restoration site, approximately 110 acres would be restored to tidal marsh and while the remaining 38 acres would remain scrub/shrub wetland habitat. The area presently consists of previously filled marsh areas that were developed into a residential community. The proposed project requires the acquisition of approximately 144 acres of developed and undeveloped properties in addition to the use of 4 acres of land being acquired via the County / FEMA process. Portions of approximately 7 parcels of previously developed land fall within the restoration area (20 acres) with the remaining being undeveloped. The recommended project would require the acquisition of the subject properties according the Corps regulations. In addition, this would also provide additional future storm surge protection to the overall coastal area by increasing the natural protection that marsh provides.

Wetlands, marshes, and nearshore marine and estuarine habitat are the nursery grounds for the entire marine food chain in the Gulf of Mexico. These habitats have been identified by the U.S. Fish and Wildlife Service as habitats of high value for evaluation species and is unique and irreplaceable on a national basis or in the ecoregion section (Category 1) (Service Mitigation Policy, FR 46(15):7656-7663; dated 23 Jan 1981).Pollution, development, and other factors are destroying such habitat throughout the Gulf region. As this habitat is destroyed, it further depletes the species that form the base of the food chain throughout the Gulf of Mexico. Numerous species of marine flora and fauna begin their life cycles in marshes and wetlands. Ultimately, the entire Gulf of Mexico ecosystem is threatened by the accelerated destruction of this habitat. Failure to address the loss of this habitat in the Gulf of Mexico region threatens the long-term health of the entire ecosystem and human culture, with the attendant loss of billions of dollars of marine-related resources.

The recommended plan will restore 148 acres. The recommended plan consists of acquiring lands and restoring the natural ecosystem by excavating old fill material, removing exotic plant species from non-excavated areas, filling existing artificial ditches, and planting native vegetation, such as *Spartina alterniflora* (Smooth Cordgrass) at the seaward edge of marsh; *Juncus roemerianus* (Black Needle Rush) at a slightly higher elevation; and *Spartina patens* (Saltmeadow Cordgrass) at even higher elevations at a density of 1 meter (Plan 2).

Bayou Cumbest Restoration Benefits

Benefits are measured in terms of AAFU. The HGM approach was used to assess wetland function. A HGM assessment was performed in 2000 using the *Regional Guidebook for Applying the HGM Approach to Assessing Wetland Functions of Wet Pine Flats on Mineral Soils in the Atlantic and Gulf Coastal Plains*. Results from this assessment were used to establish baseline (current) conditions and, ultimately, to measure the functional unit benefits resulting from different restoration plans. Table 5-6 shows the total functional units under each implemented plan and the AAFU net benefit. To calculate the AAFU net benefit, it is assumed that benefits will be maximized at year 5 with 0.5 meter spacing of vegetation, at year 7 with 1.0 meter spacing of vegetation, and at year 10 with 2.0 meter spacing of vegetation. These benefits are estimated to be sustainable over the life of the project. Net AAFU benefits are calculated as the difference between the total functional units for the ecosystem restoration plan and the total functional units for the no action plan. As with the other ecosystem restoration area, the benefits are likely to be underestimated since it is assumed that the existing functional value of the site will continue into the future with no diminishment. This is highly unlikely due to the aggressive nature of the exotic species that are currently in the area.

Table 5-6
Bayou Cumbest Ecosystem Summary of Benefits

Plan	Plan Description	Total Functional Units	Net AAFU Units
Existing Condition	Existing Condition	-	-
No Action	No Action	1,052	0
Recommended Plan 2	Excavate Fill Remove Exotics Fill Ditches Plant at Density 1.0m	1,719	637

Bayou Cumbest Restoration Costs

First Costs: $25,530,000
Annual O&M: $114,000.

5.3.4.5 Admiral Island Ecosystem Restoration

The 123 acre restoration area is located in Hancock County adjacent to Bayou La Croix and near Bay of St. Louis. The site contains of 62 acres of emergent tidal marsh and 61 acres of scrub shrub habitats. The property is owned by the State of Mississippi and consists of degraded wetland habitat as a result of debris and sediment deposited during the storm surge event of Hurricane Katrina.

The tidal marshes in this area were ditched during the 1960s causing changes in the natural hydrology and subsequent changes in the species composition. Hurricane Katrina left extensive debris fields and sedimentation throughout the area and destroyed many native trees and vegetation. Due to the loss of native species, this area is experiencing a severe infestation of the invasive Chinese tallow tree, which is invading the marshes and the adjacent flatwoods. These exotic species out-compete the native vegetation, which provides food sources to the many fish and wildlife important species, including T&E species. Without any native competing species, these exotic species eventually become the only species in the area and result in a much degraded function of the wetlands.

The recommended plan consists of restoring the study area by excavating old fill material, removing exotic plant species from non-excavated areas, planting native vegetation at a density of 1.0 meter, and filling existing artificial ditches. T he planting of native vegetation consist of *S. alterniflora, J. roemerianus, and S. patens* (Plan 2).

Admiral Island Restoration Benefits

Benefits are measured in terms of AAFU. The HGM approach was used to assess wetland function similar to Bayou Cumbest. Table 5-7 shows the total functional units under each implemented plan and the AAFU net benefit. To calculate the AAFU net benefit, it is assumed that benefits will be maximized at year 5 with 0.5 meter spacing of vegetation, at year 7 with 1.0 meter spacing of vegetation, and at year 10 with 2.0 meter spacing of vegetation. These benefits are estimated to be sustainable over the life of the project. Net AAFU benefits are calculated as the difference between the total functional units for the ecosystem restoration plan and the total functional units for the no action plan. The recommended plan was selected based on the criteria used for Bayou Cumbest.

Table 5-7
Admiral Island Ecosystem Summary of Benefits

Plan	Plan Description	Total Functional Units	Net AAFU Net Benefits
Existing		-	-
No Action	No Action	358	0
Recommended Plan – Plan 2	Excavate Fill Remove Exotics Plant at Density 1.0m Fill Ditches	471	108

Admiral island Restoration Costs

First Cost: $21,810,000
Annual O&M: $58,000

Deer Island Ecosystem Restoration

Deer Island, located within the boundaries of Harrison County, Mississippi near the mouth of Biloxi Bay and the City of Biloxi, has a history of tropical storm damage. Damages from these storms has varied based on varying degrees of storm surge, wave action and wind depending on the speed, intensity, direction of travel, and proximity of the given storm. Figure 3-6 displays a recent aerial photograph of Deer Island, showing the damage exacerbated during Hurricane Katrina. The breach on the west end was significantly widened, coastal marshes were impacted by debris and sedimentation, and the maritime forest was killed by wind and salt spray. With all this damage, it is amazing that the wetland created via Section 204, Beneficial Use of Dredged Material, on the eastern end of the island survived and is currently thriving.

The island is considered a mainland remnant and is not part of the coastal barrier system of islands along the Mississippi Coast. The island contains a diversity of habitat areas including beach/dune areas, marsh area, and maritime forest areas. It's proximity to the City of Biloxi provides a certain amount of protection to the city from waves generated by approaching hurricanes. This protection comes at a cost to the island as that energy affects the seaward shoreline and the interior marshes. It has been estimated that the island has lost approximately 300 acres or about 34 percent of its area since 1850, due to eroding shoreline.

A second restoration effort is currently underway which will fill the western breach and provided selective restoration to critical areas on the southern shoreline. This project is authorized under Section 528 WRDA 2000 and will be complete in 2009.

Due to the interrelated nature of some of the features, i.e. a+b, c+d, the team evaluated a total of 7 combination plans. Of these 7 the plan which best meets the planning objectives is the most cost effective is Combination Plan 7 which includes implementation of each of the alternatives.

Deer Island Benefits

Implementation of the combination plan would significantly improve the sustainability of Deer Island and result in the creation of approximately 20 acres of tidal emergent fringe marshes, restore beach and dune habitat, create hard bottom habitat through the use of stone containment, provide protection from coastal erosion, remove sedimentation and debris, and restore the coastal maritime forest an ecosystem of regional importance and concern.

Deer Island Costs

First Costs: $21,520,000
Annual O&M: $0

5.3.4.6 Submerged Aquatic Vegetation Pilot Project

Additional study is required to assess the complex environmental make-up impacting submerged aquatic vegetation (SAV) in Mississippi Sound due to the fact that previous planting efforts utilizing vegetation alone have not been entirely successful. Many questions must be answered (i.e. water quality, circulation, etc.) prior to SAV restoration implementation. SAV restoration efforts across the nation have proven to be rather challenging and many examples can be identified close to Mississippi over in Florida. Therefore, the MsCIP environmental team is recommending additional study via an in situ pilot project. Opportunities exist to partner with Federal, state, and local resource agencies as well as NGOs. Involvement of local colleges and universities with ongoing research programs would also help to identify and pinpoint specific problems for development of potential solutions.

Bayou Cumbest Pilot Restoration

The first goal of the proposed community-based restoration project in the Grand Bay National Estuarine Research Reserve (NERR) will result in restoration of up to 5 acres of *Ruppia maritima* resulting in the recovery of an equal amount of SAV habitat to that lost during the 2005 hurricane season. The second goal is to evaluate 3 restoration techniques to demonstrate their feasibility for larger restoration projects. The third and final goal to be achieved is educational – to increase awareness of the importance of SAV habitat in Mississippi Sound and provide coastal managers and restoration practitioners with the knowledge of techniques to maximize their return on dollars spent.

Three transplanting methods for restoring *R. maritima* will be evaluated as follows:1) direct planting from the donor site, 2) harvesting plant sprigs with one or more meristems (growth regions) from the donor site with subsequent growth in a greenhouse setting prior to planting, and 3) spreading seeds or mature flowering shoots over the restoration site. All plants and seeds would be acquired from a common donor site within the same system (Figure 8.1.2.6.1-1). After transplanting, quarterly monitoring for two years would be conducted to determine plant establishment, photosynthesis, growth, and expansion.

Educational outreach materials will be disseminated through Grand Bay NERR's Coastal Training Program to inform coastal decision-makers and resource managers of successful restoration techniques.

SAV Restoration Benefits

Submerged aquatic vegetation is an essential primary producer forming the basis of the food web for many estuarine species. These grasses provide important habitat for many Aquatic Resources of National Importance. In addition, SAVs are sensitive indicators of estuarine condition because of their high light requirements (Dennison et al 1993) and susceptibility to eutrophication-induced algal blooms and hypoxia (Hauxwell et al 2001). Furthermore, loss of SAV promotes the alteration of the sediment characteristics and nutrient cycling, causing long-term changes in habitat suitability for natural plant recolonization. These changes include loss of fine sediments through resuspension and transport, promoting a feedback loop that further inhibits natural recovery. Therefore, it is vitally important that restorative replanting be undertaken soon after damage or loss of plants to inhibit a negative change in system dynamics (Fonseca et al 2004).

SAV Restoration Costs

First Costs: $900,000 for monitoring and producing a final restoration report.

5.3.4.7 Additional Ecosystem Restoration Studies

This report supports further investigations of additional ecosystem restoration components of the Comprehensive Plan in anticipation of potentially recommending the features for future authorization as part of the MsCIP Comprehensive Plan.

Introduction

Development of the GIS based SDSS tool allowed the MsCIP environmental team, working in cooperation with the USFWS and MDMR, to identify and prioritize potential wetland restoration areas throughout coastal Mississippi (Lin 2007). A detailed explanation of this GIS based SDSS tool is provided in the Environmental Appendix to this report. The recommendation for further investigations would allow ecosystem restoration to be implemented on a holistic, watershed, and regional approach. Establishment of this program would ensure commitment to restoration of the hurricane damaged and destroyed ecosystems in coastal Mississippi; thus, allowing attainment of the overall Comprehensive Plan objectives.

Unique habitats exist in coastal Mississippi that are critical to the continued health of a number of fish and wildlife species of the Gulf of Mexico. Most of these proposed restoration habitats have been impacted and/or destroyed nationally, regionally, and locally by development and/or natural events. These sites require man-intervention in order to restore to their historical environmental setting. Failure to restore these sites could impact all coastal Mississippi.

Program Development

Using the GIS based SDSS model allows effectively analysis of needs in coastal Mississippi and the broader northern Gulf region. A subset of potential restoration sites were identified by the SDSS tool and then ground-truthed by the MsCIP environmental team, including ERDC, Corps, MDMR, and USFWS. Based on this work, which allowed both confirmation of the accuracy of the SDSS results and collection of additional on-site information pertinent to restoration efforts, the projects discussed above have been developed as cost effective means of initiating ecosystem recovery. In addition to these specific projects, other potential environmental restoration projects are identified for further study. Implementation of any of these projects would be dependent upon the preparation of a decision document, such as Project Information Report, which would range from $100,000 to $350,000 depending upon the specific project complexness. This cost has been incorporated into the cost estimates that follow.

Partnerships

Development of partnerships with Federal resource agencies, state agencies, and NGOs is crucial to the success of this program. These partnerships would provide opportunities to access local knowledge of the existing environment. Specialists in specific restoration techniques would be available as well as opportunities to build on existing programs.

Planning and Evaluation Teams

Development of teams would be necessary to organize the program, establish prioritization of projects, development and evaluation of project plans, and future monitoring. Development of assessment models as well as monitoring plans would be accomplished by various inter-disciplinary planning and evaluation teams.

Projects

The SDSS model identified hundreds of potential restoration areas. The list was verified in the field and through existing partnerships with Federal and state agencies. Verification was based on personal knowledge of the overall comprehensive natural system and the level of success to be gained via these restorations as part of the overall system-wide comprehensive approach. These sites were screened further and a list of 38 additional restoration sites is proposed, as identified in the two tables below. The estimated sum total project cost for all 38 sites is $5.48 billion.

The collaborative effort with the State identified a significant acreage that could be restored without the need for additional land acquisition. Table 5-8 presents those project features that are designed to restore the hydrology and natural landscape of the coastal counties with incidental risk reduction benefits. These areas are primarily undeveloped and are owned by the State of Mississippi as part of the Coastal Preserves Program. Table 5.9 presents those project features that are designed to both reduce the risk to life and property from future hurricane storm surge events and secondly to provide for substantial environmental benefit. These areas are typically fully developed residential areas that are subject to repetitive damage from hurricane and other storm events. Acquisition of these properties could be facilitated through the future implementation of the Long-Term High Hazard Area Risk Reduction Program recommended above.

Table 5-8
Additional High Priority Ecosystem Restoration Sites
(Phase II Studies)

Site	Restoration Acres	Environmental Setting	Study Cost	Estimated Project Cost
Wachovia Coastal Preserve, Hancock	1,200 acres total – 800 marsh, 200 forested, 200 savannah	Emergent aquatic vegetation, Bayhead Swamps trees Bayhead Swamps shrubs Riverine/levee forests	$250,000	$2,830,000 ER $ 0 RE
Ansley Coastal Preserve, Hancock	900 acres – 800 marsh, 100 forested	Emergent aquatic vegetation, Wet pine savannah	$250,000	$2,420,000 ER $ 0 RE
LaFrancis Camp Trenaisse, Hancock	45 acres total – all open water	Open water	$200,000	$8,770,000 ER $ 0 RE
DuPont Coastal Preserve, Harrison	650 acres – 170 marsh, 480 forested	Emergent aquatic vegetation, Bayhead Swamps trees Bayhead Swamps shrubs Riverine/levee forests	$300,000	$4,500,000 ER $ 0 RE
Dantzler Coastal Preserve Part 2, Jackson	900 acres – 500 marsh, 385 forested	Emergent aquatic vegetation, Bayhead Swamps trees Bayhead Swamps shrubs Riverine/levee forests	$300,000	$6,597,000 ER $ 0 RE
Pascagoula River Marsh, Jackson	11,150 acres	Emergent aquatic vegetation, Bayhead Swamps trees Bayhead Swamps shrubs Riverine/levee forests	$400,000	$2,230,000 ER $ 0 RE
ER = Construction Costs, RE = Acquisition Cost, TBD = Costs for these ecosystem restoration are being developed			**Estimated Study Costs $1,700,000**	**Estimated Project Costs $22,847,000**

Table 5-9
Additional High Priority Hurricane and Storm Damage Reduction - Ecosystem Restoration Sites

Site	Specifics	Environmental Setting	Study Cost	Estimated Project Cost
Pearlington, Hancock	76 acres, 27 structures, 58 parcels	Emergent aquatics and Bayhead swamp	$1,000,000	$15,300,000 ER $14,900,000 RE
Pearlington South, Hancock	11 acres, 30 structures, 35 parcels	Emergent aquatics and Bayhead swamp	$1,000,000	$2,300,000 ER $21,100,000 RE
Port /West, Hancock	49 acres, 18 structures, 30 parcels	Emergent aquatics	$750,000	$10,000,000 ER $9,800,000 RE
Ansley, Hancock	2,023 acres, 99 structures, 1,200 parcels	Emergent aquatics wet pine savannah	$3,500,000	$399,100,000 ER $83,000,000 RE
Heron Bay, Hancock	594 acres, 93 structures, 876 parcels	Emergent aquatics	$2,000,000	$83,200,000 ER $80,000,000 RE
Lower Bay, Hancock	226 acres, 28 structures, 82 parcels	Emergent aquatics	$1,000,000	$31,700,000 ER $8,400,000 RE
Lakeshore, Hancock	275 acres, 54 structures, 151 parcels	Emergent aquatics	$1,500,000	$54,500,000 ER $14,700,000 RE
Bayou Caddy / Lakeshore, Hancock	362 acres, 72 structures, 245 parcels	Emergent aquatics	$1,500,000	$71,700,000 ER $41,700,000 RE
Clermont Harbor, Hancock	209 acres, 295 structures, 497 parcels	Emergent aquatics	$2,000,000	$41,600,000 ER $166,700,000RE
Bayou La Croix, Hancock	259 acres, 388 structures, 603 parcels	Emergent aquatics	$2,000,000	$51,400,000 ER $155,700,000RE
Shoreline Park, Hancock	889 acres, 2,583 structures, 2,748 parcels	Emergent aquatics	$5,000,000	$175,600,000ER $1,083,600,000RE
Chapman Road, Hancock	146 acres, 352 structures, 390 parcels	Emergent aquatics	$2,000,000	$29,200,000 ER $144,900,000 RE
Jourdan River Interstate 10 Development, Hancock	638 acres, 23 structures, 44 parcels	Emergent aquatics	$2,000,000	$126,200,000 ER $29,700,000 RE
Diamondhead, Hancock	433 acres, 292 structures, 514 parcels	Emergent aquatics	$2,500,000	$85,800,000 ER $182,200,000 RE

Site	Specifics	Environmental Setting	Study Cost	Estimated Project Cost
Delisle, Harrison	120 acres, 40 structures, 80 parcels	Emergent aquatics and Bayhead Swamps	$1,000,000	$24,100,000 ER $17,800,000 RE
Ellis Property, Harrison	443 acres, 13 structures, 181 parcels	Emergent aquatics and wet pine flatwoods.	$1,000,000	$46,900,000 ER $13,400,000 RE
Pine Point East, Harrison	103 acres, 28 structures, 558 parcels	Emergent aquatics and wet pine savannah	$1,000,000	$20,600,000 ER $26,900,000 RE
Pine Point West, Harrison	83 acres, 22 structures, 198 parcels	Emergent aquatics and wet pine savannah	$1,000,000	$16,800,000 ER $19,900,000 RE
Pass Christian Forested Drainway, Harrison	21 acres, 8 structures, 12 parcels	Emergent aquatics and Bayhead Swamp	$750,000	$4,300,000 ER $6,400,000 RE
Pass Christian Site – Bayou Portage, Harrison	43 acres, 46 structures, 96 parcels	Emergent aquatics and Bayhead Swamp	$1,000,000	$8,700,000 ER $19,100,000 RE
Brickyard Bayou, Harrison	14 acres, 7 structures, 10 parcels	Emergent aquatics and Bayhead Swamp	$750,000	$2,900,000 ER $4,100,000 RE
Biloxi River Shorecrest, Harrison	15 acres, 12 structures, 25 parcels	Emergent aquatics and Bayhead Swamp	$750,000	$3,000,000 ER $9,500,000 RE
Biloxi River – Eagle Point, Harrison	17 acres, 28 structures, 34 parcels	Emergent aquatics and Bayhead Swamp	$1,000,000	$3,200,000 ER $14,200,000 RE
Keegan Bayou, Harrison	54 acres, 22 structures, 30 parcels	Emergent aquatics and wet Pine Savannah	$1,000,000	$10,900,000 ER $20,600,000 RE
St. Martin, Jackson	467 acres, 32 structures, 619 parcels	Emergent aquatics	$1,000,000	$92,400,000 ER $55,100,000 RE
Fort Point, Jackson	83 acres, 7 structures, 29 parcels	Emergent aquatics	$1,000,000	$16,700,000 ER $12,700,000 RE
Pine Island, Jackson	237 acres, 14 structures, 212 parcels	Emergent aquatics	$3,500,000	$497,900,000 ER $20,700,000 RE
Griffin Point, Jackson	182 acres, 114 structures, 141 parcels	Emergent aquatics	$1,500,000	$36,000,000 ER $34,900,000 RE
Bayou Chico, Jackson	258 acres, 47 structures, 113 parcels	Emergent aquatics	$1,500,000	$51,200,000 ER $31,700,000 RE

Site	Specifics	Environmental Setting	Study Cost	Estimated Project Cost
Grand Bay/Bayou Cumbest, Jackson	2,666 acres, 374 structures, 759 parcels	Emergent aquatics	$3,000,000	$525,700,000 ER $95,700,000 RE
ER = Construction Costs, RE = Acquisition Cost, TBD = Costs for these ecosystem restoration are being developed			**Estimated Study Costs $48,500,000**	**Estimated Project Costs $5,024,000,000**

Sequencing Plan

Once the hurricane and storm damage reduction - restoration sites have been prioritized, a sequencing plan would be developed identifying the events necessary to implement. This would ensure prioritized sites received immediate attention and further details developed for the required analysis.

Costs

A rough order of magnitude cost estimate has been prepared for each project based on existing conditions and restoration measures. This could serve as an upward limit of funding for the comprehensive environmental restoration program. Costs cover feasibility study, site acquisitions including associated relocation costs, removal and site demolition activities, and ecosystem restoration activities. A breakdown of the costs at each site is presented in the table above.

Monitoring and Adaptive Management

Monitoring and adaptive management is an integral part of the ecosystem restoration program. Post-construction monitoring would provide a systematic assessment of key indicators throughout coastal Mississippi ecosystems. Monitoring would inform the implementation of any adaptive measures which might be required to achieve project benefits. The role of monitoring and adaptive management in the Comprehensive Plan is presented in section 5.5 Monitoring and Adaptive Management.

Program Status Reports

Program Status Reports would accomplish a system-wide reevaluation that would consider program and project-level considerations, and the level of success of overall met program goals and objectives. Project level formulation activities would address optimization of the overall program's contribution to the system-wide goals and objectives in general, and project goals and objectives would be more specific. The individual project monitoring reports may result in project modifications that impact or modify system output, however, these modifications would not address system-wide issues within the comprehensive plan. Status reports would provide updates on the overall success of hurricane and storm damage reduction and environmental restoration throughout coastal Mississippi.

5.3.5 Violet Freshwater Diversion Project Engineering and Design

This report supports initiating studies required to accomplish the intent of Section 3083 of the Water Resources Development Act of 2007 to design a freshwater diversion project to be located in the vicinity of Violet, LA. The project would provide sufficient inflows to the western Mississippi Sound area to support oyster reef health and productivity.

Background

Mississippi Department of Marine Resources (MDMR) has been working with the Mississippi congressional delegation in order to address impacts from saltwater intrusion and degradation of the oyster resources found within Mississippi Sound, specifically in the western portion of the state in

Hancock County. Joint efforts between Mississippi and Louisiana congressional delegates resulted in the identification of potential freshwater diversion projects from the Mississippi River as a mechanism for reversing the historic increase in salinity in the Mississippi Sound/Biloxi marshes area in order to support fresher marshes and oyster reef health and productivity thus enhancing both their economic value and the ecological services they provide (WRDA 2007, Section 3083).

Modeling Efforts

During 2002, MDMR began serious efforts into developing a freshwater diversion project and through collaboration with state academia, began running modeling scenarios. Additionally, in 2006, the MsCIP environmental team began refinement of water quality modeling utilizing existing data collected during the Gulfport Harbor widening study. The results from a simulated diversion of 7,500 cfs of Mississippi River water near Violet, Louisiana, suggest that 180 days after initiation of the diversion, salinities were lowered in western Mississippi Sound, (Dortch et al 2007) sufficiently to warrant additional examination. However, at present, absolute salinity values predicted by the model poorly match calibration data. Further refinement of the models should correct this limitation to allow the usefulness of the model results for estimating potential beneficial or deleterious effects on oysters and other coastal resources.

Collaboration

During further collaboration between the states' congressional delegations, a project has been agreed upon and consists of a freshwater diversion of Mississippi River that should prove beneficial in reaching each state's goals of establishing and maintaining salinity regimes for oysters and introducing sediment into the eroding Biloxi marshes of Louisiana. Additionally, the State of Louisiana, through CIAP funding is currently designing a much smaller diversion project into the Central wetlands that could be incorporated as a small component of the much larger overall freshwater diversion project being developed by the Corps, Mobile and New Orleans Districts.

The MsCIP environmental team has participated in initial project development meetings between the states of Mississippi and Louisiana, Corps New Orleans District, and Lake Pontchartrain Foundation. The freshwater diversion project at Violet is being incorporated into the MsCIP Comprehensive Plan as a recommendation for engineering and design.

In an effort to apply this water quality data to ecological issues, MsCIP and ERDC convened a panel of representatives from TNC, MDMR, and USM at GCRL. The aim of the panel is to suggest simplistic ecological models that can be incorporated with projections from the combined hydrodynamic and water quality models to identify simulations which might result in an improvement in oyster habitat quality. The panel has identified several key attributes that need to be incorporated into the evaluation of freshwater diversion options. The first is that salinities average as closely as possible to the optimal range for oyster health and productivity. This is clearly of critical importance since the primary purpose for contemplating freshwater diversions is to improve habitat conditions for oysters. Second, a diversion should not result in extended periods of low salinity resulting in mortality or poor growth and reproduction. This consideration is particularly critical during times of high river flow or other extreme conditions. Third, a diversion should not unduly influence habitat conditions for other critical resources.

Diversions that result in favorable conditions for oyster health may not be conductive to other equally important resources. For instance, most sea grasses do poorly at salinities less than 20 ppt. A diversion that results in excellent conditions over the prime commercial beds but drives salinities below 20 ppt in the seagrass elsewhere would not be acceptable. Other important habitat requirements that should also be considered for seagrass health include light availability and nutrient concentrations. These environmental concerns associated with water diversions, in addition to potential impacts on important fisheries species of those areas, require monitoring and adaptive operations of the diversion structure to enhance the long-term sustainability of nearshore and estuarine resources.

Project Development

The Violet diversion project will take a monitoring and adaptive operations approach in order to fully understand the impacts associated with the freshwater diversion. The project will likely consist of a gravity diversion structures constructed on the east bank of the Mississippi River at Violet, Louisiana. The structure would be designed and operated to provide for an estimated target freshwater diversion of approximately 10-12,000 cfs released into Lake Borgne. The structure would be operated in such a matter as to allow for releases in the quantities and frequencies necessary to reach the target salinity rate. Early modeling suggests timing of the release as well as frequency is crucial to ensure success at reaching the target salinity rate for oysters, an indicator species as to the overall health of the ecosystem. Further modeling would refine target frequencies and timing of releases of the freshwater to meet oyster habitat goals.

Future Development

The diversion project would be closely coordinated between the Corps, New Orleans and Mobile Districts, States of Louisiana and Mississippi, and the Lake Pontchartrain Foundation. This collaborative partnership would provide opportunities to build on information gathered during previous studies and modeling and to ensure that overall objectives and specific goals are established by the groups involved.

Violet Freshwater Diversion Study Costs

An estimated $ 12,000,000 is required for completion of engineering and design to include the preparation of supplemental NEPA documentation.

5.3.6 Escatawpa River Diversion – Grand Bay Marsh Ecosystem Restoration

This report supports the recommendation for authorization to conduct feasibility level analyses of fresh water diversion at the Escatawpa River in anticipation of potentially recommending this comprehensive plan element for future authorization as part of the MsCIP Comprehensive Plan. Historically, the estuarine marsh within the Grand Bay NERR represented the former deltaic environments of the Pascagoula and Escatawpa Rivers in eastern Jackson County. The outlets of these rivers have shifted westward over time, severely limiting the inflow of freshwater, nutrients, and sediments into the Bayou Cumbest area of the reserve.

Currently, it is speculated that much of the freshwater entering the Grand Bay NERR estuary is from surface runoff through Bayou Heron and Bayou Heron, within the Bangs Lake Hydraulic Unit, measuring approximately 21,374 acres. Human disturbances to the area have also altered historic sheet flow and surface water flows into the area, as well as the natural migration of the Pascagoula and Escatawpa Rivers.

Additional Study Efforts

Due to the time constraints, the team was only able to qualitatively determine that freshwater input into the systems does change the overall environment. It is known that these systems have been altered and/or starved by lack of freshwater inflow. An integrated environmental web exists in these rivers and also in Mississippi Sound, which needs to be fully identified, in order, to completely understand various effects that could possibly occur.

Further studies would allow for development of a refined hydrodynamic model for the area, inputting biological, water quality, and physical data into the model to evaluate a variety of freshwater diversion scenarios. This work represents a critical first step in the final assessment of potential water diversion projects for this area. Additionally, community information needs to be solicited obtained through interviews and public workshops will be solicited and a public workshop will be held to share the results.

Escatawpa River Diversion Benefits

A freshwater diversion project in the area, if feasible, may serve to enhance the wildlife resources of the area. The need for freshwater diversion at the Grand Bay savannahs and marshes would help restore the predominant wet pine savannah habitat. Shoreline erosion along the Grand Bay area (i.e. loss of the Grand Batture Islands) has also contributed to the increased salinity in the area.

Escatawpa River Diversion Costs

An estimated $ 3,000,000 is required for the additional environmental and engineering study and design.

5.3.7 Coast-wide Beach and Dune Ecosystem Restoration

This report supports the recommendation for authorization to construct beach and dune restoration improvements along the Mississippi coast. Essentially all the beaches along Coastal Mississippi are man-made. Harrison County has the most beachfront with a 26-mile stretch extending from Biloxi Bay to St. Louis Bay. This beach is the longest man-made beach in the U.S. Hancock County has several miles of beach while Jackson County only has a small beach located in the Cities of Pascagoula and Ocean Springs. In total, the beaches extend along less than half of the Mississippi coastline.

Most of the dunes that previously existed along these beaches were destroyed by Hurricane Katrina and much of the beach was damaged. Many Federal, state, and local entities raised environmental concerns regarding the various Mississippi beaches during initial discussions held to receive local citizenry input. In some areas, such as in the City of Pascagoula, the beach was completely gone. Reconstruction of the dunes, where beaches exist, will provide a reduction of damaging wave action from smaller storms (i.e. normal summer storms, tropical storms, and/or lower energy hurricanes).

A project to restore the beaches in Harrison County has been funded and is underway as part of the Flood Control and Coastal Emergencies (FCCE). Other projects to construct dunes to a height of 5-foot in Harrison County and to 2-foot in Hancock and Jackson County were proposed as part of the MsCIP Interim Report. That dune restoration project has since been funded and the Corps, Mobile District is underway preparing the plans and specifications.

The beaches, situated immediately seaward of developed areas, provide an excellent location where elevated dunes could be constructed to provide some additional protection against smaller hurricanes. Furthermore, the seaward side of the dunes also provides excellent feeding grounds at the nearshore and intertidal shore areas for various birds, crabs, and other fauna.

Beach and Dune Ecosystem Restoration Alternatives

Original concepts were to look at crest elevations of +10.0 feet and +15.0 feet as options for all dunes. Further discussions made it clear that the top elevation of the dunes needed to be below the elevation of the adjoining roadway. This was to help mitigate the migration of the sand onto the roadway as aeolian (wind blown) deposits. Alternatives evaluated included dune heights of 2 and 6 feet with planting of appropriate dune vegetation.

Beach and Dune Ecosystem Restoration Benefits

The storms of 2005 destroyed a large percentage of critical habitat for the piping plover, various shorebirds including the Least Tern, and numerous fish and wildlife species. Beach nourishment and dune restoration would benefit piping plover as well as providing lost habitats for other shorebirds, additional eco-tourism opportunities, and enhancement to the overall quality of life in Coastal Mississippi. Placement of the dunes directly against a raised seawall or roadway would also serve aesthetically to mask the appearance of a structural barrier. Thus, adding to the public acceptance and/or appeal of this proposal.

Dunes are consistent with public preference for a more natural appearing defense mechanism rather than a hardened structure. Construction of dunes will include planting vegetation, such as sea oats (*Uniola paniculata*), and sand fencing to help stabilize the dunes. Sand dunes are naturally occurring dynamic coastal features, which are formed by the accumulation of wind blown sand. Sand is naturally carried along the beach by the wind. Sand fences help facilitate the building of sand dunes by trapping and collecting this wind driven sand. Sand fences are usually made of wood or biodegradable material. Dune plants tolerate harsh beach conditions including wind, salt spray, storms, scarce nutrients, limited freshwater, and intense sunlight and heat. The plants and/or seedlings provide feeding sources to a variety of animals while also providing nesting and roosting habitat.

The recommended plan for this element of the Comprehensive Plan was determined by a combination of cost-effectiveness analysis and achievement of key restoration objectives. The most cost-effective and functionally complete alternative was determined to consist of creation of a dune field that would be constructed approximately 50 ft seaward of the existing seawall and about 2 feet above the existing berm with a width of approximately 60 ft. The most functionally-effective alternative included dune vegetation and sand fencing to enhance establishment and survival of the dune vegetation.

Table 5-10
Coastwide Beach/Dune Ecosystem Restoration Summary of Benefits

Plan	Plan Description	Functional Habitat Index
Existing Condition	Existing Condition	-
No Action	No Action	96
Recommended Plan	2-foot High x 60-foot Wide Dune With Planting & Sand Fencing	248

Beach and Dune Ecosystem Restoration Costs

First Costs: $23,320,000.
Annual O&M: $0

5.3.8 Barrier Island Ecosystem Restoration Alternatives

This report supports the recommendation for authorization to construct ecosystem restoration improvements at Mississippi's barrier islands. The barrier islands have historically constituted a barrier to saltwater, maintaining a careful balance of saltwater and freshwater flows, which sustain the valuable marine resources of Mississippi Sound. The barrier islands also provide a barrier to onshore movement of waves, and to a lesser extent storm surge, by attenuation. Over recent decades, the level of wave and surge reduction they provide has been steadily reduced, but much more so during the hurricane events of Camille, and Katrina, in which Ship Island was first severed, then dramatically separated, and badly eroded.

The contribution of surge reduction provided by the barrier islands, in their historic, existing, and altered states, has been subject to sensitivity analyses that indicate that some surge reduction is realized on the western Mississippi coast by the islands being in a pre-Camille footprint. Additional benefits were also predicted by creating longer and higher islands that were not subject to erosion on storms. It has also been roughly estimated that as much as ten feet of wave height reduction is provided by the barrier islands in their present condition as compared to the islands being removed from the system. It can only be speculated as to how much actual damage reduction the barrier islands provide, but one thing is known for sure, and that is that the disappearance of the barrier islands would provide the means for a dramatically increased wave climate, along the coast of

Mississippi. And unlike in previous periods, the barrier islands are incapable of rebuilding on their own due to frequent, intense storms, relative sea level rise, and anthropogenic activities that may have resulted in a reduction in sand supply to the Mississippi barrier islands.

Similarly, the degree of decline in shellfish and other marine resources within Mississippi Sound attributable to the degradation of the barrier islands is currently impossible to precisely quantify; however, it is known that declining oyster populations are directly attributable to the increasing salinity within Mississippi Sound. Oysters are sensitive to specific ranges of salinity. Under current conditions, the islands provide a natural boundary between the water's salinity [~33 parts per thousand (ppt)] of the open Gulf of Mexico and the brackish water found in Mississippi Sound. Salinity in the Sound during low flow periods range from 10 to 30 ppt. Additional study would be required to determine impacts to salinity from the loss of the barrier islands.

The alternatives for barrier island renourishment and protection of Mississippi Sound are being formulated and evaluated by a multi-agency regional study team consisting of staff from the National Park Service, U.S. Geological Survey, and Corps of Engineers. In addition, barrier island restoration has been suggested and is supported, by numerous members of the public, other agencies, and the State of Mississippi.

Alternatives being evaluated include very limited restoration of Ship Island, only in the vicinity of the endangered cultural sites of Fort Massachusetts and French Warehouse, on (the post-Katrina condition) "West" and "East" Ship Islands, respectively up to 'massive' restoration of the historic island dimensions. Although the protection of the cultural resource sites appears to be a justified option, this alternative would neither represent a complete solution, nor a completely effective means of addressing the larger problem faced on that island and the others. On the other hand, a more massive plan for barrier island restoration, or more direct application of sand, was rejected by many on the team, as unmanageable and potentially damaging, due to the unknown effects that might be introduced by placing sand into an area that could not be maintained by littoral drift over the long-term. More massive measures did not appear to provide a significantly greater volume of functional increase, for a much larger outlay of funds.

As part of the evaluation increasing the volumes of sand to the system is determined to be increasingly effective in achieving additional functional value, particularly when sand was provided directly into the littoral drift that created and nourishes the islands, so that "Mother Nature" can finish the job of distributing the sand in a natural way, to those areas of the island most suited to the current drift climate.

Table 5-11
Barrier Island Ecosystem Restoration Alternatives

Management Measure	Description
Option A	Restore Island to pre-Camille Footprint with Massive Restoration of Dune
Option B	Replenish Sand in Littoral Zone, Inland Sand Source
Option C	Replenish Sand in Littoral Zone, Offshore Sand Source
Option D	Dune Restoration with 2-foot Dune, No Additional Sand
Option E	Dune Restoration with 6-foot Dune, Minimal Additional Sand
Option F	Seagrass Restoration North of Existing Islands
Option G	Direct Sand Placement in Camille Cut

Comprehensive Plan	Direct Sand Placement in Camille Cut with Dune Vegetation Planting Littoral Zone Placement East Ends of Ship, Horn, & Petit Bois Islands Coastal Processes Analysis of Cat Island

Plan Selection

Several alternatives have been evaluated regarding the restoration of the Mississippi barrier islands. The most promising alternative for barrier island renourishment and protection of Mississippi Sound would produce the greatest functional benefit per dollar expended, would be a complete solution, would represent an efficient use of Federal and local funds, would be effective in its treatment of the problem (particularly in comparison to less effective structural wave reduction measures), and would be acceptable in terms of existing laws, policies and priorities. In addition, the public is highly supportive of measures meant to address the degradation of the barrier islands, as an element of a natural barrier to storms, and in the restoration of marine resources associated with Mississippi Sound.

This alternative includes the direct placement of sandy sediments to fill the breach in Ship Island and thereby reconnect West and East Ship Islands to their historic condition and to place sandy sediments within the littoral zones of Ship, Horn and Petit Bois Islands to ensure that the sediment budget of the islands is sufficient to maintain the islands in the future. This littoral zone placement would also benefit from the modification of dredging and disposal practices of the federally maintained Gulfport and Pascagoula Harbor navigation projects. These coupled efforts would begin the long-term process of barrier island repair and sustainability. Another consideration that still must be addressed is the best alternative for dealing with the erosion of Cat Island. This island is geomorphically different from the other 3 barrier islands and our understanding of the processes controlling Cat Island is not well developed. Additional effort would be required to add this island into an overall comprehensive barrier island restoration plan.

Barrier Island Ecosystem Restoration Benefits

Restoration of the Mississippi barrier island system would provide significant system-wide ecosystem benefits as well as economic benefits associated with damages and economic losses avoided and regional economic benefits.

Most notably the restoration of the islands would help maintain and sustain the fragile Mississippi Sound ecosystem with its economic, recreational, environmental, and aesthetic benefit and provide for additional nesting habitat for threatened and endangered sea turtles and over wintering critical habitat for the piping plover. A functional habitat index evaluation of just the direct placement of sand in Camille Cut with the associated dune habit restoration would increase that habitat value of Ship Island to approximately 500 habitat units vs. the 96 units provided currently by Ship Island. With the continued erosion of this island, the habitat value will only decline in the future without intervention. No environmental benefits have been calculated relative to the maintenance of the Mississippi Sound but a rough estimate of the fishery losses avoided by restoration of the island is over $43 million in average annual benefits. Additional economic benefits are provided in Table 5-12 and detailed in the Economic Appendix to this report.

Table 5-12
Summary Benefits for Barrier Island Comprehensive Plan

	Damages Avoided (Annual $)	Recreation Losses Avoided (Annual $)	Fishery Losses Avoided (Annual$)	Change in Sales Volume	Change in Income	Change in Employment
Barrier Island Comprehensive	$17,699,600	$466,341	$43,618,143	$843,210,000	$177,140,450	5,192

Plan (G)						

Barrier Island Ecosystem Restoration Costs

First Costs: $479,710,000

Annual O&M: $0

5.4 Operation, Maintenance, Repair, Rehabilitation, and Replacement (OMRR&R)

It is anticipated that the State of Mississippi will assume complete responsibility for the operation of, maintenance of, repair of, and rehabilitation of, programs and projects recommended for implementation in this Interim Report.

5.5 Monitoring and Adaptive Management

Monitoring project performance, followed by adaptive changes to the project if necessary, is a responsible means of ensuring project performance. Monitoring determines if the projected outputs are being achieved and provides feed back for future projects. Post-implementation monitoring of ecosystem restoration components of the Comprehensive Plan is projected to be conducted for no more than five years at a cost of less than 1% of the total first cost of the project's ecosystem restoration features.

Adaptive management of proposed comprehensive ecosystem restoration programs and projects is an important aspect of project success. It is generally anticipated that some post-implementation project modifications will be required based on the feed back provided by project monitoring. Because the nature of the recommended plans made in this Comprehensive Report is not extremely risky in terms of projected outputs, it is anticipated that adaptive management would not be a major project expense. Adaptive management of ecosystem restoration features is expected to cost no more than 3% of ecosystem restoration feature first costs, and may in some cases be less than that figure. Monitoring and adaptive management costs have been accommodated in the cost estimates for each potential ecosystem restoration component as part of the contingency estimate.

Information gained from post-implementation monitoring and adaptive management of recommended ecosystem restoration plans will be used to provide "lessons learned" for the design and implementation of future ecosystem restoration projects. These "lessons learned" will provide important information, which will be used to improve the effectiveness and reduce the costs of future ecosystem restoration components of the Comprehensive Plan.

5.6 Environmental Considerations

A detailed discussion of the potential environmental impacts associated with near-term recommended plans is included in Chapter 4 and the Environmental Appendix accompanying this report.

5.7 Cultural and Archaeological Resource Considerations

A detailed discussion of the potential cultural and archaeological resource considerations associated with near-term recommended plans is included in Chapter 4 and the Environmental Appendix accompanying this report.

5.8 Compliance with Environmental Laws and Regulations

The comprehensive recommended plans have been determined to be in compliance with all applicable State and Federal laws and regulations. Based on the conclusions of this integrated Draft Report and Environmental Impact Statement, a Record of Decision will be prepared pending the public review of the integrated draft report. On 5 May 2009 the Mississippi Department of Marine Resources concurred that the projects discussed in the MsCIP Comprehensive Plan were consistent with he Mississippi Coastal Program and that these actions would not have adverse environmental effects on Mississippi's coastal resources. The Mississippi Department of Environmental Quality indicated that they supported the goals of the MsCIP comprehensive plan and that the elements described in the report support the goals of the State Water Quality program (31 March 2009). The MSDEQ will issue invididual State Water Quality Certification for each comprehensive plan element as they are designed. A Section 404(b)(1) Evaluation can be found in the Environmental Appendix. An Environmental Laws compliance table can be found in Section 3 of the Environmental Appendix.

5.9 Summary of Plan Accomplishments

The recommended plan elements presented in this Comprehensive Report are limited in nature, given the requirements of rapid technical, economic, and environmental analysis and implementation. They do, however, provide a firm basis for a cost-effective comprehensive plan that will greatly aid the communities of coastal Mississippi in their road to recovery.

Many of the most critical elements of recovery are being dealt with by other agencies, through FEMA's Public Assistance and other programs, by HUD's grants for recovery of water supply and treatment, and many more. However, the issues of recovery of advanced warning systems, adoption of a more comprehensive education and evacuation campaign and plans, and recovery of pre-Katrina protection measures, drainage, infrastructure, and environmental resources, has not been thoroughly covered.

The recommended plan elements made herein, the benefits of which are summarized below, should provide some measure of recovery beyond that which has currently occurred. All potential programs presented here are of a need that has been clearly demonstrated by the effects of Hurricane Katrina. Analysis of an array of alternatives at each final problem area resulted in selection of a well-balanced, cost-effective recommendation for implementation, as demonstrated in each of the System of Accounts comparison.

All recommended projects presented here have been shown to be cost-effective, technically sound, and environmentally feasible, by virtue of a System of Accounts analysis, and by evaluation of each recommendation by the rigorous use of criteria presented in the report.

The recommended plan elements made will provide vital assistance in the recovery, and insurance of provision of added safety for the residents of, visitors to, environmental resources within, and property residing on the coast of Mississippi.

Justification of the cost-effectiveness, technical feasibility, environmental feasibility, and other plan accomplishments for each recommendation, are presented in detail, in the individual appendices attached to the main report.

5.9.1 Summary of Plan Benefits

The benefits of the plan address the goals of hurricane and storm damage reduction, shoreline erosion, saltwater intrusion, and fish and wildlife preservation. The benefits of the plan elements, provided in greater detail in chapter 3 of this report and the Economic and Environmental Appendices, are attributable to the various elements previously described. Please refer to Figure 5-1 at the beginning of this chapter for a map depicting the relationship of the Comprehensive Plan elements. The benefits of the individual elements could be achieved by only implementing that element, and would still achieve some level of performance. However, when implemented as a system, the elements provide synergistic benefits far beyond that which could be achieved by individual plans.

These system-wide benefits, depicted in Table 5-13 below, begin at the barrier islands. Restoration would replenish the sand within the system to reduce shoreline erosion and prevent further saltwater intrusion into the Mississippi Sound estuary. This brackish ecosystem provides an estimated $43 million dollars in fisheries landings to the State of Mississippi, and is part of a $500 million dollar industry that supports thousands of jobs throughout the region. It is also the home of such threatened and endangered species as the Gulf sturgeon providing critical habitat necessary for its survival, brown pelican, and green, Kemp's ridley, and loggerhead sea turtles. It would also restore critical over-wintering grounds deemed as critical habitat for the federally protected piping plover and nesting habitat for the brown pelican, green, Kemp's ridley, and loggerhead sea turtles, all federally protected by the ESA. Restored islands would also prevent approximately $19 million in annual damages to the Mississippi coast, provide $466,000 in annual recreation benefits, and protect the culturally significant Fort Massachusetts site on Ship Island.

Landward of the Mississippi Sound where water meets land can be described in various terms – it is a buffer area, the land-water interface, or an ecotone - an area where the terrestrial ecosystem transitions into the aquatic ecosystem. Critical habitats exist in this ecotone area: swamps, marshes, coastal ridges, coastal forests, littoral zone, dunes, and beaches. These areas serve as vital breeding areas, nursery grounds, and areas where much of the massive amounts of organic carbon needed to fuel aquatic food chains are produced. This area is also a human habitat, with an estimated 15,000 structures and tax parcels within the High Velocity Zone as designated by FEMA. Proposed elements in this area would provide 690 acres of tidal marsh critical for various lifestages of red snapper, tuna, redfish, Spanish and king mackerel, grouper, speckled trout, jack crevalle, cobia, amberjack, marlin, and various species of sharks which have all been classified as species of national economic importance by NOAA. This flood damage reduction with ecosystem system restoration effort would reduce over $33 million dollars in damages by removing 2,000 parcels from the High Velocity Zone.

Northward of the shoreline within a narrow swath wet pine savannahs, a very unique habitat within the overall Gulf region, provides crucial habitat to several federally protected species - gopher tortoise, black pine snake, eastern indigo snake, Mississippi gopher frog, Mississippi sandhill crane, yellow-blotched map turtle, and red-cockaded woodpecker. The ecology within this area supports a very unique plant community found nowhere else and includes the pitcher plant, a micro eco-system within the plant itself. This habitat is nationally scarce and is declining rapidly. A structural component – Forrest Heights ring levee – reduces approximately $100,000 in annual damages within the predominantly minority residential community (residual damages within the area are $40,000).

The recommended plan restores 690 acres of tidal habitat, 436 acres of beach and dune habitat, 1,223 acres of wet pine savannah habitat during the initial phase, reduces over $50 million dollars in annual damages, and creates over 11,000 new jobs. Projects dependent upon further study and design would evaluate restoration for over 27,000 acres of wet pine savannah, emergent tidal marsh, scrub shrub, and bayhead swamp habitat, evaluate risk reduction for over 58,000 tax parcels accounting for over $420 million in annual damages, and potential create in excess of 130,000 new jobs.

Table 5-12
Comprehensive Plan Expected Performance

Management Measure	Description
Barrier Island	$20M annual damages avoided, $43M annual fishery losses avoided, 1,150 acres restored, protect of threatened and endangered species including piping plover and nesting habitat for the brown pelican, green, Kemp's ridley, and loggerhead sea turtles and 4,900 jobs created
Near-term HARP	2,000 parcels removed from the FEMA VE Zone, $33M in annual damages reduced, 4 municipal structures relocated and elevated, and 5,200 jobs created
Waveland	25 residential structures elevated and 50 jobs created
Forrest Heights	$100K annual damages reduced in a minority community (including $40,000 residual damages) and 200 jobs created
Beach & Dune	60 miles of dune restoration, 200 jobs created, and incidental damage reduction
Turkey Creek	689 acres of wet pine savannah restored, incidental flood storage capacity, and 30 jobs created
Bayou Cumbest	110 acres of tidal wetland restored, 38 acres scrub/shrub restored, __ structures removed, and 280 jobs created
Dantzler	385 acres of wet pine savannah restored, incidental flood storage capacity, and 10 jobs created
Admiral Island	62 acres of tidal wetland restored, 61 acres of scrub/shrub restored, and 280 jobs created
Franklin Creek	149 acres of wet pine savannah restored, incidental flood storage capacity, and 10 jobs created
SAV Pilot	5 acres submerged aquatic vegetation
Deer Island	400 acres of critical habitats restored
Violet Diversion	MS Sound Salinities 15 – 22 ppt during, avoid annual losses of 3 million pounds of oyster harvest (8-percent of national oyster harvest)

6 IMPLEMENTATION REQUIREMENTS

A Letter of Intent from the State of Mississippi indicating the intent to be the non-Federal sponsor of the Comprehensive Plan was received by the Mobile District on 27 May 2009. A copy of the letter is provided as an attachment to this report.

6.1 Cost-Sharing

The recommended plans contained herein are subject to cost sharing, financing, and other applicable requirements of Federal and State laws and policies, including WRDA 1986, as amended, and with the non-Federal sponsor agreeing to comply with applicable Federal law and policies, and with the following requirements:

a. Provide a minimum of 35 percent, but not to exceed 50 percent of total project costs allocated to flood damage reduction, as further specified below:

(1) Provide 25 percent of design costs allocated to structural flood damage reduction in accordance with the terms of a design agreement entered into prior to commencement of design work for a project element for structural flood damage reduction;

(2) Provide, during the first year of construction of a project element for structural flood damage reduction, any additional funds necessary to pay the full non-Federal share of design costs allocated to structural flood damage reduction;

(3) Provide, during construction of a project element for structural flood damage reduction, a contribution of funds equal to five percent of total project costs allocated to structural flood damage reduction;

(4) Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of a project element for structural flood damage reduction;

(5) Provide, during construction of a project element for structural flood damage reduction, any additional funds necessary to make its total contribution for structural flood damage reduction equal to at least 35 percent of total costs allocated to structural flood damage reduction;

b. Provide 35 percent of total project costs allocated to hurricane and storm damage reduction, as further specified below:

(1) Provide 25 percent of design costs allocated to hurricane and storm damage reduction in accordance with the terms of a design agreement entered into prior to commencement of design work for a project element for hurricane and storm damage reduction;

(2) Provide, during the first year of construction of a project element for hurricane and storm damage reduction, any additional funds necessary to pay the full non-Federal share of design costs allocated to hurricane and storm damage reduction;

(3) Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of a project element for hurricane and storm damage reduction;

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

c. Provide 35 percent of total project costs allocated to ecosystem restoration, as further specified below:

(1) Provide 25 percent of design costs allocated to ecosystem restoration in accordance with the terms of a design agreement entered into prior to commencement of design work for a project element for ecosystem restoration;

(2) Provide, during the first year of construction of a project element for ecosystem restoration, any additional funds necessary to pay the full non-Federal share of design costs allocated to ecosystem restoration;

(3) Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of a project element for ecosystem restoration;

(4) Provide, during construction of a project element, any additional funds necessary to make its total contribution for ecosystem restoration equal to 35 percent of total project costs allocated to ecosystem restoration;

d. Provide 35 percent of total project costs allocated to nonstructural flood damage reduction, as further specified below:

(1) Provide 25 percent of design costs allocated to nonstructural flood damage reduction in accordance with the terms of a design agreement entered into prior to commencement of design work for a project element for nonstructural flood damage reduction;

(2) Provide, during the first year of construction of a project element for nonstructural flood damage reduction, any additional funds necessary to pay the full non-Federal share of design costs allocated to nonstructural flood damage reduction;

(3) Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of a project element for nonstructural flood damage reduction;

(4) Provide, during construction of a project element for nonstructural flood damage reduction, any additional funds necessary to make its total contribution for nonstructural flood damage reduction equal to 35 percent of total project costs allocated to nonstructural flood damage reduction;

e. Not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefore, to meet any of the non-Federal obligations for a project element unless the Federal agency providing the Federal portion of such funds verifies in writing that expenditure of such funds for such purpose is authorized;

f. Not use a project element for ecosystem restoration or lands, easements, and rights-of-way required for a project element for ecosystem restoration as a wetlands bank or mitigation credit for any other project or project element;

g. Not less than once each year, inform affected interests of the extent of protection afforded by the project elements for structural flood damage reduction, nonstructural flood damage reduction, or hurricane and storm damage reduction;

h. Agree to participate in and comply with applicable Federal floodplain management and flood insurance programs for project elements for structural flood damage reduction, nonstructural flood damage reduction, or hurricane and storm damage reduction;

i. Comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12), which requires a non-Federal interest to prepare a floodplain management plan within one year after the date of signing a project cooperation agreement, and to implement such plan not later than one year after completion of construction of a project element for structural flood damage reduction, nonstructural flood damage reduction, or hurricane and storm damage reduction;

j. Publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with protection levels provided by a project element for structural flood damage reduction, nonstructural flood damage reduction, or hurricane and storm damage reduction;

k. For so long as a project element for hurricane and storm damage reduction remains authorized, ensure continued conditions of public ownership and use of the shore upon which the amount of Federal participation is based;

l. For so long as a project element for hurricane and storm damage reduction remains authorized, provide and maintain access roads, parking areas, and other public use facilities, open and available to all on equal terms;

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

n. Comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. 46014655), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way required for construction, operation, and maintenance of a project element, including those necessary for relocations, the borrowing of materials, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act ;

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

p. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to a project element for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project element;

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

r. Keep and maintain books, records, documents, or other evidence pertaining to costs and expenses incurred pursuant to a project element, for a minimum of three years after completion of the accounting for which such books, records, documents, or other evidence are required, to the extent and in such detail as will properly reflect total project costs, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20;

s. 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; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141- 3148 and 40 U.S.C. 3701- 3708 (revising, codifying and enacting without substantial change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.) and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c et seq.);

t. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended (42 U.S.C. 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of a project element. 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;

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

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

w. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. 1962d-5b), and Section 1030) of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 22130)), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project or separable element. Table 6-1 provides a summary of all recommended comprehensive plan elements including total cost and cost share requirements.

Table 6-1
Mississippi Coastal Improvements Program
Cost Sharing (August 2008 Price Level)

Phase I Recommended Plan Feature (AUTHORIZATION 65/35 percent)	Total Project Cost	Federal Cost *	Non Federal Cost *

Hurricane Risk Reduction Education	**	**	**
Hurricane and Storm Warning	**	**	**
Hurricane Evacuation Planning	**	**	**
Floodplain Management	**	**	**
Building Code Update	**	**	**
Zoning Code Update	**	**	**
Long-term Critical Infrastructure and Services Relocation (LOD 5)	**	**	**
Phase I High Hazard Area Risk Reduction Plan	$408,424,000	$265,475,600	$142,948,400
Waveland Floodproofing	$4,611,000	$2,997,150	$1,613,850
Forrest Heights Levee	$14,500,000	$9,425,000	$5,075,000
Turkey Creek Ecosystem Restoration	$7,200,000	$4,680,000	$2,520,000
Dantzler Ecosystem Restoration	$2,300,000	$1,495,000	$805,000
Franklin Creek Ecosystem Restoration	$2,000,000	$1,300,000	$700,000
Bayou Cumbest Ecosystem Restoration & Hurricane Storm Damage Reduction	$26,900,000	$17,485,000	$9,415,000
Admiral Island Ecosystem Restoration	$23,200,000	$15,080,000	$8,120,000
Deer Island Ecosystem Restoration	$22,900,000	$14,885,000	$8,015,000
Submerged Aquatic Vegetation Pilot Program	$1,000,000	$650,000	$350,000
Coast-wide Beach and Dune Ecosystem Restoration	$24,900,000	$16,185,000	$8,715,000
Comprehensive Barrier Island Restoration	$516,000,000	$335,400,000	$180,600,000
Subtotal of Authorization Request	**$1,053,935,000**	**$685,057,750**	**$368,877,250**
Freshwater Diversion, Violet Louisiana*** (WRDA 2007, Sec 3083)			

Future Studies – Phase II****	**Total Study Cost**	**Federal Cost ***	**Non Federal Cost ***
LaFrancis Camp, Trenaisse Canal, Hancock County	$200,000	$100,000	$100,000
Wachovia Coastal Preserve, Hancock County	$250,000	$125,000	$125,000
Dantzler Coastal Preserve Part 2, Jackson County	$300,000	$150,000	$150,000
Pascagoula River Marsh, Jackson County	$400,000	$200,000	$200,000
Ansley Coastal Preserve, Hancock County	$250,000	$125,000	$125,000
Dupont Coastal Preserve, Harrison County	$300,000	$150,000	$150,000
Subtotal of Phase II Studies	**$1,700,000**	**$850,000**	**$850,000**

Future Studies - Phase III****	**Total Study Cost**	**Federal Cost ***	**Non Federal Cost ***
Long-term High Hazard Risk Reduction Plan	$5,000,000	$2,500,000	$2,500,000
Escatawpa River Freshwater Diversion	$3,000,000	$1,500,000	$1,500,000
Long-term Ecosystem Restoration and Hurricane Storm Damage Reduction	$48,500,000	$24,250,000	$24,250,000

Structural Hurricane Storm Damage Reduction	$84,019,000	$42,009,500	$42,009,500
Subtotal of Related Investigations	**$135,519,000**	**$67,759,500**	**$67,759,500**
Total MsCIP Comprehensive Plan	**$1,191,154,000**	**$753,667,250**	**$437,486,750**

* Indicated cost sharing is consistent with law and Corps policy.
** Work to be done by others - Additional coordination is required.
*** Violet Diversion is a critical element of MsCIP Comprehensive Plan and authorized in WRDA 2007, Section 3038.
****Refer to Tables 5-8 and 5-9, respectively for estimated total project costs.

6.2 Agency Technical Review (ATR) and Independent External Peer Review (IEPR)

The Comprehensive Plan and Integrated Programmatic Environmental Impact Statement report has undergone an Agency Technical Review (ATR) conducted by the Corps" National Center of Expertise for Hurricane and Storm Damage Reduction in North Atlantic Division (NAD). The ATR has been coordinated by the Philadelphia District and utilized resources of NAD, other Corps Divisions, and the Engineering Resource and Development Center (ERDC). Certification of completion of ATR is dated 4 December 2008.

Independent External Peer Review of the final report was coordinated by Baltimore District of the Corps via a contract with Battelle, Inc, and conducted by appropriate outside resources familiar with the study area and its resources. IEPR Final Report is dated 7 November 2008.

Consideration of information generated by the Interagency Performance Evaluation Task Force was done at all times during the conduct of this study, and was included in the development of Comprehensive Plan alternatives.

6.3 Schedule for Implementation of Recommended Comprehensive Plan

Key milestones for the completion of the Comprehensive Plan and Integrated Programmatic Environmental Impact Statement Report are displayed below.

Comprehensive Plan Report Schedule

February – March 2009	Draft Comprehensive Report/EIS for Public Review
21 May 2009	Civil Works Review Board
June – July 2009	State and Agency Review
July 2009	Report of the Chief of Engineers
July – August 2009	Report to Assistant Secretary of Army for Civil Works

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8 LIST OF ACRONYMS

AAHU	Average Annual Habitat Units
ABFE	Advisory Base Flood Elevation
ASA(CW)	Assistant Secretary of the Army for Civil Works
BEA	U.S. Bureau of Economic Analysis
BFE	Base Flood Elevation
BGEPA	Bald and Golden Eagle Protection Act
BMP	Best Management Practices
CAA	Clean Air Act
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CBRA	Coastal Barrier Resources Act
CDBG	Community Development Block Grant
CEFIT	Corps of Engineers Flood Inventory Tool
CIAP	Coastal Impact Assistance Program
Corps	U.S. Army Corps of Engineers
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DEIS	Draft Environmental Impact Statement
DHS	Department of Home Land Security
DOE	U.S. Department of Energy
DOI	Department of Interior
DOL	U.S. Department of Labor
DOT	Department of Transportation
EA	Environmental Assessment
EAD	Equivalent Annual Damages
EC	Engineering Circular
EFH	Essential Fish Habitat
EIFS	Economic Impact Forecasting System
EIS	Environmental Impact Statement
EM	Engineering Manual
EPR	External Peer Review
EO	Executive Order
EQ	Environmental Quality

ER	Engineering Regulation
ERDC	Engineering Research and Design Center
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FHI	Functional Habitat Index
FMCs	Fishery Management Councils
FPPA	Farmland Protection Policy Act
FWCA	Fish and Wildlife Coordination Act
GMEI	Gulf of Mexico Estuarine Inventory and Study, Mississippi
HCD	Habitat Conservation Office
HCWSWMD	Harrison County Wastewater and Solid Waste Management District
HEC-FDA	Hydrologic Engineering Center-Flood Damage Analysis
HGM	Hydrogeomorphic Model
HMGP	Hazard Mitigation Grant Program
HQ	Headquarters
HTRW	Hazardous, Toxic, and Radioactive Wastes
IPCC	Intergovernmental Panel of Climate Change
IPR	In-Progress Review
ITR	Independent Technical Review
IWR	Institute for Water Resources
IWR-PLAN	Institute for Water Resources-PLAN Decision Support Software
LaPR	Louisiana Coastal Protection and Restoration
LERRD	Land Costs to include Easements, Rights-of-way, Relocations and Disposal or Borrow Areas
LOD	Lines of Defense
m^2	Square Miles
MCACES	Micro-Computer Aided Cost Estimating System
MCP	Mississippi Coastal Program
MDEQ	Mississippi Department of Environmental Quality
MDMR	Mississippi Department of Marine Resources
MDWFP	Mississippi Department of Wildlife, Fisheries, and Parks
MEMA	Mississippi Emergency Management Agency
MGCRWA	Mississippi Gulf Coast Regional Wastewater Authority

MGD	Million Gallons Per Day
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Services
mph	miles per hour
MPRSA	Marine Protection, Research, and Sanctuaries Act
MsCIP	Mississippi Coastal Improvement Program
NAAQS	National Ambient Air Quality Standards
NED	National Economic Development
NEPA	National Environmental Policy Act
NER	National Ecosystem Restoration
NERR	National Estuarine Research Reserve
NGOs	Non-Governmental Organizations
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NMS	National Marine Sanctuary
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NWS	National Weather Service
O&M	Operation and Maintenance
OCRM	Office of Ocean and Coastal Resource Management
OMB	Office of Management and Budget
OSE	Other Social Effects
PCX-CSDR	Planning Center of Expertise for Coastal Storm Damage Reduction
P.L.	Public Law
PDT	Project Delivery Team
PED	Preconstruction Engineering and Design
PMP	Project Management Plan
PRD	Protected Resources Division
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RED	Regional Economic Development
RES	Real Estate Supplement

RIDF	Risk-Informed Decision Framework
RSL	Relative Sea Level
RSM	Regional Sediment Management
SAD	South Atlantic Division
SAV	Submerged Aquatic Vegetation
SDSS	Spatial Decision Support System
SHPO	State Historic Preservation Officer
SIPs	State Implementation Plans
SOA	System of Accounts
SRWMD	South Regional Wastewater Management District
SWPPP	Storm Water Pollution Prevention Plan
T&E	Threatened and Endangered
TANF	Temporary Assistance for Needy Families
TNC	The Nature Conservancy
TSCA	Toxic Substances Control Act
U.S.	United States
USEPA	U.S. Environmental Protection Agency
USCG	U.S. Coast Guard
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WRDA	Water Resources Development Act

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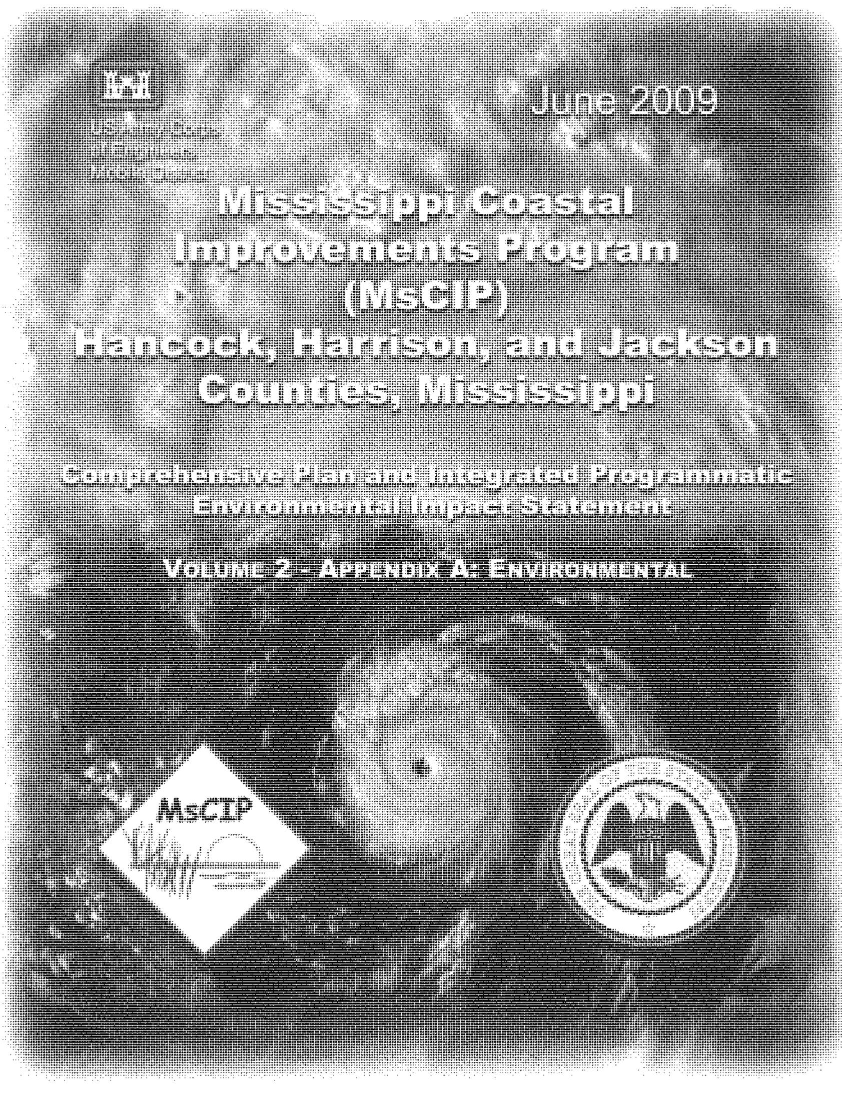
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Comprehensive Plan and Integrated Programmatic
Environmental Impact Statement
VOLUME 2 - APPENDIX A: ENVIRONMENTAL
MsCIP

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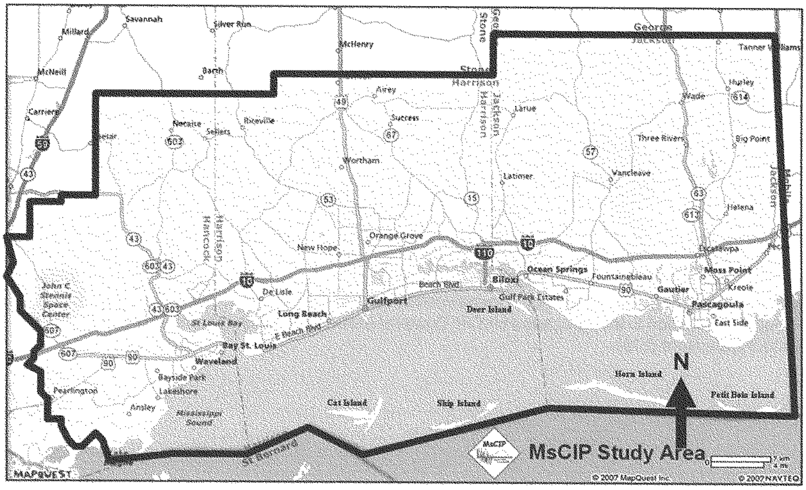
SECTION 1
ENVIRONMENTAL BASELINE AND RECOVERY

1.1 COASTAL MISSISSIPPI – THE ECOSYSTEM PRE- AND POST-HURRICANES & RECOVERY ANALYSES

FOREWORD

This document is one of a number of technical appendices to the Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan and Integrated Feasibility Report and Programmatic Environmental Impact Statement.

The Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan Integrated Feasibility Report and Programmatic Environmental Impact Statement provides systems-based solutions and recommendations that address: hurricane and storm damage reduction, ecosystem restoration and fish and wildlife preservation, reduction of damaging saltwater intrusion, and reduction of coastal erosion. The recommendations contained in the Integrated Main Report/Programmatic Environmental Impact Statement (EIS) also provide measures that aid in: greater coastal environmental and societal resiliency, regional economic re-development, and measures to reduce long-term risk to the public and property, as a consequence of hurricanes and coastal storms. The recommendations cover a comprehensive package of projects and activities, that treat the environment, wildlife, and people, as an integrated system that requires a multi-tiered and phased approach to recovery and risk reduction, irrespective of implementation authority or agency.



Source: Corps

Figure 1. The MsCIP Study Area

The purpose of the Comprehensive Plan Report is to present, to the Congress of the United States, the second of two packages of recommendations (i.e., the first being the "interim" recommendations funded in May 2007, and this "final" response, as directed by the Congress), directed at recovery of vital water and related land resources damaged by the hurricanes of 2005, and development of recommendations for long-term risk reduction and community and environmental resiliency, within the three-county, approximately 70 mile-long coastal zone, including Mississippi Sound and its barrier islands, of the State of Mississippi.

This appendix, the Integrated Main Report/Programmatic EIS, and all other appendices and supporting documentation, were subject to Independent Technical Review (ITR) and an External Peer Review (EPR). Both review processes will have been conducted in accordance with the Corps "Peer Review of Decision Documents" process, has been reviewed by Corps staff outside the originating office, conducted by a Regional and national team of experts in the field, and coordinated by the National Center of Expertise in Hurricane and Storm Damage Protection, North Atlantic Division, U.S. Army Corps of Engineers.

The report presents background on the counties that comprise the Mississippi coastline most severely impacted by the Hurricanes of 2005, their pre-hurricane conditions, a summary of the effects of the 2005 hurricane season, problem areas identified by stakeholders and residents of the study area, a summary of the approach used in analyzing problems and developing recommended features directed at assisting the people of the State of Mississippi in recovery, recommended actions and projects that would assist in the recovery of the physical and human environments, and identification of further studies and immediate actions most needed in a comprehensive plan of improvements for developing a truly resilient future for coastal Mississippi.

This appendix contains detailed technical information used in the analysis of existing and future without-project conditions, in the development of problem-solving measures, and in the analysis, evaluation, comparison, screening, and selection of alternative plans, currently presented as recommendations contained in the Integrated Main Report/Programmatic EIS.

Each appendix functions as a complete technical document, but is meant to support one particular aspect of the feasibility study process. However, because of the complexity of the plan formulation process used in this planning study, the information contained herein should not be used without parallel consideration and integration of all other appendices, and the Integrated Main Report/Programmatic EIS that summarizes all findings and recommendations.

An Environmental Appendix has been prepared to evaluate the environmental recovery of Coastal Mississippi as a result of the hurricane damage. Environmental effort focuses on the preservation of fish and wildlife [i.e. prior to the 1950s development period (Corps 1984)], prevention of saltwater intrusion, and prevention of erosion. Environmental efforts selected in this Environmental Appendix have been included in the Integrated MsCIP Comprehensive Report/Programmatic Environmental Impact Statement (EIS).

ES – 1 Executive Summary

An Environmental Appendix has been prepared to evaluate the ecological recovery of Coastal Mississippi. Environmental effort focuses on the preservation of fish and wildlife [i.e. prior to the 1950s development period (Corps 1984)], prevention of saltwater intrusion, and prevention of erosion. In order for Coastal Mississippi to environmentally recover, the MsCIP Environmental project delivery team (PDT) identified ecological issues throughout the three coastal counties – Jackson, Harrison, and Hancock – of Mississippi and the offshore ecosystem. During this effort, both a non-structural PDT and a structural PDT developed measures to benefit Coastal Mississippi from a flood-proofing stand-point (i.e. non-structural) and an engineered (i.e. hardened structures) stand-point, respectively. The environmental effort also involved close coordination with both the structural and non-structural PDTs of the MsCIP study effort to ensure environmental consistency. Environmental efforts selected in this Environmental Appendix have been included in the Integrated MsCIP Comprehensive Report/Programmatic EIS. The Integrated Programmatic EIS – Effected Environment section contained within this Environmental Appendix provides the impact analysis for those projects screened out early during the plan formulation process.

ES – 1.1 Description of Natural System

The primary study area consists of the three coastal counties in the State of Mississippi: Hancock, Harrison, and Jackson counties; and the coastal (offshore) ecosystem, including its barrier islands. This area ranges in elevation from sea level to about 30 feet above mean sea level. The essentially flat to gently undulating, locally swampy Coastal Lowlands are underlain by alluvial, deltaic, estuarine, and coastal deposits and merge with the fluvial-deltaic plains of the streams and rivers of the area. This portion of Coastal Mississippi has been classified as an alluvial coast, a terraced, and deltaic plain. According to the Cowardin et al (1979), *Classification of Wetlands and Deepwater Habitat of the United States*, there are five major wetland and deepwater systems, four of which are found within Coastal Mississippi. They include marine, estuarine, riverine, and palustrine wetland systems.

ES – 2.1 Problems and Opportunities

In response to major damages on the coast of Mississippi as a result of Hurricane Katrina, Congress directed the U.S. Army Corps of Engineers (Corps) to conduct an analysis and design for comprehensive modifications and improvements in the Mississippi coastal area for the purposes of hurricane damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resources purposes. Coastal Mississippi was the point of impact of the greatest tidal surge that has hit the mainland of the United States (U.S.) in its recorded history. Hurricane Katrina affected over 90,000 square miles (m^2) of the Gulf Coast region and caused almost complete destruction of several large coastal communities while seriously damaging numerous others. The destruction was on a scale unmatched by any natural disaster in U.S. history. The loss to Coastal Mississippi is unprecedented and has presented a high cost to the nation with a complete fisheries failure being declared by the Commerce Secretary, marine debris covering valuable productive water bottoms and coastal wetlands, exacerbated coastal erosion, loss to maritime forests, degraded water quality, increased pollution, widespread debris fields throughout coastal wetlands, degraded coastal preserve lands owned and maintained by the State of Mississippi, Department of Marine Resources (MDMR), increased risks to infrastructure and human life, danger to fish and wildlife including threatened and endangered (T&E) species and their critical habitats, and the loss of an entire way of life. Losses to many commercially important fisheries stock, foraging areas, nurseries, and etc. have been felt economically in the overall region. Spawning, breeding, and foraging grounds of fish and shellfish were severely impacted resulting in rising prices and once readily available resources are now becoming limited. The ability of wetlands to enhance protection from future storm surges, coastal erosion, and flooding has been greatly reduced. Human activities add another layer of complexity to the natural processes of coastal lands and materials. People's activities are often conducted without an adequate understanding of coastal geology and processes. As a result, they can lead to unforeseen degradation of coasts. Even human actions intended to save or improve the coast may inadvertently increase erosion. Cooperative scientific investigations are starting to provide the crucial information needed to minimize the unintended effects of human disturbances along coasts.

The Governor of the State of Mississippi has developed a *Seven-Point Strategy* for rebuilding coastal resources of the State. It is anticipated to be an on-going effort over the next 10 to 15 years. The strategy is summarized as follows:

- Implementation of breakwater structures for surge protection (natural surge diffusers, breakwaters, jetties seawalls, etc.);
- Deer Island restoration to pre-1900 footprint with fortification of the south side;
- Barrier Island restoration to pre-Camille conditions;
- Restoration of 10,000 acres of coastal marshes, beaches, and forests;
- Restoration of historical water flow to Coastal Mississippi watersheds to provide water quality and quantity critical to estuarine and marine habitats, including efforts to divert freshwater from Louisiana into the Biloxi marshes;
- Restoration of submerged aquatic vegetation (SAV) in Mississippi Sound; and the
- Restoration and enhancement of reef systems in Mississippi waters and adjacent Federal waters (i.e. oysters, nearshore low-profile reefs, and offshore artificial reefs).

The Governor of the State of Mississippi has also provided extensive guidance in the rebuilding of communities, infrastructure, the economy, and human services which were devastated by the hurricanes of 2005. Much of this guidance has been incorporated into the formulation of the environmental approach detailed in the Environmental Appendix and also in the Integrated MsCIP Comprehensive Report/Programmatic EIS. The Integrated MsCIP Comprehensive Plan/Programmatic EIS will address and consider a wide array of environmental restoration techniques to include vegetative plantings, river diversions, hydrologic restoration, marsh creation, shoreline protection, and sediment trapping and stabilization of the barrier islands.

ES – 3.1 Development of Environmental Measures and Alternatives

The formulation of measures was based on coastal resources assessments of hurricane and stormwater damage, saltwater intrusion, preservation of fish and wildlife, coastal erosion, flooding, navigation, and other problems and opportunities, in a collaborative approach involving Federal, state and local agencies, stakeholders, and citizen groups. The strategy for analyzing post-storm conditions, both for past and potential future events, was developed by the interagency PDT, and reviewed by an ITR team and an ETR team, with approval by the U.S. Army Corps of Engineers, Headquarters (Corps-HQ). This analyzing strategy was required to formulate measures and alternatives.

The interagency PDT is comprised of representatives from the following:

- U.S. Environmental Protection Agency (USEPA)
- Federal Emergency Management Agency (FEMA)
- U.S. Fish and Wildlife Service (USFWS)
- National Park Service (NPS)
- National Oceanic and Atmospheric Administration (NOAA) Fisheries, Protective Resource Division (PRD) and Habitat Conservation Division (HCD)
- National Weather Service (NWS)
- Natural Resources and Conservation Service (NRCS)
- U.S. Geological Survey (USGS)
- MDMR
- Mississippi Department of Environmental Quality (MDEQ)
- Mississippi Department of Transportation (MDOT)
- Mississippi State Historic Preservation Officer (SHPO)
- Hancock, Harrison and Jackson Counties
- Communities of Bay St. Louis, Biloxi, D'Iberville, Gautier, Gulfport, Long Beach, Moss Point, Ocean Springs, Pascagoula, Pass Christian, and Waveland
- Engineering Research and Development Center (ERDC)
- Mississippi State University (MSU)
- University of Southern Mississippi (USM) – Including the Gulf Coast Research Lab
- Coastal Restoration Network
- Audubon Society
- Sierra Club
- The Nature Conservancy (TNC)

In analyzing potential measures, the Environmental PDT has considered, in all cases in which it would be appropriate, integration of environmental measures within structural and non-structural potential solutions.

The following environmental measures were evaluated and screened by the Environmental PDT based on applicability to the specific problem area.

ES – 3.1.1 Freshwater Diversions

Consists of evaluation of current conditions of expansive marsh systems located in western and eastern portions of Coastal Mississippi. Diversions of freshwater from existing river systems would be evaluated based on ecosystems needs.

ES – 3.1.2 Ecosystem Restoration of Historical Wetlands Previously Developed

Development of a Geographical Information System (GIS) based – Spatial Decision Support System (SDSS) – by which to prioritize potential areas based on historical conditions, damages from storm surge and coastal flooding, and location to existing natural undisturbed lands (i.e. potentially State of Mississippi or Federal lands).

ES – 3.1.3 Barrier Island Restoration

Partnering with NPS to develop a vision for the barrier islands that would restore lost and damaged ecosystems including beach and dune restoration, restoration of salt and freshwater marshes, and revegetation of maritime forests. Supplemental information can be found in the Barrier Island Appendix.

ES – 3.1.4 SAV Restoration

Development of a program to determine conditions of SAVs and to determine causes of resource degradation. Identify opportunity to partner with other Federal and state agencies, as well as universities, to establish research necessary to establish potential solutions and projects.

ES – 3.1.5 Incorporation of State of Mississippi Initiative

Continue partnership with MDMR to develop and compliment the State of Mississippi projects as opportunities arise.

ES – 3.1.6 Restoration of Coastal Forests

Continue partnership with NPS to further evaluate restoration of coastal forests destroyed by the hurricanes along the barrier islands. Continue partnership with MDMR to develop and compliment the State of Mississippi projects as opportunities arise concerning the mainland of Coastal Mississippi.

ES – 3.1.7 Clean-up of Impaired Waterbodies

Determine which waterbodies in Coastal Mississippi were not cleared of deposited sediment and debris as part of the FEMA mission. Establish partnering opportunities with local and state governments to determine increased risks of flooding and develop potential projects that would lessen that risk.

ES – 3.1.8 Restoration of Degraded Coastal Wetlands

Continue to assess the degradation of coastal wetlands (i.e. wet pine savannah, etc.) using the GIS analysis tool – SDSS – in conjunction with the resource agencies to identify additional potential restoration opportunities.

ES – 3.1.9 Reduction of Coastal Flooding

Work with the Corps, non-structural PDT to assess coastal flooding impacts to developed commercial and residential areas in order to reduce adverse impacts while also restoring historical ecosystems.

ES – 3.1.10 Restoration of Oyster Resources

Continue developing and coordinating with MDMR to implement their restoration of oyster resources wherever feasible. Also incorporate oyster restoration in any applicable proposed projects.

ES – 3.1.11 Restoration of Fishing Reefs

Develop a partnership with MDMR to assist in their existing fishing reef program in order to identify any additional potential locations while also addressing any potential improvements in Mississippi Sound's water quality.

ES – 3.1.12 Restoration of Marshes

Development of a GIS analysis tool – SDSS – by which to prioritize potential homeowners assistance and relocation project areas based on historical conditions, damages from storm surge and coastal flooding, and location to existing natural undisturbed lands (i.e. potentially State of Mississippi or Federal lands).

ES – 4.1 Plan Formulation

ES – 4.1.1 Goals and Objectives

ES – 4.1.1.1 Objectives

- Recommend solutions that would assist the people of Coastal Mississippi in their efforts toward recovery of pre-hurricane conditions in the areas of coastal erosion, preservation of fish and wildlife, and prevention of saltwater intrusion;
- Recommend measures that would provide for sustainability of the overall natural system;
- Recommend continued study of specific problem areas that require further study to arrive at viable solutions;
- Recommend implementable projects directed at recovery of biological resources along the coast of Mississippi to pre-hurricane conditions, and to examine potential measures that might be implemented to increase sustainability of those resources during future events;
- Recommend measures that would provide short-term or long-term recovery of natural resources;
- Recommend implementable projects directed at either the stabilization or retreat of saltwater intrusion in the coastal zone exacerbated by the hurricanes, and to examine opportunities for minimization of saltwater intrusion during future events; and
- Recommend implementable projects directed at recovery of shore erosion protection measures along the coast of Mississippi to their pre-hurricane conditions, and to examine the opportunity for potential increases in the level of protection.

ES – 4.1.2 Planning Constraints

Development of some potential measures is constrained by legal and technical laws and/or regulations and they consist of the following:

- NPS Management Policies, Wilderness Act, and Gulf Islands National Seashore Enabling Legislation
- T&E Species and/or Critical Habitat
- State of Mississippi, Coastal Zone Management Plan
- State of Mississippi, Water Quality Standards
- Clean Water Act (CWA)
- National Historic and Preservation Act (NHPA)
- Clean Air Act (CAA)
- Essential Fish Habitat (EFH)
- Environmental Justice
- Protection of Children
- Coastal Barrier Resources Act (CBRA)

Managing sediment to benefit a region potentially saves money, allows use of natural processes to solve engineering problems, and improves the ecosystem. As a management method, Regional Sediment Management (RSM) includes the entire environment, from the watershed to the sea, accounts for the effect of human activities on sediment erosion as well as its transport in streams, lakes, bays, and oceans, and protects and enhances the nation's natural resources while balancing national security and economic needs. RSM is the Corps's standard operating practice for managing sediment on a holistic approach (i.e. regionally) rather than a project specific approach. The Corps recognizes that actions at one specific location have affects regionally. RSM will be considered during evaluation, design, and implementation of potential measures.

The State of Mississippi as part of Gulf of Mexico Alliance has acknowledged that sediment resources are integral to accomplishing many restoration initiatives. It is also recognized that there is a need for a better understanding of regional sediment systems and processes to inform decisions about projects and actions that use or affect sediment resources. Mississippi is actively involved in the development of a Gulf RSM Master Plan as an implementation action for the Gulf Alliance Conservation and Restoration Workgroup with the objective to develop a regional master plan that uses the understanding of sediment dynamics (inputs, outputs, movement) to manage sediment resources towards implementing environmental restoration, conservation, and preservation while reducing coastal erosion, storm damages, and associated costs of sediment management. The regional sediment management plan will also help link sources of sediment with sediment needs, provide a basis for assessing competing needs for sediment, and foster more cost-effective sediment management.

ES – 4.1.3 Public and Agency Involvement

- Meetings with Federal, State, and local entities
- Public Scoping
- Public Workshop
- Public Hearing

ES – 4.1.4 Plan Formulation Process

The plan formulation process began with defining the overall comprehensive natural system and its current state post-hurricanes. Development of a comprehensive list of problem areas consisting of single or multiple problems associated with a given site that were first identified as having been caused or exacerbated by the hurricane events identified with a) coastal erosion; b) damage to fish and wildlife resources; and c) saltwater intrusion.

Hurricane-caused problem areas were solicited from, and then discussed, with members of the public, state, local, and other Federal agencies, representatives of industry and commerce, and resource agencies concerned with study area resources, at a series of open meetings. The meetings also included web-casts intended on reaching those that could not physically attend one of the in-field meetings.

Hurricane-caused problems were investigated in a series of site investigations conducted in partnership with local representatives including municipalities, state resource agencies, and Federal partners, to ensure a comprehensive list of the problem areas were developed to address a full range of suitable measures and plans to deal with the identified problems.

ES – 4.1.4.1 Screening Criteria

After an initial screening of problem areas to determine their link to the hurricanes, a list of potential problem-solving measures was developed for each problem area. Each problem area was then evaluated in relation to:

a) its potential inclusion as a project recommended for Construction;

b) its potential inclusion as a project requiring additional preconstruction engineering design for specific features (i.e. a long-term solution that needs more technical analyses based on the complexity of the system);

c) its potential for inclusion as project(s) under a Longer Term Comprehensive Plan;

d) its potential inclusion as a project requiring additional Feasibility Studies (i.e. requiring extensive evaluation); and

e) its potential inclusion as a project requiring Advanced Design Studies for Innovative Concepts.

The list of measures developed for each problem area was more fully developed, and specific measures formulated for each site. These measures were then evaluated and screened once again, according to their continued technical, environmental, and cost-effectiveness feasibility, based on more detailed input from the resource agencies, public and private entities, and technical staff, and their ability to be combined into multi-purpose alternatives, capable of dealing with more than one identified problem at a given site. Selection of a measure and/or multiple measures would accomplish the overall goals and objectives - hurricane damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resources purposes - of the MsCIP effort. One measure may reduce saltwater into an area(s); however, it does not adequately reduce hurricane and storm damages and/or preservation of fish and wildlife. Thus, several measures will likely be combined in order to fully accomplish the MsCIP goals and objectives.

The screened list of measures was then combined into a group of well-balanced alternatives, that included both non-structural and if applicable, structural measures that could potentially address the entire suite of ecological problems plaguing an individual site or problems area. Formulation of these alternatives also incorporated the following criteria:

- Does a potential alternative provide for potential preservation of fish and wildlife and their habitats?
- Does a proposed action or project negatively impact low income or minority populations and/or children [i.e. Executive Orders (EOs) Environmental Justice and Protection of Children]?
- Does a proposed alternative provide a potential reduction in coastal erosion?
- Does a proposed alternative provide a potential reduction in the extent or level of saltwater intrusion?
- Does the proposed project fit in, with, or compliment the objectives of the State of Mississippi and/or locals plans and desires for the area?
- Does the proposal contribute to the short-term or long-term recovery of Coastal Mississippi?

Using these questions, as screening criteria in a narrowing of the potential list of measures, the MsCIP PDT provided for formulation of better project components and alternative plans. This guided the process so that each alternative formulated incorporated measures that would be complimentary while also being mutually exclusive measures that would be evaluated as components of separate alternatives for the following criteria.

- Effectiveness
- Completeness
- Acceptability
- Efficiency (cost-effectiveness)

The following measures were forwarded for potential inclusion in a list of alternatives for the study area:

- Ecosystem Restoration for Preservation of Fish and Wildlife;
- Freshwater Diversion for Prevention of Saltwater Intrusion;
- Barrier Islands Restoration; and
- SAV Restoration Program

The screened list of measures was then combined into a group of well-balanced alternatives that addresses the entire suite of problems plaguing an individual site or problem area. The following alternatives, then, were developed and carried forward for further analysis:

1. The No-Action Plan
2. Freshwater Diversion at Violet, Louisiana
3. Purchase, removal of structures, and ecosystem restoration within historical wetlands previously developed
4. Restoration of Barrier Island Ecosystems
5. Restoration of SAVs within Mississippi Sound
6. Projects from Interim Report carried for further consideration

7. State of Mississippi *Seven-Point Strategy* Initiative Plan

ES – 4.1.5 Recommended Plans

The Environmental Recommended Plan, which will be incorporated into the overall Integrated MsCIP Comprehensive Main Report/Programmatic EIS, envisions the construction of environmental restoration projects that would ensure preservation of fish and wildlife, prevent saltwater intrusion, and provide stabilization of the State of Mississippi's shorelines in order to reduce or eliminate coastal erosion and restore lost fish and wildlife habitat by identifying degraded critical components of the vital coastal system. Potential projects include freshwater diversion projects at Violet, Louisiana in order to physically move freshwater into the Western Hancock County Marshes, which have severely degraded over the years due to levee systems in eastern Louisiana and along the Pearl River. Comprehensive restoration of barrier islands (i.e. Ship Island Breach and the supplemental placement of sand source in the littoral zones) would also be recommended in order to restore the islands and continue Mississippi Sound's biological productivity. Restoration of lost ecosystem functions where restoration needs are immediate due to unchecked wetland deterioration. As Coastal Mississippi residents are rebuilding much needed housing, there is an increase in development pressures on these valuable ecosystems due to housing shortages. The Environmental Recommended Plan would allow for restoration of storm damaged habitats and coastal systems and would prevent further destruction of these vital habitats. Wetlands in Coastal Mississippi can be restored to a sustainable level, one that coexists with human uses and communities. Restoring critical landforms, barrier shorelines, and historical hydrologic patterns are crucial to sustaining ecological and geomorphological function. The Environmental Recommended Plan has emphasized interagency cooperation as dedicated staff members include representatives from the MDMR, USFWS, and NPS. Additionally, we have collaborated with other resource agencies that include USEPA, USGS, NRCS, NOAA Fisheries, MDEQ, NWS, MDOT, and SHPO. The Environmental Recommended Plan partners with the State and recommends for construction of those state projects that allows for recovery of badly damaged ecosystems. Additional collaboration has and will continue to occur with non-governmental organizations (NGOs), including TNC, Gulf Restoration Network, Sierra Club, Audubon Society, etc., in addition to Mississippi academic coastal engineers and biologists, such as USM, Gulf Coast Research Lab, and MSU, in order to accomplish widespread support for this environmental effort. A strong public involvement campaign has been used to ensure contributions have been submitted by local constituencies and stakeholders in order to create strong *buy-in* on potential restoration projects. All recommended plans on ecosystem restoration have incorporated adaptive management capabilities, where needed.

ES – 5.1 Potential Projects

The Environmental Recommended Plan proposes for the construction of two (2) initial projects (i.e. Turkey Creek – Harrison County and Bayou Cumbest – Jackson County) identified based on the GIS SDSS analysis tool inputs. These two projects are identified as part of Phase I of a two Phased approach. These two initial projects give a basis for future ecological restoration sites identified to be developed under a longer term comprehensive effort (i.e. Phase II). Also, the plan recommends construction of a freshwater diversion structure project at Violet, Louisiana. The MsCIP PDT will closely work in partnership with the State of Louisiana in order to achieve both states diversion goals. Comprehensive barrier island ecosystem restoration (i.e. filling of the Ship Island Breach and littoral zones placement) and SAV restoration selected features are included in the project recommendation plans. Continued coordination with NPS, MDMR, MDEQ, USFWS, NOAA-PRD, NOAA-HCD, and other NGOs will also continue. The Governor of the State of Mississippi's *Seven-Point Strategy* for rebuilding coastal resources of the State has also been included as part of the ecological recommended plan. Two State projects – Dantzler and Admiral Island – are being recommended for construction. Again, these are part of the Phase I effort. During development of the interim report, several of the approximately 180 potential projects were developed in conjunction with local city and county government representatives and several were of an environmental nature. These will be recommended under five separate categories as specified in *Section ES 4.1.4.1 Screening Criteria*. Franklin Creek, Jackson County is included in the 180 project list that is being recommended for construction.

ES – 6.1 Summary

The MsCIP Comprehensive Plan establishes an environmental program for Coastal Mississippi that addresses specific concerns stated as required in the legislation which include prevention of saltwater intrusion, preservation of fish and wildlife, prevention of coastal erosion, and other water related issues, such as reduction in coastal flooding. This approach allows us to establish a program that can be carried forward into the future while building and fostering necessary partnerships and relationships with the citizens and local governments within the study area. This will provide for comprehensive solutions based on changing policies, future land-use trends, and availability of property.

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ACRONYMS

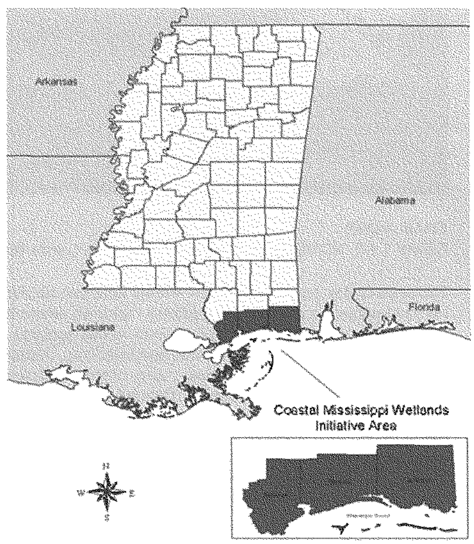
AAFU	Average Annual Functional Units
BFE	Base Flood Elevation
CAA	Clean Air Act
CEQ	Council of Environmental Quality
CFR	Code of Federal Register
Corps	U.S. Army Corps of Engineers
Corps-HQ	U.S. Army Corps of Engineers, Headquarters
CRBA	Coastal Barrier Resources Act
CWA	Clean Water Act
DOI	U.S. Department of Interior
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EO	Executive Order
ER	Ecosystem Restoration
ERDC	Engineering Research and Development Center
ETR	External Technical Review
FCCE	Flood Control and Coastal Emergency
FDR	Flood Damage Reduction
FEMA	Federal Emergency Management Agency
FHI	Functional Habitat Index
FIS	Flood Insurance Study
ft^3/s	cubic feet per second
GIS	Geographic Information System
GMEI	Cooperative Gulf of Mexico Estuarine Inventory and Study
HARP	High Hazard Area Risk Reduction Plan
HCD	Habitat Conservation Division
HEC-FDA	Hydrologic Engineering Center's Flood Damage Analysis
HGM	Hydrogeomorphic Model
HSDR	Hurricane storm damage & reduction
ITR	Independent Technical Review
LOD	Line of Defense
m^2	square mile

MDEQ	Mississippi Department of Environmental Quality
MDMR	Mississippi Department of Marine Resources
MDOT	Mississippi Department of Transportation
MsCIP	Mississippi Coastal Improvements Program
MSU	Mississippi State University
NAVD	North American Vertical Datum
NEPA	National Environmental Protection Act
NERR	National Estuarine and Research Reserve
NHPA	National Historic and Preservation Act
NGOs	Non-Government Organizations
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRCS	Natural Resources and Conservation Service
NWS	National Weather Service
PDT	Project Delivery Team
ppt	Parts Per Thousand
PRD	Protective Resources Division
PSGH	Potential Seagrass Habitat
RSM	Regional Sediment Management
SAVs	Submerged Aquatic Vegetation
SDSS	Spatial Decision Support System
SHPO	State Historic Preservation Officer
T&E	threatened and endangered
TED	Turtle Excluder Device
TNC	The Nature Conservancy
U.S.	United States
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Service
USM	University of Southern Mississippi
WRDA	Water Resources and Development Act

CHAPTER 1. COASTAL MISSISSIPPI ENVIRONMENT

1.1 Introduction - An Environmental Framework for Coastal Mississippi

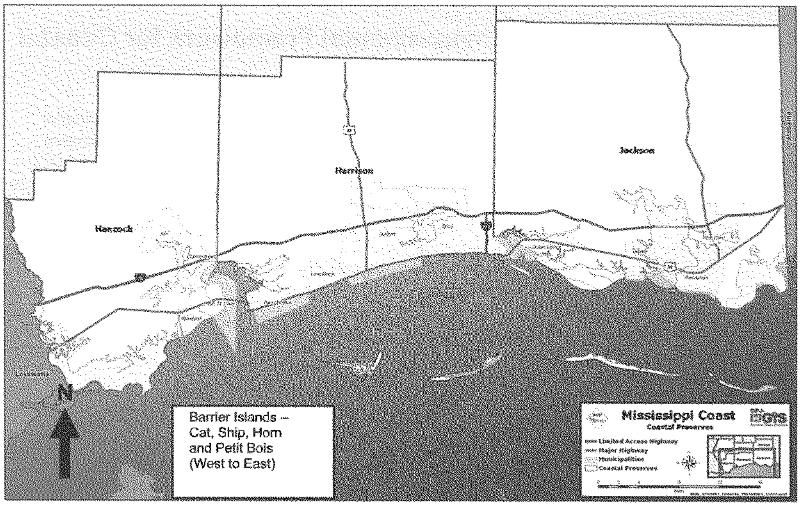
In response to major damages on the coast of Mississippi as a result of the 2005 Hurricane Katrina, Congress directed the Corps to conduct an analysis and design for comprehensive modifications and improvements in the Mississippi Coastal area for the purposes of hurricane damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife [i.e. prior to the 1950s development period (Corps 1984)], prevention of erosion, and other related water resources purposes. Coastal Mississippi was the point of impact of the greatest tidal surge that has hit the mainland of the U.S. in its recorded history. Hurricane Katrina affected over 90,000 m^2 of the Gulf Coast region and caused almost complete destruction of several large coastal communities while seriously damaging numerous others. The destruction was on a scale unmatched by any other natural disaster in U.S. history. The loss to Coastal Mississippi is unprecedented and has presented a high cost to the nation with a complete fisheries failure being declared by the Commerce Secretary, marine debris covering valuable productive water bottoms, exacerbated coastal erosion, loss of maritime forests, degraded water quality, increased pollution, widespread debris fields throughout coastal wetlands, degraded coastal preserve lands owned and maintained by the MDMR (Figures 1.1-1 and 1.1-2), increased risks to infrastructure and human life, danger to fish and wildlife including T&E species and their critical habitats, and the loss of an entire way of life. Losses to many commercially important fisheries stock, foraging areas, nurseries, and etc. have been felt economically in the overall region. Spawning, breeding, and foraging grounds of fish and shellfish were severely impacted resulting in rising prices and once readily available resources are experiencing shortages.



Source: MDMR

Figure 1.1-1. Coastal Mississippi Map

Wetlands have historically provided natural protection from storm surges, coastal erosion, and flooding and a reduction in these natural systems (i.e. filling in of wetlands) has greatly impacted the Gulf Coast. The Comprehensive Plan will address and employ a wide array of restoration techniques to include vegetative plantings, river diversions, hydrologic restoration, marsh creation, shoreline protection, sediment trapping, and stabilization of the barrier islands.



Source: MDMR

Figure 1.1-2. MDMR Coastal Preserves – State Lands Map

The area or the zone where water meets land can be described in various terms – it is a buffer area, the land-water interface, or an ecotone - an area where the terrestrial ecosystem transitions into the aquatic ecosystem. Critical habitats exist in this ecotone area: swamps, marshes, coastal ridges, coastal forests, littoral zone, dunes, and beaches. These areas serve as vital breeding areas, nursery grounds, and areas where much of the massive amounts of organic carbon needed to fuel aquatic food chains are produced. These are areas where sediments, nutrients and even contaminants eroded from the uplands can be detained before entering the aquatic system and energy from the water, through waves, tides, and surges can be captured and mitigated before impinging upon the upland. These sediments can contain nutrients that are critical to water quality and wetland building. And when terrestrial organisms, like humans beings, encroach upon this ecotone between land and water, there can be devastating consequences, such as flooding, loss of property and even loss of life.

Fundamentally, the environmental framework (as well as much of the recommended comprehensive plan) for the MsCIP is the protection, restoration, enhancement and re-establishment of the natural buffering capacities of these **coastal ecotone** areas. These land-water ecotone areas outline every barrier island, beach, bay, stream, and river on the coast, thereby creating a comprehensive, system-wide, network of areas that are critical both to the ecosystem and to society. These coastal ecotones have been eroded by natural and man-made forces, thus decreasing the resiliency of the Mississippi Coastal system.

1.1.1 Creation and Dynamic Nature of the Coastal Ecotones

The current geomorphology, and by extension, the ecology of coastal Mississippi is defined by its geological history. Oivanki (1993) states that the last major low-stand of sea level was about 18,000 years ago, and sea level has been rising ever since that time. The sea level at that time was about 350 feet below its present level, which shifted the shoreline to about 70 to 80 miles of its present position. Streams and rivers cut deep valleys into the landscape. As the glacial ice melted, these valleys were covered with water. The Back Bay of Biloxi, St. Louis Bay and the Pascagoula River valley are all present day expressions of these drowned valleys. As the landscape eroded, the drowned valleys began to fill, creating the extensive riverine swamp systems, such as those in the Pascagoula and Pearl River basins. Thus, the eastern and western ends of the MsCIP project area have broad expanses of riverine swamps, which are largely absent from Harrison County.

These geologic patterns have resulted in very different present day shoreline types in the three coastal counties. For example, Hancock County shoreline is 50% marsh, Harrison County shoreline is dominated by artificial beach, and Jackson County is 18% marsh and 32% washover terrace (Oivanki 1993a).

The five principal barrier islands, Petit Bois, Horn, East Ship, West Ship and Cat, are the result of the emergence of offshore sand shoals approximately 3,000 to 4,000 years ago. The location of the islands and the source of their sand was determined by the longshore drift pattern established by Dauphin Island in Alabama, which accumulated sand from the Florida shoreline and directed it parallel to the coast offshore (Otvos 1979).

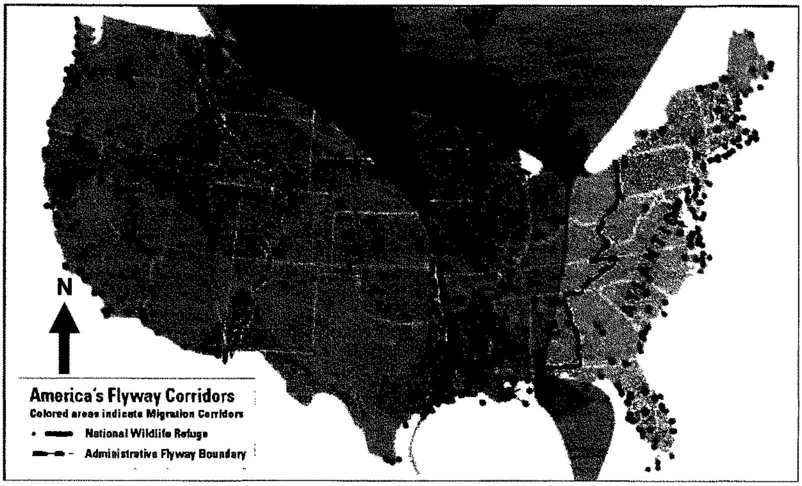
All of these geologic processes have formed, shaped and continue to rework the coastal ecotone. The ecotone, the ribbon of area at the land-water interface is dynamic, constantly shifting based on the local geology, re-working itself after extreme events and human perturbation. The current expression of eustatic sea level rise causes the coastal ecotone to move "upland" or northward. It is a continuation of a trend that started about 18,000 years ago. In some places, subsidence or compaction or other factors have caused the relative sea level rise to be locally greater than eustatic sea level rise. When the upland migration of the coastal ecotone is limited due to geology or manmade features, such as seawalls, bulkheads, or waterways, a net loss of the ecotone can occur, as well as damage to the manmade structures.

The anthropogenic loss of the coastal ecotone can be documented by looking at estimations of wetland loss on the Mississippi Coast. Eleuterius (1973) noted that approximately 1,000 acres of marshland was filled on the Mississippi Coast prior to the 1930's. However, wetland loss accelerated after that time. Oivanki et al. (1995) conducted a study that showed that 13% of the total coastal marsh area in the Mississippi coast zone was lost between the 1950's and 1992. The amount of wetland loss was highest in Jackson County and lowest in Harrison County. Developed land use tripled during the study period. It is the desire of the State of Mississippi to replace about 10,000 acres of this loss as stated.

1.1.2 Importance of the Coastal Ecotones to the Fish and Wildlife Resources of Coastal Mississippi

The coastal ecotone in Mississippi provides a vital habitat for fish and wildlife that is found in no other place in the world. The annual waterfowl migrations, both spring and fall, are one of the most amazing spectacles in nature. Driven by changing weather conditions and the search for food, certain species of waterfowl will migrate thousands of miles stopping only briefly to rest and replenish their nutrient reserves. Others migrate more slowly and have longer stopovers en route. Yearly variation in weather, food supplies, and available habitat will greatly affect these migration patterns. Largely because of the success of early banding programs, it became possible in the early

1930's to map the main migration corridors or flyways, used by waterfowl on their annual fall migration. That information became the concept of the four flyway corridors – Atlantic, Mississippi, Central, and Pacific – upon which biologists now focus their management (Figure 1.1.2-1). The MsCIP study area falls within the Mississippi Flyway. The longest migration route of any in the Western Hemisphere lies in this flyway. Its northern terminus is on the Arctic coast of Alaska and its southern end in Patagonia. Well timbered and watered, the entire region affords ideal conditions for the support of hosts of migrating birds. The two rivers that mark it, the Mackenzie emptying on the Arctic coast and the Mississippi in the Gulf of Mexico, have a general north-and-south direction, another factor in determining the importance of this route which is used by large numbers of ducks, geese, shorebirds, blackbirds, sparrows, warbler and thrushes. The majority of North American land birds, seeking winter homes in the tropics that come south through the Mississippi Flyway take the short cut across the Gulf of Mexico in preference to the longer, though presumably safer, land or island journey by way of Texas or the Antilles (Association of Fish and Wildlife Agencies 2008).



Source: USFWS

Figure 1.1.2-1. America's Flyway Corridors (*USFWS 1996b*)

Although waterfowl are what most people think of when they hear the word flyway or migration, many other birds migrate as well. Approximately two thirds of the breeding bird species of eastern United States forests migrate to tropical wintering areas in the Caribbean, Mexico, and Central and South America (Keast and Morton 1980). The movement of birds across the Gulf of Mexico each spring and fall is a prominent feature of Nearctic-Neotropical bird migration system (Ramos 1988). From early April through mid-May, the day-to-day consistency of migration across the Gulf of Mexico is rarely interrupted, and then only when strong cold fronts are positioned over the southern Gulf of Mexico (Gauthreaux 1971). Even with favorable weather, migrants use coastal habitats in large numbers.

The coastal woodlands and narrow barrier islands that lie scattered along the northern coast of the Gulf of Mexico provide important stopover habitat for Neotropical landbird migrants (Moore et al.

1990). They represent the last possible stopover before fall migrants make a non-stop flight (18-24 hr) of greater than 1,000 km, and the first possible landfall for birds returning north in spring (Moore and Kerlinger 1987). Unfortunately, the loss of coastal habitat suitable for forest-dwelling migrants is fast accelerating due to the extensive development of coastal regions (Moore and Simons 1989). Habitats along the northern coast of the Gulf of Mexico are fragmented, and many woodlands average only a few hectares in area. Development in the coastal zone is likely to continue the fragmentation of stopover habitat in the future (Moore and Simons 1989). As stopover habitat is transformed or degraded, continued migration of these species is jeopardized. A study of the distribution of spring trans-Gulf migrants among five plant habitats on Horn Island found that the distribution of migrants deviated from that expected based on availability of habitats. Migrants settled most frequently in scrub-shrub, forest, and relic dune habitats (Moore et al. 1990). Birds are the ultimate indicator of ecological quality. Clean air, clean water, and abundant, diverse habitats are essential for birds to continue to survive and flourish. Without a healthy ecosystem, bird populations will diminish and species will disappear, along with the quality of life for people on this planet.

Approximately two (2) dozen large estuaries are present along the coastline of the Gulf of Mexico between the Mexican border and the Florida Keys. Over one-half of all stream discharge that takes place to the oceans bordering the United States is discharged into the Gulf of Mexico. A substantial portion of this first enters the estuaries, carrying with it large quantities of suspended sediment and nutrients.

Mississippi Sound is fed from the north by eight coastal mainland watersheds and drainage from the south by tidal exchange from the Gulf of Mexico. From west to east the mainland drainages include: Lake Borgne, the Pearl River, the Jourdan River, the Wolf River, the Tchoutacabouffa River, the Pascagoula River, and Mobile Bay. Combined drainage area from streams and rivers entering the Mississippi estuarine basin is approximately 19,660 square miles (mi^2). The Pearl River and Pascagoula River drainage areas far exceed those of Biloxi and St. Louis Bays. Pascagoula River has a drainage area of 9,400 mi^2 with an average discharge of 15,185 cubic feet per second (ft^3/s). Pearl River drains 8,700 mi^2 and has an average discharge of 12,890 ft^3/s. The combined drainage area for rivers emptying into Biloxi and St. Louis Bays is 1,400 mi^2 with an average discharge of 2,790 ft^3/s (NMFS 1998).

The influx of rivers creates a salinity gradient within the Sound (Priddy et al. 1955). Both east-west and north-south gradients occur in the Sound in addition to vertical gradients. Generally, positive salinity gradients exist from the mainland seaward and vertically, surface to bottom (Gulf of Mexico Fisheries Management Council 1998). Surface salinity is influenced by the discharge of freshwater from large rivers and is reduced during periods of higher flow in late spring and early summer (Thompson et al. 1999). Temperature follows expected salinity trends. Levels of dissolved oxygen are usually above lethal limits. The Pascagoula and Pearl Rivers, Bayou Casotte, and Biloxi Bay are the primary sources of nutrients entering the Mississippi Sound. The temporal and spatial variability of estuarine salinity is dependent on water supply, evaporation, and mixing, and also management, which includes the direct influence of activities, such as water withdrawal for inland irrigation projects and diversions, and the indirect effects of global climate change. Oysters grow faster in areas with fluctuating salinities within their normal ranges, compared to constant salinity (Pierce and Conover 1954). Oyster reefs of commercial importance are subtidal and form aggregates that cover thousands of acres of the Mississippi Sound. The aerial extent of oyster reefs in Mississippi is estimated at 10,000 to 12,000 acres, of which over half is located in the western Mississippi Sound south of Pass Christian.

The eighty-mile-long body of water north of the string of five barrier islands is the Mississippi Sound, a large dynamic estuary extending from Mobile Bay in Alabama on the east to Lake Borgne in Louisiana to the west. Mississippi Sound is located within the very center of what fisheries biologists term the Fertile Fisheries Crescent. The Gulf of Mexico produces 28 to 30 percent of the total fishery products of the United States. Gunter (1963) showed that between 1936 and 1962, production from the Gulf of Mexico increased at a rate of 7 times its former production, with the shrimp fishery being the most valuable in the country. The Fertile Fisheries Crescent has been called "the core of the Gulf's $800 million fishing industry." Mississippi Sound forms a major part of the Fertile Fisheries Crescent within the northern Gulf of Mexico.

Large quantities of freshwater are emptied into Mississippi Sound by the Pascagoula and Alabama Rivers on the east and Pearl River along the western state line and to an extent, the Mississippi River further west. Several freshwater coastal streams empty into Mississippi Sound in-between the Pascagoula and Pearl Rivers providing nutrient rich freshwater which results in the Sound's great productivity. It is within this brackish estuarine water that several species of fish, classified as aquatic resources of national importance, thrive from the shallow waters to the deep sea 70 miles offshore.

The Fertile Fisheries Crescent can be divided into three sections, the West Florida Shelf, The Mississippi-Alabama Shelf and the Louisiana-Texas Shelf. The Mississippi-Alabama Shelf extends from the DeSoto Canyon westward to the Mississippi River Delta. Sediments within this area range from more carbonate in the eastern part to mostly terrigenous nearer the Mississippi River Delta. Bottom features within the area are small peaks of cemented together sediments called "pinnacles", dense fields of reef-like mounts, and low ridges that run parallel to shore. Also located within nearshore waters are hard bottoms and rock outcroppings.

Recent studies have determined of the total fishes found within the northern Gulf of Mexico, excluding the southern Florida reef habitats, approximately 1,200 species, almost 400 species are found within the Mississippi-Alabama Continental Shelf. The Mississippi Sound estuary plays a key role in these numbers by providing prime habitat for various lifestages of red snapper, tuna, redfish, Spanish and king mackerel, grouper, speckled trout, jack crevalle, cobia, amberjack, marlin, and various species of sharks. Mississippi Sound's productivity is unequalled in the Gulf which makes it ideal for avid sport fishermen, commercial fishing, and local recreational use. Biloxi, Mississippi, located in the center of Coastal Mississippi was once known as "The Seafood Capital of the World" and in 1910 canning factories located here shipped over 15 million cans of oysters, more than any place else in the world.

The fishing industry contributed $1.1 billion to the state's economy prior to the devastation by Hurricane Katrina. According to Mississippi Department of Marine Resources, during a five-year average before the storm, Mississippi shrimp accounted for five to seven percent of all the shrimp landings in the U.S. The commercial seafood industry which includes the harvesting, processing and distribution of all seafood products created a total economic impact of $900 million in 2003. The total ex-vessel value of commercial landings amounted to $46 million while the total plant-gate value of commercial seafood production was $338 million in 2003. The recreational fishing industry which includes saltwater and freshwater fishing produced a total economic impact of $463 million in 2001 and $1,306 million in 1996. This once thriving commercial fishery always has and will continue to play a significant role in the overall economy, both on a regional and national level.

1.1.3 Impacts from Hurricanes of 2005

The destruction caused by the hurricanes of 2005 came in two forms: the wind and tidal action of the hurricane itself. When Hurricane Katrina struck the Gulf Coast, it was a Category 3 hurricane; it had been as high as Category 5 as it moved through the Gulf of Mexico. The hurricane was also massive, which meant that these intense winds were spread over a wide area – in fact the entire Gulf Coast. The same forces that wrecked New Orleans damaged or destroyed wetlands along the Gulf Coast. Barrier islands took the initial damage. Wetlands suffered less from wind damage than from flood waters that dumped saltwater, trash, and toxic chemicals into the fragile ecosystems.

When saltwater is introduced into a freshwater habitat it kills the vegetation – i.e. valuable wet pine savannah habitat.

Disturbance of soils and vegetation, such as vegetation covered by trash or complete removal of trees and/or marsh grasses, in coastal wetlands has allowed an excessive amount of exotic species to colonize the area. The destruction of wetlands and coastal habitat occurred in a sensitive area for birds. As previously discussed, the northern Gulf Coast is a stopping point for birds in migration; it also serves as nesting ground for many species of terns and other waterbirds. Damage to the barrier islands was particularly bad for the nesting species; nests the following couple of years were lower for several species. Threatened birds in the area include a rare sandhill crane subspecies. Twelve important bird areas lay in Hurricane Katrina's path: two in Florida and ten on the northern Gulf Coast. The hardest hit were Breton NWR and the Gulf Islands National Seashore.

The habitats of several endangered species were altered by the hurricanes. The endangered Alabama beach mouse has lost several acres of primary and secondary dunes that serve as habitat, and has lost scrub forest habitat, where it finds prey, to saline ocean waters. Along the Alabama coast, some nesting sites for the endangered Kemp's ridley sea turtle have been destroyed, and forested areas have been blown down in the Noxubee National Wildlife Refuge in Mississippi, where the listed red-cockaded woodpecker has habitat.

The Gulf Coast states are significantly forested and are major producers of lumber and plywood. The U.S. Department of Agriculture (USDA) Forest Service estimated 19 billion board feet of timber damaged on over 5 million acres in Mississippi, Alabama, and Louisiana. This would translate into an estimated $5 billion loss in potential timber revenues according to the Forest Service. The forested area damaged represents 30% of the total timberland in the affected region, 90% of which occurred on non-federal lands. Eighty percent of the damage occurred in Mississippi. The Mississippi Forestry Commission issued a news release estimating that 1.3 million acres of forestland in the state had been damaged, with commercial timber valued at about $1.3 billion; urban tree damage in Mississippi was estimated at $1.1 billion.

Some scientists believe that the risk of long-term damage of toxic floodwaters entering the Gulf of Mexico is not high. They contend that tidal flows and flushing of Gulf waters will dilute substances to non-harmful levels. Specifically, scientists contend that bacterial contaminants will die off quickly, and that other organic material will degrade with natural processes. Other scientists offer a different perspective on the impacts of toxic waters in the Gulf of Mexico. They contend that toxic chemicals and excess nutrients will severely deplete fisheries by killing fish and will contaminate sediments.

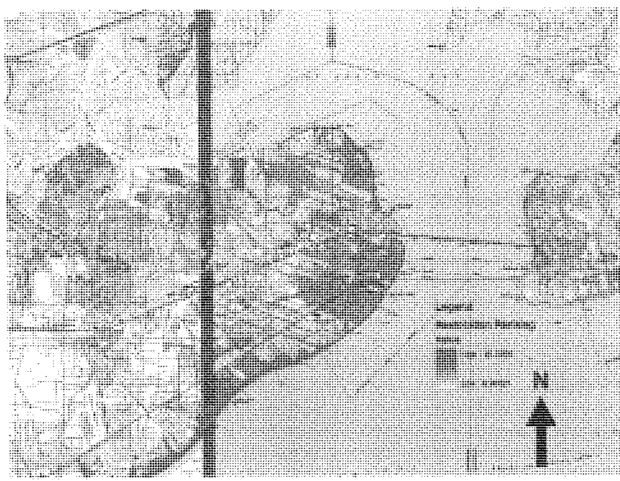
The Gulf Coast where Hurricane Katrina struck is an especially important center of commercial and recreational fishing, producing 10% of the shrimp and 40% of the oysters consumed in the U.S. Further, commercial shrimpers fishing out of or delivering to Alabama, Mississippi, and Louisiana ports account for almost half of all U.S. shrimp production. Hurricane Katrina has destroyed or severely damaged fishing boats and processing and storage facilities throughout this area. The impact of Katrina on fish populations, habitat, and their viability for consumption was significant.

1.1.4 Relationship Between the Coastal Ecotones and the Multiple Line of Defenses Concept

The MsCIP effort developed multiple arrays of Line of Defenses (LODs) to protect the Mississippi coast and its citizens from future storm events. These LODs are structural measures that have specific locations along Coastal Mississippi starting from the barrier islands moving inland to north of Interstate-10. LOD 1 restores lost habitats – beaches, dunes, coastal forests, and emergent marshes - at the barrier islands offshore of Mississippi to provide that first natural barrier against future storms. The barrier island ecotone – water and land interface – covers the entire area and is essential for numerous fish and wildlife species. Furthermore, this area is an essential coastal ecotone allowing the future persistence of Mississippi Sound – i.e. creating the fertile brackish waters from the mixing of freshwater from the rivers and salty waters from the Gulf of Mexico. LOD 2 restores lost beach and dune habitat along the coastal mainland while also providing an added natural buffer to the mainland. This ecotone – water and land interface – provides an important habitat to many migratory bird species stopovers to farther destinations, nesting least terns, wintering piping plovers, and many other important bird species. LOD 3 elevates existing roadways and seawalls while also protecting communities by ring levees. This defense protects the very people dependent upon these vital coastal resources. This structural defense along with LODs 4 and 5 - inland barriers and surge gates across water bodies and a critical boundary north of Interstate-10 – provides the required protection and enables future sustainability of human beings living along the Gulf Coast as they have done for hundreds of years. These LODs provide sustainable living the coastal resources and also for the people of Coastal Mississippi.

1.1.5 Relationship Between the Coastal Ecotones and Storm Damages

A hydric soil is one that is defined as "a soil formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper part." (Federal Register, 1994) Since the soils of these areas formed under hydric conditions due to the proximity of water. The spatial extent of the coastal ecotone can be indicated by the presence of these hydric soils. Analysis through GIS shows that 76% of all of the houses seriously damaged (damage estimated as greater than 90%) by Katrina, as defined by FEMA, were also located in areas mapped as hydric soils or areas composed of dredged material from adjacent channels. Figure 1.1.5-1 provides the overlay of the FEMA-damaged maps with the soil conditions that shows the ranking of ecological restorability potential. This correlation is an additional demonstration that the importance of restoring the coastal ecotone extends beyond ecological interests into insuring the well-being of the human population.



Source: Corps

Figure 1.1.5-1. FEMA Damaged Maps Overlaid upon Soil Conditions

1.1.6 Relationship between the Proposed Restoration Projects and the Environmental Framework

The MsCIP Comprehensive Plan presents a very complex challenge to identify Mississippi coast recovery plans. The investigation was focused on 3 components – environmental, non-structural and structure plans – to achieve an array of protection and restoration measures. While developing these components, the team ensured that the specific measure or a compilation of measures addressed the 2005 congressional authorization of:

- future hurricane storm and flood damage reduction;
- prevention of saltwater intrusion;
- prevention of coastal erosion;
- preservation of fish and wildlife; and
- other water related resources (reduction of flooding).

Ultimately, several hundred measures were identified ranging from restoring the barrier islands at varying levels, raising existing structures' elevation, constructing ring levees around communities, building surge gates across water bodies, restoring dune and beaches, developing housing assistance and relocation programs, and restoring wet pine savannah, emergent tidal marsh, and scrub shrub habitats. These measures were screened throughout the plan formulation process in order to develop alternatives. The comprehensive nature of the MsCIP effort resulted in the ability to implement certain alternatives while others required additional study. Thus, the team categorized identified measures into the following management components:

- Additional Study and Design (designated as orange in Table 1.1.6-1);
- Advanced Engineering and Design (designated as green in Table 1.1.6-1); and
- Construction (designated as purple in Table 1.1.6-1).

Table 1.1.6-1.
MsCIP Comprehensive Approach

Proposed Restoration Project	Portion of the Ecozone to be Addressed	Ecological/Societal Functions to be Addressed	Comprehensive Plan Objectives to be Addressed
Freshwater Diversion, Escatawpa River, MS	Littoral areas, emergent wetland areas	Enhanced oyster production, enhanced productivity of brackish marshes	3, 4, 5, 6
Other Coastal Wetland and Forest Restoration	Emergent Tidal Marsh Scrub/Shrub	Enhanced productivity of emergent tidal wetland, habitat enhancement, relocation of human development out of the coastal ecozone for public safety	1, 2, 3, 5, 6
Levee Projects – Belle Fontaine, Gulf Park Estates, Pascagoula/ Moss Point, Pearlington, Gautier, Ocean Springs, Bay St. Louis	Reduces flooding	Adds protection to human development out of the coastal ecozone for public safety zone	1, 2, 6
Long-term High Hazard Area Risk Reduction Plan	Restore natural flooding buffer	Restore natural buffer zone, relocation of human development out of the coastal ecozone for public safety	1, 2, 6
Freshwater Diversion of the Mississippi River	Littoral areas, emergent wetland areas	Enhanced oyster production, enhanced productivity of brackish marshes	3, 4, 5, 6
High Hazard Area Risk Reduction Plan	Emergent tidal marsh, forested wetlands	Enhanced productivity of wetlands and forested wetlands in order to restore natural buffer zone	1, 2, 6
Moss Point Municipal Relocation Component	Restore natural flooding buffer	Restore natural buffer zone, relocation of human development out of the coastal ecozone for public safety	1, 2, 6
Waveland Floodproofing	Restore natural flooding buffer	Restore natural buffer, relocation of human development out of the coastal ecozone for public safety zone	1, 2, 6
Forest Heights Hurricane and Storm Damage Reduction Component	Reduces flooding	Adds protection to human development out of the coastal ecozone for public safety zone	1, 2, 6
Turkey Creek Ecosystem Restoration	Wet Pine Savannah Wetlands	Enhanced productivity of wetlands Removes structures from project area	1, 2, 3, 6
Dantzler Restoration Area, Ansley	Wet Pine Savannah Wetlands	Enhanced productivity of wetlands	1, 3, 6

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Table 1.1.6-1.
MsCIP Comprehensive Approach (continued)

Proposed Restoration Project	Portion of the Ecotone to be Addressed	Ecological/Societal Functions to be Addressed	Comprehensive Plan Objectives to be Addressed
Franklin Creek Ecosystem Restoration	Wet Pine Savannah Wetlands	Moves Residents out of Harms Way (MsCIP Interim Project) Enhanced productivity of wetlands	1, 2, 3, 5, 6
Bayou Cumbest Ecosystem Restoration, Pearlington, Pearlington South, Port/West, Chapman Road, Diamondhead, Delisle, Ellis Property, Brickyard Bayou, Biloxi River – Shorecrest , Biloxi River – Eagle, Jourdan River – I-10 Development, Pine Island, Fort Point, St. Martin, Keegan Bayou	Emergent Tidal Marsh Scrub/Shrub	Enhanced productivity of emergent tidal wetland, habitat enhancement, relocation of human development out of the coastal ecotone for public safety	1, 2, 3, 5, 6
Admiral Island Ecosystem Restoration Lakeshore, Bayou Caddy/Lakeshore, Clermont Harbor Bayou La Croix, Shoreline Park, Pine Point East, Pine Point West, Pass Christian Site – Bayou Portage,	Emergent Tidal Marsh Scrub/Shrub	Enhanced productivity of emergent tidal wetland, habitat enhancement, relocation of human development out of the coastal ecotone for public safety	1, 2, 3, 5, 6
SAV Pilot Project at Bayou Cumbest	SAV – *Ruppia maritime*	Enhance fishery production	3, 6
Beach and Dune Ecosystem Restoration	Coastal Dune Habitat	Buffer mainland from storm surge and waves energy	1, 2, 3, 5, 6
Barrier Island Restoration, Biloxi Front Beach – South of Highway 90	Littoral zones, beach, dunes, emergent tidal marsh	Buffer mainland from storm surge and waves energy, enhanced productivity of emergent tidal marsh, enhance productivity of SAVs in littoral areas, enhance fisheries production	1, 2, 3, 4, 5, 6
Deer Island Ecosystem Restoration	Coastal Forests, Emergent Tidal Marsh	Enhanced productivity of wetlands	1, 2, 3, 5, 6

Footnote: Objectives - Green –Recommended Elements, Purple – Site Specific Elements, Orange – System Wide Elements. 1. Reduce loss of life caused by hurricane and storm surge by 100%; 2. Reduce damages caused by hurricane and storm surge by $150M-$200M annually; 3.Restore 10,000 acres of fish and wildlife habitat including coastal forests, coastal wetlands, wet pine savannah, submerged aquatic seagrasses, oyster reefs, and beaches and dunes by the year 2040; 4. Manage seasonal salinities within the western Mississippi Sound, such that optimal conditions for oyster growth (surrogate for other aquatic resources, 15 ppt during summer months) are achieved on an annual basis by 2015; 5. Reduce erosion to barrier islands, mainland, and interior bay shorelines by 50%; 6. Create opportunities for collaboration with local, state, and Federal agencies to facilitate implementation of programs and activities that maximize the use of resources in achieving the comprehensive goal.

1.1.7 Analysis Tools Used in the MsCIP Project to Identify and Assess the Coastal Ecotones

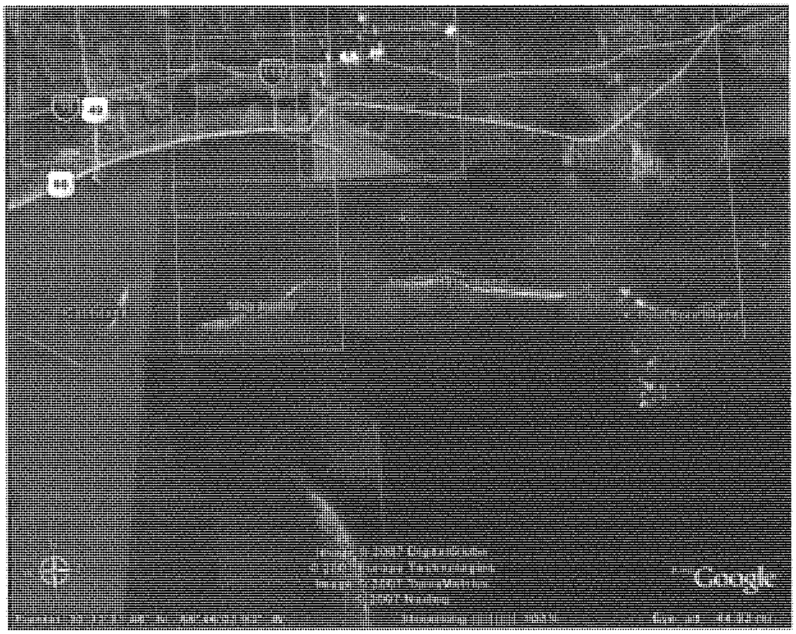
At the 8th Annual Coastal Development Strategies Conference in Biloxi, Governor Haley Barbour said in his keynote speech, "Our goal is not to get it like it was; our goal is to get it how it can be." Governor Barbour urged local officials among some 400 attendees to take the advantage of post-hurricane recommendations from the Governor's Commission on Recovery, Rebuilding and Renewal, and create smart growth community plans for generations ahead. This is still to date the worst disaster in the history of the U.S. yet it provides great potential for ecological recovery and associated sustainable development. Hurricane Katrina provided a blank canvas to make the coast of Mississippi the premier ecological setting that promotes sustainable development. This once-in-a-lifetime opportunity allows us to restore natural resources, provide protection to coastal residents, while also promoting future use of Coastal Mississippi by generations to come.

In other U.S. disasters, those impacted areas are bought by the Federal government – typically the FEMA – for the sole purpose of moving humans out of hazardous areas. Unfortunately, the natural ecosystem is not considered and those remaining structures are left behind. The vacant land is not restored to its historical ecological setting. With the MsCIP effort, not only would the land be purchased but also restored to its historical ecological habitat – i.e. emergent tidal marsh, wet pine savannah, dunes, beaches, scrub shrub, etc. The MsCIP team developed a GIS based SDSS tool to quickly identify and prioritize potential wetland restoration areas throughout Coastal Mississippi. The SDSS tool evaluated potential wetland restoration sites that had been initially selected based on having a non-natural land cover (i.e. urban, deforested, and agricultural land cover, based on MDMR 2001 land cover GIS layer) and were located in the 100-year floodplain. Numerous potential environmental restorations sites were initially identified but later screened by certain ecological characteristics. Ultimately, what the environmental team found was the SDSS identified areas that were historically wetlands – i.e. emergent tidal marsh – which were also developed. These ecotones – water and land interface – were and are still essential for fish and wildlife, natural buffers from storm surge, and overall health of the ecosystem. Restoring these systems provides benefits to both the ecosystem and humans.

The HGM approach was applied to develop functional indices and protocols for the assessment of wetland functions at those site-specific scales. HGM allowed the team to quantifiably evaluate biological, chemical, and physical functions of wetlands - a critical part of the coastal ecotone. Thus, allowing the MsCIP team to select the optimal environmental restoration plan based on the biological, chemical, and physical benefits.

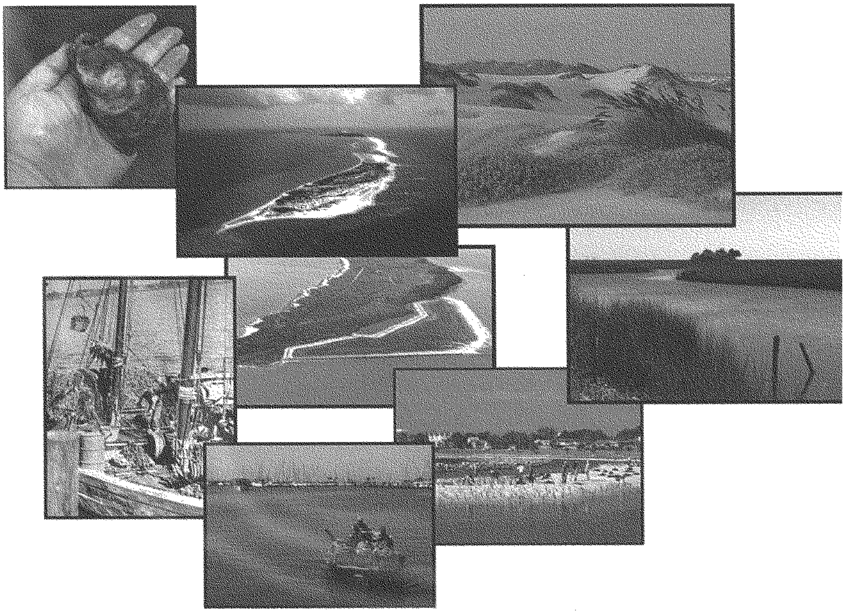
1.2 Description of the Natural System

The primary study area consists of the three coastal counties comprising the State of Mississippi: Hancock, Harrison, and Jackson counties; and the coastal (offshore) ecosystem including its barrier islands (Figures 1.2-1 and 1.2-2). This area ranges in elevation from sea level to about 30 feet. The essentially flat to gently undulating, locally swampy Coastal Lowlands are underlain by alluvial, deltaic, estuarine, and coastal deposits and merge with the fluvial-deltaic plains of the streams of the area. This portion of Coastal Mississippi has been classified as an alluvial coast, a terraced, and deltaic plain (Corps, Mobile District 1984). According to the Cowardin et al (1979), *Classification of Wetlands and Deepwater Habitat of the United States*, there are five major wetland and deepwater systems, four of which are found within Coastal Mississippi. They include marine, estuarine, riverine, and palustrine wetland systems.



Source: Google Earth

Figure 1.2-1. Aerial Photograph of Mississippi Coast



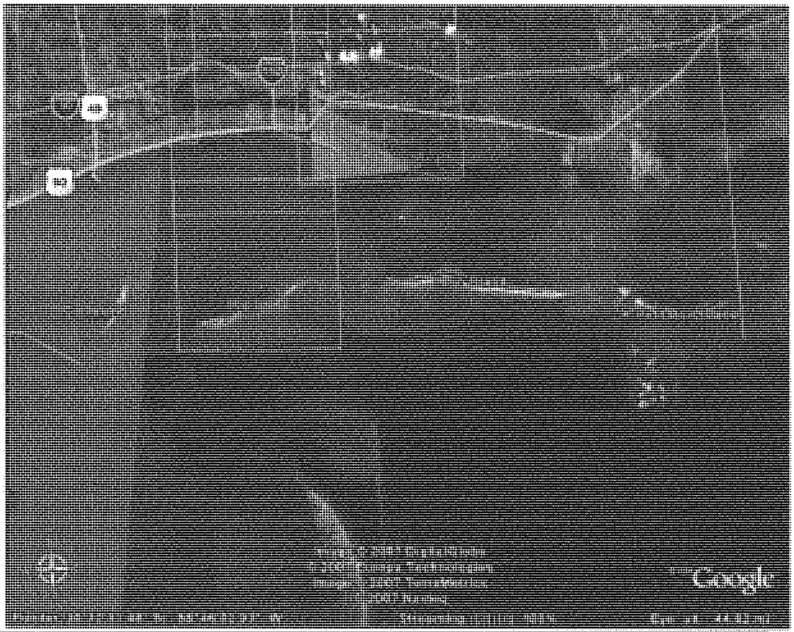
Source: Corps
Figure 1.2-2. Coastal Mississippi Ecological Resources

1.2.1 Marine System

The marine system is defined as the open ocean overlying the continental shelf and its associated high energy coastline. Within Coastal Mississippi, the marine system is the area along the Gulf of Mexico front south of the barrier islands. It is comprised of the intertidal beachfront of the barrier islands along the Gulf of Mexico, and subtidal habitat which consists of the unconsolidated sandy or silty water bottoms.

1.2.1.1 Barrier Islands

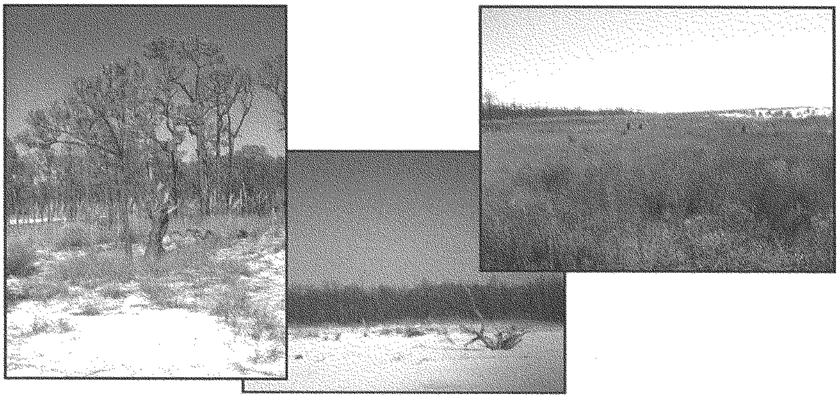
Mississippi's mainland is bordered on the south by Mississippi Sound, a shallow body of water that separates the coast from four (4) barrier islands that lie approximately 11 to 13 miles offshore (Figure 1.2.1.1-1). The string of barrier islands are comprised of dynamic and diverse habitats and are part of a complex integrated system of beaches, dunes, marshes, bays, tidal flats, and inlets. These barrier islands are located along a littoral drift zone that moves sand westward creating three elongated islands and then to the westward most island (i.e. Cat) where littoral currents are not as well defined.



Source: Google Earth
Figure 1.2.1.1-1. Coastal Mississippi

From east to west, the islands are Petit Bois, Horn, Ship, and Cat. Ship Island was breached by prior hurricanes and now is actually two small islands, West Ship Island and East Ship Island, with a shallow sand bar between the two. Since Hurricane Camille in 1969, this breach has existed with varying amounts of natural rebuilding between later storms. The western ends of both Petit Bois and Ship Islands have migrated westward into maintained navigation channels and the continuing littoral drift of the sand into the channels is causing an artificial termination of the migration. However, recent redirect of placing dredged sand in the designated littoral zone disposal sites (i.e. sand-bypassing) assists in continuing the littoral drift. A new island has emerged on the west side of the channel from Petit Bois Island, created from dredged sand being placed on the west side of the channel. This island is known as Sand Island.

All of Petit Bois, Horn, and Ship Islands and part of Cat Island are within the boundaries of the Gulf Islands National Seashore under the jurisdiction of the NPS (Figure 1.2.1.1-2). In most cases, the boundary extends one mile seaward from the shore of the island. Petit Bois and Horn Islands have also been designated as Wilderness Areas by Congress, which affords additional significance and protection than is applicable to the other islands.



Source: Corps
Figure 1.2.1.1-2. Horn Island

Under current conditions, the islands provide a natural boundary between the water's salinity [~33 parts per thousand (ppt)] of the open Gulf of Mexico and the brackish water found in Mississippi Sound. Salinity in the Sound during low flow periods range from 10 to 30 ppt. Highest salinities occur just south of Pascagoula and Gulfport and the lowest salinities in the Lake Borgne-Pearl River area.

Loss of the barrier islands would increase salinity in Mississippi Sound; thus, greatly changing ecological habitats that exist, which could lead to saltwater intrusion, increased wave action, and the destruction of wetlands. Increased salinity within Mississippi Sound would impact shellfish and many other forms of marine life. At the Chandeleur Islands in Louisiana, loss of those island masses allows us to anticipate potentially similar environmental changes. Initial assessments in the Chandeleur system are showing SAVs diminishing, marsh erosion ongoing/accelerating, and wave energy having no natural barrier. Unlike the Mississippi barrier islands, Chandeleur Islands are a remnant of a delta lobe from the Mississippi River where wave action created a beach that remained as a island after sea level rise and erosion removed the land mass between the island and the mainland.

The NPS is currently assessing eventual fate of the barrier islands in light of climate change, sea level rise, and other anthropogenic impacts that have already, or could lead to a disruption of the natural sediment transport and budget system that the islands are dependent upon for their very survival. The Service is concerned East and West Ship Islands will not recover naturally due to the aforementioned causes. Consequently, NPS is contemplating management actions focused upon restoring the sediment transport and budget system in order to sustain the barrier islands in perpetuity.

1.2.2 Estuarine System

Estuarine systems within Coastal Mississippi consist of deepwater tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open partly obstructed or sporadic access to the open ocean and in which ocean water is occasionally diluted by freshwater runoff from the land. Mississippi Sound consists of both sub-tidal and inter-tidal estuarine systems.

1.2.2.1 *Mississippi Sound*

Mississippi Sound is a shallow coastal lagoon along northern Gulf of Mexico from Mobile Bay, Alabama, in the east to Lake Borgne, Louisiana, in the west. It extends from the Mississippi coastline to a string of sandy barrier islands, which separate it from the Gulf of Mexico. The Gulf Intracoastal Waterway parallels the mainland coast offshore through the entire length of Mississippi Sound. Mississippi Sound receives both high saline waters from the Gulf of Mexico and freshwater from the streams/rivers, which drain some 20,000 m^2 of land area (Corps 1984). Circulation is driven by tides modified slightly with the wind. Gulf waters enter the Sound through the deep passes between the barrier islands with the help of tidal forces. This mixing of freshwater runoff and saline waters has created a dynamic estuarine ecosystem. Mississippi Sound receives its major freshwater flow from the Pascagoula and Pearl Rivers and is critical to the survival of numerous birds, mammals, fish, and other marine organisms of national importance.

Many different habitat types are found in and around the estuarine ecosystem, including shallow open-waters, salt marshes, sandy beaches, mud and sand flats, oyster reefs, river deltas, tidal pools, and SAVs. These diverse ecosystems serve a variety of critical functions necessary to sustain a vital thriving commercial fishing industry of national economic significance.

Mississippi Sound is identified as EFH for postlarval and juvenile red drum, Spanish mackerel, and white and brown shrimp. In addition to EFH designated for white and brown shrimp, Spanish mackerel, and red drum, the estuary provides nursery and foraging habitat that supports various species including economically-important marine fishery species, such as black drum, spotted seatrout, southern flounder, Gulf menhaden, bluefish, croaker, mullet, and blue crab. These estuarine-dependent organisms serve as prey for other important fisheries, such as mackerels, snappers, and groupers, and highly migratory species, such as billfishes and sharks. These habitats produce nutrients and detritus, important components of the aquatic food web, which contribute to the fishery productivity of the Mississippi Sound estuary. Several of the species, such as T&E species, brown shrimp (*Penaeus aztecus*), red drum (*Sciaenops oellatus*), and pink shrimp (*P. duorarum*) listed by NOAA Fisheries, are identified as being of national economic importance in Section 906(e)(1) of the Water Resources Development Act (WRDA) of 1986 and, therefore, are aquatic resources of national importance. Mudflats and sand flats provide valuable habitat for oysters and other important shellfish. SAVs provide vital foraging habitat and refuge for all stages of fish.

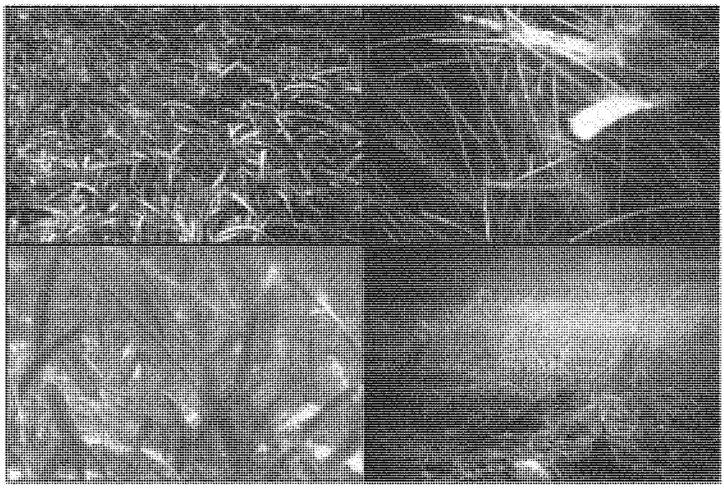
Marshes act as filters removing pollution from runoff with wetland plants and soils that act as natural buffers improving water quality, storing floodwaters, and reducing coastal erosion. Diminished and degraded habitats are less available to support healthy populations of wildlife and marine organisms and less able to perform the economic, environmental, and aesthetic functions that help to sustain Coastal Mississippi. According to the National Coastal Condition Report II, Gulf Coast estuaries are among the most productive natural systems, producing more food per acre than the most productive Midwestern farmland and are second only to Alaska for domestic landings of commercial fish and shellfish. Shrimp landings in the Gulf of Mexico accounted for 80% of the total U.S. shrimp landings in 2000.

The hurricane-induced loss of fisheries to Coastal Mississippi is unprecedented in national history and has presented a high cost to the nation. Following Hurricane Katrina, the Commerce Secretary declared a complete fisheries failure due to the extensive devastation to the processing facilities, docks, loss of boats, degradation of habitat, deposition of marine debris, and degraded water quality. Losses to many commercially important fisheries stock, foraging areas, nurseries, etc. have been felt economically in the region. Increased salinity due to continued degradation of the barrier islands will result in detrimental impacts to the vital economic fisheries industry that the estuarine environment sustains. Furthermore, increased turbidity decreases foraging efficiency of certain fish species.

Increased turbidity disperses pollutants and contaminants found in bottom sediments throughout the water column. Marine debris causes obvious adverse effects on coastal resources detrimental to various species' survival, such as T&E sea turtles mistaking plastic bags for their preferred diet of jellyfish. Aesthetics and recreational activities are also negatively impacted by the presence of marine debris. An essential ingredient to reduce marine debris generated on a long-term basis is the use of educational and outreach efforts. Opportunities exist to partner with local, state, and Federal outreach programs as part of an overall comprehensive approach.

1.2.2.2 SAVs

SAVs or seagrasses are currently restricted to the northern shores of the barrier islands and small patches throughout the immediate shorelines. These areas are characterized by *Diplanthera wrightii* (Shoal grass), *Cymodocea manatorum* (Manatee grass), *Thalassia testudinum* (Turtle grass), and *Ruppia maritime* (Widgeon grass) (Figure 1.2.2.2-1). Approximately 20,000 acres of SAVs were present in Mississippi Sound prior to 1969; however, in late 1969, Hurricane Camille caused a substantial destruction of these areas (Moncrieff 1998).



Source: Unknown
Figure 1.2.2.2-1. Seagrasses

SAVs serve as nursery areas for fish and shellfish, such as shrimp and crabs, and as food for ducks. The continued survival and growth of SAVs may be threatened by the cumulative effects of man's activities, in addition to, natural processes in the coastal marine environment. Natural causes of SAV decline, such as disease, storm events, salinity fluctuation, and hypoxic (i.e. low oxygen) events, coupled with declining water quality caused by anthropogenic eutrophication (i.e. man-made overloading of nutrients) currently threaten the health of many SAV systems (Montague and Ley 1993, Durako and Kuss 1994, Olesen and Sand-Jensen 1994, Zieman et al 1999). These habitats provide vital refuges, feeding, resting, staging, and spawning grounds for a variety of species found in Mississippi Sound and also in the Gulf of Mexico. Past studies throughout the years have attributed anywhere from 50% to 90% of all marine species to utilize this vital habitat at some point in their life stage.

As of 1998, only 2,000 acres remained (Moncrieff 1998). Dramatic decreases in SAVs along the north shoreline of Horn Island have been observed. An approximate 5,000 acre decrease in coverage was calculated for the period between 1969 and 1992. The overall distribution of SAVs among Mississippi's other barrier islands has also decreased considerably in the same time period, with Cat Island losing approximately 430 acres, Ship Island losing approximately 1,280 acres, and Petit Bois Island losing approximately 1,300 acres. Areas of SAVs along Coastal Mississippi's mainland have also declined. Buccaneer State Park is estimated to have lost about 150 acres while Point-aux-Chenes Bay has lost approximately 680 acres. The following three (3) areas were documented in which the potential seagrass habitat was less than the historical distribution of SAVs, indicating habitat loss. Dog Keys Pass, Horn Island, and Point-aux-Chenes Bay all exhibited this pattern with approximately 930 acres, 1,200 acres, and a 770 acres loss, respectively. By 1975, vascular seagrasses had been reduced to 33% and algal cover had been reduced by 41%. Additional losses of seagrass beds from 1971 to 1975 occurred as a result of the prolonged exposure to low salinity-water during the springs and winters of those years.

Seagrasses in Mississippi Sound are threatened by the cumulative effects of both natural events and anthropogenic activities in the coastal environment. The primary factors contributing to the decline of seagrass populations in Mississippi Sound are an overall decline in water quality, physical loss of habitat, decreased availability of light, extended periods of depressed salinity, and physical disturbances, such as tropical storms and hurricanes. In 1973, 67.6% of potential seagrass habitat was vegetated; however this amount was reduced to 13.4% percent by 1992 (Eleuterius 1973, Moncrieff 1998). The loss of previously vegetated areas in Mississippi Sound that are considered potential seagrass habitat totals 54.2% (Moncrieff 1998). Seagrass habitat loss in Mississippi Sound coincides with areas where rapid coastal erosion and massive long-term movement of sand have occurred (Moncrieff et al 1998). The coastal development is likely to result in indirect and cumulative adverse affects on seagrass beds by contributing to elevated nutrient levels, higher sediment loads, and the introduction of contaminants, leading to degraded water quality.

The adverse effects from natural perturbations, as evident by the catastrophic effects from Hurricane Camille on the seagrass beds, have been substantial and long-lasting. Continued physical loss of habitat, fluctuating salinity (i.e. erosion of barrier islands), and declining water quality will weaken the condition of existing beds and inhibit the revegetation of those areas that represent potential seagrass habitat. Opportunities exist to partner with other Federal or State resource agencies or with established NGOs, such as TNC. TNC has named the Mississippi Sound's marine habitat as one of their priority conservation areas on the Gulf Coast, which involves identification of SAVs, specifically seagrasses, as a critical target for protection and restoration. TNC states numerous publications have demonstrated that seagrass beds or meadows are critical habitat for many recreational and commercial marine fisheries species, such as shrimp, crabs, scallops, redfish, speckled trout, and mullet, and due to an increase in activities related to inshore fisheries and the increase in shallow draft recreational boating in most areas around the Gulf, propeller scarring has been identified as a serious threat to the integrity of seagrasses. Propeller scarring destabilizes the substrate as well as uproots the seagrasses themselves. This damage has been shown to be reversible, provided the seagrasses have the time to regenerate, and even then, can be unpredictable according to studies done in Texas in Redfish Bay.

Increased turbidity within Mississippi Sound causes less light penetration through the water column, which results in the lack of SAVs photosynthesis. Replanting seagrass beds has been found to be expensive and not always successful. It is imperative that a public outreach and awareness building campaign begin that would include signage and materials to promote recreational boat use that is compatible with these sensitive areas. Opportunities exist to partner with Federal, state, and local resource agencies as well as NGOs. Extensive coordination with the NPS, responsible for managing and operating the Gulf Islands National Seashore, would be required for areas of potential restoration within park boundaries. Involvement of local schools, colleges and universities with ongoing research programs would also help to identify and pinpoint specific problems for development of potential solutions.

1.2.2.3 Mississippi Shoreline-Manmade beaches and seawalls

The majority of the shoreline in Coastal Mississippi consists of manmade beaches beyond concrete seawalls. A few remaining areas along the shoreline consist of more natural areas, such as expanses of marsh along the western and eastern borders of the state. Before the construction of roadways along the Coastal Mississippi shorelines, the beach did not exist as it does today. The shoreline facing Mississippi Sound was a natural marsh, similar to that found along stretches of the South Carolina "Low Country" (Corps, Mobile District 1984). As development occurred and the beachfront roads and seawalls were constructed, i.e., U.S. Highway 90 along the entire stretch of shoreline in Harrison County, this marsh was filled in to create the sandy beach. This beach was built for protection of the roadways and seawalls and also added esthetic benefits to the region. The marsh habitat was destroyed and/or eliminated along with its associated storm surge protection.

A natural beach and dune system, located along Belle Fontaine in the central portion of Coastal Mississippi, is the only natural beach remaining and has experienced severe erosion to a point that it is virtually non-existent. Seawalls have been constructed along portions of this eroding beach for protection of property, which has exacerbated beach erosion. The seawalls confine the wave energy and intensify the erosion by concentrating the sediment transport processes in an increasingly narrow zone. The beaches continue to disappear resulting in the seawalls directly exposed to the full force of the waves.

Two major deep draft Federal navigation projects are located along Coastal Mississippi, Gulfport Harbor in Harrison County and Pascagoula Harbor in Jackson County. These Federal channels serve two international ports located along the shoreline. Numerous small navigation projects and boat harbors are also located along Coastal Mississippi's shoreline. The ports, harbors, and navigation channels received major damage as a result of Hurricane Katrina and repairs and/or reconstruction is still on-going.

Deer Island is a small mainland island located just offshore of Ocean Springs and Biloxi. The island experienced some hurricane damaged. The Corps, Mobile District has an existing Section 204: Beneficial Use of Dredged Material project and is currently working on a Section 528 of WRDA of 2000 project at the island. This recent project will restore the island to its 1850s footprint (i.e. beach/dune system, coastal maritime forest, and emergent marsh). The island is protected under the Coastal Barrier Resources Act of 1990 which replaced and reauthorized the Coastal Barrier Resources Act of 1982.

The beach of Coastal Mississippi provides a unique habitat for a variety of plants and animals. For example, 75% of migratory waterfowl live in or depend on coastal beaches during their lifespan (USFWS 1990b). Dune vegetation provides nesting areas for several kinds of birds, such as least terns, and animals, such as mole crabs and rodents. The beaches also provide numerous recreational opportunities for people. Boating, fishing, swimming, walking, beachcombing, bird-watching, and sunbathing are among the numerous activities enjoyed by beachgoers. The esthetic aspects of a beach/dune system provide additional benefits, even inspiring works of art and literature.

Beaches provide some protection to residents living near the waterfront by acting as a buffer against the high winds and waves of powerful storm systems or turbulent seas. MDMR has obtained funding through Federal Coastal Impact Assistance Program (CIAP) to begin initial phases of a project that would create manmade marshes along parts of the Coastal Mississippi shoreline. This project would provide a measure of bio-filtration of water-borne pollutants, and mitigate wind erosion of sand, as well as prevention of coastal erosion and siltation protection for sites selected for construction. Projects of this nature would be consistent with and offer additional opportunities for partnering with the State of Mississippi, especially during preliminary development of project goals, evaluation, and public input as potential sites are identified and evaluated.

1.2.2.4 Wetlands – Tidal Marsh

Coastal wetlands include swamps and tidal flats, coastal marshes, and bayous. They form in sheltered coastal environments often in conjunction with river deltas, barrier islands, and estuaries. They are rich in wildlife resources and provide nesting grounds and important stopovers for waterfowl and migratory birds, as well as spawning areas and valuable habitats for commercial and recreational fish. Intertidal and subtidal bottoms are populated by communities of macrofauna whose structure is dependent upon substrate, salinity, temperature, depth, and ecological relationships.

Coastal wetlands can be dominated by saltwater, as found along the Gulf coast of Louisiana, or they can contain a complex and changing mixture of salt and freshwater, like the estuaries of the Chesapeake, Galveston, and San Francisco Bays. Mississippi Sound is bordered to the east and west by two expansive marsh systems, Grand Bay Marshes along the eastern boundary and Hancock County Marshes along the western boundary. The Pascagoula River marsh system is located primarily inland of the shoreline and will be discussed in context with the freshwater rivers.

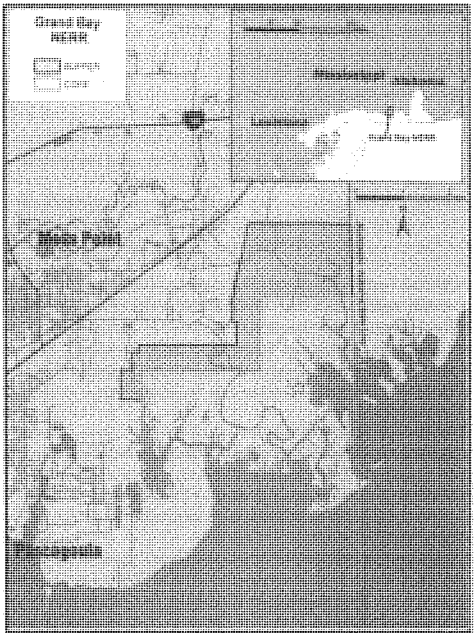
Western Hancock County along Mississippi Sound consists of extensive marshes that have suffered from lack of sediment and freshwater flows resulting in increased saltwater intrusion and coastal erosion. The lack of sediment has resulted in a reduction of natural accretion and marsh building. The Grand Bay marshes and wet pine savannahs along the eastern portion of the state have also experienced severe coastal erosion and are further threatened by increased saltwater intrusion.

Wetlands, marshes, and nearshore marine and estuarine habitat are the nursery grounds for the entire marine food chain in the Gulf of Mexico. Pollution, development, and other factors are destroying such habitat throughout the Gulf region. As this habitat is destroyed, it further depletes the species that form the base of the food chain throughout the Gulf of Mexico. Numerous species of marine flora and fauna begin their life cycles in marshes and wetlands. Ultimately, the entire Gulf of Mexico ecosystem is threatened by the accelerated destruction of this habitat. Failure to address the loss of this habitat in the Gulf of Mexico region threatens the long-term health of the entire ecosystem and human culture, with the attendant loss of billions of dollars of marine-related resources.

1.2.2.4.1 Grand Bay Marsh – Jackson County

Historically, the estuarine marsh within the Grand Bay National Estuarine Research Reserve (NERR) represented the former deltaic environments of the Pascagoula and Escatawpa Rivers in eastern Jackson County (Figures 1.2.2.4.1-1 and 1.2.2.4.1-2). The outlets of these rivers have shifted westward over time, severely limiting the inflow of freshwater, nutrients and sediments into the Bayou Cumbest area of the NERR. Several attempts have been made over the past 50 years to reroute freshwater from the marshes to the north to add additional freshwater to the estuary. Until recent years, minimal flow from the Escatawpa River existed into Bayou Cumbest through the system of meandering oxbows from the Holocene Pascagoula River.

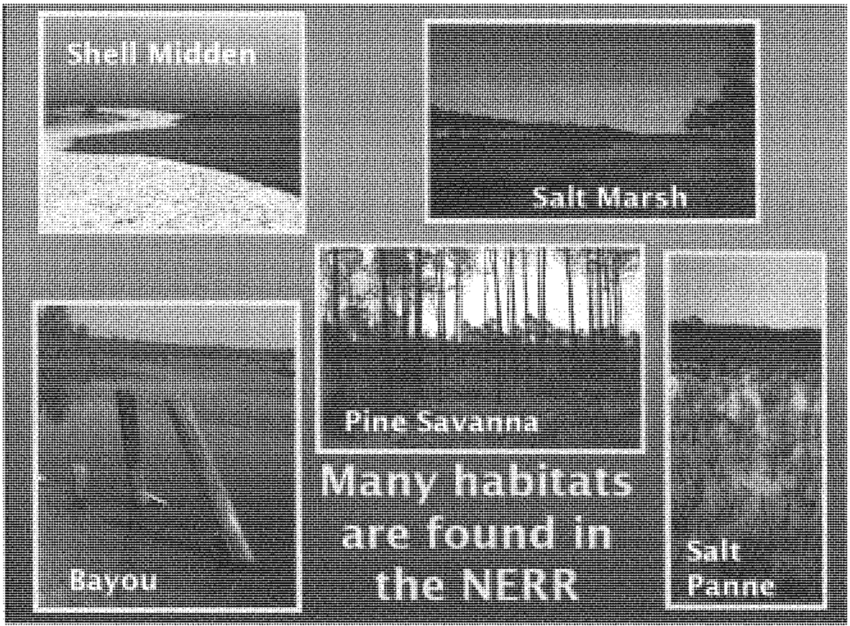
Currently it is speculated that much of the freshwater entering the Grand Bay NERR estuary is from surface runoff through Bayou Cumbest and Bayou Heron, within the Bangs Lake Hydrologic Unit, measuring approximately 21,374 acres. Human disturbances to the area have altered historic sheet flow and surface water flows into the area, as well as the natural migration of the Pascagoula and Escatawpa Rivers.



Source: MDMR

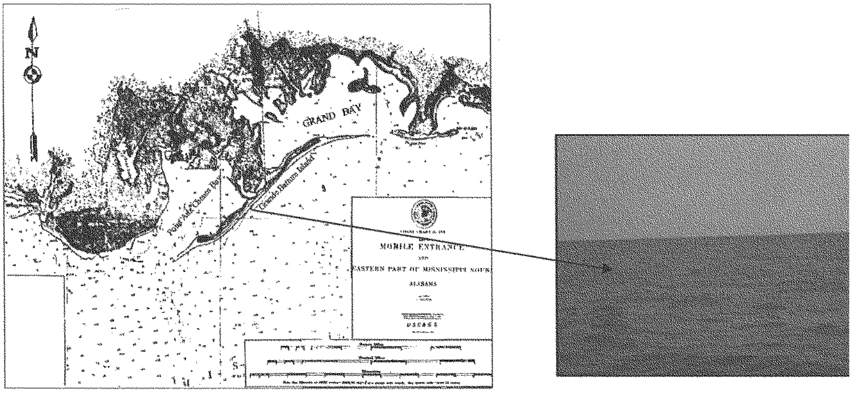
Figure 1.2.2.4.1-1. Grand Bay Marsh – Jackson County

The Grand Bay marshes lie within the gently sloping, lower Gulf coastal plain. It is thought that the Pascagoula River once flowed through these marshes, emptying into Point Aux Chenes Bay, forming a rich delta. Sometime after the sea reached its current level, however, the river changed its course and now flows into the Mississippi Sound approximately five miles west of the Grand Bay NERR. This natural diversion of the river water and its associated sediments away from Point Aux Chenes Bay has led to a condition that has resulted in the retrograding (erosion) of this estuarine system. Currently, the only major channels within the NERR are Bayou Cumbest and Bayou Heron. These tidal bayous are relatively small and have slow-moving, tea-colored waters that are rich in tannins, a natural by-product of decaying vegetation.



Source: MDMR
Figure 1.2.2.4.1-2. Grand Bay Marsh – Jackson County

The Grand Batture Islands located at the mouth of Point Aux Chenes Bay once formed a significant chain of islands on the southern boundary of the reserve (Figure 1.2.2.4.1-3). However, between the years of 1853 and 1950, coastal erosional forces ate away at the islands until today they are little more than giant mud lumps (i.e. shoals). Because these islands are no longer large enough to protect the bay from high winds and waves, the sensitive coastal salt marshes located along the fringe of the bay are being eroded away at an alarming rate (over 30 feet per year).



Source: MDMR and Corps

Figure 1.2.2.4.1-3. Grand Batture Islands – Remnants of only a Shoal

1.2.2.4.2 Hancock County Marsh – Hancock County

This is the second largest continuous marsh area in the state. The boundary of this 13,570-acre preserve includes all of the adjoining marshlands bordering Mississippi Sound from the Pearl River to Point Clear (Figure 1.2.2.4.2-1). This saline marsh area includes a historically significant captured relic barrier island (Campbell Island) and an Indian shell midden (Cedar Island) over 1,600 years old. Included within the marshes are several low ridges and small hummocks that are above mean high tide. Most important of these areas are Point Clear Island and Campbell Island, which are sandy areas with characteristics similar to the barrier islands. The islands of this marsh support several rare plant species including one of the rarest shrubs in the U.S., the tiny-leaved buckthorn (*Sageretia minutiflora*), found on the shell midden. The marsh area is also well-known for an abundance of waterfowl.

Source: Corps

Figure 1.2.2.4.2-1. Hancock County Marsh – Hancock County

The largely mesohaline area of Bayou Caddy and Point Clear Island consists of a mosaic of elevation zones bordering both sides of old dune/ridge systems (Point Clear Island and Campbell Island to the west) that are forested (pines, cedar, oak). The Pearl River and associated river swamp are freshwater tidal with bald-cypress (*Taxodium distichum),* blackgum (*Nyssa sylvatica var biflora* and *Nyssa aquatica*) balancing the swamp canopy. This area is experiencing saltwater intrusion as less freshwater inflows from the west due to extensive levee systems of the Mississippi River and smaller systems in Plaquemines Parish in Coastal Louisiana. As the salt tolerance of species in the tidal marshes and seagrasses is exceeded, changes in the food web and reductions in fish and shellfish productivity occur. Also, the yield of estuarine-dependent fisheries, such as shrimp, will be influenced by the quality of the habitat over time.

1.2.3 Riverine System

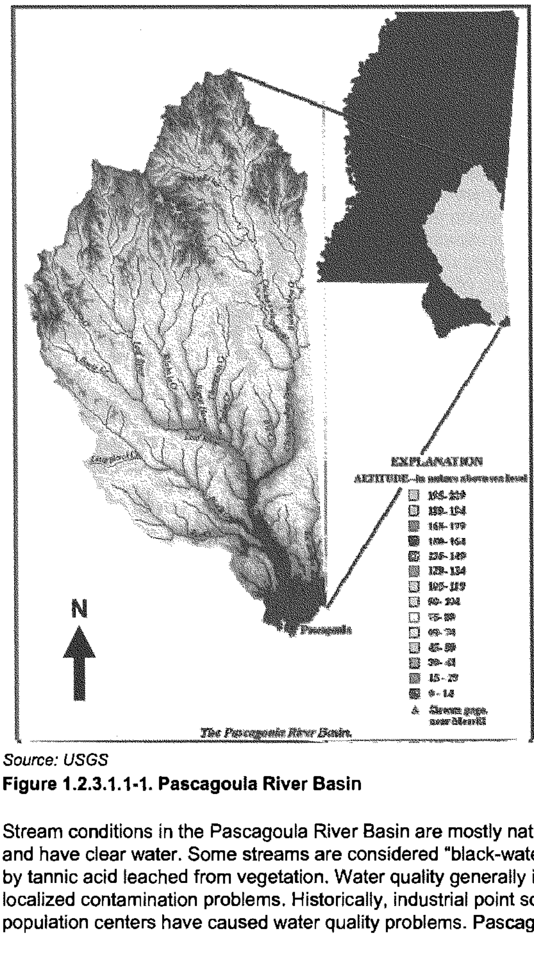
Riverine systems are bounded on the landward side by upland, by the channel bank, or by wetlands dominated by trees, shrubs, and persistent emergents. Cowardin et al (1979) divides the riverine system into four sub-systems: tidal, lower perennial, upper perennial, and intermittent, two of which are found in Coastal Mississippi. These include freshwater tidal marsh and lower perennial emergent wetlands. Coastal Mississippi's freshwater resources are very important in maintaining healthy aquatic ecosystems and are under continuing urban and industrial development pressure as the population continues to grow and rebuilding efforts are underway. Coastal marshes and forested wetlands located throughout the many freshwater coastal streams play a vital role in the sustainability of Coastal Mississippi for the future. Most rivers cutting through the low-lying coastal plain flow slowly to the sea and deposit their sand-sized sediment in bays and estuaries before reaching the coast. The river's suspended load of finer particles settles out in the sounds and bays that are protected by barrier islands and spits. Freshwater and sediments from these systems are essential to the continued existence of estuaries, marshes, and the species that depend on these habitats for survival. As wetlands continue to degrade or are being filled as development continues, valuable habitat available to support healthy populations of wildlife and marine organisms are lost and are not being effectively replaced. Additionally, water quality suffers due to many point and non-point sources of contamination near the coastal population centers. A comprehensive review and appropriate measures for preservation, restoration, and enhancement of the many components that make-up the diverse and vital coastal ecosystems will ensure sustainability of Coastal Mississippi. Additionally, the wetlands associated with the rivers storage floodwaters, both from the river systems and from storm surge, buffer the upland areas.

1.2.3.1 Tidal and Lower Perennial Riverine Systems

The USGS lists approximately 10 major drainage basins within the State of Mississippi and of these, two are located within the Coastal Mississippi Study Area (Corps 1984). These two basins include the Pascagoula River and its tributaries within the eastern portion of the state and the Coastal Streams Basin located within Coastal Mississippi. Additionally, the Pearl River makes up the western boundary of the state within Coastal Mississippi.

1.2.3.1.1 Pascagoula River Basin – Jackson County

The Pascagoula River Basin covers an area of about 8,800 m^2 in southeastern Mississippi (Figure 1.2.3.1.1-1). The Pascagoula River is formed by the confluence of the Chickasawhay and the Leaf Rivers. From this confluence, the river flows southward for about 80 miles before emptying into the Gulf of Mexico. Okatoma Creek, a tributary of the Leaf River, is a particular favorite to canoeists. The Escatawpa River, located mostly in Alabama, flows into the Pascagoula River very near the Gulf Coast. Elevations in the Pascagoula River Basin range from sea level to about 650 feet above sea level. About 72% of the basin is forested and about 21% is agricultural land. Near the coast are low-lying flatlands and marshlands. Farther inland, the landforms consist primarily of low rolling hills and broad, flat flood plains. The economy of the area is based, as it has been since prior to the Civil War, heavily on lumber, the manufacture of wood products, and shipbuilding. The City of Pascagoula on the densely populated Mississippi Gulf Coast is one of the great shipbuilding centers of the world. Tourism, commercial fishing, and oil and gas production are also significant components of the economy in the basin.



Source: USGS

Figure 1.2.3.1.1-1. Pascagoula River Basin

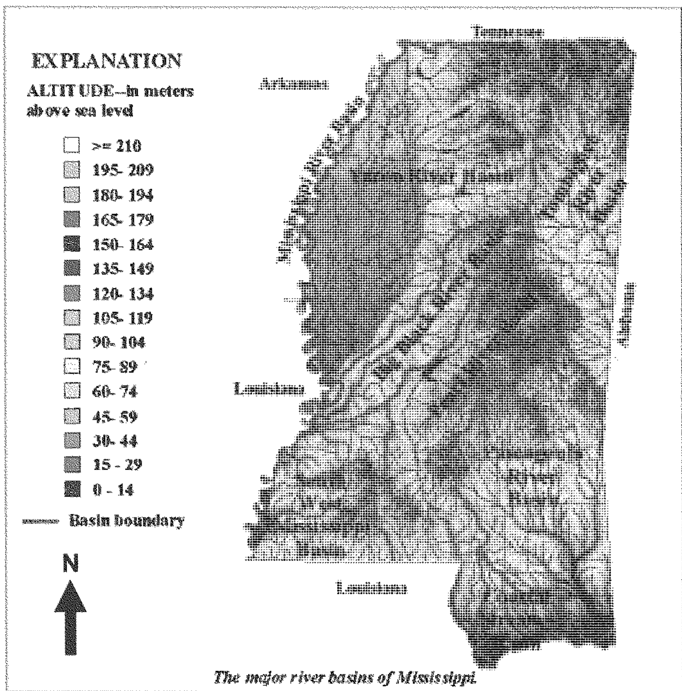
Stream conditions in the Pascagoula River Basin are mostly natural, or unmodified in appearance, and have clear water. Some streams are considered "black-water streams" because they are stained by tannic acid leached from vegetation. Water quality generally is good to excellent with only localized contamination problems. Historically, industrial point sources and urban runoff near major population centers have caused water quality problems. Pascagoula River Basin is critical habitat for

Gulf sturgeon and represents critical breeding, migrating, and wintering habitat for 327 additional species of birds.

1.2.3.1.2 Coastal Streams Basin – Harrison County

The Coastal Streams Basin (Figure 1.2.3.1.2-1) covers an area of about 1,650 m^2. Unlike most of the other basins in Mississippi, the streams and creeks do not all flow into a single main stream within the basin. Instead, most of the streams discharge directly into the Gulf of Mexico. Some of the larger streams in the basin include Bayou la Croix, Tuxachanie Creek, and the Tchoutacabouffa, Biloxi, Little Biloxi, Wolf, and Jourdan Rivers. Headwaters for these streams generally are in the northern part of the basin, and the streams discharge into either St. Louis Bay or the Back Bay of Biloxi. Elevations in the Coastal Streams Basin range from sea level to almost 420 feet above sea level. Much of the basin consists of gently rolling to hilly terrain. Silviculture and agriculture are principal uses of the basin. About 74% of the basin is forested, and about 12% is agricultural land. Most industries are located near the larger population centers.

Use of surface water in the Coastal Streams Basin is relatively large. About 300,000 gallons/day are used for irrigation, about 400,000 gallons/day are used for livestock, and about 20 million gallons/per day are used for industry.



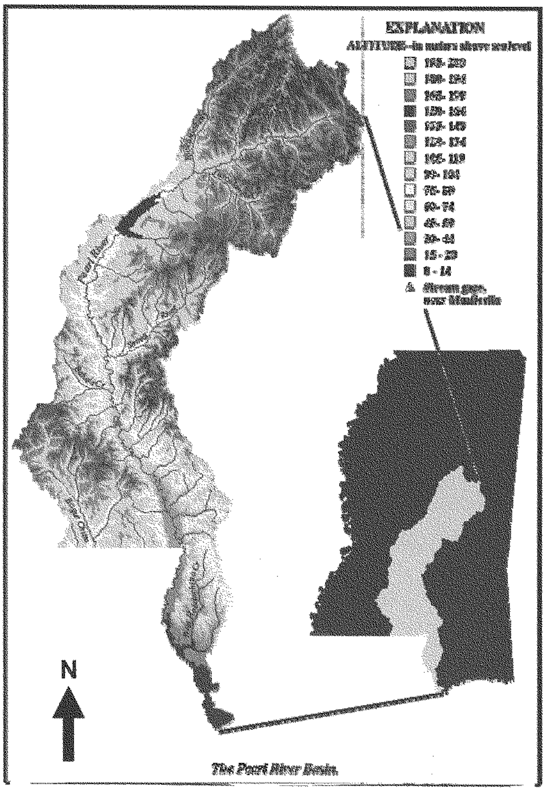
The major river basins of Mississippi

Source: USGS

Figure 1.2.3.1.2-1. Coastal Streams Basin

1.2.3.1.3 Pearl River

The Pearl River Basin covers an area of about 7,800 m^2 (Figure 1.2.3.1.3-1). The headwaters of the Pearl River consist of several tributaries in east-central Mississippi. From there the Pearl River flows southwesterly, forming the boundary between Louisiana and Mississippi in the southern part of the basin, and discharging into the Gulf of Mexico. Near the coast, the river becomes estuarine, bounded by salt marsh and affected by tidal influence.



Source: USGS

Figure 1.2.3.1.3-1. The Pearl River Basin in Mississippi

The Pearl River is about 490 miles long and divides into the Pearl River and the West Pearl River about 50 miles above the mouth. Significant tributaries include the Yockanookany and Strong Rivers. Elevations in the Pearl River Basin range from sea level to almost 700 feet above sea level. Much of the upper two-thirds of the Pearl River Basin consist of gently rolling to hilly terrain. In the southern part of the basin, the land is much flatter. About 65% of the basin is forested, and about 30% is agricultural land. The timber industry and the manufacture of wood products dominate the economy of the lower basin, whereas soybeans and poultry are the major components of the economy in the upper basin. This is the largest urban area in the State, the Jackson Metropolitan area, is located in this basin.

The flow of the Pearl River near Monticello averages 54,600 gallons/second. However, in the past, flow has been as low as about 2,000 gallons/second and as high as about 913,000 gallons/second. Use of surface water in the Pearl River basin is relatively large. About 1.2 million gallons/day are used for irrigation, about 6.2 million gallons/day are used for livestock, about 30.7 million gallons/day are used for industry, about 220,000 gallons/day are used for sand and gravel mining, and about 33 million gallons/day are used for municipal drinking-water supply.

Turbidity is often high in the upper two-thirds of the Pearl River basin; however, the water quality of streams is generally fair. In the southern third of the basin, streams generally have a fast, deep flow and generally are of fair to good water quality. Water quality impacts occur below Jackson and at Columbia due to point and non-point sources of contamination.

Channel diversions at the lower end of the Pearl River can leave the original river channel near Picayune virtually dry during low-flow conditions. Deforestation and water diversion are major concerns in the portion of the Pearl River basin nearing Coastal Mississippi. Deforestation and lack of streamside management zones increase the occurrence of cut banks and bank erosion contributing unnatural amounts of sediment into the system. Use of pesticides has also created problems with runoff.

1.2.3.2 General Problems in Riverine Systems

Increased development adjacent to streams and rivers and within their floodplains have caused extreme flooding conditions within most watersheds. The storm surge associated with Hurricane Katrina was so severe that it depicted this problem on an extreme scale. An example of this is what happened throughout the Pascagoula River watershed where the limits of the storm surge were seen several miles north of the coastline. Businesses and residences were flooded as far as 30 miles north due to the low elevations found within the watershed. Areas were flooded that had never experienced problems with flooding before. As a result of this, the base flood elevation maps throughout Coastal Mississippi are undergoing changes.

Numerous watersheds within close proximity to the coast and associated connected drainageways are flood hazards due to past development and associated impacts by landuse modification. Additionally, a number of these waterbodies have been determined impaired by the USEPA and MDEQ due to nutrient levels. A prime example of this can be seen in the Turkey Creek watershed. Turkey Creek, a small flowing channel, has been named by MDEQ as an impaired body of water that has been impacted by encroachment, changing landuse patterns, and channel modifications resulting in loss of habitat, flooding, and degradation of a once natural waterway.

Ongoing programs through local waterway citizen groups are in the process of identifying sensitive habitat that is at risk due to negative impacts associated with increased development. This development results in the loss of valuable adjacent wetlands, fragmentation and loss of vital wildlife habitat, loss of channel structure that provides fisheries habitat, and increased sedimentation due to runoff associated with natural landuse modification. Opportunities exist to partner with these waterway user groups (i.e. NGOs) in order to supplement their ongoing efforts of ecosystem restoration and habitat enhancement around these sensitive waterbodies and their associated wetlands, which would help reduce coastal flooding and erosion. A large part of the comprehensive plan will develop the framework needed to build these relationships with local efforts that are underway and gaining momentum.

1.2.3.3 Freshwater Emergent marsh

Freshwater marshes act in many ways like salt marshes, but the biota reflect the increased diversity made possible by the reduction of the salt stress found in saltwater marshes. Plant diversity is high, and more birds use these freshwater marshes than any other marsh type. Because they are inland from the saline parts of the estuary, they are close to urban centers, which make them more prone to human impacts associated with urbanization, runoff, development pressures, etc. The freshwater newly emergent marshes are formed in pro-grading deltas that depend on flooding waters to supply their nutrient needs. One of the challenges facing the sustainability of the freshwater marsh is a lack of sediment from upstream. Also, pollutants from upstream wash downstream, which could cause an eutrophic environment that harms the plants. Lack of sediment hampers natural accretion and causes further erosion and subsidence. Old fill, houseboats, sewage runoff pollution, and erosion further exacerbate the problems. Marshes serve as floodwater retention and over time, the loss of these marshes has contributed to increased flooding throughout the coast, especially in the developed areas south of Interstate-10.

Oyster Bayou is a prime example of what has been described. Oyster Bayou was once a small tributary to Mississippi Sound that meandered through the historic grounds of Jefferson Davis' mansion, known as Beauvoir. As a result of the U.S. Highway 90 construction, development of the Mississippi Coast Coliseum, and many other residential and commercial developments, Oyster Bayou has been degraded and no longer functions as a natural system. Local efforts are currently underway to restore Oyster Bayou; however, additional study/efforts are needed to effectively restore this natural system. Projects like this one provide opportunities for the MsCIP efforts to again partner with local restoration efforts.

Emergent marshes absorb and dissipate wave energy and somewhat reduce storm surge. The Pascagoula River basin received major flooding damage during Hurricane Katrina due to the large storm surge. Even though the tidal range is low, because the inland slope is so slight, freshwater marsh still are tidally influenced but are mostly overridden by wind driven tides and storm runoff. Many species of ducks and waterfowl use these freshwater systems, which are important components of the Mississippi Flyway, the direct route of migrating waterfowl (i.e. their north-south route). Many species use Coastal Mississippi as overwintering grounds for foraging of diverse invertebrates, plant roots, and tubers. These freshwater systems have been designated as critical habitat for the threatened Gulf sturgeon, an anadromous fish that use both the Pearl and Pascagoula River systems for staging, spawning, migration routes, and feeding. The juvenile Gulf sturgeon may spend several years upriver before migrating back to the ocean. This valuable habitat is important for survival of the species. The freshwater marsh serves as havens for shrimp, crabs, etc, during periods of droughts which causes higher salinity within the estuary and salt marshes.

1.2.4 Palustrine System

The palustrine system includes all nontidal wetlands dominated by trees, shrubs, and persistent emergents. It also includes small, shallow, permanent or intermittent waterbodies, such as ponds or coastal plain depressional wetlands. Coastal Mississippi is interlaced with a rich and diverse complex system of vital wetlands that provide floodwater storage, groundwater recharge, water filtering and purification systems, as well as wildlife habitat that include Pine Savannahs, headwater slopes (Bayhead Drain), swamps, and ephemeral pools.

1.2.4.1 Pine Savannah

Pine Savannah wetlands found in Coastal Mississippi provide for diverse habitat for a number of plants and animals including many T&E species found only in these unique habitats. Pine Savannah wetlands are commonly referred to as sponges that provide floodwater retention, groundwater recharge, and water purification. This wetland habitat is under increased developmental pressures due to the extreme and urgent housing need faced by Mississippians as they are trying to rebuild. This habitat is becoming fragmented and with the increased development, fire maintenance is increasingly harder to perform. Due to the nature of the flat coastal plains with little relief, these lands are some of the first to be considered for housing development. Urbanization and developmental pressure have created what are commonly referred to as forested wetlands. These wetlands are significantly different than what occurred naturally in Pine Savannah habitats. Lack of fire and altered hydrology allow hardwoods, various shrub species, and increased pine basal area to dominate what should be emergent grasses with very few pines in the overstory layer. Fragmentation causes loss of wildlife corridors and contiguous expanses of habitat necessary for continued species existence. Coastal Mississippi has lost over half of its Pine Savannahs due to urbanization throughout the area; thus, creating a threatened ecosystem that in turn is home to many T&E species. Because of the loss of these habitats, the species dependent upon them are increasingly becoming diminished.

1.2.4.2 Depressional Wetlands

A unique depressional wetland type, locally just known as "ponds" exists in the central Gulf coastal plain. Ponds are rain filled by mid-winter, remain high until mid-April, and then drop through October with some drying completely through the heat of the summer. They are typically shallow and flat bottomed. Vegetation changes abruptly from surrounding lands.

Ponds are widespread throughout the southeast but are especially prevalent in the coastal plain because of the flat terrain. Based on substrate which is predominantly citronelle soil-based ponds and are formed through the dissolution and removal of kaolinitic clays from surface rainfalls on a runoff, and shallow seepages. These are naturally occurring and are located in the central Gulf coastal plain from Pearl River County, Mississippi to Okaloosa, Florida. These areas are not afforded protection through the CWA through the Corps' regulatory program due to isolation rules. These habitats are lost directly by conversion to agriculture and forestry. They are temporarily wet portions of the year and landowners may not realize they exist. Additionally, they're adversely affected by land management of the adjacent uplands. The resultant changes in hydrology, and management of uplands degrades water quality. Lack of burning also results in tree growth and a reduction of the herbaceous community.

The ephemeral nature of the ponds prevents the persistence of fish, which allows uninhibited use by breeding amphibians. Amphibians have very important functions within the food chains of both aquatic and terrestrial systems. Amphibians consume aquatic vegetation as well as invertebrates and other vertebrates, and in the absence of fish, are usually the top predators in freshwater systems. Consequently amphibians influence the population dynamics of other organisms, as well as the cycling of nutrient and the flow of energy. Concerns have increased about declines and disappearances of the amphibian populations worldwide, with habitat destruction and modification being major causes cited (Wake and Morowitz 1991). These small wetlands are extremely valuable for obtaining biodiversity. Loss causes direct reduction in the connectivity in the remaining species population. They're also being lost to invasive exotics, such as privet and Chinese Tallow.

1.2.4.3 Headwater Slopes – Seeps, Bayhead Drains

Slope wetlands normally are found where there is a discharge of groundwater to the land surface. They normally occur on sloping lands; elevation gradients may range from steep hillsides to slight slopes. Slope wetlands are usually incapable of depressional storage because they lack the necessary closed contours. Principal water sources are usually groundwater return flow and interflow from surrounding uplands as well as precipitation. Hydrodynamics are dominated by downslope unidirectional waterflow. Slope wetlands can occur in nearly flat landscapes, if groundwater discharge is a dominant source to the wetland surface. Slope wetlands lose water primarily by saturation subsurface and surface flows and by evapotranspiration. Slope wetlands may develop channels, but the channels serve only to convey water away from the slope wetland. Changes in hydrology and deforestation and landclearing for development have caused a decline in these type wetlands throughout Coastal Mississippi.

1.2.4.4 Swamps – Bottomland Hardwood, Cypress – Tupelo

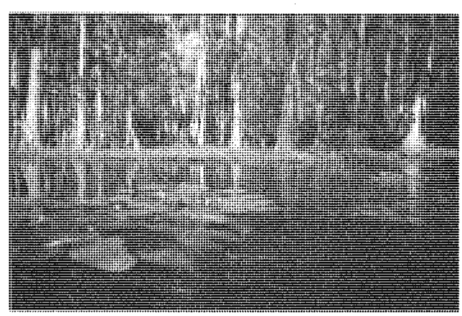
Trees in forested wetlands have developed several unique adaptations to the wetland ecosystem, creating what is commonly referred to as swamps. Tree adaptations commonly seen in swamps include cypress knees, wide buttresses and adventitious roots that provide gas transport to the rhizosphere. Swamp primary productivity is closely tied to hydrologic conditions, such as standing water, pulsing hydro-periods, and high water. Swamps have been shown to be nutrient sinks. This is true particularly in studies of nitrogen budget (i.e. farm fields runoff, golf courses, and yards fertilizer) and the swamps have been investigated for their value as nutrient sinks when wastewater is applied. Coastal Mississippi swamps are predominantly vegetated with cypress – tupelo species and bottomland hardwoods, known as river swamps, specifically the Pascagoula River Swamp and the Pearl River Swamp.

1.2.4.4.1 Cypress Tupelo Swamp

Cypress tupelo swamps were once common throughout the southeastern U.S. and only a small portion now remains (Figure 1.2.4.4.1-1). These swamps were abundant throughout the Pascagoula and Pearl River basins but have declined due to extensive logging operations during the late 1800s. Brandt and Ewel (1989) estimated only approximately 10% of cypress tupelo swamps found in pre-settlement times still remain in the U.S., particularly in the southeast including Coastal Mississippi. Removal of these trees created changed conditions, which altered hydrology and converted natural systems into open water and sometimes even mesic forests. When deepwater swamps are drained or when their dry period is extended dramatically, they become invaded by pine or hardwood species, which results in changes to functions of the wetlands. An example of reduced functions would be the loss of water purification, which results in a decline in overall water quality. Historically, farming, community development and urbanization resulted in portions of natural lands becoming developed while communities that thrived around the logging industry, such as Moss Point, Pascagoula, Gautier, and Pearlington, emerged. The remaining swamps continue to be impacted by non-point source runoff from surrounding urbanization. Ongoing logging operations continue to threaten and degrade these coastal swamps. This valuable commodity still exists today. Demands for housing continue to threaten the resource as filling occurs for future development further inland from the coastline and is commonly referred to as urban sprawl.

1.2.4.4.2 Bottomland hardwood forests

E. P. Odum describes these as an interface of man's most vital resource, mainly water and his living space, the land (1981). Major expanses of riparian ecosystems have been drained and cleared for agriculture and development. Bottomland hardwood forests are generally low-lying flat extensive floodplain swamps with strong seasonal hydrologic pulses with well developed soils.



Source: Corps

Figure 1.2.4.4.1-1. Cypress Tupelo Swamp

Bottomland hardwood forests provide floodwater retention and are valuable for many animals that seek its refuge, diversity of habitat, and abundant water, or that use it as a corridor for migration (Figure 1.2.4.4.2-1). The bottomland hardwood is an essential component of the Mississippi Coastal Birding Trail, ecotourism in South Mississippi that is part of the National Audubon Society. These areas are crucial for supporting neo-tropical migrant species. Protecting habitat produces more eco-tourism dollars. One of the major attractions and highly used sites exist along the Pascagoula River swamp, especially on the Lower Pascagoula Wildlife Management Area. The bird watching industry is large in the country and is growing in popularity. This area is part of the global network of Important Bird Areas. As these habitats are altered, filled, or destroyed, this ecosystem becomes fragmented causing decreases in populations of the dependent species. Increased flooding to nearby communities and residential development leads to further channelization to streams throughout the developed area, which creates further habitat destruction and fragmentation causing species to further decline. Thus, reduced breeding habitat and wintering habitat along with threats during migration, predation, or competition from other species, such as exotics and possible contaminants, such as direct exposure to chemicals, further negatively impact these habitats. It has been estimated that approximately $104 billion dollars are spent in the U.S. on eco-tourism per year (USFWS 2001a). In comparison, we, as a nation, only spent $88 billion on new car sales.

1.2.5 Upland Forests

Source: Corps

Figure 1.2.4.4.2-1. Bottomland Hardwood Forests

Coastal Mississippi upland forests are comprised of pine plantations, mixed pine hardwood, and maritime forests. Healthy forests are an important resource in the southeastern U.S. They provide clean air, jobs, recreation, tourism, healthy habitats for wildlife, and construction materials for homes. Coastal Mississippi has abundant uplands forests and some of those areas are owned by the USDA Forest Service. However, the majority of uplands forests are privately owned. The USDA Forest Service uses numerous practices to restore the health of the South's forests, such as thinning forests to reduce the risk of devastating diseases and insects from both private and public forestlands. The South's forests are different from those of 200 years ago and they continue to change. Urbanization, the absence of fire, harvesting, fragmentation, forest ownership, and forest uses are but a few components of this change. Current threats to upland forests in Coastal Mississippi are urbanization, lack of fire management, and harvesting of timber.

Maritime forests are located primarily along the coastline, coastal ridges, and on the barrier islands and are predominantly vegetated with live oaks, southern magnolia, redbay, yaupon, saw palmetto, and Spanish moss. These forests act as a barrier between the mainland and the sea because of their great tolerance of salt spray. This absorbs the salt spray before it can reach more sensitive species found further inland. Live oaks are disease resistant and are very dense, which helps them to stand up to hurricane winds. The live oak forests, historically referred to as Naval Live Oaks were harvested in early naval vessel construction during the 1800s. When migratory birds fly from South and Central Americas, this forest is important habitat because it is the first land the birds reach for several hundred miles. Migratory birds stop here to rest before continuing their migration northward.

The majority of upland forests in Coastal Mississippi is comprised of the mixed pine hardwood forest. These are widespread throughout and are under increased pressure due to urban sprawl as more and more residential and commercial ventures are developed. These forests are a result of past logging operations that changed the natural succession of native forests forever. They provide good hard mast for several species of wildlife including the Louisiana Black Bear, a federally listed threatened species.

An unnatural forest found throughout Coastal Mississippi consists of pine plantations, which are planted for harvesting. This is an agriculturally regulated crop throughout the southeast. Intensive pine plantation management practices are aimed at short rotation (12 or 15 years or less) and managed intensively with herbicides and fertilizers for maximum production for pulpwood and paper. These areas also require an intense site preparation to clear debris for planting, control residual vegetation, and to improve drainage. This often results in excessive sedimentation, changes in hydrology and non-point source pollution that includes runoff from herbicide treatments and fertilization. The areas frequently experience heavily compacted soils with fragipan development, which permanently alters the sites. Natural forests are lost to pine plantations and are planted with loblolly pines, a non-native plant. As a result of Hurricane Katrina and the associated losses of loblolly pines, studies were conducted that proved the native Longleaf was able to withstand higher winds and more people are becoming interested in planting this native species. This practice would be more beneficial even within a non-natural plantation setting.

1.3 Fauna

Many species of invertebrates and vertebrates make up the various fauna population along the Gulf coast. Invertebrate populations in Mississippi Sound and the nearshore area of the Gulf of Mexico transfer energy through the coastal food web. Microscopic estuarine zooplankton live throughout the water column with limited mobility. Larval stages of benthic forms and eggs and larval stages of many fish species are often interspersed throughout zooplankton. Many important commercial species feed upon zooplankton.

Vittor and Associates (1982) investigated the macrofauna of Mississippi Sound and selected areas in the Gulf of Mexico. Over 532 taxa from offshore Mississippi and Alabama and 437 taxa from the Mississippi Sound were identified. Densities of individuals varied from 910 to 19,536 individual/ yard^2 for the offshore and 1,200 and 38,863 individual/ yard^2 for the Sound area. Abundance of macrofauna is temporal with greatest densities occurring from fall to spring.

Oyster production in Mississippi depends on public reefs managed by the MDMR. The State of Mississippi accounts for about 13% to 17% of Gulf oyster landings. Reefs are located along the coast across the entire state with the largest reefs near the western boundary. According to a 1966 survey by W.J. Demoran, there were 9,934 acres of oysters. At that time, there were 582 acres of planted oyster beds. Additional acreage has been planted. A few small areas of oyster bottom have been leased for private development; however, production from these areas has been negligible. There have been considerable annual variations in size of productive areas due to natural ecological fluctuations, such as freshwater flow into the oyster beds. Many of Jackson County's most productive areas have been closed to harvest due to increased pollution associated with coastal development.

Many commercially important species of crustaceans are harvested in Mississippi Sound and the nearshore of the Gulf of Mexico. Brown shrimp (*Penaeus aztecus*) is the main shrimp species harvested by commercial fishermen in the Gulf of Mexico and is the most important commercial species in the Mississippi Sound and Mobile Bay area. White shrimp and blue crab are also harvested within the study area. In addition to those commercial species, there is a very diverse community of crustaceans within Mississippi Sound and adjacent waters including a wide variety of forms and habitat preferences. Epibenthic crustaceans dominate the diet of flounder, catfish, croaker, porgy, and drum.

Christmas and Waller (1973) reported 138 fish species in 98 genera and 52 families taken from areas across Mississippi Sound. The major fisheries landed along the Mississippi Gulf coast are anchovies, menhaden, mullet, croakers, shrimp, and oyster. Jackson County, primarily the ports of Pascagoula and Moss Point, receives greater than 85% of all Mississippi landings, including all industrial fish (menhaden), 95% of the mullet, trout, and red snapper, and 74% of the croaker landed (Corps 1992).

The Cooperative Gulf of Mexico Estuarine Inventory and Study (GMEI) observed 251 fish species in its estuarine study area from a list of 294 fish species from Mississippi estuaries and continental shelf waters off Mississippi (Christmas and Waller 1973). The bay anchovy (*Anchoa mitchilli*), Gulf menhaden (*Brevoortia patronus*), Atlantic croaker (*Micropogon undulates*), spot (*Leiostomus xanthurus*), butterfish (*Perilus burti*), and sand seatrout (*Cynoscion areanarius*) composed 93 percent of the total number of fish collected. Over 93 percent of the fish caught were in the families *Engraulidae* (bay anchovy), *Clupeidae* (Gulf menhaden), and *Sciaenidae* (seatrout and spot).

The finfish industry in Mississippi is composed of two segments: menhaden and edible finfish (Posadas 2001). The state's menhaden industry is centered in Pascagoula and is responsible for Mississippi's fifth-place national ranking in total pounds of seafood landed. The Gulf fishing fleet contains approximately 50 large vessels owned by individual processing firms. Mississippi is a very small producer of edible finfish obtained commercially, with fewer than 30 individuals participating full-time (Posadas 2001). More than 300 commercial licenses are sold annually for the harvest of edible finfish, however, indicating many part-time participants. In addition, trawlers catch foodfish incidental to shrimping and industrial fishing. Total foodfish landings average about one million pounds annually.

The blue crab, *Callinectes sapidus*, and its smaller cogener, the Gulf crab, *Callinectes similes*, are abundant in Mississippi coastal waters. About 200 commercial crab licenses are sold annually in Mississippi, but only about 60 fishermen trap crabs. The other licenses are sold to allow for incidental harvest in other fisheries.

Annual landings from 1972 to 1992 averaged 1,378,831 pounds. Average annual landings from 1993 through 2000 declined markedly to 524,383 pounds; however, the reduced landings can be attributed to social, economic, and regulatory changes that have taken place in the fishery rather than major declines in stock abundance. The average number of blue crab trappers declined from 61 during the 1970s and 1980s to 42 during the 1990s (Guillory 2001). These accounts of the landings do not include crabs taken in local waters and landed in neighboring states, nor those taken on a subsistence or recreational basis.

While seafood landings in Mississippi are significant, the bulk of economic activity is generated by the processing sector. Much of the seafood processed in Mississippi is landed in other Gulf states. There are 32 processing plants and 22 wholesale operations in Mississippi, employing about 1,300 people. A study by Mississippi State University's Coastal Research and Extension Center documents the total economic impact of the Mississippi seafood industry: $489 million annually, including $256 million in income and about 28,000 man-years of employment (Posadas 2001).

Coastal wetlands of Mississippi Sound, St. Louis Bay, Biloxi Bay, Pascagoula Bay, and the tidal Pascagoula River provide the resource base for commercial and marine recreational fishing and tourism in Mississippi. The dockside value of commercial fish landings in Mississippi was almost $42 million in 1995. Recreational fisheries also play an important role in the state's economy. In 1991, 500,000 people spent more than $236 million fishing in Mississippi's waters, generating almost $14 million in state sales tax, resulting in $131 million in earnings, and supporting more than 8,000 jobs. Approximately one-quarter of the recreational fishing occurs in coastal waters. Communities such as Moss Point, Pascagoula, Gautier, Ocean Springs, Biloxi, Long Beach, Gulfport, Pass Christian and Bay St. Louis all depend on fishing to support their local economies (NOAA 2002).

Coastal Mississippi supports an array of reptiles, amphibians, birds, and mammals. Reptiles and amphibians found in the area include snakes, turtles, lizards, toads, frogs, salamanders, and crocodilians. Coastal Alabama and Mississippi have a great diversity of reptiles including 23 species of turtles, 10 species of lizards, 39 species of snakes, and the alligator. Eighteen species of salamanders and 22 species of frogs and toads are indigenous to the coastal region.

Mammals found within the area include marsupials, moles and shrews, bats, armadillos, rabbits, rodents, carnivores, even-toed hoofed mammals, and dolphins. Mammals occur within all habitats of the system, using underground burrows, the soil surface, vegetative strata, the air, and the water for feeding, resting, breeding, and bearing and rearing young. There are 57 species of mammals found in the area. Several species of mammals include the raccoon, river otter, gray fox, striped skunk, mink, whitetailed deer, bottlenose dolphin, beaver, possum, and nine-banded armadillo. A number of whales are known to occur offshore Mississippi and Alabama and occasionally are sighted within the Mississippi Sound.

Over 300 species of birds have been reported as migratory or permanent residents within the area, several of which breed there as well. Shorebirds include osprey, great blue heron, great egret, piping plover, sandpiper, gulls, brown and white pelicans, American oystercatcher, and terns. Birds of the area eat a great variety of foods, are also food to many predators, and exhibit a diversity of nesting behaviors.

On September 9, 2005, within 2 weeks after Hurricane Katrina struck coastal Mississippi, the U.S. Commerce Secretary announced a formal determination of a fishery failure in the Gulf of Mexico due to the devastation. This declaration was in response to a virtual fishery shutdown in the affected states, including Mississippi, due to major flooding, damage to fishing boats and fishing ports, waterways clogged with debris and closed processing facilities. This action was made through provision of the Magnuson-Stevens Fishery Conservation and Management Act, which makes Federal relief funds available to assess the impacts, restore the fisheries, prevent future failure and assist fishing communities' recovery efforts. The Administration is working with Congress and the State to identify on-the-ground needs and develop an emergency plan to meet those needs.

Environmental monitoring including analyses of fish, water, and sediment samples collected from coastal waters of the Mississippi has begun by Federal and State resource agencies including the MDMR, MDEQ, PRD and HCD of NOAA, USEPA, the Food and Drug Agency, and others. Toxicology surveys taken from Gulf of Mexico waters, marine species, and sediment samples, after Hurricane Katrina have determined no elevated toxins of bacteria exist and NOAA has stated no cause for concern. The samples were tested for toxins that might have been released into the marine ecosystem after hurricane flooding, such as pesticides and fire retardants, and results have shown all levels are well below Federal guidelines for safe seafood consumption. The samples were tested for potential bacteria such as *E. coli* and none harbored the bacteria. The presence of *Vibrio* bacteria was found as expected and all fish, crab, and shrimp should be thoroughly cooked prior to consumption as recommended by the Food and Drug Agency. It has been concluded that Gulf seafood was deemed safe for human consumption; NOAA is continuing its sampling program to detect potential trends or changes that might occur over time.

NOAA recently completed a survey which depicts that Hurricane Katrina did not cause a reduction in fish and shrimp populations in offshore areas for the Gulf of Mexico. Additionally, NOAA annual surveys of shrimp and bottomfish, completed in November 2006, shows some species, such as the commercially valuable and overfished red snapper, to have a higher population in 2005 than the average populations between 1972 and 2004 which could be a result of the reduction in fishing activities in the Gulf of Mexico since Hurricane Katrina. NOAA will continue to monitor potential population changes due to damaged habitats, nursery areas and wetlands.

Oyster reefs have been seriously impacted by Hurricane Katrina and all reefs in coastal Mississippi will remain closed until further notice. Many boats were damaged or lost, and many processing facilities were damaged or destroyed. There are signs the reefs are beginning some of the healing processes on their own; however, much work will be needed to restore the oyster reefs to their former prime condition. Extensive sampling of the reefs is currently being conducted by the MDMR to provide information needed to plan extensive long-term recovery activities. Initial assessments of the reef conditions are underway but at present, are incomplete. Conditions of the reefs are highly variable. Generally, offshore areas were heavily scoured. Recent very heavy oyster spat set (less than one inch in length) was found in some of these areas with no spat set in other areas. Some light SAVs, marsh grass and drift wood were found. Inshore reefs generally had moderate to very low numbers of live oysters in some areas with other areas revealing no live oysters. Some of these areas had a good recent oyster spat set, typically lower than the offshore reefs (MDMR Press Release September 23, 2005).

Greater amounts of debris were found closer to shore than in the offshore areas and consisted of housing materials, such as lumber, siding and wire screens, SAVs, marsh grass, roots, twigs, pine needles, branches, palmetto and other leaves. Some oysters were found to be spawning. Deep gullies and holes were cut into the waterbottoms in many places by the extreme currents of Hurricane Katrina. Mud also covered many of the samples collected both inshore and offshore. Dredging proved to be very difficult due to the amount of debris in the water and reef contours having changed (MDMR Press Release September 23, 2005).

The initial assessments indicate that a majority of the commercial oyster resource and substrate have been scoured away, buried by sedimentation and debris, or moved. Additional assessments will be conducted by MDMR to better define the extent of loss of oyster resource or habitat. Cooperation from all parties is vital for reconstruction and revitalization of the Mississippi Oyster Program and reefs. Assistance has been received and additional assistance is expected from many local, state, and federal agencies in order to develop programs to involve the oyster fishermen and industry in this recovery effort.

1.4 Federal T&E Species and Their Critical Habitats

1.4.1 Baseline Conditions

Coastal Mississippi is home to 19 federally listed T&E, or candidate species. Federally listed species known to occur within the project area are shown on Table 1.4.1-1. Several other T&E species are known from marine habitats in the Gulf of Mexico. These species are blue whale (*Balaenoptera musculus*), finback whale (*Balaenoptera physalus*), humpback whale (*Megaptera novaeangliae*), Sei whale (*Balaenoptera borealis*), sperm whale (*Physeter macrocephalus*), hawksbill sea turtle (*Eretmochelys imbricata*), and leatherback sea turtle (*Dermochelys coriacea*). These T&E marine species might be occasional visitors to the project area.

Table 1.4.1-1.
Federally Listed Rare T&E Species

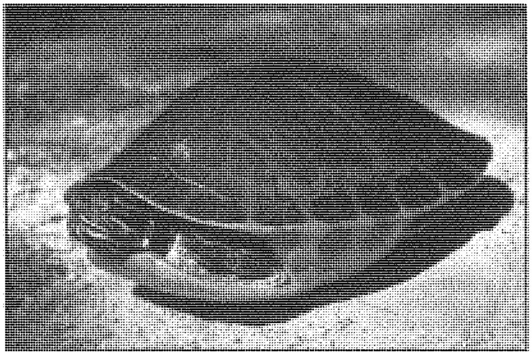
Common Name	Scientific Name	Status	County	Habitat
Alabama red-bellied turtle	*Pseudemys alabamensis*	LE	Harrison, Jackson	Submerged aquatic vegetation in brackish coastal rivers; freshwater reaches
Black pine snake	*Pituophis melanoleucus ssp. lodingi*	C	Harrison, Jackson	Fire-dependent, upland longleaf pine forests
Brown pelican	*Pelecanus occidentalis*	LE	Hancock, Harrison, Jackson	Feeds over water in coastal areas, nests on small islands.
Eastern indigo snake	*Drymarchon corais couperi*	LT	Harrison, Jackson	Fire-dependent, upland longleaf pine forests
Gopher tortoise	*Gopherus polyphemus*	LT	Hancock, Harrison, Jackson	Fire-dependent, upland longleaf pine forests
Green sea turtle	*Chelonia mydas*	LT	Hancock, Harrison, Jackson	Shallow coastal waters with SAV and algae, nests on open beaches.
Gulf sturgeon	*Acipenser oxyrhynchus desotoi*	LT	Hancock, Harrison, Jackson	Migrates from large coastal rivers to coastal bays and estuaries

Inflated Heelsplitter	*Potamilus inflatus*	LT	Harrison	Soft, stable substrata in slow to moderate currents of tributaries and large rivers
Kemp's Ridley sea turtle	*Lepidochelys kempii*	LE	Hancock, Harrison, Jackson	Nearshore and inshore coastal waters, often in salt marshes
Loggerhead sea turtle	*Caretta caretta*	LT	Hancock, Harrison, Jackson	Open ocean; also inshore areas, bays, salt marshes, ship channels, and mouths of large rivers
Louisiana black bear	*Ursus americanus luteolus*	LT	Hancock, Harrison, Jackson	Bottomland hardwood forest; frequently ranges into other habitats
Louisiana quillwort	*Isoetes louisianensis*	LE	Hancock, Harrison, Jackson	Small blackwater streams with sand and gravel substrate and forest cover
West Indian Manatee	*Trichechus manatus*	LE	Hancock, Harrison, Jackson	Fresh and salt water in large coastal rivers, bays and estuaries.
Mississippi gopher frog	*Rana capito sevosa*	LE	Harrison, Jackson	Fire-dependent, upland longleaf pine forests; open, ephemeral upland pools
Mississippi sandhill crane	*Grus canadensis pulla*	LE	Jackson	Wet pine savannah
Pearl darter (Pascagoula River System)	*Percina aurora*	C	Jackson	Rivers and large creeks with sand and gravel bottoms and flowing water.
Piping Plover	*Charadrius melodus*	LT	Hancock, Harrison, Jackson	Barrier islands and coastal beaches
Red-cockaded woodpecker	*Picoides borealis*	LE	Harrison, Jackson	Fire-dependent, upland longleaf pine forests
Yellow-blotched map turtle	*Graptemys flavimaculata*	LT	Jackson	Rivers and large creeks with habitat suitable for basking

LT = listed threatened, LE = listed endangered, C = candidate for listing
Source: Mann, 2000. Bald eagle was delisted from threatened in August 9, 2007.

1.4.1.1 Alabama Red-bellied Turtle

The Alabama red-bellied turtle (*P. seudemys alabamensis*) is a relatively large freshwater turtle with a carapace (top shell) length of up to 13 inches (Figure 1.4.1.1-1). The plastron (bottom shell) is orange to red in color; the carapace is olive green, brown, or black, accompanied by distinct vertical markings in yellow, orange or red. The Alabama red-bellied turtle is distinguished from other similar species by the stripes of color on its head, and also the shape of the upper jaw (USFWS 1989). This turtle primarily feeds on aquatic plants and is most common in sluggish bays and bayous in brackish marshes adjacent to the main channels of large coastal rivers (Mann 2001). In Alabama, the turtle is known from the lower reaches of the Alabama River and its tributaries in Baldwin and Mobile Counties. In Mississippi, recent surveys have located Alabama red-bellied turtles in the lower reaches of the Old Ft. Bayou, Escatawpa, and Pascagoula Rivers in Jackson County, and Tchoutacabouffa and Biloxi Rivers in Harrison County (Mann 2001).



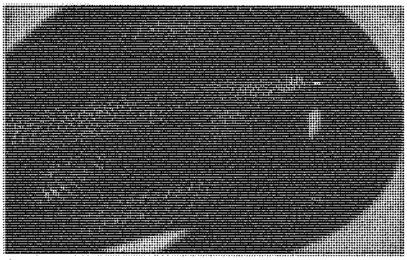
Source: USFWS

Figure 1.4.1.1-1. Alabama Red-Bellied Turtle Photograph

This turtle was listed as endangered by the USFWS on 16 June 1987; it is threatened by low reproductive success and taking of adult turtles. Although adult turtles spend most of their time feeding and basking in SAV, they must return to land to lay eggs. Disturbance of nests and destruction of eggs has been identified as major threats to the population; local residents collect eggs and live turtles for food. Recreational use of natural sand beaches have also disturbed nests and dredged material areas, such as Gravine Island in Alabama (USFWS 1989). Feral pigs, crows, and fire ants also raid nests to eat turtle eggs. Some collection of these turtles for the pet trade still persists, as does trawling to collect turtles for food. Some turtles are harvested accidentally by commercial fishermen in nets, traps, and trawls. Recovery efforts include learning more about the life history of the species; protecting nests in recreational areas; preventing destruction of aquatic vegetation used for basking, cover, and food; preventing taking of eggs and adult turtles through law enforcement; and educating the public about turtle conservation.

1.4.1.2 Black Pine Snake

The black pine snake (*P. melanoleucus lodingi*) is one of 15 subspecies of a widespread snake species commonly called bullsnake or gopher snake (Figure 1.4.1.2-1). This non-venomous snake with black or dark brown scales and a reddish or white snout can grow up to 8.3 feet in length (Jordan 1998). Black pine snakes feed on small mammals, but will also take other vertebrates, such as birds, lizards and other snakes. The black pine snake was once known in longleaf pine forests from extreme southeastern Louisiana, east to southern Mississippi, to extreme southwestern Alabama (Jordan 1998). Recent surveys have found the highest concentration of black pine snakes in DeSoto National Forest in Mississippi, including habitat in Harrison County (USFWS 2001b). The snakes are known from eight other Mississippi counties and three counties in Alabama. Black pine snake is believed to be extirpated from Louisiana (Natureserve 2001a), and has been listed as a candidate for protection under the Endangered Species Act.



Source: USFWS
Figure 1.4.1.2-1. Black Pine Snake Photograph

Black pine snakes require well-drained, upland longleaf pine forest with few shrubs and abundant herbaceous vegetation. Historically, these conditions were maintained with frequent wildfires. Longleaf pine forests were once abundant in the southeastern U.S., but have been reduced to less than 5% of their former range (USFWS 2001b). Degradation, fragmentation, and fire suppression of upland longleaf forests is thought to be responsible for the decline of black pine snakes (Natureserve 2001a). Conversion of upland habitats to urban development, agriculture, and pine plantation have made habitat unsuitable for the species. Pine snakes avoid forests with a dense mid-story shrub layer, which is often the result of fire suppression (USFWS 2001b). There is evidence that the snakes use the underground portions of rotting pine stumps for shelter. Modern forestry practices that remove stumps and downed trees before replanting threaten the survival of black pine snakes (Natureserve 2001a). Direct human impacts such as roadkill, shooting, and collecting black pine snakes for the pet trade are thought to be significant threats to the snake's survival (USFWS 2001b).

1.4.1.3 Brown Pelican

The brown pelican (*P. occidentalis*) is a large brown and gray seabird with a characteristic long bill attached to an expandable pouch used for capturing prey (Figure 1.4.1.3-1). Brown pelicans can reach up to 8 pounds and have wingspans of more than 7 feet (USFWS 2001c). These birds are known from marine environments in coastal areas of the U.S.; they feed by diving for small fish. Breeding pairs use small coastal islands for nesting, building nests in trees or on the ground. The brown pelican suffered dramatic population losses during the middle of the 20th century because DDT poisoning impaired reproductive success. Since DDT use was banned in the U.S., brown pelican populations have increased or stabilized. In the Southeastern U.S., the brown pelican is considered endangered only in Mississippi and Louisiana (USFWS 2001c). Threats to brown pelicans include disturbance of nesting colonies, entanglement in fishing gear, oil and toxic chemical spills, severe storms, heavy tick infestations, and unpredictable food availability (USFWS 2001c).

Source: USFWS

Figure 1.4.1.3-1. Brown Pelican Photograph

1.4.1.4 Eastern Indigo Snake

The Eastern indigo snake (*D. corais couperi*) is a large constrictor, usually 5 to 7 feet in length, with a heavy black body and red or orange on the chin and throat (Figure 1.4.1.4-1). This snake actively forages along wetland edges to feed on rodents, birds, reptiles, and amphibians. In coastal Mississippi, Eastern indigo snakes prefer high, dry, mature pinelands dominated by longleaf pine (*P. palustris*), wiregrass (*Aristida stricta*), and turkey oak (*Q. laevis*). They are often found in association with gopher tortoises, using gopher tortoise burrows for shelter. The species is most abundant in peninsular Florida and south Georgia, although scattered populations persist in coastal Mississippi, Alabama, the Florida panhandle, and coastal South Carolina (Natureserve 2001b).

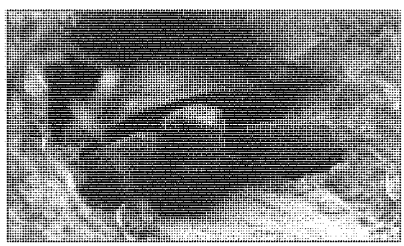
Source: USFWS

Figure 1.4.1.4-1. Eastern Indigo Snake Photograph

The eastern indigo snake is listed threatened by the USFWS. Species decline is thought to be directly related to the loss of mature longleaf pine forest in the Southeast coastal plain. Much of this habitat has been converted to pine plantation stocked with species other than longleaf pine. In other areas, fire suppression has allowed hardwood trees to invade and become dominant in former mature longleaf pine forests. The decline in the Eastern indigo snake may also be related to the decline in the gopher tortoise. Fewer gopher tortoises create fewer burrows, reducing shelter for the Eastern indigo snake as well as many other vertebrates and invertebrates. Research indicates that Eastern indigo snakes might require large areas of contiguous habitat in excess of 10,000 acres in order to thrive. Efforts are underway to restore longleaf pine forests in the southeastern U.S. and maintain these areas with prescribed fire. Commercial collection of these snakes for the pet trade (now illegal) has also caused the species to decline. However, Eastern indigo snakes are able to reproduce in captivity, which might facilitate captive breeding programs to reintroduce the species to appropriate habitat (Natureserve 2001b).

1.4.1.5 Gopher Tortoise

The gopher tortoise (*G. polyphemus*) is a terrestrial turtle with a carapace (top shell) length between 12 to 24 inches (USFWS 1990a). The carapace is dark brown to gray-black, and often worn smooth from moving through the deep burrows it digs for shelter (Figure 1.4.1.5-1). The gopher tortoise is found in the southeastern coastal plain from Louisiana to South Carolina, although it is rare and scattered throughout its range. Gopher tortoises can live for several decades. Depending on habitat quality, it may take between 10 and 20 years for tortoises to become sexually mature. Egg laying and nesting takes place in the spring months. Clutch size is usually between 5 and 9 eggs. Nest predation is high, with roughly 90 percent of gopher tortoise nests destroyed by predators such as raccoons, armadillos, and opossums. Predation on hatchling tortoises is also very high. Research indicates that hatchling mortality rates of more than 90 percent are not unusual (Natureserve 2001c).



Source: USFWS

Figure 1.4.1.5-1. Gopher Tortoise Photograph

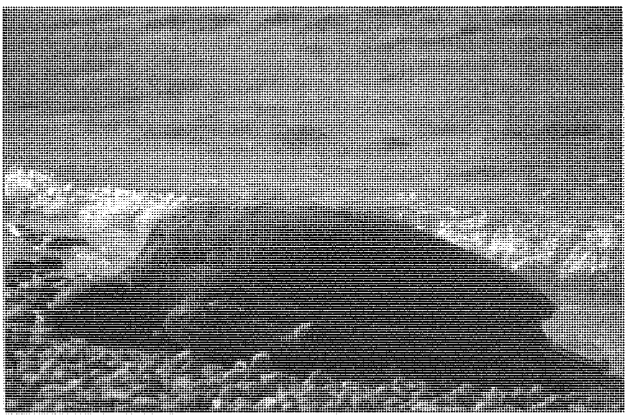
Gopher tortoises are found in a variety of upland habitats. The best tortoise habitat consists of open upland woodlands with well-drained sandy soils suitable for easy burrowing. An open tree canopy lets in sunlight necessary for the growth of grasses and herbaceous plants on which the gopher tortoise feeds (USFWS 1990a). Sunlight is thought to be necessary for tortoise basking thermoregulation, and also for egg incubation while nesting (Natureserve 2001c). Periodic low-intensity fires have been observed to be beneficial to maintaining gopher tortoise habitat. In the western part of its range, including Mississippi, gopher tortoises inhabit xeric longleaf pine–scrub oak forests located on sand ridges. They may also found on the edges of crop fields, in pastures, and power line right-of-ways (USFWS 1990a).

The gopher tortoise has been listed threatened by the USFWS. The species population has undergone an 80 percent decline in the past 100 years (Natureserve 2001c). Decline is expected to continue because of habitat elimination and fragmentation. In the early 20th Century, gopher tortoises were collected for food. This problem has decreased, although tortoises continue to be adversely impacted by rattlesnake collectors who pour toxic substances down gopher tortoise burrows in order to flush out resident rattlesnakes. Road kill is also a persistent problem for adult turtles (Puckett and Franz 2001). The most frequently cited reason for gopher tortoise decline throughout its range is loss of habitat. Conversion of pinelands to agricultural lands has reduced gopher tortoise habitat in Mississippi (Natureserve 2001c). Fire suppression in longleaf pine natural communities has resulted in an increase in shrub cover and a decrease in herbs and grasses used for food. Throughout its range, conversion of open woodlands to dense slash pine plantation monocultures has eliminated large tracts of suitable habitat. In Florida, urbanization has also eliminated gopher tortoises and tortoise habitat.

1.4.1.6 Green Sea Turtle

The green sea turtle (*C. mydas*) was listed on July 28, 1978. The breeding population off Florida and the Pacific coast of Mexico is listed as endangered while all others are threatened (NOAA 2001). Green sea turtles range throughout the Atlantic, Pacific, and Indian Oceans, primarily in tropical regions and shallow waters (except during migration), inside reefs, bays, and inlets. The green sea turtles are attracted to lagoons and shoals with abundant marine grass and algae on which the turtles feed.

Green sea turtles have been observed in the Mississippi Sound (Figure 1.4.1.6-1). In fact, a juvenile green sea turtle was captured in the mouth of Back Bay of Biloxi several years ago (Mann 2000, Mann, T. 2003. Personal comm.). The turtles are not known to nest on the Mississippi coast or barrier islands, but might be attracted to seagrass beds as a food source in nearshore waters (Gunter 1981).



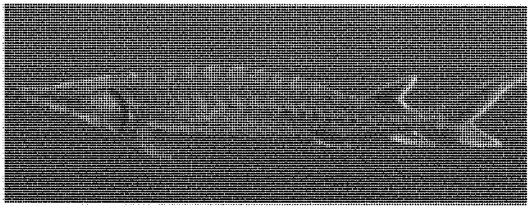
Source: USFWS

Figure 1.4.1.6-1. Green Sea Turtle Photograph

Exploitation of green sea turtle nesting grounds either by human interference or pollution poses the greatest threat to these turtles. The greatest cause of decline in green turtle populations is commercial harvest for eggs and food in nesting areas outside the U.S. Incidental catch during commercial shrimp trawling is a continuing source of mortality that adversely affects recovery in North America (NOAA 2001). Today, turtle excluder devices (TEDs) pulled by shrimp boats help reduce mortality from net entanglement.

1.4.1.7 Gulf Sturgeon

The Gulf sturgeon (*A. oxyrhynchus desotoi*) was listed throughout its range as a threatened subspecies on September 30, 1991. The Gulf sturgeon, considered a subspecies of the Atlantic sturgeon (*A. oxyrhynchus*), is an anadromous fish, migrating from saltwater into large coastal rivers (Figure 1.4.1.7-1). Historically, the Gulf sturgeon occurred in rivers from the Mississippi River to the Suwannee River, and in bays and estuaries from Florida to Louisiana. Little is known about current population levels outside the Suwannee, Apalachicola and Pearl Rivers, but they are thought to have declined from historic levels.



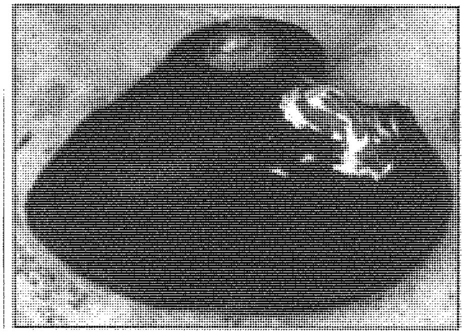
Source: USFWS
Figure 1.4.1.7-1. Gulf Sturgeon Photograph

Adult fish spend 8 to 9 months each year in rivers and 3 to 4 of the coolest months in estuarine Gulf rivers. In the Suwannee River, adult sturgeons frequent areas near the mouths of springs and cool water rivers during the summer months. Adult fish tend to congregate in deeper waters of rivers with moderate currents and sandy and rocky bottoms. Seagrass beds with mud and sand substrates appear to be important marine habitats (Mason and Clugston 1993). The adult Gulf sturgeon is known to spend the fall and winter months in the estuary of Mississippi Sound and migration routes extend from the Sound to the Back Bay of Biloxi. Occurrences of the Gulf sturgeon have been documented within Mississippi Sound, Biloxi River, and Pascagoula River area. The Gulf sturgeon is known to spawn in the Pearl River system. Major threats to this rare, primitive species include physical barriers (e.g., locks and dams) to spawning grounds, habitat loss, and poor water quality.

On March 19, 2003, USFWS and NOAA designated 14 geographic areas among the Gulf of Mexico rivers and tributaries as critical habitat for the Gulf sturgeon (FR Vol. 68, No. 53). These 14 geographic areas encompass approximately 1,739 river miles and 2,333 square miles of estuarine and marine habitat. In Mississippi, the critical habitat includes 392 kilometers of the Pearl River, including Bogue Chitto, and 126 miles of the Pascagoula River, including the Leaf, Bouie, Chickasawhay, and Big Black Creek tributaries (FR Vol. 68, No. 53).

1.4.1.8 Inflated Heelsplitter

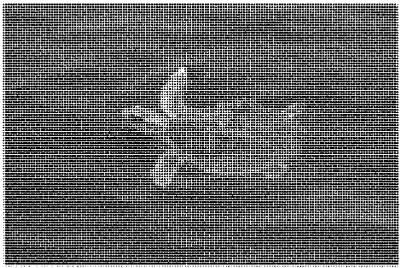
The inflated heelsplitter (*P. inflatus*), also known as the Alabama heelsplitter, was listed was listed as threatened throughout its range on September 28, 1990 (Figure 1.4.1.8-1). The inflated heelsplitter is a large freshwater mussel with a brown to black shell with green rays in young individuals (USFWS 1993). Like other freshwater mussels, the inflated heelsplitter feeds by filtering food particles from the water column. The specific food habits of the species are unknown, but other juvenile and adult freshwater mussels have been documented to feed on detritus, diatoms, phytoplankton, and zooplankton. The diet of inflated heelsplitter, like other freshwater mussels, comprises water (until encysted on a fish host) and fish body fluids (once encysted). The preferred habitat of this species is soft, stable substrata in slow to moderate currents. It has been found in sand, mud, silt and sandy-gravel, but not in large or armored gravel. It is usually collected on the protected side of bars and may occur in depths over 20 feet. The occurrence of this species in silt does not necessarily indicate that the species can be successful in that substratum. Adult mussels may survive limited amounts of silt, whereas juveniles would suffocate. In addition, it is possible that the species was established in an area prior to deposition of the silt (USFWS 1993). George et al (1996) documented this species in the Lower Pearl River in 1996.



Source: USFWS
Figure 1.4.1.8-1. Inflated Heelsplitter

1.4.1.9 Kemp's Ridley Sea Turtle

The Kemp's Ridley sea turtle *(L. kempii)* was listed as endangered throughout its range (Gulf of Mexico and Atlantic Ocean) on December 2, 1970, and its status has remained unchanged (Figure 1.4.1.9-1). The Kemp's Ridley population has declined since 1947 (when an estimated 42,000 females nested in one day) to a nesting population of approximately 1,000 in the mid-1980s. The decline of this species was primarily due to human activities including collection of eggs, fishing for juveniles and adults, killing adults for meat and other products, and direct take for indigenous use. In addition to these sources of mortality, Kemp's Ridley sea turtles have been subject to high levels of incidental take by shrimp trawlers. Kemp's Ridley turtles are occasionally caught on fishing hooks and incidentally injured by recreational anglers and boaters (Mann personal communication, 2003). Today, under strict protection, the population appears to be in the earliest stages of recovery. The increase can be attributed to two primary factors: full protection of nesting females and their nests in Mexico, and the requirement to use TEDs in shrimp trawls both in the U.S. and Mexico (NOAA 2001).



Source: USFWS

Figure 1.4.1.9-1. Kemp's Ridley Sea Turtle Photograph

The major habitat for Kemp's Ridley sea turtle is the nearshore and inshore waters of the northern Gulf of Mexico, especially Louisiana waters outside of the nesting season. Kemp's ridley sea turtles are often found in salt marsh habitats; the majority nest on approximately 4.9 miles of beach between Barra del Tordo and Ostional in the state of Tamaulipas, Mexico. It is the only known major nesting beach in the world for this turtle.

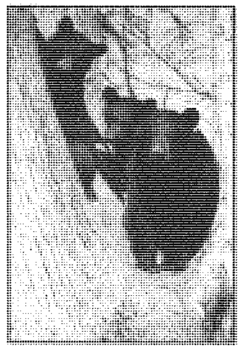
1.4.1.10 Loggerhead Turtle

The loggerhead turtle (*C. caretta*) was listed as threatened throughout its range on July 28, 1978 (43 FR 82808), and its status has not changed (Figure 1.4.1.10-1). The loggerhead sea turtle is widely distributed throughout its range and may be found hundreds of miles out to sea as well as in inshore areas, such as bays, lagoons, salt marshes, creeks, ship channels, and the mouths of large rivers (Corps, Mobile District 2000). Loggerheads are known to migrate over long distances, with tagged specimens having been recaptured 1,200 to 1,500 miles from the point of release. Loggerheads are seen annually inshore in Mississippi Sound, but are more commonly seen offshore in the proximity of oil rigs (Mann personal communication, 2003). Most recent evidence suggests that the number of nesting females in South Carolina and Georgia may be declining, while the number of nesting females in Florida appears to be stable. Until the 1970s, loggerhead turtles were commercially harvested for their meat, eggs, leather, and fat. Its meat and leather are not as valuable as the green sea turtle, and its shell is of less value than the hawksbill. However, in places where regulations are not enforced, the harvest of turtle meat and eggs remains a problem. Because of their feeding behavior and their habit of wintering in shallow waters, loggerheads, along with Kemp's Ridley sea turtles, are more likely to be caught in large shrimp trawl nets and drown. Today, TEDs pulled by shrimp boats help reduce mortality from net entanglement by allowing turtles to escape from the nets. However, loggerhead turtles are hooked by recreational fishermen offshore near oil rigs and are frequently injured by being struck by boats and boat propellers (Mann personal comm. 2003).

Source: USFWS

Figure 1.4.1.10-1. Loggerhead Sea Turtle Photograph

Loggerheads are capable of living in a variety of environments, such as in brackish waters of coastal lagoons and river mouths. During the winter, they may remain dormant, buried in the mud at the bottom of sounds, bays, and estuaries. The major nesting beaches are located in the southeastern U.S., primarily along the Atlantic coast of Florida, North Carolina, South Carolina, and Georgia. As of 1981, there was no record of loggerhead turtles nesting in Mississippi, although a small group of these turtles were seen swimming off the western end of Horn Island in 1976. Mississippi Heritage Program database includes a record for loggerhead turtle southeast of Deer Island (Mann 2000).



Source: USFWS

Figure 1.4.1.11-1. Louisiana Black Bear Photograph

Loggerheads are know to nest annually in small numbers on the Gulf Island National Seashore in Mississippi, with one nest being documented on the mainland beach and one nest several years ago on Round Island (Mann personal comm. 2003).

1.4.1.11 Louisiana Black Bear

The Louisiana black bear (*U. americanus luteolus*) is one of 16 subspecies of American black bear (Figure 1.4.1.11-1). Black bears are large, bulky mammals that can grow to more than 600 pounds. The Louisiana black bear differs from other subspecies by having a longer, narrower skull and larger molar teeth (USFWS 1995). The Louisiana black bear was listed as threatened in its former range of Louisiana, southern Mississippi, and eastern Texas on January 7, 1992. Other black bear species that could occur in this area are treated as threatened due to similarity of appearance. Black bears are opportunistic omnivores that rely heavily on plant foods such as acorns and berries. Bears are also known to eat insects and carrion, and to raid garbage cans, agricultural crops, and bee hives (USFWS 1995).

Louisiana black bears typically inhabit bottomland hardwood forests, but may also use other habitat types, especially when food is available. Bottomland hardwood forests feature the food sources and denning sites that are necessary for successful bear reproduction. Many different species of hardwood trees, shrubs, vines, and herbaceous plants provide food at different times of the year. Large hollow trees common in swamps provide ideal dens for winter hibernation and birthing young. Reproducing populations of Louisiana black bear are thought to be restricted to two large bottomland hardwood forest areas in Louisiana (USFWS 1995). The Tensas River Basin and Atchaflaya River Basin support several reproducing sub-populations of bears. Louisiana black bears can range long distances in search of food and have been sighted far from the Tensas and Atchaflaya River Basins. Bottomland hardwood forests along lower Pearl River and lower Pascagoula River have suitable habitat that might be occupied by Louisiana black bears (USFWS 1995). It is difficult to determine whether bears seen outside Louisiana are reproducing females, or only wandering subadult bears. There has been at least one confirmed sighting of a female with cubs in Mississippi, and USFWS monitoring data indicate that females will cross the Mississippi River from Louisiana to Mississippi (Rummel 2002).

Habitat loss is thought to be the primary threat to the survival of the Louisiana black bear. Former bear habitat had been reduced by 80 percent within its historic range by 1980 (USFWS 1995). Remaining bear habitat has been fragmented and degraded; degraded habitats often do not provide sufficient food for bears. As bears travel in search of food, they are more likely to come into conflict with humans, and human-related mortality is thought to pose a direct threat to Louisiana black bears. Education programs and strong penalties for poachers have been implemented to help reduce intentional harm to bears (USFWS 1995). Land acquisition and bottomland hardwood forest restoration efforts are underway to increase habitat available to bears. Fewer than 160 Louisiana black bears were thought to exist in breeding habitats in Louisiana in 1995 (USFWS 1995).

1.4.1.12 Louisiana Quillwort

Louisiana quillwort (*I. louisianensis*) is a primitive seedless wetland plant with a grass-like appearance, although it is actually more closely related to ferns (Figure 1.4.1.12-1). It has many simple, hollow leaves 1 to 2 inches wide and up to 24 inches long. Quillworts reproduce by producing spores in special structures embedded in the leaves. The Louisiana quillwort is restricted to gravel bars and sandy soils in or near shallow blackwater creeks and overflow channels in narrow riparian woodlands or bayheads in pine flatwoods and upland longleaf pine vegetative communities (USFWS 1996). This species has been documented in the Pleistocene High Terraces ecoregion in southern Mississippi. Louisiana quillwort was discovered in southeastern Louisiana in 1972. In 1996, it was known from a handful of sites in southeastern Louisiana and in two Mississippi counties, Jackson and Perry (USFWS 1996). Recent survey work however, has discovered this plant in more than 50 locations spread over 10 Mississippi counties (Natureserve 2001d).

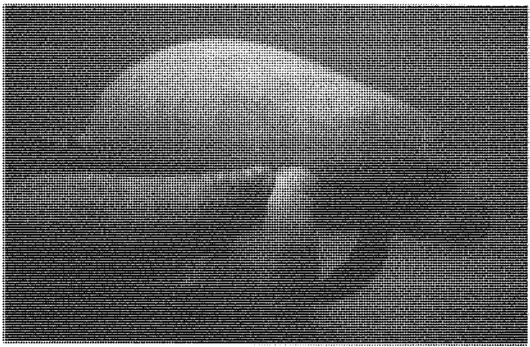
Source: USFWS
Figure 1.4.1.12-1. Louisiana Quillwort Photograph

Louisiana quillwort is listed as endangered by the USFWS. Threats to quillwort populations include timber harvest, sand and gravel mining, construction, and other activities with potential to alter the hydrology of small stream habitats (Natureserve 2001d). Louisiana quillwort is adapted to dynamic stream ecosystems in which natural processes scour and redeposit individual plants and spores on constantly changing gravel bars and sandy streambanks. This species has not been observed to grow on silt substrates even when other habitat factors are appropriate (USFWS 1996).

1.4.1.13 West Indian Manatee

The West Indian or Florida manatee (*T. manatus*) was listed as an endangered species in 1967 (under a law that preceded the Endangered Species Act of 1973) throughout all or a significant portion of its range (USFWS 2001g). The West Indian manatee also is protected at the federal level under the Marine Mammal Protection Act of 1972.

The West Indian manatee (sometimes called sea cow) is found primarily along the coast of Florida. Most adult manatees are about 10 feet long and weigh 800 to 1,200 pounds, although some larger than 12 feet and weighing as much as 3,500 pounds have been recorded (Figure 1.4.1.13-1). These "gentle giants" have a tough, wrinkled brown-to-gray skin that is continuously being sloughed off. Hair is distributed sparsely over the body. With stiff whiskers around its mouth, the West Indian manatee's face looks like a walrus without tusks.



Source: USFWS

Figure 1.4.1.13-1. West Indian Manatee Photograph

Manatees spend their lives moving between freshwater, brackish, and saltwater ecosystems. They prefer large, slow-moving rivers, river mouths, and shallow coastal areas, such as coves and bays. Great distances may be covered as the animals migrate between winter and summer grounds. During the winter, the U.S.' West Indian manatee population confines itself to the coastal waters of the southern half of peninsular Florida and to springs and warm water outfalls as far north as southeast Georgia. During summer months, manatees may migrate as far north as coastal Virginia on the east coast and the Louisiana coast on the Gulf of Mexico. Manatees are known to migrate through the study area, and several have been rescued in the study area during cold weather outbreaks (USFWS personal communication 2003). In fact, one or more West Indian manatees have been seen annually in Mississippi waters each year for the past decade (Mann personal communication 2003).

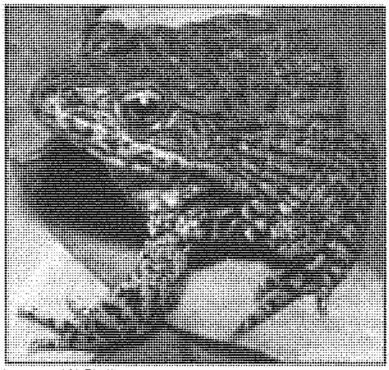
Manatees are adversely impacted by collisions with boats, crushing and drowning in canal locks, harassment by skin divers and boaters, entanglement in fishing line, toxins ingested during red tide (toxic algae bloom) events, and destruction of seagrass beds for boating facilities. Manatee population trends are poorly known, but deaths are thought to have increased steadily (6.1% a year, exponential regression, 1976 to 1991). Mortalities from collisions with watercraft are up 10.3% a year from 21% of all deaths in 1976–1980 to 29% in 1986–1991. Deaths of dependent calves are up 12% a year, from 14% to 24% of all deaths. The manatee has difficulty rebounding from these threats because of its late breeding maturity and its low reproductive rate. In general, the birth rate is not able to keep up with manatees killed by boats. The combination of high mortality rates and low reproductive rates have led to serious doubts about the species' ability to survive in the U.S.

1.4.1.14 Mississippi Gopher Frog

The Mississippi gopher frog (*R. capito sevosa*) is a medium-sized, stocky frog with brown, black, or gray coloration and many dark spots and warts (Figure 1.4.1.14-1). Adult frogs reach approximately 3 inches in body length. These frogs spend considerable time underground in abandoned gopher tortoise burrows, mammal burrows, and under tree stumps (USFWS 2000). Mississippi gopher frogs breed in isolated ponds surrounded by sandy, upland, longleaf pine forest. Breeding ponds only fill with water after substantial winter rains; Mississippi gopher frogs, therefore, do not reproduce successfully in drought years. The Mississippi gopher frog population has been reduced to approximately 100 known individuals near one breeding pond in Harrison County, Mississippi.

Development projects in the vicinity of the pond have severed movement corridors that formerly helped sustain the frog population and otherwise have deteriorated remaining frog habitat. The species was at one time known from coastal counties and parishes from the Mississippi River in Louisiana east to the Mobile River in Alabama (USFWS 2000).

The Mississippi gopher frog was listed as endangered whenever found west of the Mobile and Tombigbee Rivers in Alabama, Mississippi, and Louisiana (USFWS 2001). Threats to the last remaining frog population include inbreeding, local changes in hydrology, fire suppression, sedimentation, toxic chemical runoff, and habitat destruction and fragmentation. The last remaining breeding pond used by the species is located within 656 feet of a proposed highway, housing development, and golf course (USFWS 2000).



Source: USFWS

Figure 1.4.1.14-1. Mississippi Gopher Frog Photograph

1.4.1.15 Mississippi Sandhill Crane

Mississippi sandhill crane (*G. canadensis pulla*) is a large wading bird similar in appearance to herons and other cranes (Figure 1.4.1.15-1). Sandhill cranes have gray feathers with long legs and neck. Adult sandhill cranes have a red patch on the forehead (USFWS 2001d). The Mississippi sandhill crane is a non-migratory subspecies of sandhill crane found only in Jackson County, Mississippi. Most sandhill cranes are migratory, but there are three recognized subspecies that do not migrate: Florida sandhill crane (*G. canadensis pratensis*), Cuban sandhill crane (*G. canadensis nesiotes*), and Mississippi sandhill crane. Somewhere between 110 to 120 Mississippi sandhill cranes existed in the wild in 2000 (Natureserve 2001e). An USFWS captive breeding program has been successful in reintroducing several breeding cranes to the Mississippi Sandhill Crane National Wildlife Refuge. These cranes are found in wet and dry open forests and savannahs with longleaf pine, slash pine, and cypress (*T. ascendens*). Mississippi sandhill cranes feed on live prey, such as amphibians, worms and insects. At certain times of the year, the cranes also eat plant foods, such as corn, roots, tubers, and pecans. Mississippi sandhill cranes reproduce slowly, raising only one chick per year. Hatching success is low, and very few young birds have been observed. Low population levels and inbreeding might be responsible for low hatching success and a high rate of disease in Mississippi sandhill cranes (USFWS 2001d).

Source: USFWS

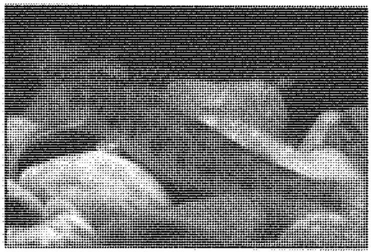
Figure 1.4.1.15-1. Mississippi Sandhill Crane Photograph

Critical habitat for the Mississippi sandhill crane covers about 26,000 acres in Jackson County. The main threat to the survival of this subspecies is loss and fragmentation of habitat. Conversion of open forests to dense pine plantation, fire suppression, encroachment of residential and commercial developments, roads that facilitate access to and fragment crane habitat, and chemical spraying on roadsides all contribute to population decline (Natureserve 2001e, USFWS 2001d). These cranes are territorial when nesting. Nests can be separated by a half mile or more. If the Mississippi sandhill crane population recovers, more suitable habitat will be needed so that adult cranes have space to hatch and rear young. Habitat maintenance, which requires occasional fire—either prescribed or wild, is increasingly difficult with the encroachment of suburbia and urban areas on crane habitat.

1.4.1.16 Pearl Darter

The pearl darter (*P. aurora*) is a small fish in the perch family that usually grows to just over 2 inches in length. It has a blunt nose, horizontal mouth, large eyes placed high on the head, and a black spot on the caudal fin (Figure 1.4.1.16-1). Pearl darters have been collected in rivers and large creeks with moderate current and sand and gravel substrates. It is not found in deep, sluggish pools, lacustrine ecosystems, or headwater creeks with insufficient flow. Chironomids and small crustaceans probably make up a large part of pearl darter diet (USFWS 2001e).

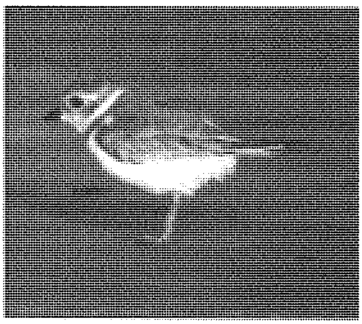
Never considered abundant, the pearl darter was once found in both the Pearl and Pascagoula River systems. It has not been collected in the Pearl River system since 1973. The pearl darter is thought to be restricted to 88 river miles of the Pascagoula River watershed (USFWS 2001e). The pearl darter has the potential to occur in the Pascagoula River and its tributaries in Jackson County. Threats include sedimentation from forestry and development in the watershed, permitted industrial and municipal discharges of toxic chemicals and sewage, sand and gravel mining, and proposed impoundments for reservoirs. Sand and gravel mining activities are ongoing in the Pascagoula River system. In-stream mining not only removes substrates preferred by the pearl darter, it also delivers sediment to aquatic habitats downstream. Holes in river channels left by sand and gravel mining activities function similar to lake habitats, which pearl darters avoid (Natureserve 2001f).



Source: USFWS
Figure 1.4.1.16-1. Pearl Darter Photograph

1.4.1.17 Piping Plover

The piping plover *(C. melodus)* is a small, stocky, sandy-colored bird resembling a sandpiper (Figure 1.4.1.17-1). The adult has yellow-orange legs, a black band across the forehead from eye to eye, and a black ring around the base of its neck. Like other plovers, it runs in short starts and stops. When still, the piping plover blends into the pale background of open, sandy habitat on outer beaches where it feeds and nests. The bird's name derives from its call notes, plaintive bell-like whistles which are often heard before the birds are seen.



Source: USFWS
Figure 1.4.1.17-1. Piping Plover Photograph

The piping plover is listed as a federally threatened species within the watershed of the Gulf Coast as listed in the Federal Register, December 11, 1985. The piping plover breeds on sandy or pebble coastal beaches of Newfoundland and southeastern Quebec to North Carolina. These birds winter primarily on the Atlantic coast from North Carolina to Florida, although some migrate to the Bahamas and West Indies. Decline in piping plover populations has been linked to loss of breeding habitat. Shoreline development, river flow alteration, river channelization, and reservoir construction have all led to loss of breeding habitat. The piping plover is a federally threatened and state endangered shorebird. All piping plovers are considered threatened species under the Endangered Species Act when on their wintering grounds. The piping plover winters along the Gulf coast but does not nest in Mississippi. The Mississippi Natural Heritage Program database indicates three over-wintering sightings of piping plovers: one along the beaches of Gulfport, one on Deer Island, and one on Ship Island.

Several factors are contributing to the decline of the piping plover along the Atlantic coast. Commercial, residential, and recreational development have decreased the amount of coastal habitat available for piping plovers to nest and feed. Human disturbance often curtails breeding success. Foot and vehicular traffic may crush nests or young. Excessive disturbance may cause the parents to desert the nest, exposing eggs or chicks to the summer sun and predators. Interruption of feeding may stress juvenile birds during critical periods in their development. Pets, especially dogs, may harass the birds. Developments near beaches provide food that attracts increased numbers of predators, such as raccoons, skunks, and foxes. Domestic and feral cats are also very efficient predators of plover eggs and chicks. Stormtides may inundate nests.

Piping plovers winter in coastal areas of the U.S. from North Carolina to Texas. Piping plovers begin arriving on the wintering grounds in July, with some late-nesting birds arriving in September. Behavioral observations of piping plovers on the wintering grounds suggest that they spend the majority of their time foraging (Nicholls and Baldassarre 1990). The international piping plover winter censuses of 1991 and 1996 located only 63 percent and 42 percent of the estimated number of breeding birds, respectively (Haig and Plissner 1992; Haig and Plissner 1993). Of the birds located on the U.S. wintering grounds during these two censuses, 89% were found on the Gulf Coast and 8% were found on the Atlantic Coast.

1.4.1.17.1 Critical Habitat for the Piping Plover

On August 9, 2001, the USFWS designated 137 areas along the coasts of North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas as critical habitat for the wintering population of the piping plover. This includes approximately 1,798.3 miles of mapped shoreline and approximately 165,211 acres of mapped area along the Gulf and Atlantic coasts and along margins of interior bays, inlets, and lagoons.

Critical habitat identifies specific areas that are essential to the conservation of a listed species, and that may require special management considerations or protection. The primary constituent elements for the piping plover wintering habitat are those habitat components that are essential for the primary biological needs of foraging, sheltering, and roosting, and only those areas containing these primary constituent elements within the designated boundaries are considered critical habitat. The primary constituent elements are found in coastal areas that support intertidal beaches and flats (between annual low tide and annual high tide) and associated dune systems and flats above annual high tide.

1.4.1.17.2 Critical Habitat Designation/Land Ownership

The critical habitat areas contained within the conservation units described below constitute USFWS's best evaluation of areas needed for the conservation of the wintering piping plover. The USFWS may revise critical habitat through a rulemaking process if new information becomes available. USFWS calculated linear distances of critical habitat shoreline (in kilometers and miles) by ownership for the state of Mississippi. In addition, state-level values of area in hectares and acres were calculated for the critical habitat units by ownership (Table 1.4.1.17.2-1). Ownership for both the shoreline and units were broken into three classes (Federal—federally owned lands, State—state owned lands, and Other—non-Federal or non-state mapped lands). Assignment of ownership was based on existing digital state-level managed/protected lands geodata set (GIS data set) where possible. If no existing digital data were available, ownership was assigned based on other data sources. Detailed descriptions of critical habitat units for the piping plover are provided in Table 1.4.1.17.2-2.

Table 1.4.1.17.2-1.
Approximate Land Area of Designated Critical Habitat Units for Wintering Piping Plover (Rows)

Land Owner	Shoreline Ownership in Hectares (acres)	Shoreline Ownership in Kilometers (miles)
Federal	2,376 (5,870)	98.2 (61.4)
State	0 (0)	0 (0)
Other	1,479 (3,655)	105.9 (66.2)
Total	3,855 (9,525)	204.1 (127.6)

USFWS, 2001i

Table 1.4.1.17.2-2.
Piping Plover Critical Habitat in Mississippi

Unit	Description
MS-1	Lakeshore through Bay St. Louis. 41 ha (101 ac) in Hancock County. This unit extends from the north side of Bryan Bayou outlet and includes the shore of the Mississippi Sound following the shoreline northeast approximately 15.0 km (9.3 mi) and ending at the southeast side of the Bay Waveland Yacht Club. The landward boundary of this unit follows the Gulf side of South and North Beach Boulevard and the seaward boundary is MLLW. The shoreline of this unit is privately owned.
MS-2	Henderson Point. 34 ha (84 ac) in Harrison County. This unit extends from 0.2 km (0.12 mi) west of the intersection of 3rd Avenue and Front Street and includes the shore of the Mississippi Sound following the shoreline northeast approximately 4.4 km (2.7 mi) to the west side of Pass Christian Harbor. The landward boundary of this unit follows the Gulf side of U.S. Highway 90 and the seaward boundary is MLLW. The shoreline of this unit is privately owned.
MS-3	Pass Christian. 77 ha (190 ac) in Harrison County. This unit extends from the east side of Pass Christian Harbor and includes the shore of the Mississippi Sound following the shoreline northeast approximately 10.5 km (6.5 mi) to the west side of Long Beach Pier and Harbor. The landward boundary of this unit follows the Gulf side of U.S. Highway 90 and the seaward boundary is MLLW and the seaward boundary is MLLW. The shoreline of this unit is privately owned.
MS-4	Long Beach. 38 ha (94 ac) in Harrison County. This unit extends from the east side of Long Beach Pier and Harbor and includes the shore of the Mississippi Sound following the shoreline northeast approximately 4.4 km (2.7 mi) to the west side of Gulfport Harbor. The landward boundary of this unit follows the Gulf side of U.S. Highway 90 and the seaward boundary is MLLW. The shoreline of this unit is privately owned.
MS-5	Gulfport. 39 ha (96 ac) in Harrison County. This unit extends from the east side of Gulfport Harbor and includes the shore of the Mississippi Sound following the shoreline northeast approximately 4.8 km (3.0 mi) to the west side of the groin at the southern terminus of Courthouse Road, Mississippi City, MS. The landward boundary of this unit follows the Gulf side of U.S. Highway 90 and the seaward boundary is MLLW. The shoreline of this unit is privately owned.
MS-6	Mississippi City. 62 ha (153 ac) in Harrison County. This unit extends from the east side of the groin at the southern terminus of Courthouse Road, Mississippi City, MS, and includes the shore of the Mississippi Sound following the shoreline northeast approximately 7.9 km (4.9 mi) to the west side of President Casino. The landward boundary of this unit follows the Gulf side of U.S. Highway 90 and the seaward boundary is MLLW. The shoreline of this unit is privately owned.
MS-7	Beauvoir in Harrison County. Excluded. The proposed rule included this unit, but it was deleted for lack of evidence of regular use by piping plovers.
MS-8	Biloxi West in Harrison County. Excluded. The proposed rule included this unit, but it was deleted for lack of evidence of regular use by piping plovers.

Table 1.4.1.17.2-2.
Piping Plover Critical Habitat in Mississippi (continued)

Unit	Description
MS-9	Biloxi East in Harrison County. Excluded. The proposed rule included this unit, but it was deleted for lack of evidence of regular use by piping plovers.
MS-10	Ocean Springs West. 11 ha (27 ac) in Jackson County. This unit extends from U.S. 90 and includes the shore of Biloxi Bay following the shoreline southeast approximately 1.9 km (1.2 mi) to the Ocean Springs Harbor inlet. The landward boundary of this unit follows the Bay side of Front Beach Drive and the seaward boundary is MLLW. The shoreline of this unit is privately owned.
MS-11	Ocean Springs East. 7 ha (17 ac) in Jackson County. This unit extends from the east side of Weeks Bayou and includes the shore of Biloxi Bay following the shoreline southeast approximately 1.8 km (1.1 mi) to Halstead Bayou. The landward boundary of this unit follows the Bay side of East Beach Drive and the seaward boundary is MLLW. The shoreline of this unit is privately owned.
MS-12	Deer Island. 194 ha (479 ac) in Harrison County. This unit includes all of Deer Island, where primary constituent elements occur to the MLLW. Deer Island is privately owned
MS-13	Round Island. 27 ha (67 ac) in Jackson County. This unit includes all of Round Island to the MLWW and is privately owned.
MS-14	Mississippi Barrier Islands. 3,168 ha (7,828 ac) in Harrison and Jackson Counties. This unit includes all of Cat, East and West Ship, Horn, Spoil, and Petit Bois Islands where primary constituent elements occur to MLLW. Cat Island is privately owned, and the remaining islands are part of the Gulf Islands National Seashore.
MS-15	North and South Rigolets. 159 ha (393 ac) in Jackson County, MS, and 12 ha (30 ac) in Mobile County, AL. This unit extends from the southwestern tip of South Rigolets Island and includes the shore of Point Aux Chenes Bay, the Mississippi Sound, and Grand Bay following the shoreline east around the western tip, then north to the south side of South Rigolets Bayou; then from the north side of South Rigolets Bayou (the southeastern corner of North Rigolets Island) north to the northeastern most point of North Rigolets Island. This shoreline is bounded on the seaward side by MLLW and on the landward side to where densely vegetated habitat, not used by the piping plover, begins and where the constituent elements no longer occur. Approximately 4.4 km (2.7 mi) are in Mississippi and 2.9 km (1.8 mi) are in Alabama. Almost half the Mississippi shoreline length is in the Grand Bay National Wildlife Refuge.

1.4.1.18 Red-Cockaded Woodpecker

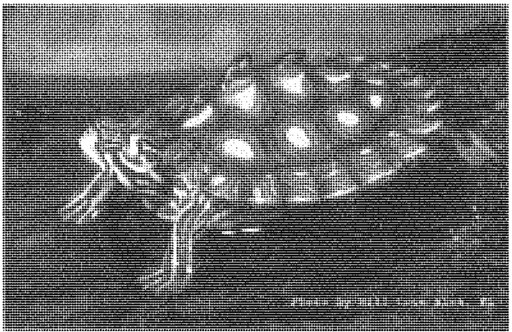
Red-cockaded woodpeckers (*P. borealis*) are small- to medium-sized woodpeckers 8 to 16 inches long, with a 20 to 24 inch wingspan (Figure 1.4.1.18-1). White spots on black feathers give the bird a "ladder- back" appearance. Red-cockaded woodpeckers have a white cheek patch on either side of the head, as well as a black cap. Male woodpeckers have thin red streaks on the cheeks that are barely visible (Natureserve 2000). Red-cockaded woodpeckers nest and forage in mature pine stands frequently burned to promote an open understory and thick herbaceous layer. Research indicates that red-cockaded woodpeckers excavate nest cavities in pines 60 years or older (USFWS 1998a). The birds were once abundant in pinelands throughout the southeastern U.S., but fire suppression, subsequent hardwood encroachment, conversion to short-rotation pine plantations, and development have eliminated most suitable habitat.

Source: USFWS
Figure 1.4.1.18-1. Red-Cockaded Woodpecker Photograph

The red-cockaded woodpecker is listed by the USFWS as endangered throughout its range. Scattered populations exist from southeastern Oklahoma to southern Virginia, south to Florida and eastern Texas. In Mississippi, red-cockaded woodpeckers have been reported in Harrison and Jackson Counties.

1.4.1.19 Yellow-Blotched Map Turtle

The yellow-blotched map turtle (*G. flavimaculata*) is a small turtle that gets its name from the distinctive yellow blotches on its carapace (top shell) (Figure 1.4.1.19-1). The turtle has a greenish-black body covered with yellow stripes. The plastron (bottom shell) is yellow to tan in color. Adult male turtles have been observed with carapace length between 3.5 to 4.8 inches, while the normally larger female turtles have been observed with carapace length of 4.1 to 8.5 inches (USFWS 1993). Several prominent spine-like projections extend from the top of the carapace. Yellow-blotched map turtles are endemic to the Pascagoula River system. They live in the main channels of rivers and large creeks; they have also been observed in oxbow lakes (USFWS 1993). These turtles have been observed in the Pascagoula and Escawtawpa Rivers in Jackson County. Yellow-blotched map turtles avoid small streams where the surface of the water is shaded by bank vegetation. Aquatic insects and snails are thought to make up a large part of the turtles' diet. Turtles often bask on snags and logs that have fallen in the water. Nesting occurs during the summer months on sandbar beaches (USFWS 1993).



Source: USFWS
Figure 1.4.1.19-1. Yellow-Blotched Map Turtle Photograph

Yellow-blotched map turtle populations in the upper Pascagoula watershed have been in decline since the early 1990s. Navigation improvement projects to remove logs and snags from the Pascagoula River have taken away structures needed by the turtles for basking (USFWS 1993). Snag removal has also adversely impacted populations of the turtles' invertebrate prey that use snags as habitat. Gravel mining activities in the watershed have increased sedimentation and further impacted aquatic invertebrate populations. Four reservoirs and ongoing channel modification projects in the Pascagoula River system have altered or eliminated sandbars that turtles use for nesting. These small, colorful turtles are illegally collected for the pet trade, and basking turtles are used for target practice by some individuals (USFWS 1993). Some turtles have been observed to drown in illegal catfish traps.

Water pollution is a serious problem in some Pascagoula River tributaries. Permitted industrial and municipal effluents degrade water quality (USFWS 1993). Brine discharge from oil fields and a dioxin spill that once prompted a fishing ban in the Pascagoula River have also impacted river water quality. Sedimentation and water pollution are threats to aquatic invertebrates, a main food source for the turtles. Food availability is thought to be a limiting factor for turtle populations. Nest predation is likely to average between 90% and 100%, typical for similar turtle species. Few juvenile turtles were observed in a 1989 survey. Reproduction might be impaired by lack of nesting habitat, exclusion of the turtles from suitable nesting beaches by excessive human presence, or effects of chemical pollutants on turtle reproductive biology. Direct and indirect adverse impacts to yellow-blotched map turtles would be expected from point and non-point source discharges of toxic chemicals, brine, sewage, and sediment to the Pascagoula River system (USFWS 1993).

1.4.2 Historical Trends

1.4.2.1 Introduction

There are 14 T&E species that use terrestrial or freshwater aquatic habitats, in the three coastal counties in Mississippi. Several of these species are endemic to Mississippi or the Gulf Coast, while others migrate long distances to breed or winter in coastal Mississippi. Population declines in some of these species are linked to effects of habitat loss, taking for food or pets, or water pollution in Mississippi. In other species, declines have been linked to phenomena outside the study area. Because most T&E species are rare, population information is difficult to obtain. A review of current literature shows most of the populations of listed species appear to be in decline or have stabilized at levels below what many scientists believe will ensure the long-term survival of the species. Populations of two listed bird species—the bald eagle (recently delisted) and brown pelican—appear to be increasing throughout the Southeast as effects of the now-banned pesticide DDT decrease with time. Although most of the listed species have habitat requirements more specific than the land use categories in the land use analysis, some useful conclusions can be drawn from the available data.

1.4.2.1.1 The Period of 1972 through 1992

Land area in Hancock, Harrison, and Jackson counties combined (excluding surface water) is just over 1.1 million acres. From 1972 to 1992, the largest land use change observed was a loss of more than 200,000 acres of pine forest. At the same time, agricultural lands and shrub-scrub and cutover land together increased by slightly more than 150,000 acres. Deciduous forest cover increased by about 40,000 acres. Urban land and land devoted to transportation infrastructure increased by more than 20,000 acres, while emergent wetlands declined by about the same amount. Overall, natural land cover declined by approximately 8 % from 1972 to 1992, while agricultural and shrub-scrub lands increased by more than half, and urban land by a third.

The decline of frequently burned, open-canopy longleaf pine woodlands has occurred throughout the southeastern U.S. in the past century. From 1972 to 1992, just over 200,000 acres of pine forest (including wet pine savannah) were lost in the three-county study area. Loss and fragmentation of mature pine forests are thought to be caused by a combination of fire suppression, hardwood encroachment, timber harvest, conversion to short-rotation pine plantations, and development (USFWS 1990a). Part of the observed increase of 40,000 acres of deciduous forest might be explained by fire suppression and hardwood encroachment in pine forests. The loss of the once-dominant longleaf pine forest has been implicated in the population declines for a number of now T&E species in the Southeast, including several species known from Hancock, Harrison, and Jackson Counties. Black pine snake, eastern indigo snake, gopher tortoise, Mississippi gopher frog, and red-cockaded woodpecker are all in some way dependent on frequently burned, open-canopy pine woodlands, and are in decline because of loss and fragmentation of their habitats throughout their range. Similarly, the population of the Mississippi sandhill crane that forages and breeds only in coastal wet slash pine savannah has been reduced to just over 100 birds. Population declines that led to the listing of these species were observed before 1992, and in many instances were underway before 1972.

Although habitat loss is frequently cited as a major cause for localized extinction of endangered species, the effects of habitat fragmentation are in many cases equally important. From 1972 to 1992, land use analysis shows losses of pine forests and emergent wetlands. Likewise, increases were observed in cutover land, shrublands, and deciduous forest, which reflect conversion of pine forest to these other types. Large areas of pine forest and wetlands have been fragmented into smaller habitats that are in many cases less suitable for the long-term survival of many species. For example, research indicates that eastern indigo snakes might require large areas of contiguous habitat in excess of 10,000 acres in order to thrive (Natureserve 2001b). Habitat fragmentation undoubtedly increased during the period from 1972 to 1992, and has been implicated as one of many continuing cumulative adverse impacts to T&E species.

Many species are listed as T&E for reasons beyond habitat loss and fragmentation. Trends in human behavior can be also significant to population dynamics of T&E species. Many of the federally listed reptiles in coastal Mississippi were at one time collected for the pet trade or for food. For example, Alabama red-bellied turtle eggs and adults have been collected for food by local residents (USFWS 1989). Gopher tortoises were also collected for food during the mid-20th century (USFWS 1990a), and eastern Indigo snakes were collected for the pet trade (Natureserve 2001b). The taking of listed reptiles and turtle eggs probably continued up until the time most the species were protected under the Endangered Species Act in the 1980s. Illegal and accidental take is still likely to occur into the future, but take has been observed to decline as exploitable species become scarcer and more difficult to locate (USFWS 1989).

Land use in urban and agricultural settings has indirect effects upon the rest of the watershed. For example, pesticides and herbicides can run off agricultural lands and leave residues in nearby streams and wetlands. The pesticide DDT was implicated in the drastic population declines of the bald eagle and brown pelican in the middle part of the 20th century. Since DDT was banned, bald eagle and brown pelican populations have rebounded. Although the effects of DDT appear to be waning, other pollutants are thought to be responsible for declines in some aquatic species in the three-county study area. For example, populations of yellow-blotched map turtle and pearl darter are thought to have been adversely impacted by point and non-point source discharges of toxic chemicals, brine, sewage, sediment, discharge from oil fields, and a dioxin spill (USFWS 1993). Some of these sources of pollution could be reflected in the observed increases from 1972 to 1992 of more than 20,000 acres of urban and transportation land in the three-county area. Along with increases in urban land come increases in impervious surface, which increased by about 10,000 acres from 1972 to 1992. Impervious surface is known to increase the rate at which runoff reaches streams. Urban runoff is a known non-point source of sediment and chemical pollutants that can have adverse effects to aquatic life.

1.4.2.1.2 The Period of 1992 through 2000

The years 1992—2000 saw an increase of about 8,000 acres of urban land and about 50,000 acres of cutover/scrubland in the three-county study area. At the same time, the 1.1 million-acre three-county area lost about 15,000 acres of agricultural lands, about 6,000 acres of deciduous forest, about 5,000 acres of emergent wetlands, and roughly 34,000 acres of pine forests. Losses in agricultural lands and deciduous forest represent a reversal from the observed increases in these land use types from 1972–1992. The rate of pine forest loss slowed by about half in the period 1992–2000, while the rate of increase in cutover/shrub land stayed about the same. It is likely that efforts to replant pine trees in timber production lands are catching up to the rate of timber harvest in the region. Under natural conditions there is some degree of change expected between cutover land, pine forest, and deciduous forest. Natural phenomena, such as fires, floods, and hurricanes, can dramatically rearrange the landscape. Also, species dominance in vegetative communities can change as old trees die and new trees of different species take their place. Forests, wetlands, and agricultural lands that are converted to urban uses tend to remain in urban use for long periods of time however and seldom change back to natural environments.

Agricultural lands were not considered “natural” for the purposes of this study. Some T&E species (such as the gopher tortoise and Louisiana black bear), however, have been observed foraging in pastures and field edges (USFWS 1990a, USFWS 1995). If left uncultivated, agricultural lands have the potential to revert to forests, floodplains, or other natural land use types. The small increase in natural lands seen from 1992 to 2000 in the three-county area most likely came at the expense of agricultural lands; agricultural lands lost about 15,000 acres during that time. That 15,000 acres was split to supply the acreage increases seen in natural and developed lands. Although agricultural lands are not considered primary T&E species habitat, conversion of pastures and farms to urban lands represents a loss of land available for habitat restoration projects.

1.5 Essential Fish Habitat

The Magnuson Fisheries Conservation and Management Act of 1976 (the Act) was passed to promote sustainable fish conservation and management. Under the Act, the NOAA, HCD was granted legislative authority for fisheries regulation in the United States within a jurisdictional area located between three miles to 200 miles offshore, Exclusive Economical Zone depending on geographical location. The NOAA, HCD was also granted legislative authority to establish eight regional fishery management councils responsible for the proper management and harvest of fish and shellfish resources within these waters. Measures to ensure the proper management and harvest of fish and shellfish resources within these waters are outlined in Fisheries Management Plans prepared by the eight councils for their respective geographic regions. The Mississippi Sound system and nearshore Gulf of Mexico is within the management jurisdiction of the Gulf of Mexico Fisheries Management Council.

NOAA, HCD recognized that many marine fisheries are dependent on nearshore and estuarine ecosystems for at least part of their life cycles. The Act was reauthorized, and changed extensively via amendments in 1996 (P.L. 104-297), which aimed to stress the importance of habitat protection to healthy fisheries. The authority of the NOAA, HCD and their councils was strengthened by the reauthorization to promote more effective habitat management and protection of marine fisheries. Specific marine environments important to marine fisheries are referred to as EFH in the Act and are defined as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity" (16 U.S.C. § 1802 (10)). The EFH regulations (at 50 C.F.R. 600 Subpart J) provide additional interpretation of the definition of EFH: "*Waters* include aquatic areas and their associated physical, chemical, and biological properties that are used by fishes and may include areas historically used by fishes. *Substrate* includes sediment, hardbottom, structures underlying the waters, and any associated biological communities. *Necessary* means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem. *Spawning, breeding, feeding, or growth to maturity* covers all habitat types used by a species throughout its life cycle." Tables 1.5-1 and 1.5-2 provide those species managed by the Gulf of Mexico Fishery Management Council and those species managed in the Gulf of Mexico under federally implemented Fishery Management Plans.

Table 1.5-1. Gulf of Mexico Fishery Management Council

Shrimp Fishery Management Plan	Stone Crab Fishery Management Plan
brown shrimp - *Farfantepenaeus aztecus*	Florida stone crab - *Menippe mercenaria*
pink shrimp - *F. duorarum*	Gulf stone crab – *M. adina*
royal red shrimp - *Pleoticus robustus*	
white shrimp - *Litopenaeus setiferus*	Spiny Lobster Fishery Management Plan
	spiny lobster - *Panulirus argus*
Red Drum Fishery Management Plan	slipper lobster - *Scyllarides nodife*
red drum - *Sciaenops ocellatus*	
	Coral and Coral Reef Fishery Management Plan
Reef Fish Fishery Management Plan	varied coral species and coral reef communities comprised of several hundred species
almaco jack – *Seriola rivoliana*	
anchor tilefish - *Caulolatilus intermedius*	
banded rudderfish – *S. zonata*	
blackfin snapper - *Lutjanus buccanella*	Coastal Migratory Pelagic Fishery Management Plan
blackline tilefish - *Caulolatilus cyanops*	
black grouper- *Mycteroperca bonaci*	cobia - *Rachycentron canadum*
blueline tilefish – *C. microps*	king mackerel – *Scomberomorus cavalla*
cubera snapper – *L. cyanopterus*	Spanish mackerel - *S. maculatus*
dog snapper – *L. jocu*	
dwarf sand perch - *Diplectrum bivittatum*	
gag grouper - *M. microlepis*	
goldface tilefish – *C. chrysops*	
goliath grouper - *Epinephelus itajara*	
gray snapper – *L. griseus*	
gray triggerfish - *Balistes capriscus*	
greater amberjack – *S. dumerili*	
hogfish - *Lachnolaimus maximus*	

lane snapper - *Lutjanus synagris*
lesser amberjack - *S fasciata*
mahogany snapper – *L. mahogoni*
marbled grouper – *E. inermis*
misty grouper – *E. mystacinus*
mutton snapper – *L. analis*
Nassau grouper – *E. striatus*
queen snapper - *Etelis oculatus*
red hind - *Epinephelus guttatus*
red grouper – *E. morio*
red snapper - *L. campechanus*
rock hind – *E. adscensionis*
sand perch - *Diplectrum formosum*
scamp grouper - *M phenax*
schoolmaster – *L apodus*
silk snapper – *L vivanus*
snowy grouper – *E niveatus*
speckled hind - *E drummondhayi*
tilefish - *Lopholatilus chamaeleonticeps*
vermilion snapper - *Rhomboplites aurorubens*
Warsaw grouper – *E nigritus*
wenchman - *Pristipomoides aquilonaris*
yellowedge grouper *E lavolimbatus*
yellowfin grouper – *M. venenosa*
yellowmouth grouper – *M interstitialis*
yellowtail snapper - *Ocyurus chrysurus*

Table 1.5.2. Species Managed in the Gulf of Mexico under Federally Implemented Fishery Management Plans.

Billfish
blue marlin - *Makaira nigricans*
longbill spearfish - *Tetrapturus pfluegeri*
sailfish - *Istiophorus platypterus*
white marlin - *T albidus*
Swordfish
swordfish - *Xiphias gladius*

Tuna
albacore - *Thunnus alalunga*
Atlantic bigeye - *T. obesus*
Atlantic yellowfin - *T. albacares*
skipjack - *Katsuwonus pelamis*
western Atlantic bluefin - *T. thynnus*
Sharks
Atlantic angel shark - *Squatina dumerili*
Atlantic sharpnose shark - *Rhizoprionodon terraenovae*
basking shark - *Cetorhinus maximus*
bigeye sand tiger - *Odontaspis noronhai*
bigeye sixgill shark - *Hexanchus vitulus*
bigeye thresher shark - *Alopias superciliosus*
bignose shark - *Carcharhinus altimus*
blacknose shark - *C acronotus*
blacktip shark - *C. limbatus*
blue shark - *Prionace glauca*
bonnethead - *Sphyrna tiburo*

bull shark - *C. leucas*
Caribbean sharpnose shark - *R. porosus*
common thresher shark - *A. vulpinus*
dusky shark - *C. obscurus*
finetooth shark - *C. isodon*
Galapagos shark - *C. galapagensis*
great hammerhead - *S. mokarran*
lemon shark - *Negaprion brevirostris*
longfin mako shark - *Isurus paucus*
narrowtooth shark - *C. brachyurus*
Caribbean reef shark - *C. perezi*
oceanic whitetip shark - *C. longimanus*
porbeagle shark - *Lamna nasus*
sandbar shark - *C. plumbeus*
sand tiger shark - *O. taurus*
scalloped hammerhead - *S. lewini*
shortfin mako shark - *I. oxyrinchus*
silky shark - *C. falciformis*
sixgill shark - *H. griseus*
smalltail shark - *C. porosus*
smooth hammerhead - *S. zygaena*
spinner shark - *C. brevipinna*
whale shark - *Rhinocodon typus*
white shark - *Carcharodon carcharias*
night shark - *C. signatus*
nurse shark - *Ginglymostoma cirratum*
sharpnose sevengill shark – *Heptranchias perlo*
tiger shark - *Galeocerdo cuvieri*

CHAPTER 2. PROBLEMS AND OPPORTUNITIES

2.1 Problems

The problems caused by Hurricane Katrina within Coastal Mississippi are in association with the unprecedented storm surge and associated coastal flooding as a result of the large volumes of storm surge introduced into the system from the south, during the landfall of the tidal surge. Sediment and debris carried by the surge into many areas of the coastal system further impeded flow through drainage systems and has exacerbated existing coastal flooding, making the entire study area even more susceptible to inundation from smaller hurricanes, tropical storms, or even severe rainfall events.

The unprecedented storm surge has caused increased coastal erosion along the barrier islands coastline, the mainland shoreline, and along tidal and freshwater bodies throughout the study area. Some small communities in Coastal Mississippi suffered complete destruction, while others received unprecedented damage. The natural systems have further been degraded and in some cases, suffered complete destruction. Salt marshes and freshwater marshes suffered erosion and debris fill deposits on top of them. Coastal forests lost numerous trees as a result of the winds and numerous trees were killed due to salt spray as far inland as 20 miles. As a result, the natural environment has experienced further losses to fish and wildlife habitats and an overall decline in water quality. Due to the widespread destruction, there is increased development pressure being felt on remaining natural lands as people return and begin looking for housing. A number of residential and commercial developments are being proposed further inland of the coast, which has resulted in once natural lands becoming increasingly urbanized. This contributes to the ongoing problems that have faced Coastal Mississippi throughout the last two decades.

2.2 Opportunities

A comprehensive ecological analysis is being considered as part of the long-term efforts in Coastal Mississippi. This will ensure the stability and future sustainability of the natural system within Coastal Mississippi while enhancing the productivity of fish and wildlife habitat and restoring critical loss of fish and wildlife habitat that once existed. In addition to the environmental benefits, the economic benefits to the area will be realized for decades by preventing future damages to structures. Ongoing Corps programs, such as Continuing Authorities Programs, and opportunities exist to partner with the State of Mississippi and various other local NGOs to take advantage of ongoing established restoration programs. This partnering effort enables the Corps, Mobile District to ensure no duplication of efforts occurs while also building onto valuable relationships with State and local city and/or county governments and NGOs in order to ensure preservation of fish and wildlife habitat, restoration of ecosystems, prevention of saltwater intrusion, and ensure future sustainability of the diverse natural system that used to exist in Coastal Mississippi. Opportunities associated with the environmental component of the Comprehensive Report and Integrated Programmatic EIS include:

- Reduction of future hurricane and storm damage created by storm surge;
- Prevention of future saltwater intrusion exacerbated by storm surge associated with Hurricane Katrina;
- Reduction of coastal erosion due to shoreline instability;
- Restoration of ecosystems for preservation of fish and wildlife; and

- Reduction of loss of life and property by moving people out of low-lying, environmentally sensitive areas.

2.3 Study Goals and Objectives

Congress directed the Corps to conduct an analysis and design for comprehensive modifications and improvements in the Mississippi coastal area for the purposes of hurricane damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resources purposes. Coastal Mississippi was the point of impact of the greatest tidal surge that has hit the mainland of the U.S. in its recorded history.

Around the 1950s, Coastal Mississippi had heightened development with both commercial and residential structures. Population began to increase during this period also. This increase continued with the onset of Hurricane Camille and has continued with each hurricane event. It is anticipated to increase following Hurricane Katrina.

With this development came the filling in of various kinds of wetland habitats. Natural ecosystem habitats, such as tidal marsh, freshwater marsh, wet pine savannah, and beaches, were altered, if not, completely destroyed. This development was severely impacted by the storm surge associated with Hurricane Katrina. Unfortunately much of Coastal Mississippi has been completely lost – both environmentally and culturally. The MsCIP effort will formulate alternatives that address Congress directives. In order to fully accomplish Congress directives - hurricane damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resources purposes - the MsCIP efforts were divided between non-structural, structural, and environmental. These three PDTs worked closely to develop alternative(s) that accomplished all directives.

CHAPTER 3. DEVELOPMENT OF ENVIRONMENTAL MEASURES AND ALTERNATIVES

3.1 Environmental Restoration Measures Evaluated

The formulation of measures was based on watershed-scale assessments of hurricane and stormwater damage, saltwater intrusion, preservation of fish and wildlife, coastal erosion, flooding, navigation, and other problems and opportunities, in a collaborative approach involving Federal, state and local agencies, stakeholders, citizen groups, and NGOs. The strategy for analyzing post-storm conditions, both for past and potential future events, was developed by the interagency PDT, and reviewed by ITR Team, with approval by the Corps-HQ.

The interagency PDT is comprised of representatives from the following:

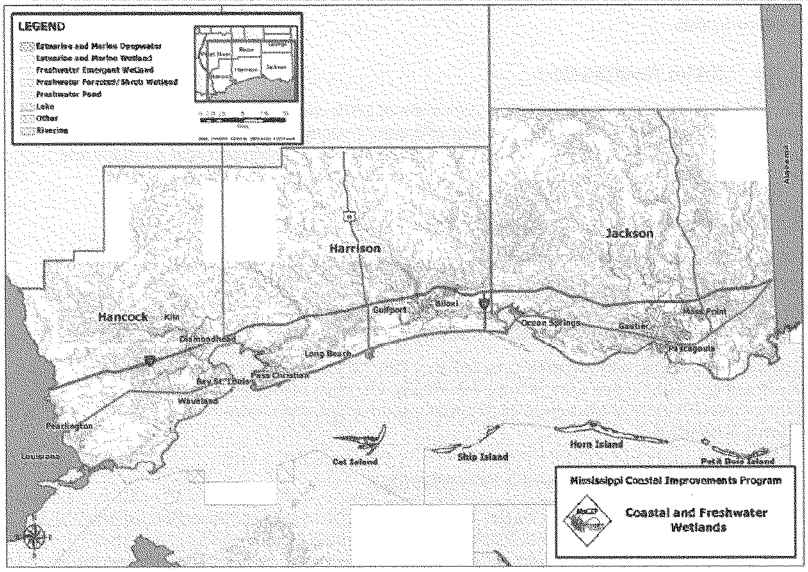
- USEPA
- FEMA
- USFWS
- NPS
- NOAA Fisheries, PRD and HCD
- NWS
- NRCS
- USGS
- MDMR
- MDEQ
- MDOT
- Mississippi SHPO
- Hancock, Harrison and Jackson Counties
- Communities of Bay St. Louis, Biloxi, D'Iberville, Gautier, Gulfport, Long Beach, Moss Point, Ocean Springs, Pascagoula, Pass Christian, and Waveland
- Coastal Restoration Network
- TNC
- Audubon Society
- Sierra Club

In analyzing potential measures, the PDT considered, in all cases in which it would be appropriate, integration of environmental measures within structural and non-structural potential solutions. The following measures have been identified as measures to be examined.

In order to manage all potential measures, the lines of defenses (LOD) concept were developed as a means to effectively address Coastal Mississippi. The LODs moving from offshore, to nearshore, shoreline, and inland, effectively reduce damage potential from large hurricane and storm events. The LOD concept is intended to extend the damage reducing attributes of natural or man-made features and to limit, as far as practicable, the inland reach of destruction. The concept is reasonably flexible and can be tailored to topographic and physical advantage, public preference, and economy.

LOD 1 consists of the four barrier islands that lie several miles to the south. These barrier islands are located along a littoral drift zone that moves sand westward creating three elongated islands and then to the westward most island where littoral currents are not as well defined. LOD 2 consists of essentially all the beaches along coastal Mississippi. Harrison County has the most beachfront with 26 miles extending from Biloxi Bay to St. Louis Bay. Hancock and Jackson County have several miles of beach. The beaches extend along less than half of the Mississippi coastline. Most of the dunes that existed along these beaches were destroyed by Katrina and much of the beach was damaged. LOD 3 consists of raising the roadway or seawall. All of the beaches described as LOD 2 have a roadway landward of the beach. The roads vary from local or county roads to U.S. Highway 90, a four-lane highway that extends across the entire Harrison County coast. The roadways vary in elevation from a few feet to several feet above sea level. All of these roads are evacuation routes and all have been damaged in past hurricanes. This coastal barrier will connect to public right-of-ways that will structurally tie these roadways to other, higher, LODs inland. Also associated with this continuous barrier will be several ring structures that will encircle areas that cannot be included behind the primary line. This will include the cities of Pascagoula, Moss Point, Gautier and Pearlington as well as some large residential developments. LOD 4 is would be the highest line. In order to protect much of the developed areas around Biloxi and St. Louis Bays, this line would be a structural barrier that would also cross the mouth of these bays. These barriers would be to prevent storm surge from moving in through the inlets of the bays. The structural barrier across the bays could be similar to designs used in Europe for storm surge protection. The general alignment of line 4 is envisioned along the path of a railway that crosses the coast of Mississippi. Computer simulations have predicted how far inland storm surge will extend if the worse-case hurricane hits the Mississippi coast. This would consist of LOD 5 and represents a line of safety where homes, facilities or transportation routes north of this line should not be affected by storm surge. This would be an area where hospitals, schools, emergency response and management facilities might be located. Present predictions based on modeling sets this line near elevation 40 feet.

The following environmental measures were evaluated and screened by the MsCIP Environmental PDT based on applicability to the specific problem area. Preliminary measures were assessed by the interagency PDT that included excavating, planting native species, removing exotic species, microtopographic contouring, and restoring of hydrologic connections (Figure 3.1-1). These were all carried further for additional development. The following measures were developed for ecosystem restoration. Several of these measures include integration of non-structural and structural components.



Source: Corps

Figure 3.1-1. Coastal and Freshwater Wetlands

3.1.1 Measures Addressing Saltwater Intrusion

Consists of evaluation of current conditions of saltwater effects on expansive marsh systems located in western and eastern portions of Coastal Mississippi. Diversions of freshwater from existing river systems and other potential measures would be evaluated based on ecosystems needs.

3.1.2 Ecosystem Restoration of Historical Wetlands Previously Developed

Development of an analysis tool – SDSS – by which to prioritize potential environmental restoration and/or homeowners assistance and relocation project areas based on historical conditions, damages from storm surge and coastal flooding, and location to existing natural undisturbed lands (i.e. potentially State of Mississippi or Federal lands).

3.1.3 Barrier Island Restoration

Partnering with the NPS to develop a vision for the barrier islands that would restore the sediment transport and budget system by implementing beach, dune, and littoral system restoration projects, as well as further evaluate the merits of additional restoration of damaged ecosystems including beach and dune restoration, restoration of salt and freshwater marshes, and revegetation of maritime forests.

3.1.4 SAVs Restoration

Development of a program to determine conditions of SAVs and to determine causes of resource degradation. Identify opportunities to partner with other Federal and state agencies, as well as universities and/or NGOs, to establish research necessary to establish potential solutions and projects.

3.1.5 Incorporation of State of Mississippi Initiative

Continued partnership with MDMR to develop and compliment State of Mississippi projects as opportunities arise.

3.1.6 Restoration of Coastal Forests

Continue partnership with the NPS to further evaluate the feasibility of restoring coastal forests destroyed by the hurricane along the barrier islands. Continue partnership with MDMR to develop and compliment State of Mississippi projects as opportunities arise concerning the mainland of Coastal Mississippi.

3.1.7 Clean-up of Impaired Waterbodies

Determine which waterbodies in Coastal Mississippi were not cleared of deposited sediment and debris as part of the FEMA mission. Establish partnering opportunities with local and state governments to determine increased risks of flooding and develop potential projects that would lessen that risk.

3.1.8 Restoration of degraded coastal wetlands

Continue to assess the degradation of coastal wetlands using the analysis tool – SDSS – in conjunction with the resource agencies to identify additional potential restoration opportunities.

3.1.9 Restoration of Oyster Resources

Continue developing and coordinating with MDMR to implement their restoration of oyster resources wherever feasible. Also incorporate oyster restoration in any applicable proposed projects.

3.1.10 Restoration of Fishing Reefs

Develop a partnership with MDMR to assist in their existing fishing reef program to identify any additional potential locations while also addressing any potential improvements in Mississippi Sound's water quality.

3.1.11 Restoration of Marshes

Development of an analysis tool – SDSS – by which to prioritize potential homeowners assistance and relocation project areas based on historical conditions, damages from storm surge and coastal flooding, and location to existing natural undisturbed lands (i.e. potentially State of Mississippi or Federal lands).

3.2 Development and Evaluation of Mitigation Measures

3.2.1 Potential Mitigation Associate with Non-Structural, Hurricane Storm Damage Measures

Work with the Corps, Non-Structural Team to assess mitigation requirements associated with implementation of the non-structural plans.

3.2.2 Potential Mitigation Associated with Structural, Hurricane Storm Damage Measures (LODs 1-5)

Work with the Corps, Structural Team to assess mitigation requirements associated with implementation of the structural plans.

3.2.3 Potential Mitigation Associated with Structural and Non-Structural Hurricane Storm Damage Measures (LODs 1-5)

Work with both Corps teams to assess mitigation requirements associated with implementation of components of both plans.

3.2.4 Potential Mitigation Associated with Saltwater Intrusion Reduction in Mississippi Sound

Evaluate impacts of diverting freshwater from existing river systems would be evaluated based on ecosystems needs.

3.2.5 Potential Mitigation Associated with Erosion Reduction Measures

Work with both Corps team to assess erosion reduction measures.

CHAPTER 4. PLAN FORMULATION

4.1 Plan Formulation

The development of measures to address ecosystem restoration integrated the input of the multi-disciplinary, and the potential areas as discussed in *Chapter 3*. The multi-disciplinary PDT assessed potential restoration sites in Coastal Mississippi based on the following initial screening criteria:

- Does not require human intervention for recovery
- Does require human intervention for recovery

The multidisciplinary PDT then evaluated sites based on their significance on the following three levels:

- National
- Regional
- Local

The environmental PDT was faced with assessing the three counties in Coastal Mississippi, which consists of hundreds of thousands of acres of uplands, wetlands, urban, coastal forest, etc. This assessment had to be conducted in a consolidated amount of time in order to meet the MsCIP condensed schedule; therefore, the team quickly began compiling various data, such as topographic maps, navigational charts, water quality reports, soil maps, etc, that would be useful in assessing potential restoration efforts. The environmental PDT also had ERDC develop the GIS-based SDSS analysis tool that could effectively assist the team in quickly narrowing down evaluation sites. In addition, the environmental PDT also coordinated closely with both the non-structural and structural PDTs to assess impacts of implementing those measures. The environmental PDT provided ample input to minimize environmental impacts, such as moving the footprint(s) and/or providing natural defenses rather than hardened structures against storm damage.

4.1.1 Goals and Objectives

- Recommend solutions that would assist the people of Coastal Mississippi in their efforts toward recovery of pre-hurricane conditions in the areas of coastal erosion, preservation of fish and wildlife, and prevention of saltwater intrusion
- Recommend measures that would provide for sustainability of the overall natural system
- Recommend measures which integrate ecosystem restoration with storm damage reduction and non-structural plans
- Recommend continued analysis of specific problem areas that require further study to arrive at viable solutions
- Recommend implementable projects directed at recovery of ecological resources along the coast of Mississippi to pre-hurricane conditions, and to examine potential measures that might be implemented to increase sustainability of those resources during future events
- Recommend measures that would provide short-term or long-term recovery of natural resources

- Recommend implementable projects directed at either the stabilization or retreat of saltwater intrusion in the coastal zone exacerbated by the hurricanes, and to examine opportunities for minimization of saltwater intrusion during future events
- Recommend implementable projects directed at recovery of shore erosion protection measures along the coast of Mississippi to their pre-hurricane conditions, and to examine the opportunity for potential increases in the level of protection

4.1.2 Planning Constraints

There are a number of issues that constrain development of certain potential measures that include:

- NPS Policy and Wilderness Areas
- T&E Species and/or Critical Habitat
- State of Mississippi Coastal Zone Management Plan
- State of Mississippi Water Quality standards
- CWA
- NHPA
- CAA
- EFH
- Environmental Justice
- Protection of Children
- CBRA

A detailed discussion of these can be found in the Integrated Comprehensive Main Report/Programmatic EIS.

Managing sediment to benefit a region potentially saves money, allows use of natural processes to solve engineering problems, and improves the ecosystem. As a management method, RSM includes the entire environment, from the watershed to the sea, accounts for the effect of human activities on sediment erosion as well as its transport in streams, lakes, bays, and oceans, and protects and enhances the nation's natural resources while balancing national security and economic needs. RSM is the Corps's standard operating practice for managing sediment on a holistic approach (i.e. regionally) rather than a project specific approach. The Corps recognizes that actions at one specific location have affects regionally. RSM will be considered during evaluation, design, and implementation of potential measures.

The State of Mississippi as part of Gulf of Mexico Alliance has acknowledged that sediment resources are integral to accomplishing many restoration initiatives. It is also recognized that there is a need for a better understanding of regional sediment systems and processes to inform decisions about projects and actions that use or affect sediment resources. Mississippi is actively involved in the development of a Gulf RSM Master Plan as an implementation action for the Gulf Alliance Conservation and Restoration Workgroup with the objective to develop a regional master plan that uses the understanding of sediment dynamics (inputs, outputs, movement) to manage sediment resources towards implementing environmental restoration, conservation, and preservation while reducing coastal erosion, storm damages, and associated costs of sediment management. The regional sediment management plan will also help link sources of sediment with sediment needs, provide a basis for assessing competing needs for sediment, and foster more cost-effective sediment management.

4.1.3 Public and Agency Involvement

- April 7, 2006 – Over 60 Federal, State and local government agency representatives and other community leaders from business and industry gathered in Biloxi to identify early needs, opportunities and recommendations for the MsCIP process.
- April 10, 11, and 13, 2006 – Public Meetings were held in Harrison, Jackson and Hancock Counties to examine a broad range of potential coastal protection options and solicit public input on designing comprehensive improvements.
- April 18, 2006 – An online agenda of the April 10-13, 2006 public meetings was held for displaced coastal residents or those who could not attend the public meetings.
- April 24 and 25, 2006 – A second Regional Coordination meeting of governmental, business and industry stakeholders was held in Biloxi. The session probed for missing or overlooked ingredients in the near-term planning process.
- May 1, 2, and 4, 2006 – A second round of public workshops was conducted where near-term projects and the screening criteria used to select them were presented.
- May 3, 2006 – A follow-up online workshop was held for displaced coastal residents or those unable to attend public meetings.
- August 21-22, 2006 – A third Regional Coordination Meeting including government partners, business and industry was held in Biloxi. Issue-related subgroups for structural, non-structural, barrier island restoration, and environmental solutions offered specific comments and recommendations to Corps planners and subject matter experts.
- December 19, 2006 – A scoping workshop session was held at MDMR to gather public input for the Integrated Programmatic EIS.
- February 6 and 9, 2007 – Online meetings for structural, nonstructural, environmental, and barrier island working groups took place. Participants had the opportunity to submit comments and be part of a facilitated discussion.
- April 5, 2007 – A public workshop was held to help finalize MsCIP measures for structural, nonstructural, environmental issues, and barrier islands. A 2-part session enabled participants to interact with Corps planners on emerging planning concepts in the first segment and formally comment on the plan during the second part.
- July 9 and 10, 2007 – A Risk Analysis workshop was held at the MDMR to weight the risk impacts to the proposed effort.
- August 13 and 14, 2007 – A follow-up to the Risk Analysis workshop was held at MDMR.
- March 16, 18, and 19, 2009 – Public Hearings for the Draft Comprehensive Main Report/Draft Integrated Programmatic EIS document.

4.1.4 Plan Formulation Process

The screening of measures discussed above and also in the Integrated MsCIP Comprehensive Report and Programmatic EIS resulted in the following measures being forwarded for potential inclusion in a list of plans for the study area:

- Ecosystem Restoration for preservation of fish and wildlife;
- Freshwater Diversions for prevention of saltwater intrusion;
- Barrier Islands Restoration;
- SAVs Restoration;
- Potential Projects Developed During Interim Report Preparation; and
- Ecosystem Restoration coupled with Storm Damage Reduction through relocations.

The screened list of measures was then combined into a group of well-balanced alternatives that address the suite of problems plaguing Coastal Mississippi. Formulation of these alternatives also incorporated the following complementary measures:

- Integration of projects associated with ongoing recovery efforts;
- Compatibility with other Federal, state, and local programs; and
- Acceptability with the public citizens within the study area.

In addition, the "No-Action" Plan was also developed as a means of comparison to the other alternatives, and as a potentially viable alternative in and of itself.

The plan formulation process began with defining the overall comprehensive natural system and its current state post-hurricane impacts. The MsCIP environmental team compared the post-hurricane conditions to the pre-hurricane conditions. In some cases, ecological contrasts were very great while in other instances not much change had occurred. The environmental team worked with a variety of Federal, state, and local entities to adequately address the magnitude of problems plaguing Coastal Mississippi. Minor problems to complex integrated problems were identified and discussed amongst the team members – structural, environmental, and non-structural. Development of a comprehensive list of problem areas consisted of single or multiple problems associated with a given site that were first identified as having been caused or exacerbated by the hurricane events. These sites were identified with a) coastal erosion; b) damage to fish and wildlife resources, and/or c) saltwater intrusion.

Hurricane-caused problem areas were solicited from, and then discussed, with members of the public, state, local, and other Federal agencies, representatives of industry and commerce, and resource agencies concerned with study area resources, at a series of open meetings previously discussed. The meetings also included a web-cast intended on reaching those that could not physically attend one of the in-field meetings.

Hurricane-caused problems have been investigated in a series of on-going site visits conducted in partnership with local representatives including municipalities, state resource agencies, and Federal partners, to ensure a comprehensive list of the problem areas are developed to address a full range of suitable measures and plans to deal with the identified problems.

4.1.4.1 Screening Criteria

After an initial screening of problem areas to determine their link to the hurricanes, a list of potential problem-solving measures was developed for each problem area. Problem-solving components consists of an array of potential solutions, such as excavating fill at a site, re-planting a destroyed area, restoring tidal flow into an area, or increasing freshwater into an estuarine system. Each problem area was then evaluated in relation to; a) its potential for inclusion as a project recommended for construction; b) its identification as a long-term solution that needs more technical analyses based on the complexity of the system; c) longer term effort; and d) detailed technical analysis required to adequately address the system. If these criteria could be satisfied, each problem area was then evaluated for their inclusion in the MsCIP Comprehensive Report and Integrated Programmatic EIS. For those projects screened out early during the plan formulation process a section included in this Environmental Appendix entitled Integrated Programmatic EIS – Effected Environment provides the impact analysis for those screened projects.

The list of measures developed for each problem area was more fully developed, and specific measures formulated for each site. These measures were then evaluated and screened once again, according to their continued technical, environmental, and cost-effectiveness feasibility, based on more detailed input from the resource agencies, public and private entities, and technical staff, and their ability to be combined into multi-purpose alternatives, capable of dealing with more than one identified problem at a given site.

The screened list of measures was then combined into a group of well-balanced alternatives, that included both non-structural and if applicable, structural measures that could potentially address the entire suite of problems plaguing an individual site or problem area. Formulation of these alternatives also incorporated the following criteria:

- Does a proposed alternative provide for potential preservation of fish and wildlife and their habitats?
- Does a proposed action or project negatively impact low income or minority populations and/or protection of children?
- Does a proposed alternative provide a potential reduction in coastal erosion?
- Does a proposed alternative provide a potential reduction in the extent or level of saltwater intrusion?
- Does the proposed project fit in, with, or compliment the objectives of the State and/or locals plans and desires for the area?
- Does the proposal contribute to the short-term or long-term recovery of Coastal Mississippi?

Using these questions, as screening criteria in a narrowing of the potential list of measures, the PDT provided for formulation of better project components and alternative plans. This guided the process so that each alternative formulated incorporated measures that would be complimentary while also being mutually exclusive measures that would be evaluated as components of separate alternatives for the following criteria:

- Effectiveness
- Completeness
- Acceptability (Applies to existing Laws and Regulations)
- Efficiency (cost-effectiveness)

The following measures were forwarded for potential inclusion in a list of alternatives for the Coastal Mississippi study area:

- Ecosystem Restoration for Preservation of Fish and Wildlife;
- Freshwater Diversions for prevention of saltwater intrusion;
- Barrier Islands restoration; and
- SAV Restoration

The screened list of measures was then combined into a group of well-balanced alternatives that addresses the entire suite of problems plaguing an individual site or problem area. The following alternatives were then developed and carried forward for further analysis:

1. The No-Action Plan
2. Freshwater Diversions within the Hancock County and Grand Bay Marshes
3. Purchase, removal of structures, and ecosystem restoration within historical wetlands previously developed
4. Restoration of Barrier Island Ecosystems
5. Restoration of SAVs within Mississippi Sound
6. Projects from Interim Report carried for further consideration
7. State Initiative Projects

4.1.4.1.1 Results of Initial Screening Criteria

- Assess barrier island restoration (i.e. entire restoration – including littoral placement, vegetation only, SAV)
- Assess LOD 2 benefits of dunes
- Saltwater Intrusion was assessed through ERDC's water quality models evaluation to assess if a change would occur from freshwater diversion (reference Section 1.1.7)
- Identify environmental restoration in Coastal Mississippi by reducing potential areas through running the GIS-based SDSS analysis tool

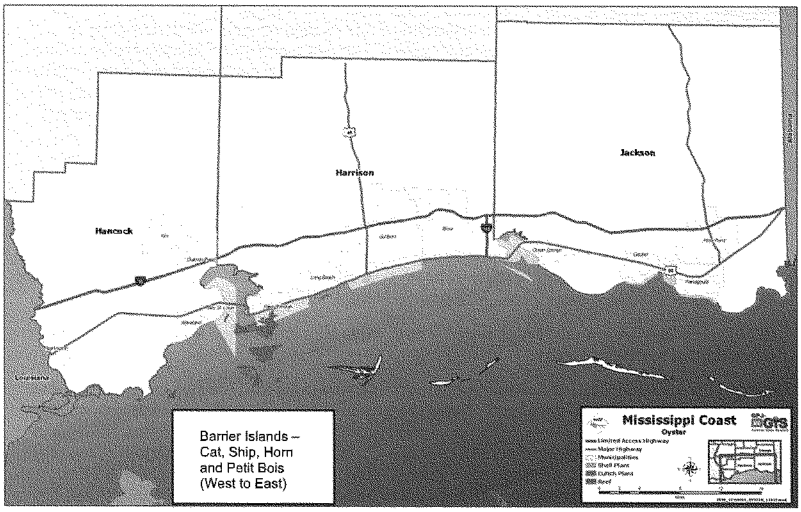
4.1.4.1.2 Results of Secondary Screening Criteria

- Barrier Island restoration options would be carried forward for further study
- Water quality model indicated freshwater diversion on the western and eastern portion of the state did change the salinities in Mississippi. Further study is required due to the complex ecosystem.
- Utilized local knowledge and ground-truthing to narrow down potential environmental restoration
- Identified the need for SAV advanced monitoring and mapping needs in Mississippi Sound
- Established a potential partnership with the State of Mississippi Universities and identified a potential pilot project

4.1.5 Environmental Restoration Measures

4.1.5.1 Freshwater Diversion

A freshwater diversion project may serve to enhance the wildlife resources of the area. While there is some disagreement to the benefits of freshwater diversion projects (Turner 2006), further study will assist in determining if such diversions are ecologically feasible in eastern Jackson County, Grand Bay Savannahs and Marshes, and in western Hancock County, Hancock County Marshes. Freshwater diversions enable redistribution of freshwater and much needed sediments to these systems that are experiencing losses and erosion. Hydrodynamic circulation, salinity, and water quality model calibrations have been conducted for Mississippi Sound. Existing or baseline salinity and water quality distributions were established for March – September 1997 and 1998. Alternative freshwater diversion scenarios were developed and simulated with the calibrated models to examine changes to the baseline salinity and water quality distributions. Freshwater diversion did impact the ecosystem in Jackson and Hancock Counties. Oysters are sensitive to specific ranges of salinity; therefore, freshwater diversions have the potential to either enhance or threaten the resource (Figure 4.1.5.1-1).



Source: MDMR

Figure 4.1.5.1-1. Active Oyster Resources in Mississippi Sound

4.1.5.2 Environmental Restoration of Historical Wetland Sites

The Corps, Mobile District began investigations for identifying potential environmental restoration sites for the purposes of storm-and flood-damage reduction, flood reduction, preservation of fish and wildlife habitat, and removal of habitable structures within high hazard areas. When residential and/or commercial structures and/or land are purchased for the purpose of restoring floodplain areas (i.e. non-structural component), the structures are demolished and the land is no longer available for residential and/or commercial development. Historically, when land is purchased across the U.S., it is left with all or some of the infrastructure at the site rather than restoring it to its historic setting. With the MsCIP environmental plan, land that is purchased (i.e. non-structural component – refer to Non-structural Appendix) would then be restored into functional wetlands. The Hydrogeomorphic (HGM) Approach is a collection of concepts and methods for developing functional indices and subsequently using them to assess the capacity of a wetland to perform functions relative to similar wetlands in a region. The Corps, Mobile District, in cooperation with ERDC, developed a tool to help identify potential restoration sites throughout the study area. A more comprehensive explanation of the SDSS effort used to identify historical wetlands is located in ERDC's *A Wetland Restoration SDSS for the Mississippi Gulf Coast* report (Linn 2007) included in this Environmental Appendix.

Development of a GIS based SDSS tool allowed the Corps, Mobile District, working in cooperation with the USFWS and MDMR, to identify and prioritize potential wetland restoration areas throughout Coastal Mississippi. A subset of potential restoration sites were identified by the SDSS tool and then ground-truthed by the MsCIP environmental team, including ERDC, Corps, MDMR, and USFWS. This interagency team allowed us to both confirm the accuracy of the SDSS results and to collect additional on-site information pertinent to restoration efforts. There are some major benefits in using a GIS-based SDSS approach to wetland restoration. First, it allows for the relatively rapid assessment of the large number of restoration sites across the wide study area. Second, potential sites can be evaluated and restored in a watershed or landscape context, which allows us to comprehensively evaluate the overall natural system. This approach can maximize the benefits of wetland restoration, as opposed to simply restoring wetlands where convenient or where property is available. Essentially use of this SDSS tool allowed the MsCIP environmental team to assess the entire coastline as a holistic natural system; thus, the team was more effectively able to analyze needs in Coastal Mississippi.

The SDSS effort resulted in the following products:

1. A ModelBuilder based SDSS tool, which can be subsequently edited and applied to other areas along Coastal Mississippi in the future as funding becomes available;

2. Maps, such as aerial photography, topographic, soil layers, etc., depicting areas in the study region that have a high probability of being successfully restored into wetland functions that buffer and/or store stormwater, and provide suitable habitat for fish and wildlife;

3. Photograph documentation and data sheets containing information on ground-truthed potential restoration sites.

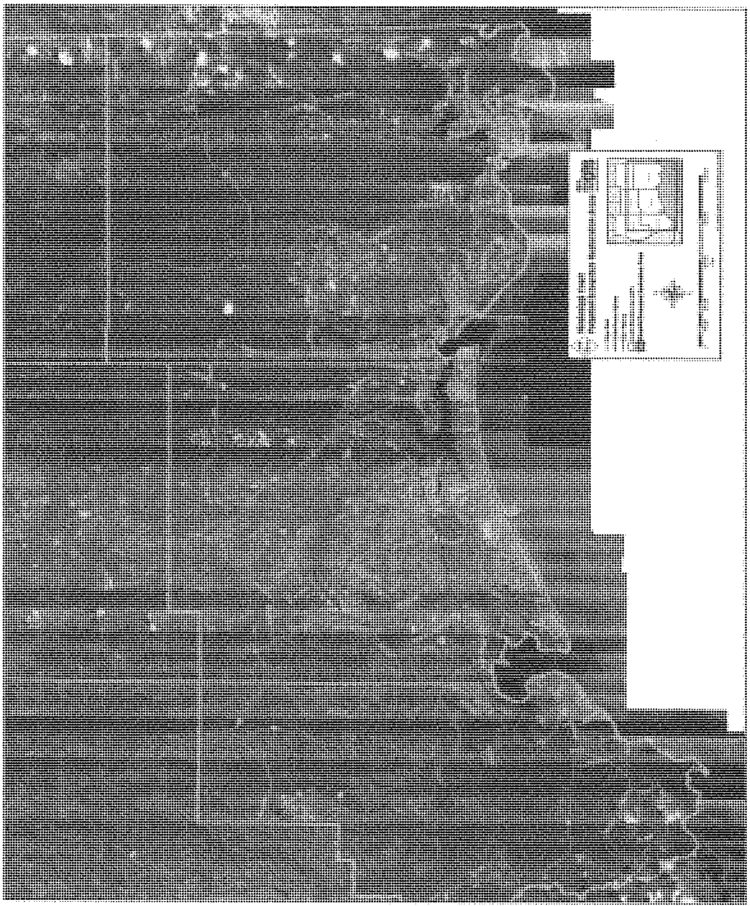
Initial runs of the SDSS tool yielded numerous sites that had to be screened by the Corps, Mobile District, MDMR, and USFWS personnel. The professional team ranked several variables, such as land ownership, proximity to State and other preserved lands, such as the Grand Bay NERR and wildlife management areas, acreage of site, proximity to water, site complexity, potential diversity of natural ecosystem at the site, existing and historical soils, etc., to screen the large list of SDSS sites. The team used these ranked variables for evaluation in order to identify those critical natural systems that would benefit the comprehensive system. Identified environmental restoration sites include a combination of those identified based on the SDSS results, as well as some additional sites (i.e. State Initiatives). These were made using only the non-natural land-use and 100-year flood calculations as the original site selectors (i.e. no damage layers were used), and sites were greater than or equal to 5 acres.

The sites contained the following characteristics:

- Sites were greater than 5 acres in size;
- Sites contained an SDSS Restorability class greater than Low or Medium Low;
- Sites contained an SDSS Habitat class greater than Low or Medium Low; and
- Sites contained an SDSS Storm Surge/Flood Protection class greater than Low.

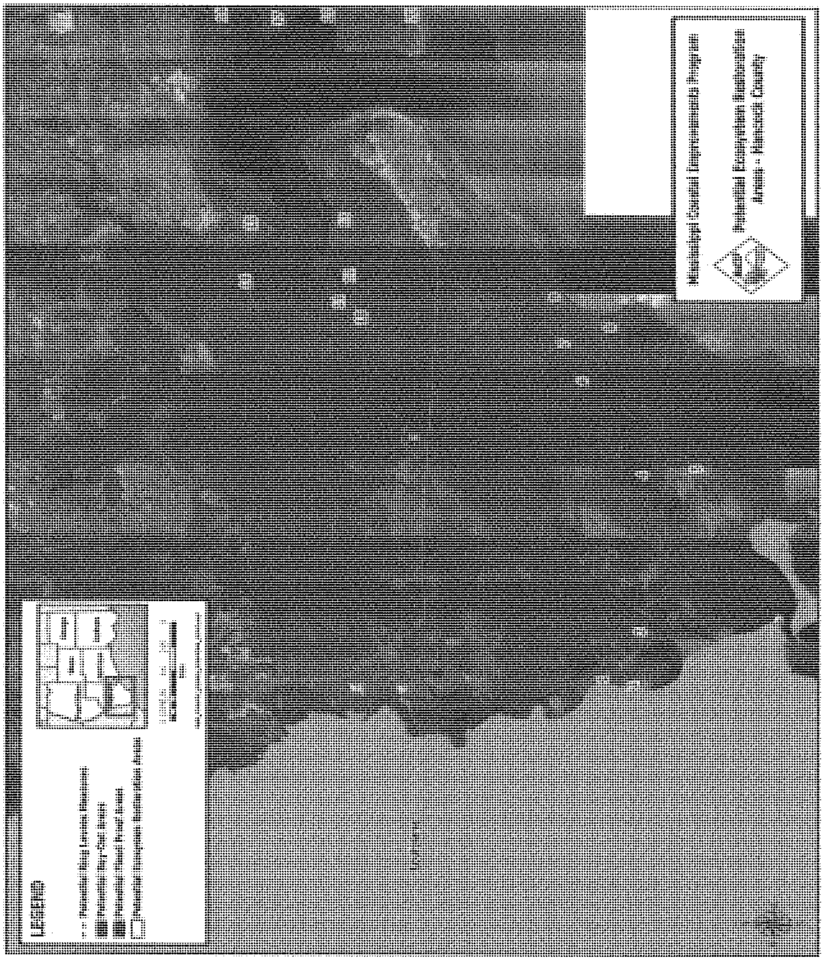
This project has been further coordinated with the ongoing efforts of the MsCIP non-structural flood-proofing committee, and their results were used as the team identified potential restorations sites in Coastal Mississippi. The following selection of 34 restoration sites was based on a combination of results from the SDSS tool and input from MDMR personnel based on local knowledge of the study area and adjacency to existing sensitive protected natural areas (i.e. State and/or Federal lands). Each of the environmental sites were evaluated and screened by using the following criteria:

availability, acceptability, location (i.e. proximity to State of Mississippi owned-lands and greenspace), accessibility, and recreational possibilities. Reference Figures 4.1.5.2-1 to 4.1.5.2-4 and Table 5.1.1.1.1-1 for the specific identified environmental restoration sites.



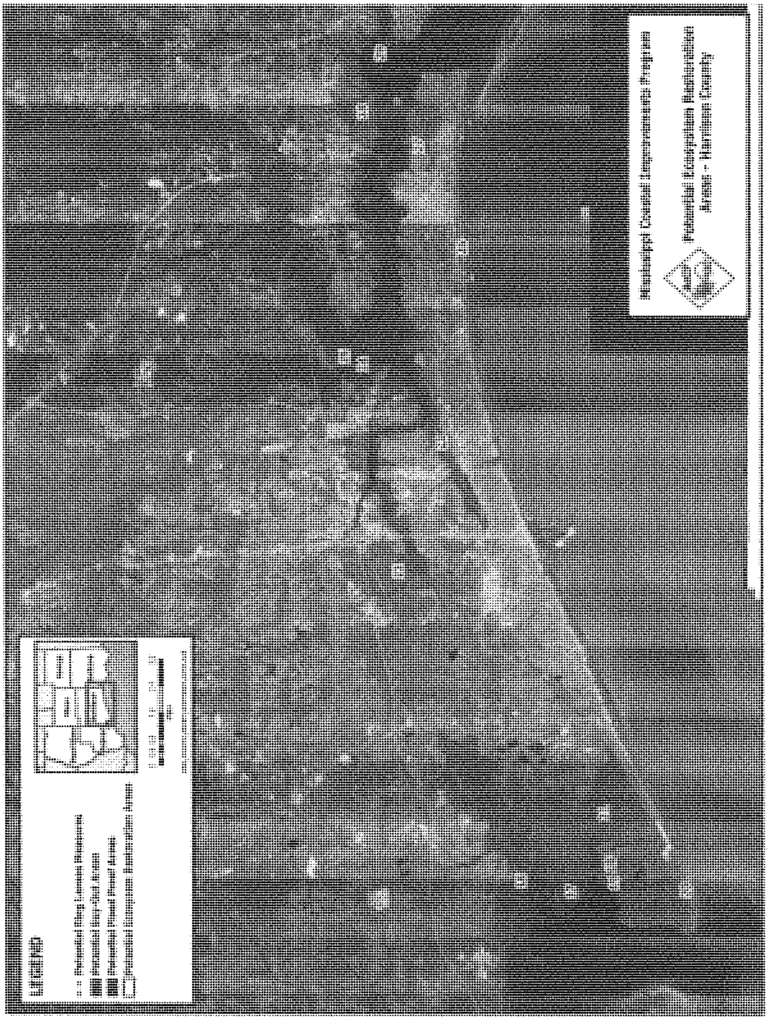
Source: Corps

Figure 4.1.5.2-1. Environmental Restoration of Historical Wetland Sites



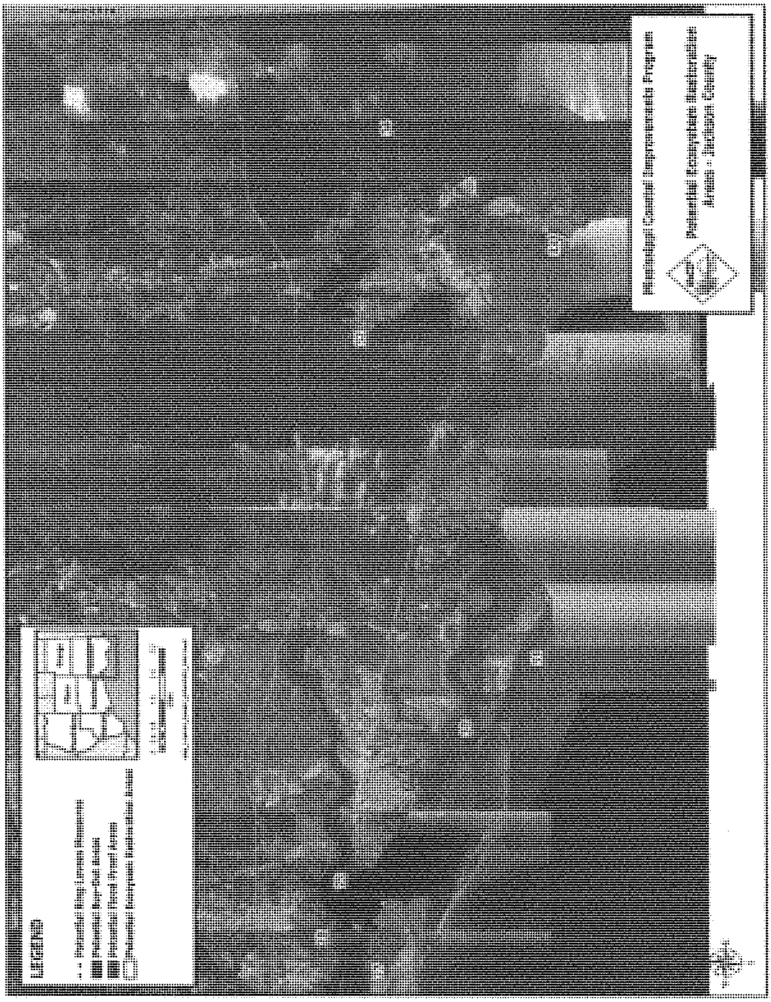
Source: Corps

Figure 4.1.5.2-2. Hancock County Restoration Sites



Source: Corps

Figure 4.1.5.2-3. Harrison County Restoration Sites



Source: Corps

Figure 4.1.5.2-4. Jackson County Restoration Sites

1. Pearlington

- **ACRES:** 76 (State owns 2,200 acres in the Pearlington area)
- **DEMOLITION:** Demolition will be required. Areas found at this site consist of residential development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet. In order to restore the area to bayhead swamps, excavation will be required to between +3 and +4 feet (i.e. the elevation must be just above the fringing marsh elevation). The slope of the site must be very gradual (i.e. slope should not result in high flow rates.)
- **PLANTING:** Emergent aquatic vegetation would be planted at the site. *Spartina alterniflora* (saltmarsh cordgrass), the low marsh species, would be planted at an elevation ranging from -0.5 to 1-foot. The middle marsh species, *Juncus roemerianus* (black needlerush), would be planted at elevations ranging between 1- and 2-foot while *S. patens* (saltmeadow cordgrass) would be planted above the 2-foot as the high marsh species. Bayhead Swamps trees to be planted consist of *Magnolia virginiana, Nyssa sylvatica, Acer rubrum*, and *Taxodium distichum* on a 10- to 30- foot spacing. Bayhead Swamps shrubs to be planted consist of *Persea palustris, Lyonia lucida*, and *Viburnum nudum*. Riverine/levee forests will be planted with *Quercus nigra, Celtis laevigata, N. aquatica, T. distichum, A. rubrum, Seronea repens*, and *Sabal minor*.

2. Pearlington South

- **ACRES:** 11
- **DEMOLITION:** Demolition will be required. Areas found at this site consist of residential development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet. In order to restore the area to bayhead swamps, excavation will be required to between +3 and +4 feet (i.e. the elevation must be just above the fringing marsh elevation). The slope of the site must be very gradual (i.e. slope should not result in high flow rates.)
- **PLANTING:** Emergent aquatic vegetation would be planted at the site. *Spartina alterniflora* (saltmarsh cordgrass), the low marsh species, would be planted at an elevation ranging from -0.5 to 1-foot. The middle marsh species, *Juncus roemerianus* (black needlerush), would be planted at elevations ranging between 1- and 2-foot while *S. patens* (saltmeadow cordgrass) would be planted above the 2-foot as the high marsh species. Bayhead Swamps trees to be planted consist of *Magnolia virginiana, Nyssa sylvatica, Acer rubrum*, and *Taxodium*.

3. Port /West

- **ACRES:** 49
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of high-end residential development and an old golf course. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet.

- **PLANTING:** Emergent aquatic vegetation would be planted at the site. *S. alterniflora*, the low marsh species, would be planted at an elevation ranging from -0.5 to 1-foot. The middle marsh species, *J. roemerianus*, would be planted at elevations ranging between 1- and 2-foot while *S. patens* would be planted above the 2-foot as the high marsh species.

4. Ansley

- **ACRES:** 2,023 (State owns 6,000 acres west of Lakeshore Road)
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of residential development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet. In order to restore the area to a wet pine savannah habitat, the higher areas will be designated as this type of habitat. These areas have depression areas within them, which will enable water to flow down to the depression areas; thus, holding water.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site as previously described in the *3. Port/West site*. Wet pine savannah habitat will be restored and planted with wet pine flatwoods, such as *Pinus elliottii, Morella cerifera, Ilex glabra, S. patens*, and *Panicum virgatum*.

5. Heron Bay

- **ACRES:** 594 (State owns 6,000 acres west of Lakeshore Road)
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of residential development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site as previously described in the *3. Port/West site*.

6. Lower Bay Road

- **ACRES:** 226 (State owns 6,000 acres west of Lakeshore Road)
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of residential development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site as previously described in the *3. Port/West site*.

7. Lakeshore

- **ACRES:** 275
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of commercial development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential and commercial infrastructure and various utilities will be required.

- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site as previously described in the *3. Port/West site.*

8. Bayou Caddy/Lakeshore

- **ACRES:** 362
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of commercial development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential and commercial infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site as previously described in the *3. Port/West site.*

9. Clermont Harbor

- **ACRES:** 209
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of residential development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site as previously described in the 3. *Port/West site.*

10. Bayou La Croix

- **ACRES:** 259
- **DEMOLITION:** Similar demolition efforts as described in *9. Clermont Harbor* are anticipated to clear the site.
- **EXCAVATION:** Similar excavation efforts as described in *9. Clermont Harbor* are anticipated to prepare the site for planting and restoring of proper hydrology.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site as previously described in the *3. Port/West site.*

11. Admiral Island

- **ACRES:** 245 (State owns 123 acres) (This site is an expansion of the State Initiatives identified in Section 4.1.5.5.)
- **DEMOLITION:** Similar demolition efforts as described in *9. Clermont Harbor* are anticipated to clear the site.
- **EXCAVATION:** Similar excavation efforts as described in *9. Clermont Harbor* are anticipated to prepare the site for planting and restoring of proper hydrology.

- **PLANTING:** Emergent aquatic vegetation would be planted at the site as previously described in the *3. Port/West site.*

12. Shoreline Park

- **ACRES:** 889
- **DEMOLITION:** Similar demolition efforts as described in *9. Clermont Harbor* are anticipated to clear the site.
- **EXCAVATION:** Similar excavation efforts as described in *9. Clermont Harbor* are anticipated to prepare the site for planting and restoring of proper hydrology.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site as previously described in the *3. Port/West site.*

13. Chapman Road

- **ACRES:** 146
- **DEMOLITION:** Similar demolition efforts as described in *9 Clermont Harbor* are anticipated to clear the site.
- **EXCAVATION:** Similar excavation efforts as described in *9. Clermont Harbor* are anticipated to prepare the site for planting and restoring of proper hydrology.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site as previously described in the *3. Port/West site.*

14. Jourdan River – Interstate-10 Development

- **ACRES:** 638
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of highend residential development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** Similar excavation efforts as described in *9. Clermont Harbor* are anticipated to prepare the site for planting and restoring of proper hydrology.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site as previously described in the *3. Port/West site.*

15. Diamondhead

- **ACRES:** 433
- **DEMOLITION:** Similar demolition efforts as described in *9. Clermont Harbor* are anticipated to clear the site.
- **EXCAVATION:** Similar excavation efforts as described in *9. Clermont Harbor* are anticipated to prepare the site for planting and restoring of proper hydrology.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site as previously described in the *3. Port/West site.*

Jourdan River Estates

Jourdan River Estates is an existing housing development that received flooding damage. This area has been restored or is in the process of completing repairs to their homes. Very little restoration opportunity exists due to the elevation and small drainage size for this project site. Therefore, it is not being considered any further for environmental restoration opportunities.

16. Delisle

- **ACRES:** 120 (State owns 1,000 acres)
- **DEMOLITION:** Similar demolition efforts as described in *9. Clermont Harbor* are anticipated to clear the site.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet. In order to restore the area to bayhead swamps, excavation will be required to between +3 and +4 feet (i.e. the elevation needs to be just above the fringing marsh). The slope of the site must be very gradual (i.e. the slope should not result in high flow rates.)
- **PLANTING:** Emergent aquatic vegetation would be planted at the site. *S. alterniflora* (saltmarsh cordgrass), the low marsh species, would be planted at an elevation ranging from -0.5 to 1-foot. The middle marsh species, *J. roemerianus* (black needlerush), would be planted at elevations ranging between 1- and 2-foot while *S. patens* (saltmeadow cordgrass) would be planted above the 2-foot as the high marsh species. Bayhead swamps trees to be planted consist of *M. virginiana, N. sylvatica, A. rubrum,* and *T. distichum* on a 10- to 30-foot spacing. Bayhead Swamps shrubs to be planted consist of *P. palustris, L. lucida,* and *V. nudum.*

17. Ellis Property

- **ACRES:** 443 Acres
- **DEMOLITION:** Very minor demolition would be required.
- **EXCAVATION:** Minor excavation would be required.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site as described in *16. Delisle*. Preservation with restoration of half tidal marsh and half pine savannah probably more like wet pine flatwoods.

18. Pine Point East

- **ACRES:** 103 (State owns 40-50 tax forfeited lots)
- **DEMOLITION:** Demolition will be required. Residential development exists at this site. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet. In order to restore the area to a wet pine savannah habitat, the higher areas will be designated as wet pine savannah. These areas have depression areas within them which will enable water to flow down to the depression areas; thus, holding water.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site, such as *S. alterniflora, J. roemerianus,* and *S. patens*. Wet pine savannah habitat will be restored and planted with wet pine flatwoods, such as *P. elliottii, M. cerifera, I. glabra, S. patens,* and *P. virgatum.*

19. Pine Point West

- **ACRES:** 83 (State owns 40-50 tax forfeited lots)
- **DEMOLITION:** Demolition will be required. Residential development exists at this site. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet. In order to restore the area to a wet pine savannah habitat, the higher areas will be designated as wet pine savannah. These areas have depression areas within them which will enable water to flow down to the depression areas; thus, holding water.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site, such as *S. alterniflora*, *J. roemerianus*, and *S. patens*. Wet pine savannah habitat will be restored and planted with wet pine flatwoods, such as *P. elliottii*, *M. cerifera*, *I. glabra*, *S. patens*, and *P. virgatum*.

20. Pass Christian low forested drainage way

- **ACRES:** 21
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of residential development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet. In order to restore the area to bayhead swamps, excavation will be required to between +3 and +4 feet. The slope of the site must be very gradual.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site as described in *13. Delisle.* Bayhead swamps trees to be planted consist of *M. virginiana*, *N. sylvatica*, *A. rubrum*, and *T. distichum* on a 10- to 30-foot spacing. Bayhead Swamps shrubs to be planted consist of *P. palustris*, *L. lucida*, and *V. nudum*.

21. Pass Christian Site – Bayou Portage

- **ACRES:** 43
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of residential development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet. In order to restore the area to bayhead swamps, excavation will be required to between +3 and +4 feet. The slope of the site must be very gradual.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site as described in 16. Delisle.

22. Turkey Creek

- **ACRES:** 948 (Of this total, 689 acres are being selected for construction which is discussed in detail in Section 5.1.1.1.2.1.)
- **DEMOLITION:** None
- **EXCAVATION:** In order to restore the area to a wet pine savannah habitat, the higher areas will be designated as wet pine savannah. These areas have depression areas within them, which will enable water to flow down to the depression areas; thus, holding water.

- **PLANTING:** Wet pine savannah habitat will be restored and planted with wet pine flatwoods, such as *P. elliottii*, *M. cerifera*, *I. glabra*, *S. patens*, and *P. virgatum*.

23. Brickyard Bayou

- **ACRES:** 14
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of residential development. Material consists of normal construction material and no anticipated hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet. In order to restore the area to a Wet Pine Savannah habitat, the higher areas will be designated as Wet Pine Savannah. These areas have depression areas within them which will enable water to flow down to the depression areas; thus, holding water.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site as described in *16. Delisle.* Bayhead swamps trees to be planted consist of *M. virginiana*, *N. sylvatica*, *A. rubrum*, and *T. distichum* on a 10- to 30-foot spacing. Bayhead swamps shrubs to be planted consist of *P. palustris*, *L. lucida*, and *V. nudum*.

24. Biloxi River – Shorecrest Drive

- **ACRES:** 15
- **DEMOLITION:** Demolition will be required. Areas found in this site consist of only residential development/bulkheads. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** Excavation of old fill material will be required to remove the foreign material.
- **PLANTING:** Plantings will consist of what has been described in *23. Brickyard Bayou at Courthouse Road*. In addition, riverine/levee forests will be planted with *Q. nigra*, *C. laevigata*, *N. aquatica*, *T. distichum*, *A. rubrum*, *S. repens*, and *S. minor*.

25. Biloxi River – Eagle Point

- **ACRES:** 17
- **DEMOLITION:** Demolition will be required. Areas found in this site consist of only residential development/bulkheads. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** Excavation of old fill material will be required to remove the foreign material.
- **PLANTING:** Plantings will consist of what has been described in *23. Brickyard Bayou at Courthouse Road*. In addition, riverine/levee forests will be planted with *Q. nigra*, *C. laevigata*, *N. aquatica*, *T. distichum*, *A. rubrum*, *S. repens*, and *S. minor*.

26. Biloxi Front Beach – South of Highway 90

- **ACRES:** 40

- **DEMOLITION:** Demolition will be required. Areas consist of only commercial retail outlet development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of commercial infrastructure and various utilities will be required.
- **EXCAVATION:** Excavation of old fill material will be required to remove the foreign material.
- **Fill:** This site is proposed as part of the Interim Report's project and as LOD 2 and 3. This proposed restoration site purchases the remaining parcels that are commercial property located directly on the beach. Dunes will be constructed to provide added protection.
- **PLANTING:** Sea oats will be planted on the dune system.

27. Keegan Bayou

- **ACRES:** 54
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of residential development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet. In order to restore the area to a wet pine savannah habitat, the higher areas will be designated as wet pine savannah. These areas have depression areas within them, which will enable water to flow down to the depression areas; thus, holding water.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site. Wet Pine Savannah habitat will be restored and planted.

28. St. Martin

- **ACRES:** 467
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of residential and commercial development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential and commercial infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site.

29. Fort Point

- **ACRES:** 83
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of residential development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site.

30. Pine Island:

- **ACRES:** 2,531

- **DEMOLITION:** Demolition will be required. Areas found in this area consist of high-end residential development and an old golf course. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site.

31. Belle Fontaine

- **ACRES:** 1,516
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of only residential development/bulkheads. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** Excavation of old fill material will be required to remove the foreign material. In addition, seawalls and bulkheads will be needed to be excavated.
- **FILL:** The beach is developed from sand eroded from the Gulfport Formation, a Pleistocene sand deposit in the center of the area; the sand is spread along the shore by longshore currents driven by wave action. Sandy material will be required to restore the lost beach back to its historic footprint (about 100 to 200 feet seaward). In addition, dunes will be constructed to provide added protection.
- **PLANTING:** Sea oats will be planted on the dune system.

32. Griffin Point

- **ACRES:** 182
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of residential development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site.

33. Bayou Chico

- **ACRES:** 258
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of residential development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site.

34. Grand Bay Marsh/Bayou Cumbest

- **ACRES:** 2,666 (Of this total, 148 acres are selected for construction. A detailed discussion is provided below in Section 5.1.1.1.2.2.)
- **DEMOLITION:** Demolition will be required. Areas found in this area consist of residential development. Material consists of normal construction material and no hazardous/toxic material is anticipated. Removal of residential infrastructure and various utilities will be required.
- **EXCAVATION:** In order to restore the area to emergent tidal marsh, excavation will be required to between -0.5 to +2.0 feet. Higher areas will be restored to wet pine savannah habitat. These areas have depression areas within them, which will enable water to flow down to the depression areas; thus, holding water.
- **PLANTING:** Emergent aquatic vegetation would be planted at the site. Wet pine savannah habitat will be restored and planted with wet pine flatwoods, such as *P. elliottii*, *M. cerifera*, *I. glabra*, *S. patens*, and *P. virgatum*.

Mary Walker Bayou

Mary Walker Bayou area was not considered as a feasible environmental restoration site. Mary Walker Bayou area is located up high on a bluff with only a few businesses in the low area; thus, the site was eliminated from any further study.

Gautier South

There are several drainage areas within the proposed environmental restoration site. This site is located within the City of Gautier and adjacent to the State of Mississippi's Shepard Park. The potential restoration site is located within several residential communities. In evaluating this in greater detail, the team, including MDMR, decided not to carry this proposed potential project any further.

Johnson Bayou Site

This site was eliminated from further consideration by the MsCIP environmental team due to it not being a feasible site for restoration as it was being redeveloped.

Ocean Springs Inner Harbor

In evaluating this potential site, several factors were considered – availability, acceptability, location, and accessibility, to determine if the proposal would be feasible to carry forward in the proposed environmental restoration effort. This site consists of a harbor with predominantly private crafts with residential housing within the area. This site has been mostly restored back to pre-2005 hurricane conditions; therefore, this area is not available as a potential restoration site at this time and would not be acceptable to the citizens of Ocean Springs. This site may be considered in the future as a possible long-term environmental restoration site as the site becomes more feasible.

East Beach – Ocean Springs

East Beach – Ocean Springs is proposed as an Interim Project consisting of beach/dune restoration. Additionally, the East Beach – Ocean Springs site is part of Lines of Defense 2 (beach/dune) and 3 (elevated roadway). This site has also been designated as a non-structural solutions consisting of homeowners assistance and relocation. Restoration of the site would consist of greenspace/recreational site, other upland habitat, and maritime forest habitat, which is a high priority habitat for the USFWS.

4.1.5.3 Restoration of Barrier Island Ecosystems

Barrier islands provide a boundary between the sea water salinity of the open Gulf of Mexico and the brackish water found in Mississippi Sound. Loss of the islands would greatly increase salinity in Mississippi Sound; thus, changing ecological habitats that exist now. This would impact, if not devastate, shellfish and many other forms of marine life. Prior to Hurricane Katrina, the State of Mississippi was working on a coastal storm protection plan and proposition to submit to NPS for consideration that included restoring the barrier islands to the condition that existed prior to Hurricane Camille. While unsubstantiated through scientific study, it was reported that many in Mississippi felt that if the islands had been in the condition that existed prior to Hurricane Camille, there would have been less damage along the coast from Hurricane Katrina. This idea was also included in the Mississippi Governor's Recovery Plan, which called for restoring the islands to a pre-Camille footprint.

Another positive effect that the barrier islands have is to provide a natural offshore breakwater for the large sea waves that are generated from hurricanes. The presence of the islands and the relatively shallow water of the Mississippi Sound between the islands and the mainland prevent the sea waves from maintaining their considerable size as they move towards the mainland. Sea waves, often reported at heights of 40 feet and higher in large storms, would break as they approach the chain of islands. The open water between the islands and the mainland, generally ten miles or more, would have enough fetch for waves to regenerate, but at a much lower height due to the shallower water. The generally accepted relationship between water depth and wave height is that the wave can sustain itself at a height that is one-half the depth of the water.

Sand of sufficient quality and quantity required for this proposed restoration of the barrier islands is not known to occur in close proximity to the islands. Prior studies of the St. Bernard Shoals (USGS personal comm. 2006) indicate that this site is probably the best source of the sand. Vegetation and a dune system would also be incorporated as prescription components as part of any sand placement on the barrier islands in order to further stabilize these restoration projects. The presence of the islands and the relatively shallow water of Mississippi Sound between the islands and the mainland prevent the sea waves from maintaining their considerable size as they move towards the mainland (i.e. a natural breakwater defense). Possible supplement of sand (i.e. from St. Bernard Shoals or an offsite source) in the littoral system is another option that could help restore the islands. This could be accomplished by adding sand in specific locations based on sediment transport modeling. Any improvements to the barrier islands must be closely coordinated with NPS because they are within the NPS boundaries and Petit Bois and Horn Islands are congressionally designated Wilderness Areas.

4.1.5.4 Restoration of SAVs in Mississippi Sound

Continued survival and growth of seagrasses (i.e. SAVs) may be threatened by the cumulative effects of man's activities, in addition to, natural processes in the coastal marine ecosystem. Natural causes of SAV (i.e. *Diplanthera wrightii, Cymodocea manatorum, Thalassia testudinum*, and *Ruppia maritime*) decline, such as disease, storm events, salinity fluctuation, and hypoxic events, coupled with declining water quality caused by anthropogenic eutrophication currently threaten the health of many SAV systems (Montague and Ley 1993, Durako and Kuss 1994, Olesen and Sand-Jensen 1994, Zieman et al 1994, Kock and Beer 1996). These habitats provide vital refuges, feeding, resting, staging, and spawning grounds for a variety of species found in Mississippi Sound and also in the Gulf of Mexico. Past studies throughout the years have attributed anywhere from 50% to 90% of all marine species to utilize this vital habitat at some point in their life state. Opportunities exist to partner with Federal, state, and local resource agencies as well as NGOs. Extensive coordination with the NPS, responsible for managing and operating the Gulf Islands National Seashore, would be required for areas of potential restoration within park boundaries. Involvement of local colleges and universities with ongoing research programs would also help to identify and pinpoint specific problems for development of potential solutions.

4.1.5.5 State Initiative Projects

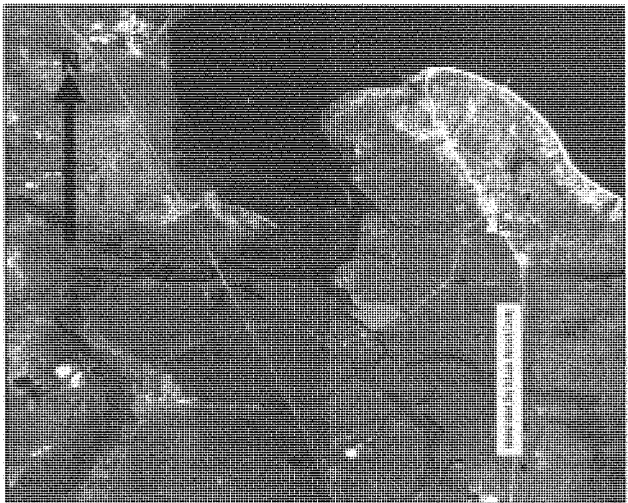
The Governor of the State of Mississippi's *Seven-Point Strategy* for rebuilding coastal resources of the State is anticipated to be an on-going effort over the next 10 to 15 years. The strategy is summarized as follows:

- Implementation of breakwater structures for surge protection (natural surge diffusers, breakwaters, jetties seawalls, etc.);
- Deer Island restoration to pre-1900 footprint with fortification of the south side;
- Barrier Island restoration to pre-Camille conditions;
- Restoration of 10,000 acres of coastal marshes, beaches, and forests;
- Restoration of historical water flow to Coastal Mississippi watersheds to provide water quality and quantity critical to estuarine and marine habitats, including efforts to divert freshwater from Louisiana into the Biloxi marshes;
- Restoration of submerged aquatic vegetation in Mississippi Sound; and the
- Restoration and enhancement of reef systems in Mississippi waters and adjacent Federal waters (i.e. oysters, nearshore low-profile reefs, and offshore artificial reefs).

MDMR has identified the following 11 restoration sites. These are being included in the ecological approach detailed in this Environmental Appendix and also in the MsCIP Comprehensive Main Report/Integrated Programmatic EIS.

Hancock County:

- **SITE:** Admiral Island, Hancock County
- **DESCRIPTION:** 123 acres total – 62 marsh and 61 forested scrub shrub
- **CONDITION:** Admiral Island has extensive debris fields washed in from Bayou Lacroix during Hurricane Katrina (Figure 4.1.5.5-1 and Figure 4.1.5.5-2). Approximately 10 acres are covered in a mat of crushed houses, boats, and other debris. Mechanized removal of these debris fields via the central road on Admiral Island will be necessary before prescribed burning takes place. Foot reconnaissance will be necessary to gather plastic and other potentially hazardous burnable materials on the remaining acreage before conducting a prescribed burn.



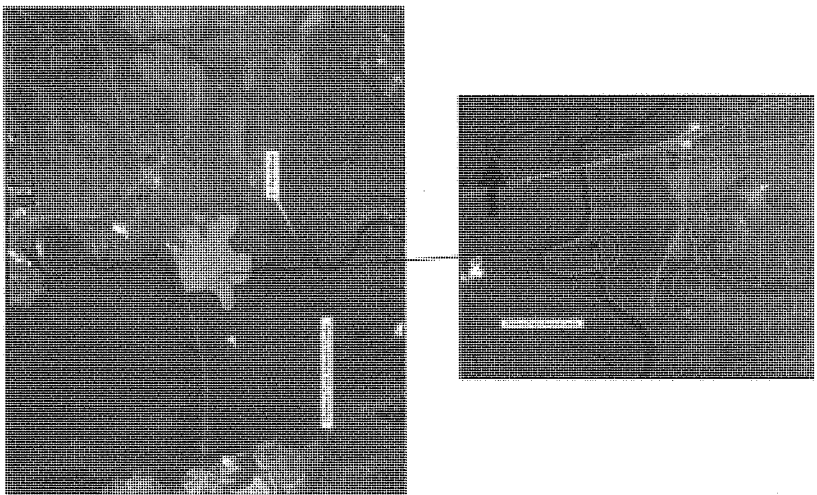
Source: MDMR

Figure 4.1.5.5-1. Admiral Island, Hancock County State Initiative Projects

Source: MDMR

Figure 4.1.5.5-2. Admiral Island, Hancock County State Initiative Projects

- **PLANTING:** Chinese tallow trees have heavily infested the property and mature trees were significantly damaged by Hurricane Katrina. However, new seedlings are property wide and are forming virtual carpets in some areas. Treatment needs to begin this year while the other vegetation is dead. It is easy to move through and makes it much easier to distinguish growing "tallows". Treatment would be even easier if a prescribed burn can be conducted first.
- **SITE:** Wachovia, Hancock County
- **DESCRIPTION:** 1,200 acres total – 800 marsh, 200 forested, 200 savannah
- **CONDITION:** Wachovia has significant marsh debris and scour from storm surge. However, the scoured areas appear to be forming high quality open-water habitat evident by a high level of dragon fly activity and breeding. The scours are several feet deep and would require an invasive operation to be filled and replanted (Figure 4.1.5.5-3). The debris is predominantly natural material, mostly the marsh "rolled up" from the scoured areas.



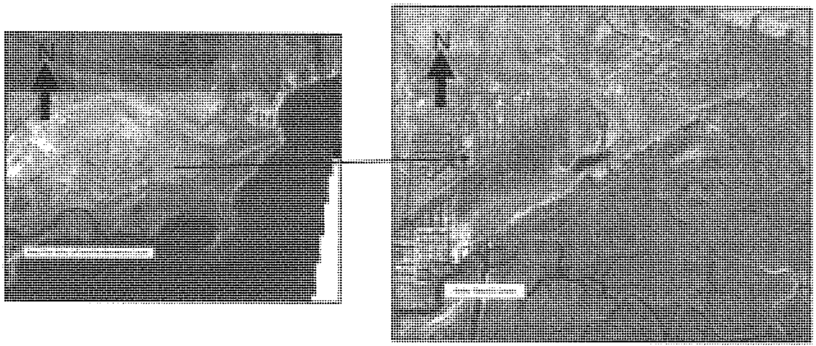
Source: MDMR

Figure 4.1.5.5-3. Wachovia, Hancock County State Initiative Project

Much of the remainder of the tract is forest and savannah, which has suffered wind damage in the form of downed trees and vegetation. This has increased fuel loads and complicated access across the property. This is significant because the fuel loads at Wachovia were already high. The tract is very much in need of prescribed burning, particularly areas that were planted with longleaf pine several years back. The tract is immediately south of Interstate-10 so special considerations will be necessary to facilitate a safe and effective burn. Invasive species, particularly Chinese tallow, are present site wide and will require special attention in the post Katrina environment.

- **SITE:** Ansley, Hancock County

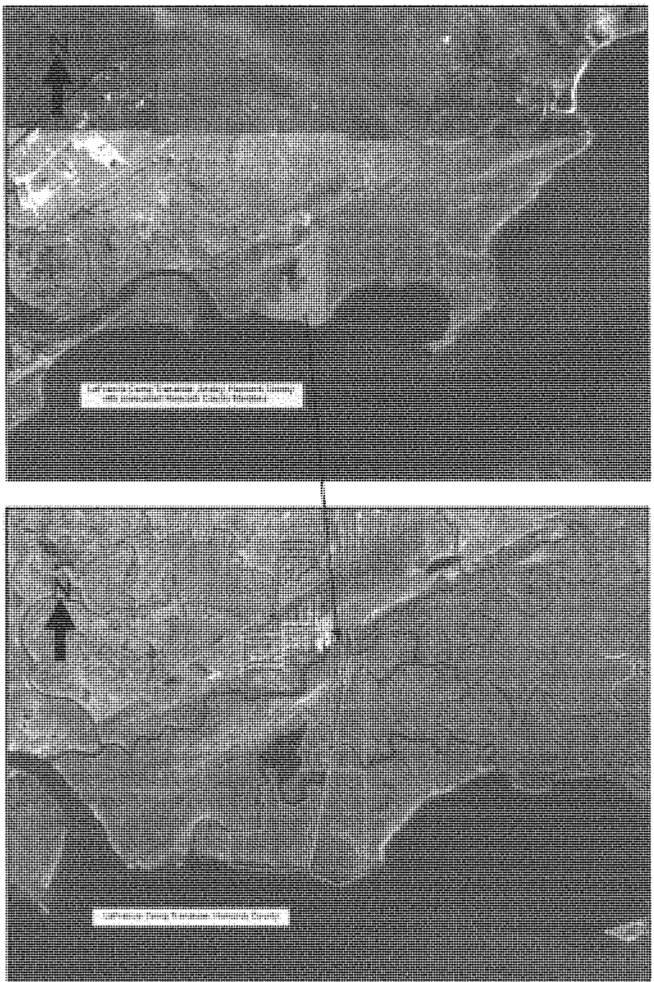
- **DESCRIPTION:** 900 acres total – 800 marsh, 100 forested
- **CONDITION:** The site is primarily marsh, which has experienced limited scouring (Figure 4.1.5.5-4). The recovery from scouring will require further monitoring and assessment. There are significant debris fields within the marsh that extend into the forested areas. Pine timber fared relatively well but hardwoods were heavily damaged. There are significant invasive infestations, primarily Chinese tallow tree. Extensive mosquito ditching disrupts hydrology and creates vectors for invasive species.



Source: MDMR

Figure 4.1.5.5-4. Ansley, Hancock County State Initiative Project

- **SITE:** LaFrancis Camp Trenaisse, Hancock County
- **DESCRIPTION:** 45 acres total – all open water
- **CONDITION:** This "trenaisse" (canal) may simply be the right of way of the underlying gas pipeline that has been progressively widened by small boat traffic and tidal flow (Figure 4.1.5.5-5). Regardless, it intersects two bayous and has significantly reduced their flow and sediment carrying capacity, resulting in a loss of navigability. It is also likely that this canal serves as a direct conduit for storm surge into the LaFrancis/ Heron bay / Ansley community. It is recommended that this channel be closed and restored to its original marsh cover. It is also recommended that the north most bayou (Campbell's Inside Bayou) be dredged to the west if necessary to reestablish navigation to the LaFrancis marina and associated community.
- **SITE:** Gulf Islands National Seashore in Mississippi: Petit Bois, Horn, Ship and Cat Islands in Jackson, Harrison and Hancock Counties
- **DESCRIPTION:** 7,000 acres total
- **CONDITION:** Hurricane Katrina and other recent storms have over washed all barrier islands in the Northern Gulf causing severe erosion, severely damaging or destroying facilities and resources, depositing massive amounts of debris, degrading habitats, and setting the stage for rampant infestations of noxious, invasive plant and animal species. The following proposal is based directly on a post-storm needs assessment prepared by Gulf Islands National Seashore science and management staff.



Source: MDMR

Figure 4.1.5.5-5. LaFrancis Camp Trenaisse, Hancock County State Initiative Project

- **SITE:** Deer Island, Harrison County
- **DESCRIPTION:** 450 acres total, 200 marsh, 250 forested

- **CONDITION:** During Katrina, Deer Island lost little actual land area but a significant amount of sand beach and dunes at higher elevations (Figure 4.1.5.5-6). Related to this, a large number of slash pine trees were killed with mortalities approaching 100% near the east end. These trees will need to be replaced to maintain soil stability and avoid more catastrophic erosion in the future. Planting with additional storm hardy tree species, such as live oak should be examined. Advanced, high yield nursery trees would be ideal for this purpose.

Source: MDMR

Figure 4.1.5.5-6. Deer Island, Harrison County State Initiative Project

The stability of current and future created marsh on Deer Island may also be improved. The existing marsh creation project survived relatively well and indicates that marsh creation should be expanded to help provide additional erosion protection and estuarine habitat. However, the very fine grain material used for substrate needs to be augmented with coarser grain sandy sediments to improve consolidation and resistance to erosion. Rip-rap breakwaters could be augmented and protected by adding shell and soil then planting with storm tolerant plants, such as live oaks.

Remaining natural marshes on Deer Island have some invasive species issues, primarily torpedo grass. Chinese tallow trees occur at the site but not as severe infestations and appear to have been stressed by Katrina so the time to treat is now. As with most of the other Coastal Preserve projects, prescribed fire is an important consideration for both for ecological and management related financial reasons.

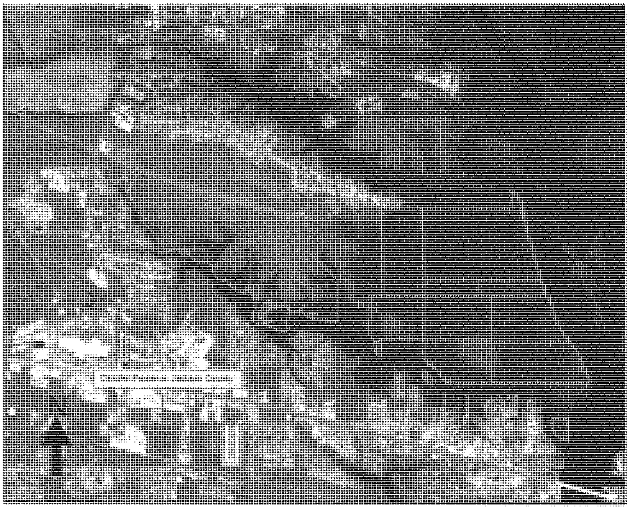
- **SITE:** DuPont, Harrison County
- **DESCRIPTION:** 650 acres total – 170 marsh, 480 forested

- **CONDITION:** The site is dominated by a 20- to 40-year rough (unburned vegetation) (Figure 4.1.5.5-7). Hurricane Katrina placed many acres of debris into the marshes and forest and downed a very high percentage of hardwoods on the property. There are massive debris fields that will require implementation of clearing and prescribed burns.

Source: MDMR

Figure 4.1.5.5-7. DuPont, Harrison County State Initiative Project

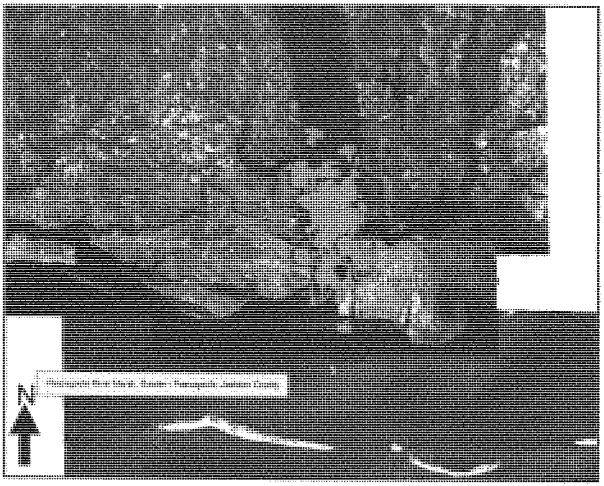
- **SITE:** Danzler, Jackson County
- **DESCRIPTION:** 900 acres total – 500 marsh, 385 forested
- **CONDITION:** The Danzler property was further from Katrina's core and suffered less direct wind and tidal surge damage than many of the other Coastal Preserves (Figure 4.1.5.5-8). However, serious long term consequences are anticipated due to the distribution of Chinese tallow tree propagules across the site. The effort to regain control of Chinese tallow site wide and clean up residual storm debris will be greatly aided by first conducting Comprehensive prescribed burns. Restoring access lost due to storm downfall can be accomplished as part of the preparation for prescribed burning.



Source: MDMR

Figure 4.1.5.5-8. Danzler, Jackson County State Initiative Project

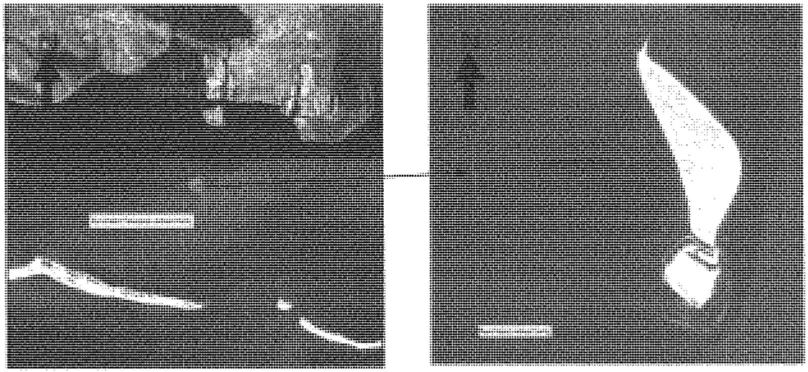
- **SITE:** Pascagoula River Marsh, Jackson County
- **DESCRIPTION:** This preserve consists of 11,150 acres that includes essentially all marsh associated with the mouth of the Pascagoula River. This drainage consist primary of tidal oligohaline marshes which give way to tidal freshwater marshes and tidal Bald Cypress forests and woodlands.
- **CONDITION:** Katrina didn't significantly impact the integrity of the Pascagoula marsh system, but left it exposed to an explosion of invasion exotic species (Figure 4.1.5.5-9). Gaps left by vegetation lost and disturbances in hydrology regimes will increase the recruitment and growth of such species. The two species that are of the greatest concern are *Salvinia molesta* (Giant Salvinia) and *Sapium sebiferum* (Chinese tallow) can truly be considered noxious. Also disturbed areas often support dense, nearly monospecific colonies of *Phragmites australis* common reed which is becoming a greater threat to native species population. Control measures are recommended.



Source: MDMR

Figure 4.1.5.5-9. Pascagoula River Marsh, Jackson County State Initiative Project

- **SITE:** Round Island, Jackson County
- **DESCRIPTION:** 65 acres total, predominantly forested
- **CONDITION:** Round Island has eroded extensively in the past decade (Figure 4.1.5.5-10). Hurricanes George, Dennis, Ivan, Katrina, and numerous tropical storms have all taken their toll. The Island needs basic management to deal with post-storm conditions. Prescribed burning is needed to reduce fuel loads, improve access, and restore ecological integrity. Invasive species control is required primarily for Chinese tallow trees. Limited planting of new trees will be conducted to improve stand quality and diversity to help insure long-term stability of the remaining original island.



Source: MDMR

Figure 4.1.5.5-10. Round Island, Jackson County State Initiative Project

Round Island also represents an excellent opportunity to restore and create marsh and other estuarine systems. It is proposed that marsh be created on the west side, protected from the prevailing long shore current. In turn the island would be protected on its east and south by a vegetated breakwater (i.e. essentially an artificial chenier). Marsh would also be created on the lee side of the breakwater to the south.

- **SITE:** Twelve Oaks and Helmer's Lane, Jackson County
- **DESCRIPTION:** 30 forested
- **CONDITION:** These properties are in the Coastal Preserve boundary and are partially owned by the Land Trust for the Mississippi Coastal Plain (Figure 4.1.5.5-11). Both tract suffered significant blow down and Helmer's received a massive amount of debris from the Ocean Spring's Harbor, which has been largely removed by volunteers. Funding is requested to help remove dangerous snagged trees, some of the heavy downed timber, treat noxious invasive weeds and reforest as needed.

Source: MDMR

Figure 4.1.5.5-11. Twelve Oaks and Helmer's Lane, Jackson County State Initiative Project

4.1.6 Projects from Interim Report carried for further Consideration

Table 4.1.6-1.
180 Projects – Environmental

Name	PRIME_AUTH	SEC_AUTH	TERT_AUTH	Problem_ID	Addressed By:
Coastal Mississippi Artificial Reef Project for Remediation of 2005 Hurricane Damage	Other			Hurricane Storm Damage & Reduction (HSDR), Sub-surface Erosion, Fish & Wildlife Habitat Degradation.	MDMR
Restore more natural freshwater flows by closing the MRGO	Ecosystem Restoration (ER)				Corps, New Orleans
Restore grassbeds in MS Sound	HSDR	ER			MsCIP Comprehensive - SAV Restoration
Replace structures with marshes.	ER	Flood Damage Reduction (FDR)			MsCIP Comprehensive - SDSS/Non-structural
Provide 100 acres of oyster reef restoration	ER	HSDR			MsCIP Interim & Comprehensive - Partnership with MDMR
Provide an incentive for replacing failing septic systems in rural areas to improve water quality along bayous and bays.	Other				USEPA
Add wetlands along main drainage systems in each location to increase capacity of the systems during rainfall and surge flooding events.	ER	FDR			MsCIP Comprehensive - SDSS
Consider brown water system to minimize demand on ground and surface waters and limit saltwater intrusion.	Other				USEPA
Consider all archaeological sites in planning process Many significant coastal sites are eroding and need to be preserved.	HSDR				MsCIP Comprehensive - Programmatic EIS

Table 4.1.6-1.
180 Projects – Environmental (continued)

Name	PRIME_AUTH	SEC_AUTH	TERT_AUTH	Problem_ID	Addressed By:
Marsh Restoration where Feasible This can be done in conjunction with private and government dredging projects	ER	HSDR	FDR		MsCIP Comprehensive - SDSS & Barrier Islands
Partnership Efforts with Louisiana to Marsh Island Areas	OTHER				LaCPR Comprehensive
Barrier Islands - Restoration (to a natural setting)	ER	HSDR			MsCIP Comprehensive - SDSS & Barrier Islands
Allow nature to dictate wetlands vs. beach to a greater degree	FDR	EC			MsCIP Comprehensive - SDSS
Hancock County Comprehensive HSDR - Ecosystem Restoration	HSDR	ER		HSDR and Erosion of beach, seawall, and road raising and/or repair; sand placement, dune restoration; potential 5-8 miler reach.	MsCIP Interim & Comprehensive
Jackson Wetland Restoration	ER	HSDR		HSDR, Erosion to drainage outfalls and interior drainage facilities.	MsCIP Interim
St. Louis Bay Comprehensive ER	ER	HSDR		HSDR, Erosion, Fish & Wildlife Habitat Degradation.	MsCIP Comprehensive - Future Studies
Lakeshore Beach ER	ER	HSDR		HSDR, Erosion, Fish & Wildlife Habitat Degradation.	Environmental Concerns - Potential SAVs
Biloxi Marshes Comprehensive ER	ER	HSDR	FDR	HSDR, Fish & Wildlife Habitat Degradation, Silt Deposition, Saltwater Intrusion.	MsCIP Comprehensive - Freshwater Diversion/Future Studies
Clermont Lake ER	ER	FDR	HSDR	HSDR, Erosion, Fish & Wildlife Habitat Degradation, Saltwater Intrusion and/or contamination.	MsCIP Comprehensive - SDSS
Magnolia Branch ER	HSDR	ER		Use conservation easements to restore magnolia branch.	MsCIP - SDSS

Table 4.1.6-1.
180 Projects – Environmental (continued)

Name	PRIME_AUTH	SEC_AUTH	TERT_AUTH	Problem_ID	Addressed By:
Jordan River Shores ER. Home owner assistance and relocation, return hydrology, begin mitigation, prohibit new/more development	FDR	ER		Return hydrology, begin mitigation, prohibit new/more development.	MsCIP Comprehensive - Non-Structural/SDSS
Pearlington ER – Home owner assistance and relocation and return hydrology	FDR	ER		Homeowners assistance and relocation project and return hydrology.	MsCIP Comprehensive - Non-Structural/SDSS
Shoreline Park Home owner assistance and relocation	FDR	ER		See Shoreline Park Home owner assistance and relocation.	MsCIP Comprehensive - Non-Structural/SDSS
Restore all Hancock (all coastal MS) marshes damaged by storm	HSDR	ER			MsCIP Comprehensive - Freshwater Diversion/Non-Structural/SDSS
Restore Hancock County Beaches to Pre-Katrina conditions	HSDR	ER			MsCIP Interim
Widen Hancock County Beaches, jump-start dunes	HSDR	ER			MsCIP Interim
Preserve Bayou Caddy Area	ER				MsCIP Interim
Protect Hancock County wetlands from filling for development	FDR	ER			MsCIP Comprehensive - SDSS
Turkey Creek Watershed Improvements	FDR	HSDR		HSD exacerbation to existing drainage systems.	MsCIP Comprehensive - Non-Structural/SDSS/ Future Studies
Tchoutacabuffa River Flood Damage and Watershed Improvement	FDR	ER		HSD to existing development, marsh damage due to surge.	MsCIP Comprehensive - Future Studies
Biloxi Back Bay Watershed Management and Ecosystem Restoration	ER	FDR		HSD, Erosion, FW Habitat Degradation, Saltwater Intrusion and/or contamination.	MsCIP Comprehensive - Future Studies
Courthouse Road Wetlands Ecosystem Restoration and Preservation	ER	FDR		HSD, Erosion, FW Habitat Degradation.	MsCIP Interim
Deer Island Ecosystem Restoration	ER	HSDR		HSD, Erosion, FW Habitat Degradation.	Section 528 Construction General & FCCE Funds

Table 4.1.6-1.
180 Projects – Environmental (continued)

Name	PRIME_AUTH	SEC_AUTH	TERT_AUTH	Problem_ID	Addressed By:
DÆlberville Wetlands Ecosystem Restoration	ER	HSDR		HSD, Erosion, FW Habitat Degradation.	MsCIP Comprehensive - Non-Structural/SDSS
Acquire wildlife corridors in lands that repeatedly flood	FDR	ER		Acquire and set aside green corridors in areas that have flooded often, such as Turkey Creek in Harrison, Bay Side Park). The Land Trust would hold land in perpetuity.	MsCIP Comprehensive - Non-Structural/SDSS
Develop Concrete Staging Center in Industrial Canal. Develop Harrison county industrial canal artificial reef staging area to stockpile concrete debris for oyster reef and other useful projects.	OTHER			Develop Harrison county industrial canal artificial reef staging area to stockpile concrete debris for oyster reef and other useful projects.	MDMR and MsCIP Comprehensive - Partnership with State
Restore or enhance Mississippi oyster reefs.	HSDR	ER		90-95% of the reefs were destroyed by Katrina. MS had around 12,000 areas of productive reefs prior to Katrina.	MDMR and MsCIP Comprehensive - Partnership with State
Utilize HW 90 bridge as artificial reef material	OTHER			Utilizing Highway 90 Bridge as Artificial Reef Material	MDMR Completed
Wiers (low level dams) within estuaries to control water flow	OTHER				MsCIP Comprehensive - Freshwater Diversion
Purchase riparian buffers, wetland areas.	FDR	ER			MsCIP Comprehensive - Non-Structural/SDSS
Reconsider dioxin cleanup on navy base post Katrina.	OTHER				USEPA
Reduce toxic exposure which exacerbates storm damage - Dioxin, Creosote, Titanium Dioxide, Gypsum.	OTHER				USEPA
Turkey Creek watershed Greenway	ER				MsCIP Comprehensive - Future Studies

Table 4.1.6-1.
180 Projects – Environmental (continued)

Name	PRIME_AUTH	SEC_AUTH	TERT_AUTH	Problem_ID	Addressed By:
Forrest Height Levee :- Restore; Vegetate with native species; Footbridges; Nature trail atop	HSDR	FDR			MsCIP Comprehensive
Turkey Creek: Mt. Pleasant UME Audubon site 41, Tidal Creek restoration of flood plain.	FDR	ER		Tidal Creek restoration of floodplain.	MsCIP Comprehensive - Future Studies
Possibly add height to the existing beach elevation and redevelop lost dune vegetation.	HSDR	ER			MsCIP Interim & Comprehensive
Front Beach Boulevard ER and Erosion Control	HSDR	ER			MsCIP Comprehensive - Non-Structural/SDSS
Front Beach Road Wetlands	ER	HSDR			MsCIP Comprehensive - Non-Structural/SDSS
East Beach Road ER	ER	HSDR			MsCIP Comprehensive - Non-Structural/SDSS
Belle Fontaine Marsh	HSDR	ER			MsCIP Comprehensive - Non-Structural/SDSS
Biloxi Back Bay	FDR	ER	HSDR		MsCIP Comprehensive - Future Studies
Davis Bayou ER	ER	HSDR			MsCIP Comprehensive - Future Studies
Jackson County Marsh Outlet ER	HSDR	ER	FDR	HSD and sediment infilling of existing drainageways and drains.	MsCIP Comprehensive - Non-Structural/SDSS
Gautier Hurricane Storm Damage Reduction and Ecosystem Restoration/Ladnir Rd	HSDR			HSD, Erosion, Storm-caused failure of bulkhead, road damage, severance of evacuation route, threats to bridge.	MsCIP Interim & Comprehensive - Non-Structural/SDSS
Pascagoula beaches, offshore breakwater/dunes/reefs/marshes to dissipate wave energy	HSDR	ER		HSD and sediment infilling of existing drainageways and drains.	MsCIP Interim

Table 4.1.6-1.
180 Projects – Environmental (continued)

Name	PRIME_AUTH	SEC_AUTH	TERT_AUTH	Problem_ID	Addressed By:
Restore natural drainage ways upper Bayou Castelle (vic Fishhawk Rd, Meadow Dale Dr., Longwood Dr, and Bayou Castelle Dr)	FDR	HSDR		Restore natural drainage ways upper Bayou Castelle (vic Fishhawk Rd, Meadow Dale Dr., Longwood Dr, and Bayou Castelle Dr).	MsCIP Comprehensive - Non-Structural/SDSS
Robert Hiram Bridge (Gautier) Hurricane evacuation route. Wetlands restoration, drainage	HSDR	FDR	ER	Hurricane evacuation route. Wetlands restoration drainage.	MsCIP Comprehensive - Non-Structural/SDSS
Graveline Road Bridge at Shepard St Park (County)	HSDR	FDR	ER	Hurricane evacuation route. Wetlands restoration drainage.	MsCIP Comprehensive - Non-Structural/SDSS
W River Delta restoration. Bulkhead western channel. Beneficial use. Wave protection for subdivisions.	HSDR	ER		Bulkhead western channel. Beneficial use. Wave protection for subdivisions.	MsCIP Comprehensive - Freshwater Diversion
Bennett Bayou tidal marsh restoration	HSDR	ER		Provide wetland function in a highly visible project area for public education and promote the Gov's Restoration Initiative.	MsCIP Comprehensive - Non-Structural/SDSS
Pascagoula Beach Restoration. Dunes, grasses, trees, with intermittent pockets of sand beach	HSDR	ER		HSD, Erosion, Bridge abutment damage.	MsCIP Interim
Ebb and flow of Intracoastal veins from the MS Sound to rebuild property with the erosion in the bayous near potential project #66.	HSDR	FDR			MsCIP Comprehensive
Cedar Point/West River-Restore beaches, sand, work, sediment management in this area	HSDR				MsCIP Comprehensive
ER along Hwy 90, Jackson County	ER	HSDR			MsCIP Comprehensive - Non-Structural/SDSS

Table 4.1.6-1.
180 Projects – Environmental (continued)

Name	PRIME_AUTH	SEC_AUTH	TERT_AUTH	Problem_ID	Addressed By:
Improve the Jackson-county seawall. Provide additional county-wide seawall construction, boardwalks, beach construction, marsh construction, or a combination of these elements	HSDR	ER			Duplicate
Rebuild and enlarge Marsh Island	ER	HSDR			Corps, New Orleans
Divert water from Escatawpa River into Bayou Cumbest to restore freshwater flow to the bayou and improve water quality.	ER				MsCIP Comprehensive - Freshwater Diversion
Pascagoula brown water system study	OTHER			Brown water system study.	USEPA
Pascagoula Beach Blvd. Restoration (Boardwalk, beach, and marsh addition along Pascagoula front beach)	HSDR	ER		Boardwalk, beach, and marsh addition along Pascagoula front beach.	MsCIP Interim/FEMA/City of Pascagoula

4.1.7 Mitigation Measures

The Council of Environmental Quality's (CEQ) Regulations for Implementing the Procedural Provisions of National Environmental Protection Act (NEPA) [40 Code of Federal Register (CFR) 1500-1508] clarify the requirements by defining direct effects, indirect effects, and cumulative effects.

- **Direct Effects.** Those effects caused by the action and occurring at the same time and place. [40 CFR 1508.8].
- **Indirect Effects.** Those effects caused by the action and occurring later in time or farther removed in distance, but still reasonably foreseeable. Indirect effects may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems. [40 CFR 1508.8].
- **Cumulative Impacts.** Those impacts on the environment, which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. [40 CFR 1508.7].

Implementation of structural plans identified in the Engineering Appendix would require placement of fill in wetlands, including open-water habitats, in Coastal Mississippi. These structural plans involve direct, indirect and cumulative impacts, such as the filling in of wetlands and loss of wetlands in the future. A more detailed discussion of these impacts can be found in the MsCIP Comprehensive Report and Integrated Programmatic EIS and also in the Engineering Appendix. Overall, structural measures have been developed in ways that avoid or minimize wetland impacts. The Environmental PDT worked closely with the Engineering PDT to ensure that levee alignments went through land that would result in the least impact. This has resulted in several alternative alignments of structural components; however, there are still some wetland impacts anticipated.

The direct loss of wetlands by structural measures would be mitigated in order to ensure no net loss occurs in Coastal Mississippi. The Environmental PDT utilized as a guide the current mitigation bank ratio policies currently implemented in Coastal Mississippi as an early surrogate to preliminarily assess mitigation costs. Mitigation for impacts to wetlands would be accomplished by creation of tidal and non-tidal wetlands throughout the three coastal drainage basins. Should any of these structural plan elements be recommended for construction and/or additional study, the actual development of the mitigation plan and associated costs would be developed at that time.

LOD 3 (i.e. elevation of the existing roadway and seawall along the mainland shoreline) would result in the loss of 2.6 acres of tidal wetlands and 13.1 acres of non-tidal wetlands. There are no alternative designs due to the technical feasibility.

LOD 3 (i.e. ring levees around coastal communities) would result in the loss of up to 81.4 acres of tidal wetlands and up to 182.8 acres of non-tidal wetlands. Several optional layouts have been considered, which would result in less wetland acreage impacts. The Forrest Heights Levee project located in the City of Gulfport, Harrison County is recommended for construction. Under this 21-foot alternative, there is an expected loss of 3.6 acres of wetland vegetation impacted by construction of the levee. Although native vegetation under the levee footprint would be lost, the levee itself would be vegetated with non-native species for stabilization of the structure. Alternative alignments results in impacts being reduced to approximately 12 acres of tidal wetlands and 67 acres non-tidal wetlands. LOD 4 (i.e. inland barrier and surge gates) would result in the loss of up to 138.1 acres of tidal wetlands and up to 287.4 acres of non-tidal wetlands. The alternate ring levee alignment can be found in the Engineering Appendix.

The surge gates crossing Bay of St. Louis would result in the loss of approximately 35 acres of waterbottoms. Detailed discussion regarding the design, location, and operations and maintenance of these structures are discussed in the Engineering Appendix. Mitigation would be accomplished by the creation of 175 acres of tidal fringe wetlands throughout the Bay of St. Louis vicinity. An alternative ring levee around Bay St. Louis would impact up to 1.4 acres tidal wetlands and up to 54.6 acres non-tidal wetlands. An alternate alignment of the inland barrier in the western portion of Harrison County along Menge Avenue would reduce impacts to waterbottoms. Implementation of this alternative alignment would impact up to 33 acres of non-tidal wetlands. By implementation of these two alternate alignments, the need for a surge gate crossing the Bay of St. Louis would be eliminated.

The surge gates crossing of Biloxi Bay would result in the loss of 27 acres of waterbottoms. Mitigation would be accomplished by creation of 135 acres of tidal fringe wetlands throughout Biloxi Bay vicinity. No alternatives have been developed.

Further development of alterative alignments are being currently refined in order to reduce potential impacts and to include all necessary structural components. An example of this is the construction of a ring levee around Bay St. Louis and an alternate alignment along Menge Avenue (i.e. LOD 4), which would eliminate the surge gate crossing the Bay of St. Louis. This is an ongoing formulation process in order to determine the best possible alignments.

4.2 Recommended Plans

The environmental component of the MsCIP Comprehensive Report and Integrated Programmatic EIS consists of the construction of environmental restoration projects that would ensure preservation of fish and wildlife, prevent saltwater intrusion, and provide stabilization of shorelines, in order, to reduce or eliminate coastal erosion and restore lost fish and wildlife habitat. These potential environmental restoration projects would restore low-lying areas; thus, reducing future storm damages to Coastal Mississippi. Residents and structures (i.e. commercial and residential) would be moved from these areas. In addition, the restoration of historic environmental settings would provide a natural buffer to future storm damages while also benefiting fish and wildlife.

Potential projects include freshwater diversion projects into Western Hancock County Marshes that have severely degraded over the years due to levee systems in eastern Louisiana and along the Pearl River, causing a decline in oyster resources.

Restoration of lost ecosystem functions where restoration needs are immediate due to unchecked wetland deterioration. As Coastal Mississippi residents are rebuilding much needed housing, there is an increase in developmental pressures on these valuable ecosystems due to housing shortages. The Environmental Recommended Plan would allow for restoration of storm damaged habitats and coastal systems and would prevent further destruction of these vital habitats. Wetlands in Coastal Mississippi can be restored to a sustainable level, one that coexists with human uses and communities.

Restoring critical landforms, barrier island shorelines, historical hydrologic patterns, and the sediment transport and budget system are crucial in order to sustain ecological and geomorphological function in perpetuity. The Environmental Recommended Plan has an emphasized interagency cooperation as dedicated staff members include representatives from the Corps, Mobile District, USFWS, and NPS. Additionally, we have collaborated with other resource agencies that include USEPA, USGS, NRCS, NOAA Fisheries (PRD & HCD), MDEQ, and MDMR.

The Environmental Recommended Plan partners with the State and recommends for construction of state recommended initiative projects that allow for recovery of badly damaged ecosystems. Additional collaboration has and will continue to occur with NGOs, including TNC, Gulf Restoration Network, The Sierra Club, The Audubon Society, etc., in addition to Mississippi academic coastal engineers and biologists, such as USM, Gulf Coast Research Lab, and MSU, in order to accomplish widespread support for this environmental effort. A strong public involvement campaign has been used to ensure contributions have been submitted by local constituencies and stakeholders in order to create strong buy-in on potential restoration projects.

CHAPTER 5. RECOMMENDED PLANS

The results of the alternative development, comparison, modification, screening, and selection process indicated that the recommended approach presented the most cost-effective solution, and was clearly the best-balanced plan where all factors were taken into consideration. All recommended plans on ecosystem restoration have incorporated adaptive management capabilities, where needed.

The **Recommended Environmental Plans for Coastal Mississippi** consists of the following:

5.1 Ecosystem restoration of historical wetlands previously developed

5.1.1 Plan Formulation

The Corps, Mobile District began investigations for identifying potential environmental restoration sites for the purposes of storm and flood damage reduction, flood reduction, preservation of fish and wildlife habitat, and removal of habitable structures within high hazard areas. When residential and/or commercial structures and/or land are purchased for the purpose of restoring floodplain areas (i.e. non-structural component), the structures are demolished and the land is no longer available for residential and/or commercial development. Historically, when land is purchased across the U.S., it is left with all or some of the infrastructure at the site rather than restoring it to its historic setting. With the MsCIP environmental plan, land that is purchased (i.e. non-structural component – refer to Non-structural Appendix) would then be restored into historical functional wetlands. The Corps, Mobile District, in cooperation with ERDC, developed a tool to help identify potential restoration sites throughout the study area.

Development of a GIS based SDSS tool allowed the Corps, Mobile District, working in cooperation with the USFWS and MDMR, to identify and prioritize potential wetland restoration areas throughout Coastal Mississippi (Lin 2007). A detailed discussion of this GIS based SDSS tool is included in this Environmental Appendix. A subset of potential restoration sites were identified by the SDSS tool and then ground-truthed by the MsCIP environmental team, including ERDC, Corps, MDMR, and USFWS. This interagency team allowed us to both confirm the accuracy of the SDSS results and to collect additional on-site information pertinent to restoration efforts. There are some major benefits in using a GIS-based SDSS approach to wetland restoration. First, it allows for the relatively rapid assessment of the large number of restoration sites across the wide study area. Second, potential sites can be evaluated and restored in a watershed or landscape context, which allows us to comprehensively evaluate the overall natural system. This approach can maximize the benefits of wetland restoration, as opposed to simply restoring wetlands where convenient or where property is available. Essentially use of this SDSS tool allowed the MsCIP environmental team to assess the entire coastline as a holistic natural system; thus, the team was more effectively able to analyze needs in Coastal Mississippi.

The SDSS effort resulted in the following products:

1. ModelBuilder based SDSS tool, which can be subsequently edited and applied to other areas along Coastal Mississippi in the future as funding becomes available;

2. Maps, such as aerial photography, topographic, soil layers, etc., depicting areas in the study region that have a high probability of being successfully restored into wetland functions that buffer and/or store stormwater, and provide suitable habitat for fish and wildlife; and

3. Photograph documentation and data sheets containing information on ground-truthed potential restoration sites.

This project has been further coordinated with the ongoing efforts of the MsCIP non-structural flood-proofing committee, and their results were used as the team identified potential restorations sites in Coastal Mississippi. The selection of 34 restoration sites, identified in Section *4.1.5.2 Environmental Restoration of Historical Wetland Sites*, was based on a combination of results from the SDSS tool and input from MDMR personnel based on local knowledge of the study area and adjacency to existing sensitive protected natural areas (i.e. State and/or Federal lands). A summary discussion of this effort follows.

5.1.1.1 SDSS

The SDSS tool evaluated potential wetland restoration sites that had been initially selected based on having a non-natural land cover (i.e. urban, deforested, and agricultural land cover, based on MDMR 2001 land cover GIS layer) and were located in the 100-year floodplain (Lin 2007). Numerous potential environmental restorations sites were initially identified. This initial group of sites was narrowed down based on the results of the SDSS. Sites with the following characteristics were screened out:

- < 5 acres in size
- Restorability class of Low or Medium Low
- Habitat class of Low or Medium Low
- Storm Surge/Flood Protection class of Low

5.1.1.1.1 Environmental Restoration Sites

Screening yielded numerous sites that were then reviewed by the Corps, Mobile District, MDMR, and USFWS personnel and based on this input the recommended sites identified as Phase I as Turkey Creek, Bayou Cumbest, Admiral Island, Dantzler and Franklin Creek (discussed in the following sections in detail) and the other 38 final restoration sites identified as Phase II (shown in Table 5.1.1.1.1-1) were selected. These final environmental restoration sites include a combination of those identified based on the SDSS results, as well as some additional sites (i.e. State Initiatives). These were made using only the non-natural land-use and 100-year flood calculations as the original site selectors (i.e. no damage layers were used), and sites were greater than or equal to 5 acres.

Table 5.1.1.1.1-1.
Environmental Restoration Sites in Coastal Mississippi

Site	Restoration Acres	Environmental Habitat Setting	Cost
(1) Pearlington, Hancock	76 acres (State owns 2,200 acres in the Pearlington area)	Emergent aquatic vegetation Bayhead Swamps trees Bayhead Swamps shrubs Riverine/levee forests	$ 30,200,000
(2) Pearlington South, Hancock	11 acres	Emergent aquatic vegetation Bayhead Swamps trees Bayhead Swamps shrubs Riverine/levee forests	$ 23,400,000
(3) Port /West, Hancock	49 acres	Emergent aquatic vegetation	$ 19,800,000
(4) Ansley, Hancock	2,023 acres (State owns 6,000 acres west of Lakeshore Road)	Emergent aquatic vegetation Wet pine savannah	$ 482,100,000
(5) Heron Bay	594 acres	Emergent aquatic vegetation	$ 192,100,000
(6) Lower Bay	226 acres	Emergent aquatic vegetation	$53,000,000
(7) Lakeshore, Hancock	275 acres	Emergent aquatic vegetation	$ 69,200,000
(8) Bayou Caddy/Lakeshore, Hancock	362 acres	Emergent aquatic vegetation	$ 113,400,000
(9) Clermont Harbor, Hancock	209 acres	Emergent aquatic vegetation	$ 208,300,000
(10) Bayou La Croix, Hancock	259 acres	Emergent aquatic vegetation	$ 207,100,000
(11) Shoreline Park, Hancock	889 acres	Emergent aquatic vegetation	$ 1,259,200,000
(12) Chapman Road, Hancock	146 acres	Emergent aquatic vegetation	$ 174,100,000
(13) Jourdan River – Interstate 10 Development, Hancock	638 acres	Emergent aquatic vegetation	$ 155,900,000
(14) Diamondhead, Hancock	433 acres	Emergent aquatic vegetation	$ 267,700,000
(15) Delisle, Harrison	120 acres (State owns 1,000 acres)	Emergent aquatic vegetation Bayhead swamps trees Bayhead Swamps shrubs	$ 41,900,000
(16) Ellis Property, Harrison	443 acres	Emergent aquatic vegetation Pine savannah - wet pine flatwoods.	$ 60,300,000
(17) Pine Point East, Harrison	103 acres (State owns 40-50 tax forfeited lots)	Emergent aquatic vegetation Wet pine savannah habitat	$ 47,500,000

Table 5.1.1.1.1-1.
Environmental Restoration Sites in Coastal Mississippi (continued)

Site	Restoration Acres	Environmental Habitat Setting	Cost
(18) Pine Point West, Harrison	83 acres (State owns 40-50 tax forfeited lots)	Emergent aquatic vegetation Wet pine savannah habitat	$ 36,700,000
(19) Pass Christian, Harrison	21 acres	Emergent aquatic vegetation Bayhead swamps trees Bayhead Swamps shrubs	$ 10,700,000
(20) Pass Christian Site – Bayou Portage, Harrison	43 acres	Emergent aquatic vegetation Bayhead swamps trees Bayhead Swamps shrubs	$ 27,800,000
(21) Brickyard Bayou, Harrison	14 acres	Emergent aquatic vegetation Bayhead swamps trees Bayhead swamps shrubs	$ 7,000,000
(22) Biloxi River – Shorecrest, Harrison	15 acres	Emergent aquatic vegetation Bayhead swamps trees Bayhead swamps shrubs Riverine/levee forests	$ 12,500,000
(23) Biloxi River – Eagle Point, Harrison	17 acres	Emergent aquatic vegetation Bayhead swamps trees Bayhead swamps shrubs Riverine/levee forests	$ 17,400,000
(24) Biloxi Front Beach - South of Highway 90, Harrison*	40 acres	Dune System	$ 60,500,000
(25) Keegan Bayou, Harrison	54 acres	Emergent aquatic vegetation Wet Pine Savannah habitat	$ 31,500,000
(26) St. Martin, Jackson	467 acres	Emergent aquatic vegetation	$ 147,500,000
(27) Fort Point, Jackson	83 acres	Emergent aquatic vegetation	$ 29,400,000
(28) Pine Island, Jackson	237 acres	Emergent aquatic vegetation	$ 518,600,000
(29) Belle Fontaine, Jackson*	1,516 acres	Dune System	$ 373,700,000
(30) Griffin Point, Jackson	182 acres	Emergent aquatic vegetation	$ 70,900,000
(31) Bayou Chico, Jackson	258 acres	Emergent aquatic vegetation	$ 82,900,000
(32) Grand Bay/Bayou Cumbest, Jackson	2,666 acres	Emergent aquatic vegetation	$ 621,400,000
(33) Wachovia, Hancock	1,200 acres total – 800 marsh, 200 forested, 200 savannah	Emergent aquatic vegetation, Bayhead Swamps trees Bayhead Swamps shrubs Riverine/levee forests	$2,830,000 Env. Rest $ 0 Real Estate
(34) Ansley, Hancock	900 acres – 800 marsh, 100 forested	Emergent aquatic vegetation, Wet pine savannah	$2,420,000 Env. Rest $ 0 Real Estate
(35) LaFrancis Camp Trenaisse, Hancock	45 acres total – all open water	Open Water	$ 8,770,000 Env. Rest $ 0 Real Estate
(36) DuPont, Harrison	650 acres – 170 marsh, 480 forested	Emergent aquatic vegetation, Bayhead Swamps trees Bayhead Swamps shrubs Riverine/levee forests	$6,597,000 Env. Rest $ 0 Real Estate
(37) Dantzler, Jackson (Alternate)	900 acres – 500 marsh, 385 forested	Emergent aquatic vegetation, Bayhead Swamps trees Bayhead Swamps shrubs Riverine/levee forests	$2,230,000 Env. Rest $ 0 Real Estate

Table 5.1.1.1.1-1.
Environmental Restoration Sites in Coastal Mississippi (continued)

Site	Restoration Acres	Environmental Habitat Setting	Cost
(38) Pascagoula River Marsh, Jackson	11,150 acres	Emergent aquatic vegetation, Bayhead Swamps trees Bayhead Swamps shrubs Riverine/levee forests	$ 2,420,000 Env. Rest $ 0 Real Estate
	27,397 acres	**Grand Total**	**$ 5,478,967,000**

* - Removed as a result of further evaluating

Source: MsCIP Environmental Team

The MsCIP environmental team then re-evaluated potential environmental restoration sites to see if there were any additional potential sites based on local knowledge of the coast. Existing wetlands targeted by MDMR for improvements, rather than restoration, were quickly identified by the team members. Because these sites are classified as having a natural land cover, they were not included in the initial selection of potential sites evaluated by the SDSS. Sites targeted by MDMR for restoration to upland habitat were also identified as potential restoration. Since the SDSS tool was evaluating sites based on wetland restoration potential, these sites were screened out for having a *Restorability class of Low or Medium Low.* Therefore, the local knowledge assisted in identifying and including these sites in the list.

For example, Shoreline Park was screened out after the SDSS evaluation because it had a *Medium Low restorability classification*. This Medium Low score was a result of large portions of Shoreline Park having been mapped in the state's soil survey as essentially a *spoil/fill* category, which is classified as non-hydric. However, it is known that historically the Shoreline Park area contained hydric soils, which could easily be restored through the removal of the existing fill and spoil. Therefore, this restoration site was then reinstated.

5.1.1.1.2 Initial Projects – Two Environmental Restoration Sites

Two potential restoration sites were chosen as *Phase I initial projects* to be carried forward in the environmental component of the MsCIP Comprehensive Plan. The potential restoration sites are located throughout the study area. One of the sites consists of restoring emergent tidal marsh and scrub/shrub habitat and the other site restores wet pine savannah habitat. The two sites allow the Corps, Mobile District to demonstrate the planning process involved in developing environmental restoration measures, development of alternatives, and selection of a cost-effective restoration plan (refer to the Economic Appendix for a detailed cost-effective discussion) for each potential environmental restoration site. This short-term effort was classified by the PDT as Phase I of a two phased approach, which allows for short-term and long-term comprehensive efforts. Phase II includes environmental restoration projects that require a longer timeframe to complete. If selected for further study, all 38 potential sites would go through a similar planning and evaluation process under the Phase II – Longer Term Comprehensive effort. Table 5.1.1.1.2-1 demonstrates how the identified environmental restoration projects allow the Environmental and overall MsCIP PDTs to achieve the overall project goals and objectives.

Table 5.1.1.1.2-1.
MsCIP Comprehensive Approach

Proposed Restoration Project	Portion of the Ecozone to be Addressed	Ecological/Societal Functions to be Addressed	Comprehensive Plan Objectives to be Addressed
Freshwater Diversion, Escatawpa River, MS	Littoral areas, emergent wetland areas	Enhanced oyster production, enhanced productivity of brackish marshes	3, 4, 5, 6
Other Coastal Wetland and Forest Restoration	Emergent Tidal Marsh Scrub/Shrub	Enhanced productivity of emergent tidal wetland, habitat enhancement, relocation of human development out of the coastal ecotone for public safety	1, 2, 3, 5, 6
Levee Projects – Belle Fontaine, Gulf Park Estates, Pascagoula/Moss Point, Pearlington, Gautier, Ocean Springs, Bay St. Louis	Reduces flooding	Adds protection to human development out of the coastal ecotone for public safety zone	1, 2, 6
Long-term High Hazard Area Risk Reduction Plan	Restore natural flooding buffer	Restore natural buffer zone, relocation of human development out of the coastal ecotone for public safety	1, 2, 6
Freshwater Diversion of the Mississippi River	Littoral areas, emergent wetland areas	Enhanced oyster production, enhanced productivity of brackish marshes	3, 4, 5, 6
High Hazard Area Risk Reduction Plan	Emergent tidal marsh, forested wetlands	Enhanced productivity of wetlands and forested wetlands, in order to restore natural buffer zone	1, 2, 6
Moss Point Municipal Relocation Component	Restore natural flooding buffer	Restore natural buffer zone, relocation of human development out of the coastal ecotone for public safety	1, 2, 6
Waveland Floodproofing	Restore natural flooding buffer	Restore natural buffer, relocation of human development out of the coastal ecotone for public safety zone	1, 2, 6
Forest Heights Hurricane and Storm Damage Reduction Component	Reduces flooding	Adds protection to human development out of the coastal ecotone for public safety zone	1, 2, 6
Turkey Creek Ecosystem Restoration	Wet Pine Savannah Wetlands	Enhanced productivity of wetlands Removes structures from project area	1, 2, 3, 6
Dantzler Restoration Area Ansley	Wet Pine Savannah Wetlands	Enhanced productivity of wetlands	1, 3, 6
Franklin Creek Ecosystem Restoration	Wet Pine Savannah Wetlands	Moves Residents out of Hamm Way (MsCIP Interim Project) Enhanced productivity of wetlands	1, 2, 3, 5, 6

Table 5.1.1.1.2-1.
MsCIP Comprehensive Approach (continued)

Proposed Restoration Project	Portion of the Ecotone to be Addressed	Ecological/Societal Functions to be Addressed	Comprehensive Plan Objectives to be Addressed
Bayou Cumbest Ecosystem Restoration Pearlington, Pearlington South, Port/West, Chapman Road, Diamondhead, Delisle, Ellis Property, Brickyard Bayou, Biloxi River – Shorecrest , Biloxi River – Eagle, Jourdan River – I-10 Development, Pine Island, Fort Point, St. Martin, Keegan Bayou	Emergent Tidal Marsh Scrub/Shrub	Enhanced productivity of emergent tidal wetland, habitat enhancement, relocation of human development out of the coastal ecotone for public safety	1, 2, 3, 5, 6
Admiral Island Ecosystem Restoration Lakeshore, Bayou Caddy/Lakeshore, Clermont Harbor Bayou La Croix, Shoreline Park, Pine Point East, Pine Point West, Pass Christian Site – Bayou Portage	Emergent Tidal Marsh Scrub/Shrub	Enhanced productivity of emergent tidal wetland, habitat enhancement, relocation of human development out of the coastal ecotone for public safety	1, 2, 3, 5, 6
SAV Pilot Project at Bayou Cumbest	SAV – *Ruppia maritime*	Enhance fishery production	3, 6
Beach and Dune Ecosystem Restoration	Coastal Dune Habitat	Buffer mainland from storm surge and waves energy	1, 2, 3, 5, 6
Barrier Island Restoration Biloxi Front Beach – South of Highway 90	Littoral zones, beach, dunes, emergent tidal marsh	Buffer mainland from storm surge and waves energy, enhanced productivity of emergent tidal marsh, enhance productivity of SAVs in littoral areas, enhance fisheries production	1, 2, 3, 4, 5, 6
Deer Island Ecosystem Restoration	Coastal Forests, Emergent Tidal Marsh	Enhanced productivity of wetlands	1, 2, 3, 5, 6

Footnote: Objectives - Green –Recommended Elements, Purple – Site Specific Elements, Orange – System Wide Elements. 1. Reduce loss of life caused by hurricane and storm surge by 100%; 2. Reduce damages caused by hurricane and storm surge by $150M-$200M annually; 3.Restore 10,000 acres of fish and wildlife habitat including coastal forests, coastal wetlands, wet pine savannah, submerged aquatic seagrasses, oyster reefs, and beaches and dunes by the year 2040; 4. Manage seasonal salinities within the western Mississippi Sound, such that optimal conditions for oyster growth (surrogate for other aquatic resources, 15 ppt during summer months) are achieved on an annual basis by 2015; 5. Reduce erosion to barrier islands, mainland, and interior bay shorelines by 50%; 6. Create opportunities for collaboration with local, state, and Federal agencies to facilitate implementation of programs and activities that maximize the use of resources in achieving the comprehensive goal.

Part of the reason these two sites were selected for the initial projects is because published HGM Functional Assessment models (Shafer et al, 2007; Rheinhardet et al 2002) exist for the regional wetland classes being restored at these sites (different HGM models exist for different regional wetland subclasses across the country), and thus could be used to measure restoration benefits. HGM models evaluate functions that are specific to a particular regional subclass by mathematically combining variable data (such as vegetation, soil, landscape, or hydrologic indicators) that have been scaled, based on a set of reference wetlands, to a value between 0.0 and 1.0, in order to obtain an index score for each function that is also between 0.0 and 1.0. Functional units are calculated by multiplying each functional index score by the total number of acres of the site. An example assessment HGM table is shown below in Table 5.1.1.1.2-2. For the two initial project sites, the functional units calculated for each function were combined so that a single functional unit benefit number was reported for each plan.

Table 5.1.1.1.2-2.
Cover Classes and Midpoint Values for Each Class

Cover Class %	Class Midpoint %	Cover Value
0	0.0	0.000
0-5	2.5	0.025
5-25	15.0	0.150
25-50	37.5	0.375
50	50.0	0.500
50-75	62.5	0.625
75-95	85.0	0.850
95-100	97.5	0.975
100	100.0	1.000
>100	100.0	1.000

Note: These midpoint values are used to estimate cover in plots. First determine if cover is more, less, or equal to 50%, If cover is >50%, decide if cover ismore or less than 75%. If >75%, decide if cover is more or less than 95%. If cover is <95%, then cover is 75-95% with a midpoint of 85% (0.85).

Because HGM functional assessments allow for restoration benefits to be evaluated in terms of functional unit gains or losses, rather than simply in acres, an advantage to using this method is that both the quality and quantity of wetland being affected are measured. Furthermore, since the variables used in the assessment are often ones that can be manipulated through restoration activities, the HGM assessment can determine the functional unit benefits for specific restoration measures.

It should also be noted several of the variables used in both HGM models require field data collection in order to accurately calculate their value pre-restoration. Because of current project time constraints, field data collection was unable to be conducted. However, the environmental team selected these sites due to their high familiarity with them which would allow effective and accurate assessment. Therefore, in order to estimate functional unit benefits, values for these variables were estimated using local, professional knowledge and assumptions concerning the areas in question. Prior to any actual restoration activities, the necessary field work could be conducted in order to obtain a more accurate measure of pre-restoration site conditions and, subsequently, the functional unit benefits resulting from restoration.

The following plans are being considered for being recommended as part of the overall MsCIP Comprehensive Report/Integrated Programmatic EIS. This effort serves as a Phase I initial project that will be enhanced by the recommended Phase II longer term comprehensive effort. The MsCIP environmental PDT has identified potential environmental restoration projects specified in Table 5.1.1.1.1-1 that would be studied further and restored under this recommended longer term effort.

5.1.1.1.2.1 Turkey Creek, Harrison County

This project site is located north of Gulfport, Mississippi, adjacent to U.S. Highway 49, a major north-west thoroughfare, and within the impaired Turkey Creek watershed. The area is becoming increasingly urbanized and development pressures are resulting in increased wetland degradation and loss by the direct filling. The project site is comprised of 689 acres south of the existing railway located on top of an elevated berm. Approximately 190 acres are located north of the railway and functions separately. The site is primarily comprised of a degraded pine savannah wetland. Several miles of ditches have been excavated throughout the site. Additionally the elevated railway berm fragments the wetland habitat and substantially alters the hydrology of the wetlands located to the north. Several plans were evaluated in order to determine the most cost-effective plan for restoration.

The Turkey Creek site had an HGM assessment performed in 2000, using the *Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Wet Pine Flats on Mineral Soils in the Atlantic and Gulf Coastal Plains* (Rheinhardt et al 2002). Results from this earlier assessment are being used to establish baseline (current) conditions at the site. The site has been divided into 8 separate assessment areas (Figure 5.1.1.1.2.1-1), as there were different baseline conditions for each area. The same HGM model is also being used to measure functional unit benefits at the site resulting from different restoration plans.

Objectives:

1. Restore native vegetation.
2. Restore natural hydrology.
3. Restore fish and wildlife habitat.
4. Provide storm water storage protection.
5. Restore and maintain State water quality.

Assumptions:

1. Mandatory homeowners assistance and relocation effort.

Measures:

Listed below are the proposed restoration measures and their expected effect on variables used in the HGM model.

1. Filling in ditches (Mandatory to achieve overall restoration project).

   This measure affects the "Outflow of Water" variable, which measures the removal of water by ditches or drains. The variable score would increase from 0.0 to 1.0 under this measure.

Source: Corps

Figure 5.1.1.1.2.1-1. Turkey Creek Restoration Site, Broken into Assessment Areas North (yellow border) and South (pink border) of the Railroad

2. Maintain vegetation (Mandatory to achieve overall restoration project).

   Alternatives:

   a) Burn (3-year cycle).

   b) Mow (annual).

This measure affects the "area of contiguous fire-maintained landscape", as well as all plant related variables used in the model. It is assumed that these variables will recover to a score of 1.0 under the burn alternative. Under the mowing alternative, the "area of contiguous fire-maintained" landscape variable will score a 0.0 but the plant related variables will still score a 1.0, similar to burning.

3. Excavate and remove existing roadbeds and any additional fill (Mandatory to achieve overall restoration project).

This measure affects the "surface water storage" variable, which measures the presence of excavation or fill at the site. This variable score would increase from 0.0 to 1.0 in areas with existing roadbeds/fill.

A combination of the measures resulted in the following plan combinations listed in Table 5.1.1.1.2.1-1:

Table 5.1.1.1.2.1-1.
Turkey Creek Restoration Measures

Plans 1-2.	Restoring areas north and south of railroad Plan 1. 1, 2a, 3	Plan 2. 1, 2b, 3
Plans 3-4.	Restoring just areas south of railroad Plan 3. 1, 2a, 3	Plan 4. 1, 2b, 3
Plans 5-6.	Restoring just areas north of railroad Plan 5. 1, 2a, 3	Plan 6. 1, 2b, 3

Table 5.1.1.1.2.1-2 shows the total functional units of the site under each plan, and the Average Annual Functional Unit (AAFU) benefit. It is assumed here that functional units will remain the same under existing conditions and the no-action plan. To calculate the AAFU, it is assumed all benefits are immediately accrued following plan implementation, and that the benefits are sustainable over the life of the project. Therefore, the AAFU was simply calculated as the difference between the total functional units for the restoration plan the total functional units for the no-action plan.

Table 5.1.1.1.2.1-2.
Summary of Functional Unit Benefits From Various Restoration Plans

Site	Restoration Acres	Plan	Total Functional Units	Average Annual Functional Unit Benefit
Turkey Creek	879	Existing Condition (plans 1-2)	1,222	-
Turkey Creek	689	Existing Condition (plans 3-4)	1,012	-
Turkey Creek	190	Existing Condition (plans 5-6)	210	-
Turkey Creek	879	No-action plan (plans 1-2)	1,222	0
Turkey Creek	689	No-action plan (plans 3-4)	1,012	0
Turkey Creek	190	No-action plan (plans 5-6)	210	0
Turkey Creek	879	plan 1	3,268	2,046
Turkey Creek	879	plan 2	2,574	1,352
Turkey Creek	689	plan 3	2,577	1,565
Turkey Creek	689	plan 4	2,037	815
Turkey Creek	190	plan 5	691	481
Turkey Creek	190	plan 6	537	327

(1) AAFU's are based on a 50-year period of analysis.
(2) See economic appendix for cost-effective analysis.

5.1.1.1.2.1.1 Plan Selection

These management measures were combined to create six plans that were analyzed to determine the cost-effectiveness of each. Economically ineffective plans are identified and eliminated to determine which plans are cost-effective. An economically ineffective plan is a plan that cost more or the same as a subsequent plan but produces less benefit than that subsequent plan. Of the six plans analyzed, three plans were eliminated because they produced less benefit at greater cost than a subsequent plan. Of the three remaining plans, one proved to be more cost-effective and consists of restoration of 689 acres south of the railway by restoration maintained by burning.

The recommended plan requires filling ditches, maintaining vegetation growth by burning and mowing the project area in the initial year of construction as well as maintaining it by burning every three years over the life of the project, and excavating and removing existing roadbeds and any additional fill.

5..1.1.1.2.1.2 Benefits

In order to restore this area to a wet pine savannah habitat, the higher areas will be designated as wet pine savannah. These areas have depression areas within them which will enable water to flow down to the depression areas; thus, holding water. The wet pine savannah habitat will be restored with wet pine flatwoods, such as *Pinus elliotti, Morella cerifera, Ilex glabra, Spartina patens, and Panicum virgatum.*

Many species of wildlife are indigenous to the wet pine savannah habitat. Understory plant communities may contain wiregrass, sedges, orchids, American chaffseed and rough-leaved loosestrife. Insectivorous plants that may be found include pitcher plants, bladderworts, Venus flytrap, and sundews. Rare, T&E birds that may occur in these areas include Henslow's sparrow, Bachman's sparrow, red-cockaded woodpecker, and Mississippi sandhill crane. This ecosystem may also benefit the Mississippi gopher frog and in drier areas along ridges, the black pine snake and the gopher tortoise.

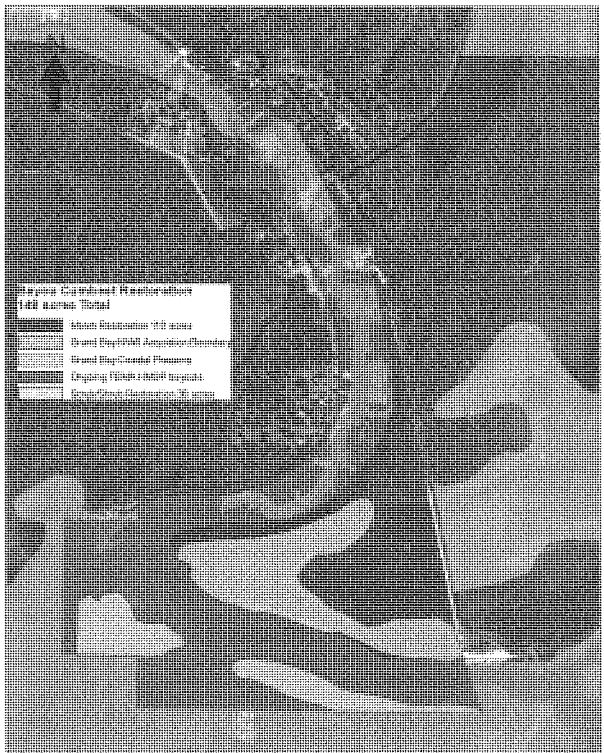
Benefits are measured in terms of AAFU. The HGM approach was used to assess wetland function. Results from this assessment were used to establish baseline (current) conditions and, ultimately, to measure the functional unit benefits resulting from different restoration plans. Table 5.1.1.1.2.1.2-1 shows the total functional units under the recommended plan and the AAFU net benefit. It is assumed that functional units will remain the same under existing conditions and the no action plan. The AAFU net benefit was calculated as the difference between the total functional units for the ecosystem restoration plan and the total functional units for the no action plan. An essential component necessary when selecting the recommended plan at Turkey Creek was the need for burning. Burning allows the wet pine savannah environment to continue naturally as a functioning system. Although mowing does effectively keep understory plants from over colonizing the area, it does not simulate the natural conditions (i.e. seed germination, heating the pine bark, etc.) Therefore, the environmental PDT ranked the burning measure higher than that of the mowing. This resulted in Plan 2 being eliminated due to its mowing component. When evaluating between Plan 1 and 3, the AAFU units were very different. The acreages were also very different due to Plan 1 including both the north and south parcels while Plan 3 included only the south parcel. The team noted that the man-made barrier within the project site produced hydrology constraints. Dominant flora species in wet pine savannah habitats are dependent upon burning; thus, the MsCIP environmental team selected the following plan knowing that most of these plant species would colonize the area upon establishment of routine burning and hydrology. The Environmental PDT then noted that the desired environmental restoration outputs (i.e. a functioning wet pine savannah) could be achieved by selecting Plan 3 which would also provide a cost-effective plan.

Table 5.1.1.1.2.1.2-1.
Summary of Benefits

Plan	Plan Description	Total Functional Units	AAFU Net Benefit
Existing Condition	Existing Condition	1,012	-
No Action	No Action	1,012	0
Recommended Plan – Plan 3	689 Acre Restoration Fill Ditches Remove Structures Excavate Fill Burn Every Three Years	2,577	1,565

5.1.1.1.2.2 Bayou Cumbest, Jackson County

The project site is located in the extreme southeastern portion of Jackson County adjacent to Bayou Cumbest and Mississippi Sound. The Bayou Cumbest restoration area (Figure 5.1.1.1.2.2-1) contains approximately 148 acres to be restored consisting of 110 acres of emergent tidal marsh and 38 acres of scrub/shrub wetland habitat. Existing scrub shrub vegetation at the site supports natural propagation through removal of exotic species that currently outcompete native vegetation. The area also consists of existing tidal marsh as well as filled and developed areas. Due to the severity of Hurricane Katrina, most of the residential development was severely damaged or destroyed. The site has low elevations and since most residential structures have been destroyed, an opportunity exists to excavate the old fill material and restore the once existent marsh. For increased habitat diversity, the team proposed to leave some of the higher elevations as is and plant shrub/scrub species in order to enhance ecological benefits at the restoration site.



Source: USFWS

Figure 5.1.1.1.2.2-1. Bayou Cumbest Restoration Site

Objectives:

1. Restore marsh to historical (pre-development ~1950's) conditions.
2. Provide storm surge protection.
3. Restore native tidal wetland plant community.
4. Provide fish and tidal wildlife habitat.
5. Prevent saltwater intrusion.

Assumptions:

1. Mandatory property purchase.
2. 100% removal of existing structures.

Measures:

1. Excavation of old fill material (includes 90-95% removal of existing exotic species in excavated areas). (Mandatory to achieve overall restoration in all plans)

   This measure, in conjunction with measure 3, affects the hydrologic regime variable, which under existing conditions receives a score 0.50, on the assumption that approximately half the site has been filled above the normal tidal flooding zone. This measure by itself would raise the hydrologic regime variable to a 0.75.

2. 100% removal of exotics from non-excavated areas and maintain removal of exotic species, such as Chinese Tallow, Phragmites, Cogon Grass, in all areas over project lifetime. (Mandatory in all plans).

   This measure affects the "percent cover by invasive or exotic species" variable, and would raise the variable score to 1.0 under all plans.

3. Filling in 100% of existing artificial ditches/channels.

   If this measure is performed in addition to the mandatory measure 1, the hydrologic regime variable score would increase to 1.0 as there would be no more hydrologic alterations to the site.

4. Native Vegetation Planting.

   Alternatives:

   a) 0.5 meter spacing

   b) 1 meter spacing

   c) 2 meter spacing

This measure affects the "percent cover by woody plant species", "wildlife habitat diversity", "vegetation height", "wetland indicator status" and "mean percent cover emergent plant species" variables. The relevant vegetation variables are assumed to reach their highest potential score at year 5 under 0.5 meter spacing, year 7 with 1.0 meter spacing, and year 10 with 2.0 meter spacing, and then sustained at that level for the 50 -year project life, Variable subindex scores are treated as increasing linearly from their value under the no-action plan up to their highest potential value obtained at year 5, 7, or 10, depending on the planting spacing, and then remaining constant thereafter.

A combination of the measures resulted in the following plan combinations listed in Table 5.1.1.1.2.2-1:

Table 5.1.1.1.2.2-1.
Bayou Cumbest Restoration Measures

Plan 1. 1,2,3,4a	Plan 2. 1,2,3,4b	Plan 3. 1,2,3,4c
Plan 4. 1,2,4a	Plan 5. 1,2,4b	Plan 6. 1,2,4c

Table 5.1.1.1.2.2-2 shows the AAFU benefit under each plan.

Table 5.1.1.1.2.2-2.
Summary of AAFU Benefits From Various Restoration Plans

Site	Restoration Acres	Plan	AAFU Benefit[1]
Bayou Cumbest	110	No-action plan	0
Bayou Cumbest	110	plan 1	191
Bayou Cumbest	110	plan 2	188
Bayou Cumbest	110	plan 3	184
Bayou Cumbest	110	plan 4	172
Bayou Cumbest	110	plan 5	169
Bayou Cumbest	110	plan 6	164

(1) AAFU's are based on a 50-year period of analysis.
(2) See economic appendix for cost-effective analysis.

5.1.1.1.2.2.1 Plan Selection

These management measures were combined to create six plans that were analyzed to determine the cost-effectiveness of each. Economically ineffective plans are identified and eliminated to determine which plans are cost-effective. An economically ineffective plan is a plan that cost more or the same as a subsequent plan but produces less benefit than that subsequent plan. Of the six plans analyzed, two plans were eliminated because they produced less benefit at greater cost than a subsequent plan.

The recommended plan will restore 110 acres of emergent marsh and 38 acres of scrub shrub habitat. Existing scrub shrub vegetation at the site supports natural propagation with exotic species management. The recommended plan consists of restoring the study area by excavating old fill material, removing exotic plant species from non-excavated areas, filling existing artificial ditches, and planting native vegetation, such as *Spartina alterniflora* (Smooth Cordgrass) at the seaward edge of marsh; *Juncus roemerianus* (Black Needle Rush) at a slightly higher elevation; and *Spartina patens* (Saltmeadow Cordgrass) at a slightly higher elevation at a density of 1 meter. For those higher elevation areas identified in Figure 5.1.1.1.2.2-1, exotics would be removed and replanted with scrub/shrub species in order to enhance habitat diversity at the restoration site.

5.1.1.1.2.2.2 Benefits

Benefits are measured in terms of AAFU. The HGM approach was used to assess wetland function. A HGM assessment was performed. Results from this assessment were used to establish baseline (current) conditions and, ultimately, to measure the functional unit benefits resulting from different restoration plans. Table 5.1.1.1.2.2.2-1 shows the total functional units under each implemented plan and the AAFU net benefit. To calculate the AAFU net benefit, it is assumed that benefits will be maximized at year 5 with 0.5 meter spacing of vegetation, at year 7 with 1.0 meter spacing of vegetation, and at year 10 with 2.0 meter spacing of vegetation. These benefits are estimated to be sustainable over the life of the project. Net AAFU benefits are calculated as the difference between the total functional units for the ecosystem restoration plan and the total functional units for the no action plan.

The environmental MsCIP team selected the 1.0 meter spacing based on professional experience by the Corps, universities, NGOs, State, and other Federal agencies with restoration of emergent marsh habitats. Past experience in Coastal Mississippi has proven that spacings, elevation, and hydrology are the three key essential components to obtain a successful emergent marsh site. The three spacing scenarios (i.e. 0.5, 1.0, 2.0 meters) have been used at a local Coastal Mississippi project (i.e. Deer Island, Harrison County). Upon assessing the propagation of those different spacings, the environmental PDT determined that although the 0.5 meter spacing is the desired planting technique, the overall goal of the restoration project can be achieved by spacing the tidal emergent plants out to 1.0 meters per plant. The 2.0 meter spacing was determined to leave the site too vulnerable to storms and/or hurricanes; thus, this spacing technique proofed to be rather risky. Marsh restoration along Coastal Mississippi will provide nursery habitat for various vertebrates and invertebrates while also providing a natural storm protection buffer from future storms. Therefore, the environmental PDT recommended Plan 2 because it provides both the optimal elevation and hydrology requirements while also providing suitable spacings for the tidal marsh plants that will allow the plants the ability to quickly colonize the site.

Table 5.1.1.1.2.2.2-1.
Summary of Benefits

Plan	Plan Description	AAFU Units	Net AAFU Units
Existing Condition	Existing Condition	1,052	-
No Action	No Action	1,052	0
Recommended Plan 2	Excavate Fill Remove Exotics Fill Ditches Plant at Density 1.0m	1240	188

5.2 Freshwater Diversions

5.2.1 Plan Formulation

Several projects are presently being considered to divert freshwater from the Mississippi River or other sources as a mechanism to promote reversing a historic increase in salinity in the Mississippi Sound/Biloxi marshes area in order to support fresher marshes and oyster reef health and productivity thus enhancing both their economic value and the ecological services they provide.

Oysters not only support a commercial fishery but interact directly with local hydrodynamic conditions, affecting currents, flow conditions, and sedimentation patterns (Lenihan 1999). They filter large amounts of phytoplankton and detritus exerting a powerful influence on water quality, phytoplankton productivity, and nutrient cycling of estuaries (Dame 1996). Oyster reefs provide habitat for a wide range of other invertebrates present either on the oyster shell itself or in the interstices between shells. Oyster reefs also support numerous resident, transient, and juvenile fish and decapod species and may provide a refuge from predation and poor water quality conditions.

Oysters are sensitive to specific ranges of salinity; therefore, freshwater diversions have the potential to either enhance or threaten the resource. For instance, where the average salinity exceeds 15 ppt oysters often experience increased predation rates by oyster drills whereas young oysters are more susceptible to certain diseases at salinities greater than 9 ppt (Cake 1983; Chatry et al. 1983). Similarly, salinities averaging below 7.5 ppt can inhibit oyster growth and sexual maturation while salinities that persist for extended periods of time below 2 ppt can result in direct mortality (Sellers and Stanley 1984). The relationship between oyster productivity and river flow is a complex one and there does not appear to be a close link between oyster harvests and freshwater inflow (Turner 2006).

Alternately, the water diverted from riverine sources not only has lower salinity, but it usually carries more sediment and nutrients. Diversions may result in areas of excess nutrients and thus cause algal blooms, lower light attenuation and other signs of eutrophication.

Therefore, any proposed diversion project needs to be carefully evaluated in order to insure the maximum probability that proper habitat and water quality conditions are met. Because of the potentially large number of projects that might require evaluation, it is essential that a screening tool be developed to cost effectively identify those proposals which warrant the level of detailed study required to make informed decisions. It is essential that proposals that have no likelihood of success are eliminated early in the evaluation process in order to maximize the effectiveness, eliminated negative impacts from poorly designed projects, and reduce costs of evaluating the remaining candidates.

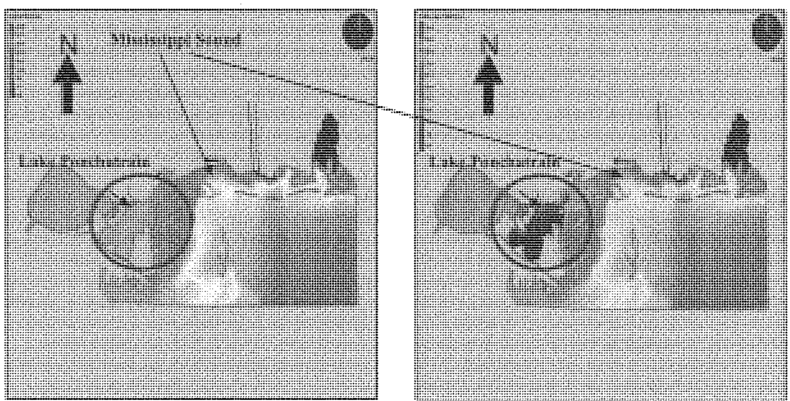
In an effort to initiate the proper evaluation of freshwater diversions, a water quality model, which is based on the CE-QUAL-ICM water quality model code, is coupled to output from a three-dimensional hydrodynamic model of the region, which is based on the CH3D hydrodynamic model (Dorth et al 2007). The version of CH3D with sigma coordinate in the vertical dimension is being used. The model grid extends seaward beyond the Chandeleur Island and includes Mobile Bay, Lake Borge, Lake Pontchartrain, the Inner Harbor Navigation Channel of New Orleans and the Mississippi river Gulf Outlet Channel. Predicted water quality constituents, including nutrients, phytoplankton, dissolved oxygen, temperature, salinity, and underwater light intensity, were evaluated for several scenarios and compared to modeled existing baseline conditions to assess relative changes.

The water quality model was applied for three alternative scenarios: (1) diversion of freshwater flow from the Mississippi River at Bonnet Carre' spillway, (2) diversion of freshwater flow from the Mississippi River at Violet Marsh, and (3) diversion of all of the Escatawpa River flow into Grand Bay. The Bonnet Carre' diversion varied by month while the Violet Marsh diversion was a constant flow of 7,500 ft^3/s. The Escatawpa diversion is the flow that occurred in the Escatawpa River during 1998, and those values were varied daily in the model. The water quality model was applied for the period April through September 1998 using the same inputs as the final calibration run except for different hydrodynamics and different boundary conditions for the diverted flow and associated concentrations of the flow. The hydrologic model was run with the same conditions as used for the base conditions used in the water quality model calibrations for 1998 except that the additional freshwater flows were introduced.

In an effort to apply this water quality data to ecological issues, MsCIP and ERDC convened a panel of representatives from TNC, MDMR, USM at the Gulf Coast Research Laboratory. The aim of the panel is to suggest simplistic ecological models that can be incorporated with projections from the combined hydrodynamic and water quality models to identify simulations which might result in an improvement in oyster habitat quality. The panel has identified several key attributes that need to be incorporated into the evaluation of freshwater diversion options. The first is that salinities average as closely as possible to the optimal range for oyster health and productivity. This is clearly of critical importance since the primary purpose for contemplating freshwater diversions is to improve habitat conditions for oysters. Second, a diversion should not result in extended periods of low salinity resulting in mortality or poor growth and reproduction. This consideration is particularly critical during times of high river flow or other extreme conditions. Third, a diversion should not unduly influence habitat conditions for other critical resources. Diversions that result in favorable conditions for oyster health may not be conducive to other equally important resources. For instance, most seagrasses do poorly at salinities less than 20 ppt. A diversion that results in excellent conditions over the prime commercial beds but drives salinities below 20 ppt in the seagrass elsewhere would not be acceptable. Other important habitat requirements that should also be considered for seagrass health include light availability and nutrient concentrations. These ecological concerns associated with water diversions, in addition to potential impacts on important fisheries species of those areas, require conservative actions and more study of potential impacts (positive and negative) of such practices for the long-term sustainability of nearshore and estuarine resources.

As an example, the results from a simulated diversion of 7,500 ft^3/s of Mississippi River water near Violet, Louisiana are presented in Figure 5.2.1-1. The results suggest that 180 days after initiation of the diversion salinities were lowered in western Mississippi Sound. Dortch et al. (2007) sufficiently warrant additional examination. However, at present, absolute salinity values predicted by the model poorly match calibration data. Further refinement of the models should correct this limitation and must be made to allow the usefulness of the model results for estimating potential beneficial or deleterious effects on oysters and other coastal resources.

Results also showed that diversion through the Bonnet Carre and through the Escatawpa/Grand Bay system have the potential to significantly influence coastal salinities.



Base Conditions **With Diversion**

Source: Corps

Figure 5.2.1-1. Projected Salinity Values 180 Days after Initiation of a Diversion of 7,500 cfs of Mississippi River Water at Violet, LA Simulated Diversion of Mississippi River into Lake Borgne Near Violet, Louisiana

Ongoing and future studies can be used to refine the hydrodynamic and water quality model and tighten the calibrations. This will allow for better integrating the water quality results to ecological concepts. Also, this preliminary effort just developed information for some possible discharge scenarios in order to do a sensitivity analysis as to whether diversion could potentially affect the areas of concern. These efforts showed the potential for freshening the systems. Future studies and model runs will need to be performed to test precise operational discharge plans and seasonal influences.

5.2.1.1 Grand Bay Savannahs and Marshes

Historically, the estuarine marsh within the Grand Bay NERR represented the former deltaic ecosystems of the Pascagoula and Escatawpa Rivers in eastern Jackson County. The outlets of these rivers have shifted westward over time, severely limiting the inflow of freshwater, nutrients, and sediments into the Bayou Cumbest area of the reserve.

Currently, it is speculated that much of the freshwater entering the Grand Bay NERR estuary is from surface runoff through Bayou Heron and Bayou Heron, within the Bangs Lake Hydraulic Unit, measuring approximately 21,374 acres. Human disturbances to the area have also altered historic sheet flow and surface water flows into the area, as well as the natural migration of the Pascagoula and Escatawpa Rivers. A freshwater diversion project in the area, if feasible, may serve to enhance the wildlife resources of the area. The need for freshwater diversion at the Grand Bay savannahs and marshes would help restore the predominant wet pine savannah habitat. Shoreline erosion along the Grand Bay area (i.e. loss of the Grand Batture Islands) has also contributed to the increased salinity in the area.

The proposed project will seek to develop a refined hydrodynamic model for the area, inputting biological, water quality, and physical data into the model to evaluate a variety of freshwater diversion scenarios. This work represents a critical first step in the final assessment of potential water diversion projects for this area. Community information will be solicited and a public workshop will be held to share the results.

5.2.2.2 Hancock County Marshes

Diversion of Mississippi River freshwater and/or sediments in the vicinity of Violet, Louisiana has been strongly considered because of a number of positive factors. These include proximity of the river to target coastal wetlands restoration areas, strong public support, and high confidence in potential environmental benefits. The Violet Diversion Project is under consideration by the MsCIP (Corps, Mobile District) and Corps, New Orleans District as a freshwater diversion project that could potentially have a positive impact to the Hancock County Marshes. Preliminary results from modeling a simulated diversion of 7,500 ft^3/s of Mississippi River water near Violet, Louisiana, suggest that after 180 days of initiation of the diversion, salinities were lowered in Western Mississippi Sound sufficiently to warrant additional examination (Dortch et al 2007). Further refinement of the models should address current limitations and must be made to estimate potential beneficial or deleterious effects on oysters, seagrasses, marsh systems, and other coastal resources. Although the idea is viable, at this point, additional information is needed to determine current problems within Hancock County Marshes and potential impacts to existing coastal resources as well as navigational impacts.

5.2.2 Recommended Plan

Due to the time constraint of this MsCIP Comprehensive Report/Integrated Programmatic EIS, the MsCIP team was only able to qualitatively determine that freshwater input into the systems does change the overall environment. It is known that these systems have been altered and/or starved by lack of freshwater inflow. An integrated environmental web exists in these rivers and also in

Mississippi Sound, which needs to be fully identified, in order, to completely understand various effects that could possibly occur.

The MsCIP environmental team recommends additional study, such as water quality and quantity, of this freshwater diversion plan (i.e. Hancock County Marshes and Grand Bay Savannahs and Marshes) as part of the MsCIP Comprehensive Report/Integrated Programmatic EIS. This study is necessary to assess the quantitative amount of freshwater flows required to positively impact each ecosystem.

In a collaborative effort, the MsCIP Environmental PDT closely worked with the Louisiana Coastal Protection and Restoration PDT to coordinate efforts. This close coordination allowed both the States of Mississippi and Louisiana to accomplish its respective goal of increasing sedimentation and freshwater via diverting water from the Mississippi River. Congress recently passed a law authorizing water resources projects and investigations throughout the U.S. WRDA of 2007 recommended a freshwater diversion project at Violet, Louisiana. The project is authorized to produce the same benefits for the Biloxi Marshes and Mississippi Sound as an earlier project (1988) at the Bonnet Carre Spillway in Louisiana. As authorized this effort would be designed and built by the Corps in partnership with the States of Mississippi and Louisiana.

The Louisiana Coastal Protection and Restoration and MsCIP PDTs will accomplish the following:

- Investigation of hurricane protection and coastal restoration for south Louisiana lead by the Corps, New Orleans and Mobile Districts in cooperation with the States of Louisiana and Mississippi.
- Evaluates four options for freshwater diversion at Violet for enhancement and preservation of wetlands in eastern St. Bernard Parish, Louisiana. Recommend construction of a freshwater diversion at Violet for salinity reduction in Mississippi Sound to improve oyster bed habitat.
- Flow rate alternatives range from 250 ft^3/s to 50,000 ft^3/s and estimated construction costs range from $1 million to $279 million.
- The Louisiana Coastal Mississippi Protection and Restoration and MsCIP final technical reports are due in December 2007 but it will not contain a construction plan for any of these alternatives.

5.3 Beach and Dune Restoration – LOD-2

5.3.1 Plan Formulation

Essentially all the beaches along Coastal Mississippi are man-made. Harrison County has the most beachfront with a 26-mile stretch extending from Biloxi Bay to St. Louis Bay. This beach is the longest man-made beach in the U.S. Hancock County has several miles of beach while Jackson County only has a small beach located in the Cities of Pascagoula and Ocean Springs. In total, the beaches extend along less than half of the Mississippi coastline.

Most of the dunes that previously existed along these beaches were destroyed by Hurricane Katrina and much of the beach was damaged. Many Federal, state, and local entities raised environmental concerns regarding the various Mississippi beaches as part of the 180 projects previously discussed. In some areas, such as in the City of Pascagoula, the beach was completely gone. Reconstruction of the dunes, where beaches exist, will provide a reduction of damaging wave action from smaller storms (i.e. normal summer storms, tropical storms, and/or lower energy hurricanes).

A project to restore the beaches in Harrison County has been funded and is underway as part of the Flood Control and Coastal Emergencies (FCCE). Other projects to construct dunes to a height of 5-

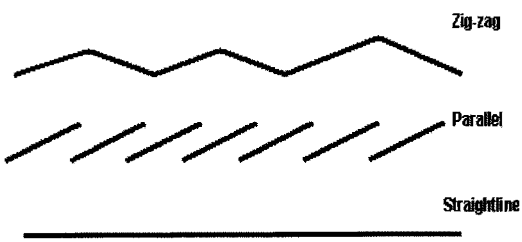
foot in Harrison County and to 2-foot in Hancock and Jackson County were proposed as part of the MsCIP Interim Report. That dune restoration project has since been funded and the Corps, Mobile District is underway preparing the plans and specifications.

The beaches, situated immediately seaward of developed areas, provide an excellent location where elevated dunes could be constructed to provide some additional protection against smaller hurricanes. Furthermore, the seaward side of the dunes also provides excellent feeding grounds at the nearshore and intertidal shore areas for various birds, crabs, and other fauna. The MsCIP environmental and engineering PDTs cooperatively assessed various dune elevations. The teams quickly designated this component of the plan as LOD 2. The engineering team evaluated the structural benefits while the environmental team evaluated habitat benefits to the Coastal Mississippi ecosystem.

Original concepts were to look at crest elevations of +10.0 feet and +15.0 feet as options for all dunes. Further discussions made it clear that the top elevation of the dunes needed to be below the elevation of the adjoining roadway. This was to help mitigate the migration of the sand onto the roadway as aeolian (wind blown) deposits. It was decided to correlate the top of the dune to an elevation that would be +1-foot lower than the adjacent road that would be included in LOD-3. LOD-3 elevated roadway elevations of +11.0 feet were selected for Jackson and Hancock Counties and +16.0 feet for Harrison County. These decisions for LOD-3 then dictated dune crest elevations of +10.0 feet for Jackson and Hancock Counties and +15.0 feet for Harrison County. Supplemental information can be found in the Barrier Island Appendix.

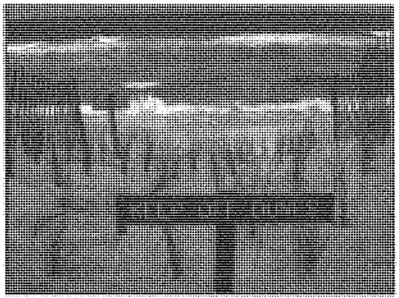
Dunes are consistent with public preference for a more natural appearing defense mechanism rather than a hardened structure. Construction of dunes will include planting vegetation, such as sea oats (*Uniola paniculata*), and sand fencing to help stabilize the dunes (Figures 5.3.1-1 and 5.3.1-2). Sand dunes are naturally occurring dynamic coastal features, which are formed by the accumulation of wind blown sand. Sand is naturally carried along the beach by the wind. Sand fences help facilitate the building of sand dunes by trapping and collecting this wind driven sand. Sand fences are usually made of wood or biodegradable material. Without dune vegetation, sand dunes become unstable; thus, the MsCIP environmental team recommended planting dune vegetation. Dune plants tolerate harsh beach conditions including wind, salt spray, storms, scarce nutrients, limited freshwater, and intense sunlight and heat. The plants and/or seedlings provide feeding sources to a variety of animals while also providing nesting and roosting habitat.

These dunes would be a sacrificial barrier, but could also be important by providing additional protection for the toe of the existing roadway, especially in an elevated seawall or roadway configuration as LOD-3. Placement of the dunes directly against a raised seawall or roadway would also serve aesthetically to mask the appearance of a structural barrier. Thus, adding to the public acceptance and/or appeal of this other proposal.



Source: Corps

Figure 5.3.1-1. Examples of Sand Fence Patterns



Source: Corps

Figure 5.3.1-2. Dune Vegetation with Sand Fencing

While the measure described above joins LOD-2 with the adjoining roadway (i.e. LOD-3), consideration could be given to having a stand-alone LOD-2 dune system that is on the existing beach, but separated from the road. The quantity of sand for an option, such as this, would increase since the northern slope of the dune is adjacent to the roadway. The grade elevation would go down to about +5.0 feet and not abut against the roadway. By doing so, the top elevation of the dune could vary and be above the roadway as necessary. This may increase the need for maintaining the sand in the designated dune alignment since it would be expected that the sand dune would tend to migrate under the prevailing wind direction. This option was not fully designed as many unanswered questions remain that may have to be simulated with models. This includes the width of the dune crest and the width of the beach berm that might be required in front of the dune. This option would also block any view of the water from the existing roadway in most areas, replacing the view with a dune scene including plantings of sea oats or other beach type vegetation.

5.3.2 Recommended Plan

A dune system, 60-foot wide and 2-foot high, planted with sea oats along the mainland coast is recommended for construction. Sand fencing would be used to stabilize the dune feature. A detailed description is conducted in the Engineering Appendix.

5.4 Barrier Island Restoration

5.4.1 Plan Formulation

A significant environmental impact from the barrier islands continuing to diminish is the increase in Mississippi Sound's salinity. Under current conditions, the islands provide a boundary between the sea water salinity [~33 ppt] of the open Gulf of Mexico and the brackish water found in the Sound. Salinity in the Sound during low flow periods range from 10 ppt to 30 ppt. Highest salinities occur just south of Pascagoula and Gulfport and the lowest salinities in the Lake Borgne-Pearl River area. Loss of the islands would allow the salinity to greatly increase changing the ecological habitats that now exist. This would impact, if not devastate, shellfish and many other forms of marine life. Oysters currently found in concentrated Mississippi Sound areas would possibly cease to exist.

The degradation of the Chandeleur Islands in southeastern Louisiana allows us to anticipate potential environmental changes. Initial assessments are showing SAVs diminishing, marsh erosion rates accelerating, and wave energy along the mainland having no natural barrier. Unlike the Mississippi barrier islands, Chandeleur Islands are a remnant of a delta lobe from the Mississippi River where wave action created a beach that remained as a island after sea level rise and erosion removed the land mass between the island and the mainland.

5.4.1.1 Entire Restoration

Prior to Hurricane Katrina, the State of Mississippi was working on a coastal storm protection plan and proposition to submit to NPS for consideration that included restoring the barrier islands to the condition that existed prior to Hurricane Camille. Soon after Hurricane Katrina, it was reported that many in Mississippi felt that if the islands had been in the condition that existed prior to Hurricane Camille, there would have been less damage along the coast from Hurricane Katrina. This idea was also included in the Mississippi Governor's Recovery Plan, which called for restoring the islands to a pre-Camille footprint. In addition, this restoration concept was raised in the initial 180 projects previously discussed. This concept was included in the hurricane protection study as LOD-1, which is discussed more fully in the Engineering Appendix.

Modeling efforts have concluded that over a wide range of storms, there would be some protection provided to the eastern coast of Mississippi along the Jackson County shoreline if the islands are in the pre-Camille condition. This area is the most protected from the restored islands and this protection may result in only up to a 10% reduction in storm surge. The effect of this protection diminishes rapidly to the west from Jackson County. A detailed discussion of this modeling effort can be found in the Engineering Appendix.

The post-Hurricane Katrina condition can be considered a baseline condition for the modeling and the pre-Camille condition would be an improved condition (Table 5.4.1.1-1). The pre-Camille footprint of the islands was obtained from historical records and an assumption was made as to a top of dune elevation of +20 feet. [It should be noted that some of the islands have migrated to the west and any reconstruction would be to increase their footprint at their present location and not move them back to historical locations.] Restoration of Ship Island in a pre-Camille configuration includes closing the post-Hurricane Katrina, 4-mile long breach between East and West Ship Islands to a 2,000-foot width and with 20-foot high dunes, along with some rebuilding of the other islands to a larger land area. This option will only include new land mass that is being added to the islands by bringing sand dredged from an offshore location. Sand of sufficient quality in the quantities required for this type of project is not known to occur in close proximity to the islands. Prior studies of the St. Bernard Shoals (Oral Communication, USGS 2006) are probably the best source of the sand. Additional studies and sampling will be required to ensure the source. The shaping of the sand into beaches, dunes, and marsh areas will not affect the existing islands other than that narrow strip of land that will form the Gulf Island National Seashore boundary between the existing island and the new land mass.

A detailed discussion of the St. Bernard Shoals can be found in the Engineering Appendix. The average water depth over the shoals is 60 feet, which puts the sand within reach of a hopper type dredge; however, the water depth near the islands is too shallow for the draft of hopper dredge that would be used in this type of operation. In order to accomplish this, a basin would be dredged near each of the islands to discharge the sand being transported from the borrow area. Using this procedure, the hopper dredge could enter the basin and bottom dump the sand near the islands. This would be much faster than pumping off the sand. Doing this would also allow the basin to be placed outside of the NPS's National Seashore boundary. As the basin is filled, a suction dredge would be mobilized to the site and the sand could be moved to the area where it is needed to create additional land mass. As the sand was placed on the new land mass, it would be sculpted into dunes and swales, which would vary from sea level up to heights of approximately 20 feet. As the new land mass is added to the existing islands, portions of the new island will be planted with various type of vegetation to provide habitat and to aid against erosion. Vegetation would increase stabilization of the dune systems. The percentage of maritime forest varied among the islands from 1% up to 23%. For the new land mass of the islands additions, it was decided to use a quantity of 20% percent of the land mass for planting the trees consisting of longleaf pine. The lower elevations of the new land mass would be planted with emerging marsh species that would cover 38% of the area. Dunes planted with sea oats would make up 2% of the area and the beach areas would be left as open berms.

Table 5.4.1.1-1.
The Amount of Land Mass Lost from Each of the Mississippi Barrier Islands from Pre-Camille Conditions to Post-Katrina Conditions

Island	Pre-Camille (acres)	Post-Katrina (acres)	Land Loss (acres)
Cat	2,344	1,957	387
Ship	1,172	631 (East and West)	541
Horn	3,612	3,077	535
Petit Bois	1,329	1,098	231

The difference in the land mass over this period was then converted to an acreage that it would take to restore the size of the footprint. The width of the islands was maintained with the additional land mass being added as length. Each of the surface areas was converted to a quantity by using an average water depth of 7 feet and raising the sand up to elevation of +10.0. It was assumed that approximately 25% loss of the material would occur during the process of placement.

5.4.1.2 Breakwater Construction to Restore the Barrier Islands

One positive affect the islands have is to provide a natural offshore breakwater for the large sea waves that are generated from hurricanes. The presence of the islands and the relatively shallow water of Mississippi Sound between the islands and the mainland prevent sea waves from maintaining their considerable size as they move towards the mainland. Sea waves, often reported at heights of 40 feet and higher in large storms, would break as they approach the chain of islands. The open-water between the islands and the mainland, generally ten miles or more, would have enough fetch for waves to regenerate, but at a much lower height due to the shallower water. The generally accepted relationship between water depth and wave height is that the wave can sustain itself at a height that is one-half the depth of the water. Construction of breakwaters to restore the barrier island system was found technically unfeasible due to it not providing enough protection to the islands and the mainland of Coastal Mississippi.

5.4.1.3 Littoral Supplement to the Barrier Islands

With the consideration that the barrier islands lands administered by the NPS and the core preservation and protection mission and management policies applicable to the agency, any proposed improvements would be required to be subjected to additional environmental impact analysis and compliance. Additionally, Petit Bois and Horn Islands are congressionally designated Wilderness areas, an added layer of resource protection requiring proposed management actions be subjected to review according to the Wilderness Management Act. One other consideration to help restore the islands including restoration of the sediment transport and budget system they are dependent upon, is to supplement the sand in the littoral system. This could be accomplished by adding sand in specific locations based on sediment transport modeling. This would allow the littoral currents to move the sand onto the islands where the natural process of island building could take place. The source of these sands may be from inland sources and/or from offshore borrow areas. A detailed discussion pertaining to the sources of sand (i.e. inland and offshore) can be found in the Engineering Appendix. This would not directly affect the present-day islands; however, on a long-term basis, supplement of the littoral zone could continue the sustainability of this important barrier island system and ultimately protect Mississippi Sound and its very productive fisheries.

The construction of inland waterways in Alabama and Mississippi has resulted in continuing maintenance dredging to maintain the channel depths and alignments. This dredged material is now accumulated in numerous disposal areas along the banks of the river. Dredging of some of the areas along the river has produced large quantities of sand that have potential use for replenishment of littoral zones, such as are found along the Mississippi barrier islands.

An inventory of current disposal sites indicates that approximately 30,000,000 cubic yards of sand is available. Only disposal sites that contain a minimum of 100,000 cubic yards of sand were included in the inventory. Of interest to this study are disposal sites that are located along the Black Warrior–Tombigbee River system and the Tennessee–Tombigbee Waterway. The cost to store this type of dredged material is high and it has recently been estimated that removing the sand from the existing disposal areas would save the Government over $100,000,000 at today's cost.

Sand from the river was typically a finer grain size than that of the beach sand. It was also noted that the beach sand was more rounded than the river sand. All of the river sand had a brown tint described as "very pale brown" or "light yellow brown." Adding this sand into the littoral zone may diminish the differences between the natural sand in the system and the river sand that would be added. By spreading the sand over large areas to a small thickness, approximately 1-foot, it is anticipated that the natural sediment transport process would blend the two sands together. The transport process would also tend to remove any staining from the sand grains and help to round the individual particles through abrasion. Further evaluation, modeling, and study would be required in cooperation with the NPS before this riverine source could be sanctioned as a viable alternative to increase volumes of beach compatible (grain size, color, and texture) sand within the barrier island system.

The entire process would consist of loading the sand onto river barges at various disposal areas, moving the barges downriver, and into Mississippi Sound via tugboat tows, unloading the barges with a "hydraulic unloader", and spreading the sand with a "spreader barge." The process would require a continuous supply of loaded barges as the unloader only needs about an hour to remove the sand from a typical river barge. Staging this process from within Mississippi Sound would also help with down time due to weather that would be more affected on the south side of the islands. Preliminary analysis has indicated the St. Bernard Shoals source is likely compatible (grain size, color, and texture) with existing beach sand on the Mississippi barrier islands.

Another consideration to help restore the islands is to supplement the sand in the littoral system with sand obtained from offshore borrow areas. Like the upland source, this could be accomplished by adding sand in specific locations based on sediment transport modeling. The sand that could be used in this option may come from the same offshore borrow area as the St. Bernard Shoals located about 45 miles south of the barrier islands.

5.4.1.4 Reshaping the Islands

Another option with the least impact on the existing post-Hurricane Katrina barrier islands would be to re-establish the vegetation that was destroyed. This option could involve restoration of the existing islands through adding sand dunes on the beaches along with planted vegetation (i.e. *U. paniculata*), planting of marshes (i.e. *S. alterniflora, J. roemerianus*, and *S. patens*) and maritime forests (i.e. *P. elliottii engelm, S. repens, S. minor*, etc.), and planting seagrasses (i.e. *D. wrightii, C. manatorum, T. testudinum*, and *R. maritime*) in the nearshore areas of the islands.

Historically, large areas of seagrasses existed north of the islands. Much of this seagrasses is now gone and the loss of these areas have been mapped. Replanting the grass will aid in establishing valuable habitat that is part of the ecological system that has been destroyed near the islands. Foremost, the vegetation would restore the island's natural setting, which allows for the diverse array of flora and fauna to persist. This plan would not involve adding any land mass to the islands other than the possibility of adding to the dune system. Vegetation would aid in reducing erosion from wind; thus helping in maintaining the stability of the islands. The vegetation would also aid in preventing erosion in the event that the islands get overtopped by storm surge in a large hurricane. Sources of this sand could be from the beach area behind the dunes or from sources off the island.

5.4.1.4.1 Two-Foot Dune System

The dune would be shaped from sand that would be removed from the surface between the constructed dune and the edge of the vegetation north of the dune. The dune would have a height of 2-foot, with a 1-foot vertical to 3-foot horizontal slopes and a crest width of 6 feet. The dune would be continuous for the length of the gulf-side, south beach. The construction of a small 2-foot high dune on the islands' south beach could be accomplished by utilizing the existing sand on the beach berm. The sand could be scraped from the beach surface between the dune line and the vegetation that grows inland. This small dune would be used as a planting platform for establishing sea oats that have been destroyed by the recent hurricanes. While this small dune would provide very little damage reduction for the island, it would build with time as wind driven deposits of sand become trapped by the vegetation and increase the size of the dune.

5.4.1.4.2 Six-Foot Dune System

This proposal is similar to above except that it would consist of a 6-foot dune rather than a 2-foot dune. The sand that could be used may come from the same offshore borrow area as the St. Bernard Shoals located about 45 miles south of the barrier islands. In order to accomplish this restoration effort, sand would be moved from a hopper dredge to a staging area on the beach, then the sand would again be moved to the area of placement along the beach.

5.4.2 Recommended Plan

Further study is required to adequately address comprehensive barrier island restoration due to their complex ecosystem and impacts on the environment. Options of littoral zone placement and filling of the Ship Island breach (i.e. comprehensive barrier island restoration) are being recommended for construction through the need for additional detailed analysis. The MsCIP PDT will closely coordinate those efforts in cooperation with the NPS, USGS, and the State of Mississippi.

A detailed study analyzing sand movement throughout the coast of Mississippi littoral drift is ongoing by ERDC. Results from this assessment will be used to develop these two options more fully. The MsCIP environmental PDT anticipates detail analysis/study of this sand movement will be needed at Ship Island in order to restore the breached area. Other specific areas (i.e. littoral zone placement sites) will also be identified during the developments. Additional study is required in order to supplement the comprehensive restoration of barrier islands with littoral zone sand placement and to fill Ship Island's breach.

The Corps, Mobile District applied the Functional Habitat Index (FHI) tool for the recommended plan - placement of sand in the littoral zone and filling in Ship Island breach - in order to quantify the environmental outputs generated from various measures/alternatives. Potential benefits associated with restored habitat types were assessed using past scientific studies and best professional judgment. This environmental output unit (i.e. number) generated from the FHI tables was used to assess the cost-effectiveness of various ecosystem restoration at the barrier islands. An environmental output unit quantifies the expected improvements in target functions as related to project objectives. Tables 5.4.2-1 and 5.4.2-2 provide the FHI benefits that would be achieved by implementation of this proposed construction compared to the no action.

Table 5.4.2-1.
Comprehensive Barrier Island Restoration – Littoral Zone Placement & Fill of Breach Between West & East Ship Islands

	Habitat Units									
Assessment Variables	*Shoreb irds*	*Waterfowl*	*Migratory Birds*	*Raptors*	*Beach Fauna*	*Dune Flora and Fauna*	*Oysters*	*Estuarine Fish*	*T&E Species*	*FHI Unit*
Island Persistence	10	8	10	8	10	10	10	10	10	86
Shoreline Stabilization	10	8	8	8	10	10	10	6	10	80
Reproduction Habitat	10	0	0	0	8	10	10	10	10	58
Feeding Habitat	10	6	10	8	8	10	10	10	10	82
Roosting Habitat	10	6	8	6	10	10	10	10	10	80
Wintering Habitat	10	6	8	6	10	10	10	10	10	80
Dune Habitat	10	10	10	10	10	10	10	10	10	90
Beach Habitat	10	10	10	10	10	10	10	10	10	90
Water Column Habitat	8	8	8	8	8	8	10	10	10	78
Water-Land Interface Habitat	10	10	10	10	10	10	10	10	10	90
Fishery Habitat	10	10	10	10	10	10	10	10	10	90
Oyster Habitat	6	6	6	6	6	8	10	8	8	64
									TOTAL FHI	**968**

Table 5.4.2-2.
No Action

	Habitat Units									
Assessment Variables	*Shore birds*	*Waterfowl*	*Migratory Birds*	*Raptors*	*Beach Fauna*	*Dune Flora and Fauna*	*Oysters*	*Estuarine Fish*	*T&E Species*	*FHI Unit*

Island Persistence	0	0	0	0	0	0	0	0	0	0
Shoreline Stabilization	0	0	0	0	0	0	0	0	0	0
Reproduction Habitat	0	0	0	0	0	0	0	0	0	0
Feeding Habitat	0	0	0	0	0	0	0	0	0	0
Roosting Habitat	0	0	0	0	0	0	0	0	0	0
Wintering Habitat	0	0	0	0	0	0	0	0	0	0
Dune Habitat	0	0	0	0	0	0	0	0	0	0
Beach Habitat	0	0	0	0	0	0	0	0	0	0
Water Column Habitat	2	2	2	2	2	2	2	2	2	18
Water-Land Interface Habitat	0	0	0	0	0	0	0	0	0	0
Fishery Habitat	2	2	2	2	2	2	2	2	2	18
Oyster Habitat	2	2	2	2	2	2	2	2	2	18
									TOTAL FHI	**54**

For similar projects (i.e. Deer Island - Section 204: Beneficial Use of Dredged Material, Mississippi and Deadman's Islands, Florida - Section 206: Aquatic Ecosystem Restoration Project), multi-disciplinary teams of biologists, scientists, ecologists, engineers, hydrologists, and planners were formed to assess what functions a particular project could potentially provide. Functions are defined as specific habitat and environmental features that would benefit from the recommended project. A variety of functions are generated by a proposed alternative. During past FHI table development with the multi-disciplinary teams, it was determined best to group fauna generally rather than specifically identifying each species that would potentially use, or benefit from, the restored project area. If specifically listed, the team was concerned that the FHI table could quickly become unmanageable.

Functional production was quantified as an output that the fauna could potentially use. Functions evaluated in the matrix included substrates, habitat types, stabilization, and vegetation. The output was identified between a scaling of 1 and 10 – 10 being the highest benefit. The "No Action" still has a FHI score even though there is no work proposed for the area. The barrier islands provide a function to the resources *currently* even though no action is being proposed; however, this benefit is considerably reduced over time. Specifically speaking, re-establishing the barrier islands via filling the breach and littoral sand placement has a *benefit* to shorebirds because they use the shoreline for feeding, nesting, and roosting. Many of these shoreline birds would cease to be on the island without it. The FHI tables quantify expected biological output by linking biophysical benefits (termed functions) to specific restoration activities. The term biophysical, in this case, refers to the living and non-living components and processes of the ecosphere. The functions identify aspects of the project beneficial to the overall habitat quality. Adding all of these outputs together from the table provides a FHI score.

5.5 Restoration of SAVs

SAV benefits an array of ecosystems in Mississippi including the following:

- Primary production (food for other animals);
- Improves water quality;
- Storm protection (dampens waves, currents, and storm surge);
- Value to commercial and recreational fisheries by providing;
- Protection to juveniles from predators;
- Nursery habitat;
- Foraging habitat;
- Nutrient cycling (estimated to be $7,700 per acre per year in 1996);
- Sediment filtration and trapping (offset sea-level rise);
- Oxygen production;
- Organic-matter production and export (provides materials used in other habitats, such as adjacent wetlands and marsh, offsets sea-level rise);
- Prevents/reduces erosion; and
- Increased species diversity (in both the sediments and SAV beds).

Table 5.5-1 provides the fish species collected in SAV beds at Grand Bay NERR from April 2005 through February 2006.

Table 5.5-1.
Fish Species Collected at Grand Bay NERR SAV beds

Scientific Name	Common Name
Anchoa mitchilli	Bay anchovy
Bairdiella chrysoura	Silver perch (drum family)
Brevoortia patronus	Gulf menhaden
Citharichthys spilopterus	Bay whiff (flounder)
Ctenogobius boleosoma	Darter goby
Cynoscion nebulosus	Spotted seatrout
Eucinostomus argenteus	Spot-fin mojarra
Lagodon rhomboides	Pinfish
Leiostomus xanthurus	Spot

Table 5.5-1.
Fish Species Collected at Grand Bay NERR SAV beds (continued)

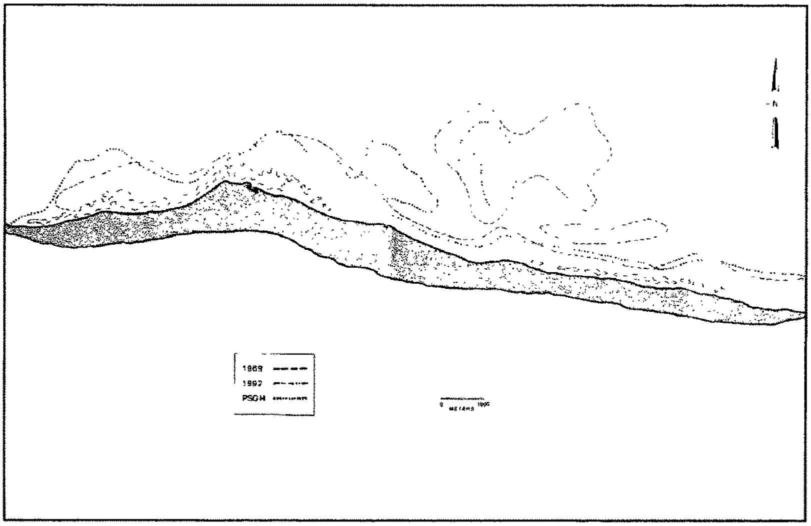
Scientific Name	Common Name
Lucania parva	Rainwater killifish
Lutjanus grisues	Grey snapper (mangrove snapper)
Menidia beryllina	Inland silverside
Mugil cephalus	Striped mullet
Oligoplites saurus	Leatherjack
Sphoeroides parvus	Least puffer

Sphyraena guachancho	Guaguanche (barracuda family)
Sygnathus louisianae	Chain pipefish
Sygnathus scovelli	Gulf pipefish
Symphurus plagiusa	Black cheeked toungefish (flounder-like)
Synodus foetens	Inshore lizardfish
Archosargus probatacephalus	Sheepshead
Mycteroperca microlepis	Gag grouper
Chasmodes saburrae	Florida blenny
Orthopristis chrysoptera	Pigfish

In addition, the SAV beds support shrimp and blue crabs, both of which have value as commercial and recreational fisheries.

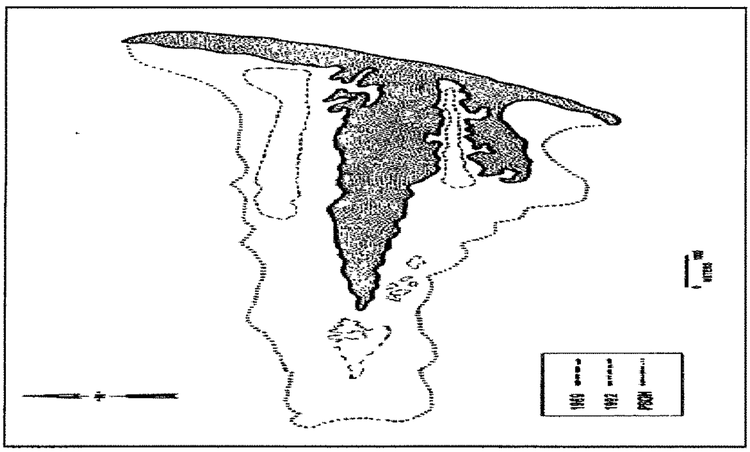
The continued survival and growth of seagrasses (i.e. SAVs) may be threatened by the cumulative effects of man's activities, in addition to, natural processes in the coastal marine environment. Natural causes of SAV (i.e. *D. wrightii, C. manatorum, T. testudinum*, and *R. maritime*) decline, such as disease, storm events, salinity fluctuation, and hypoxic events, coupled with declining water quality caused by anthropogenic eutrophication currently threaten the health of many SAV systems (Montague and Ley 1993, Durako and Kuss 1994, Olesen and Sand-Jensen 1994, Zieman et al 1994). These habitats provide vital refuges, feeding, resting, staging, and spawning grounds for a variety of species found in Mississippi Sound and also in the Gulf of Mexico. Past studies throughout the years have attributed anywhere from 50% to 90% of all marine species to utilize this vital habitat at some point in their life state.

In 1969, an estimated 20,000 acres of SAVs were documented and as of 1998, only 2000 acres were documented (Moncrieff 1998). Dramatic decreases in SAVs along the north shoreline of Horn Island have been observed. An approximate 5,040-acre decrease in coverage was calculated for the period between 1969 and 1992 (Figure 5.5-1). The overall distribution of SAVs among Mississippi's other barrier islands has also decreased considerably in the same time period, with Cat Island losing approximately 430 acres (Figure 5.5-2), Ship Island losing approximately 1,280 acres (Figure 5.5-3), and Petit Bois Island losing approximately 1,330 acres (Figure 5.5-4). Areas of SAVs along coastal Mississippi's mainland have also decline. Buccaneer State Park is estimated to have lost approximately 150 acres while Point-aux-Chenes Bay has lost approximately 680 acres (Figure 5.5-5).



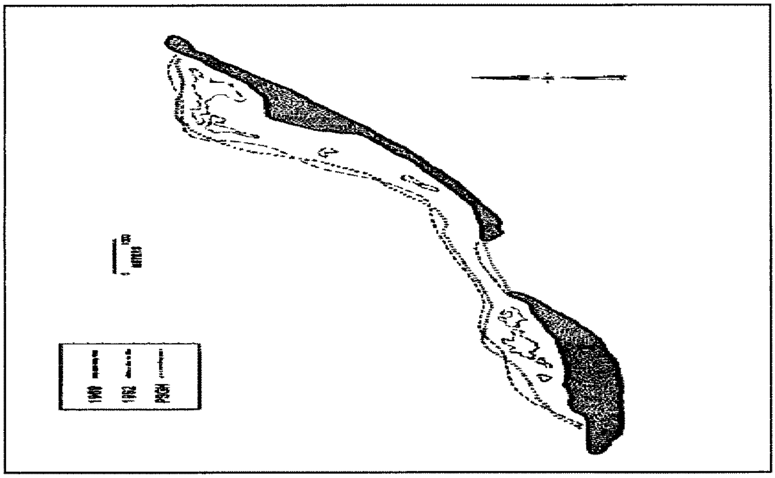
Source: GMEI

Figure 5.5-1. Horn Island – Historical, 1992, and Potential Seagrass Habitat (PSGH)



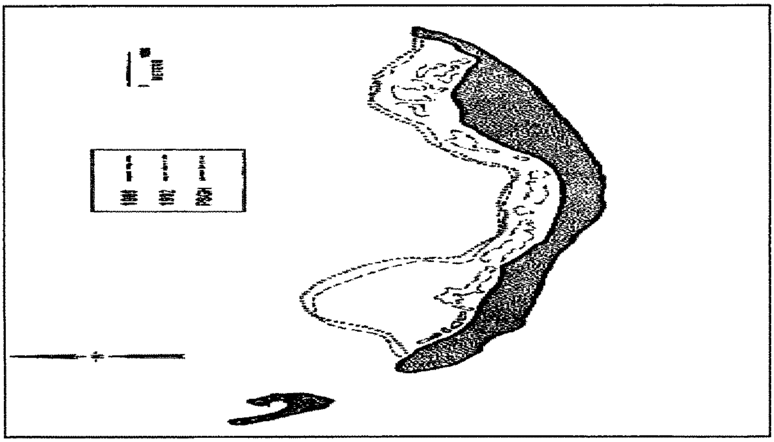
Source: GMEI

Figure 5.5-2. Cat Island – Historical, 1992, and Potential Habitat (i.e. PSGH)



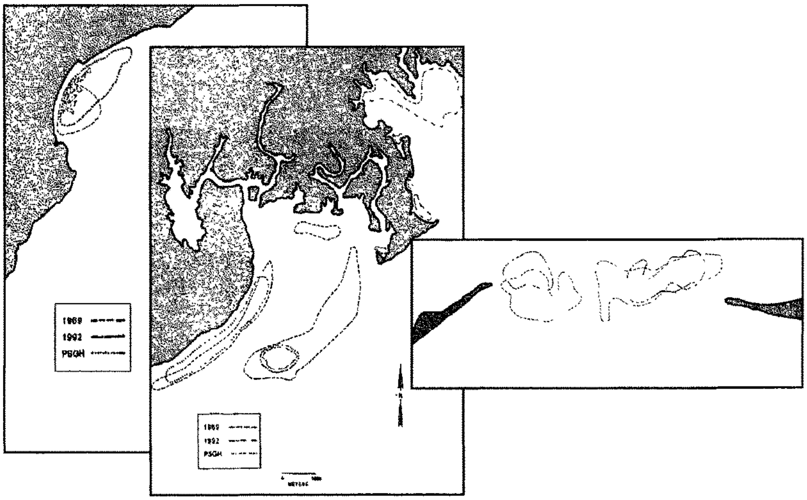
Source: GMEI

Figure 5.5-3. Ship Island – Historical, 1992, and Potential Habitat (i.e. PSGH)



Source: GMEI

Figure 5.5-4. Petit Bois Island – Historical, 1992, and Potential Habitat (i.e. PSGH)



Source: GMEI

Figure 5.5-5. Buccaneer State Park, Point-aux-Chenes Bay, Dog Keys Pass (Left to Right, respectively) – Historical, 1992, and Potential Habitat (i.e. PSGH)

Three areas were documented in which PSGH was less than the historical distribution of SAVs, indicating habitat loss. Dog Keys Pass, Horn Island, and Point-aux-Chenes Bay all exhibited this pattern with 930 acres, 1,220 acres, and 770 acres loss, respectively (Table 5.5-2).

Table 5.5-2.
SAV Historical, 1992 and Potential Habitat

Location	1969 (acres)	1992 (acres)	PSGH
Buccaneer State Park	206	55	316
Cat Island	598	169	5,128
Ship Island	1,536	253	1,603
Dog Keys Pass	2,079	0	1,149
Horn Island	5,567	530	4,350
Petit Bois Island	1,690	364	1,810
Point-aux-Chenes Bay	1,306	627	534
Totals	12,982	1,998	14,890

Reference: Moncrieff 1998

Areas of SAV habitat loss coincide with areas where rapid coastal erosion and massive long-term movement of sand has been well-documented (Otvos 1981 and Oivanki 1994). Loss of vegetated areas corresponds with potential loss in water clarity over time due either to: (1) anthropogenic influences, (2) cyclic shifts in precipitation patterns, which would affect both salinity and turbidity, or

(3) a combination of these factors (Moncrieff 1998). Primary reasons for the disappearance of SAVs are most likely an overall decline in water quality, extended periods of depressed salinities, and physical disturbances, such as tropical storms and hurricanes (Moncrieff 1998). Physical loss of habitat and decreased light availability coupled with declining water quality are the most visible features that directly affect SAVs (Moncrieff 1998). Moncrieff (1998) identified approximately 14,900 acres as being suitable SAV habitat (i.e. PSGH).

Mapping techniques have very much advanced since Moncrieff's last mapping of Mississippi Sound in the late 1990s. In discussing a potential SAV restoration project with the scientific community, the one consistent need was to re-inventory the existing SAVs in Mississippi Sound. Mississippi Sound and barrier island sedimentary processes as related to seagrass biomes are important, but not currently available. The nature, extent and volumes of sediment types within both Mississippi Sound and the barrier islands are constantly in flux, necessitating a comprehensive and ongoing assessment of sedimentary dynamics. Further studies would determine existing conditions and remaining problems that challenge establishment of SAVs within Mississippi Sound. Opportunities exist to create partnerships with other Federal and state resource agencies, and NGOs to begin identifying potential SAV restoration and establishment projects. Restoration efforts should target historical locations as a starting point to begin determining current conditions and challenges, including water quality issues, available nursery stock of plants, etc., prior to implementation of actual projects.

5.5.1 Recommended Plan

Additional study is required to assess the complex environmental make-up impacting SAVs in Mississippi Sound due to the fact that mere planting would possibly not survive. Many questions must be answered (i.e. water quality, circulation, etc.) prior to SAV restoration implementation. SAV restoration efforts across the nation have proven to be rather challenging and many examples can be identified close to Mississippi, such as in Florida. Therefore, the MsCIP environmental team is recommending additional study and re-inventory the existing SAVs in Mississippi Sound. Opportunities exist to partner with Federal, state, and local resource agencies as well as NGOs. Extensive coordination with the NPS, responsible for managing and operating Gulf Islands National Seashore, would be required for areas of potential restoration within park boundaries. Involvement of local colleges and universities with ongoing research programs would also help to identify and pinpoint specific problems for development of potential solutions. For those brackish SAV systems, limited knowledge of the functional restoration prohibited the team in developing cost effective alternatives; thus, a pilot project was identified at Bayou Cumbest to obtain the much needed described data.

Coordination with the Grand Bay NERR identified restoration of the Bayou Cumbest site to produce data, such as salinity, water quality, currents, substrates, composition of sediments, boating traffic (propellor scarring/turbidity), transplant success rates, and heterogenoity of species composition in order to determine the success criteria for future recovery efforts of SAV within brackish systems in Coastal Mississippi. As noted in other areas in the country, such as Florida, SAV restoration sometimes proves to be challenging. Thus, the MsCIP team has developed the foresight to identify these parameters to increase the recovery rates during the restoration efforts. Parameters, such as water quality/turbidity, sediment compositions, and currents will provide necessary data to better characterize other restoration sites likelihood of success. Turbidity has been noted as a constraint for SAV recovery; thus, this parameter must be quantified. Boating traffic may also limit recovery rates while increasing the species diversity could increase habitat diversity for various species of important shrimp, crabs, and juvenile fish. Until this criteria is obtained, successful recovery of SAV within these systems would prove to be very difficult if not impossible. The data gathered would be used to ensure conditions at historical SAV sites are existing to ensure the success. Future SAV restoration site could include area north of Deer Island, Bayou La Croix, Bayou Cumbest, adjacent to Round Island, Old Fort Bayou, Davis Bayou, West Pascagoula River, and Mary Walker Bayou.

SAVs are a federally designated Essential Fisheries Habitat under the Magnuson-Stevens Act of 1996. They provide numerous ecosystem services, which include: (1) nursery for juvenile stages of finfish and shellfish, (2) an important food-source to marine species and wading birds, (3) sediment stabilization and increased water clarity, and (4) nutrient uptake and sequestration to mitigate eutrophication.

Species that will benefit directly or indirectly include the SAV - estuarine invertebrates, such as blue crabs (*Callinectes sapidus*) and brown and white shrimp (*Farfantepenaeus spp.*); waterfowl, such as dabbling ducks (*Anas spp.*), numerous anadromous fish species including spotted seatrout (*Cynoscion nebulosus*), red drum (*Sciaenops ocellatus*), and mullet (*Mugil cephalus, M. curema*), and marine mammals, such as dolphins (*Terciops truncatus*) and manatees (*Trichechus manatus*), a protected species, that utilize SAV beds as nursery habitat. The economic valuation of the fisheries industry in Mississippi provided by the Center for Fisheries Research and Development at the GCRL indicates that there are more than 50 species of finfish and shellfish commercially harvested in state waters with a market value of $900 million in 2003, and a recreational industry valued conservatively at over $400 million in 2000 (Perry, unpubl data). Clearly loss of habitat would have a disproportionate impact on the socio-economic activities of coastal Mississippi.

This small initial brackish SAV recovery project will investigate the larger issue of SAV losses nationally and rates of natural recovery versus recovery after restoration. SAV are sensitive indicators of estuarine condition because of their high light requirements (Dennison et al 1993) and susceptibility to eutrophication-induced algal blooms and hypoxia (Hauxwell et al 2001). Furthermore, loss of SAV promotes the alteration of the sediment characteristics and nutrient cycling, causing long-term changes in habitat suitability for natural plant recolonization. These changes include loss of fine sediments through resuspension and transport, promoting a feedback loop that further inhibits natural recovery. Therefore, it is vitally important that restorative replanting be undertaken soon after damage or loss of plants to inhibit a negative change in system dynamics (Fonseca et al 2004).

For the SAV restoration effort, MsCIP team assessed the continued survival and growth of seagrasses (i.e. SAVs) and found them threatened by the cumulative effects of man's activities, in addition to, natural processes in the coastal marine environment. Natural causes of SAV decline, such as disease, storm events, salinity fluctuation, and hypoxic events, coupled with declining water quality caused by anthropogenic eutrophication currently threaten the health of many SAV systems (Montague and Ley 1993, Durako and Kuss 1994, Olesen and Sand-Jensen 1994, Zieman et al 1994). These habitats provide vital refuges, feeding, resting, staging, and spawning grounds for a variety of species found in Mississippi Sound and also in the Gulf of Mexico. Past studies throughout the years have attributed anywhere from 50% to 90% of all marine species to utilize this vital habitat at some point in their life state. In 1969, an estimated 20,000 acres of SAVs were documented and as of 1998, only 2,000 acres were documented (Moncrieff 1998).

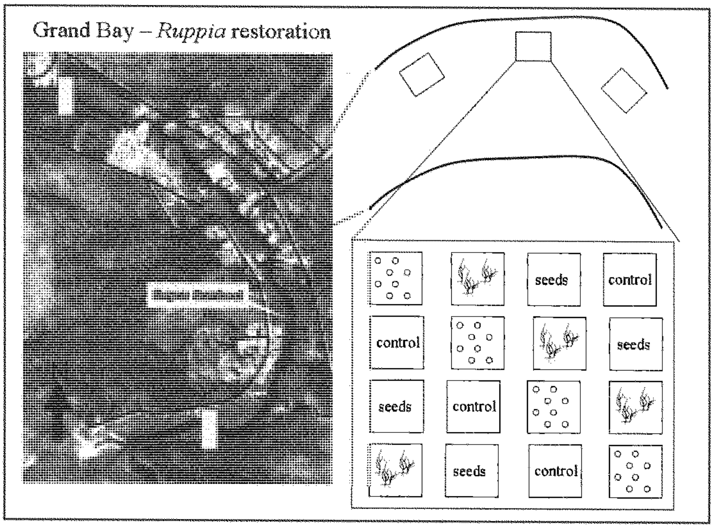
SAV restoration efforts across the nation have proven to be rather challenging and many examples can be identified close to Mississippi, such as in Florida. Thus, Bayou Cumbest was chosen due to its small size to produce data such as salinity, water quality, currents, substrates, composition of sediments, boating traffic (propellor scarring/turbidity), transplant success rates, and heterogenoity of species composition in order to determine the success criteria for future recovery efforts of SAV within brackish systems in Coastal Mississippi. Future SAV restoration site could include area north of Buccaneer State Park, Cat Island, Ship Island, Dog Keys Pass, Horn Island, Petit Bois Island, and Point aux-Chenes.

After discussing the potential SAV pilot project with biologists at ERDC, it has been determined there currently are no assessment tools for quantifying benefits of SAV restoration projects. Although quantified outputs of ecosystem projects have traditionally been used as the basis for justification, little data is available for use in establishing baseline conditions of existing SAVs, organisms currently using established beds, and the specific causes for the overall decline of brackish SAVs. As part of the data collection described above, an index would be developed most likely using acreages and density quantifying environmental outputs generated through the success of the SAV restoration pilot project. This quantifiable environmental output would then be used to demonstrate cost effective criteria for future brackish SAV systems.

SAV Pilot Project – Bayou Cumbest

The first goal of the proposed community-based restoration project in the Grand Bay NERR will result in restoration of up to 5 acres of *R. maritima* resulting in the recovery of an equal amount of SAV habitat to that lost during the 2005 hurricane season (Figure 5.5.1-1). Secondly, the Corps, Mobile District proposed to evaluate 3 restoration techniques to demonstrate their feasibility for larger restoration projects. Finally, the volunteer involvement and educational outreach will increase awareness of the importance of SAV habitat in Mississippi Sound and provide coastal managers and restoration practitioners with the knowledge of techniques to maximize their return on dollars spent.

The MsCIP environmental effort will: (1) restore SAV beds in Bayou Cumbest adjacent to the Grand Bay NERR that have been lost since the 2005 hurricanes through transplanting involving participation by the local community groups and students of the local universities and (2) determine the effectiveness of three transplanting methods (i.e. (1) a donor site, (2) harvesting plant sprigs with one or more meristems (growth regions), or (3) spreading seeds or mature flowering shoots over the restoration site) for restoring *R. maritima* in bayous, streams, and brackish marshes by quarterly monitoring using volunteers. After transplanting, quarterly monitoring for two years will be conducted to determine plant establishment, photosynthesis, growth, and expansion.



Source: MDMR

Figure 5.5.1-1. Grand Bay NERR Low Salinity Restoration Area in Bayou Cumbest using *Ruppia maritima*

The education and outreach components of the project will consist of volunteer involvement and dissemination of results through a professional workshop conducted at the end of the project. Volunteers will be recruited from Grand Bay NERR's established volunteer base, which includes local schools, universities, agencies, and civic groups. Our proposed study will also help determine the most successful and cost- and labor-effective transplanting method for restoring SAV. This information will be used in workshops and dissemination materials developed by Grand Bay NERR to inform commercial and recreational boat users/fishermen and the general public. Results will be disseminated through Grand Bay NERR's Coastal Training Program to inform coastal decision-makers and resource managers of successful restoration techniques.

This community restoration project will address the larger issue of SAV losses nationally and rates of natural recovery versus recovery after restoration. SAV are sensitive indicators of estuarine condition because of their high light requirements (Dennison et al 1993) and susceptibility to eutrophication-induced algal blooms and hypoxia (Hauxwell et al 2001). Furthermore, loss of SAV promotes the alteration of the sediment characteristics and nutrient cycling, causing long-term changes in habitat suitability for natural plant recolonization. These changes include loss of fine sediments through resuspension and transport, promoting a feedback loop that further inhibits natural recovery. Therefore, it is vitally important that restorative replanting be undertaken soon after damage or loss of plants to inhibit a negative change in system dynamics (Fonseca et al 2004).

5.6 Projects from Interim Report Carried Further

During the MsCIP Interim Report development, approximately 180 potential projects were identified. Upon further evaluation, 15 of these potential projects were recommended for immediate construction and have since been funded by Congress as a result of the MsCIP Interim effort. Of the remaining identified projects, the MsCIP PDT categorized each project into the following disciplines - structural, non-structural, environmental, and/or other. The environmental PDT then reassessed those projects identified in Table 4.1.6-1. As a result, some of those projects have been carried forward.

Due to the extreme time constraints, and ultimately funding constraints, given the enormous scope of study, the MsCIP Comprehensive Report and Integrated Programmatic EIS presents recommended features at a number of levels (presented below in decreasing order) of detail:

1) a feasibility-level of detail sufficient for selection for construction;

2) a level of detail requiring only final resolution of technical issues, but containing sufficiently-detailed cost-estimates that would not likely violate the 902 limit on that particular project (i.e., at an "Advanced Engineering" level of detail);

3) a level of detail sufficient to make selections for longer term comprehensive implementation that would require only limited additional data for refining of the final alternative and development of an Microcomputer Aided Cost Engineering System-compliant cost estimate for a selection, and;

4) detail at a "less-than-feasibility" level of analysis requiring a recommendation to seek further study in order to resolve remaining technical, societal, or environmental compliance or analysis of issues, for which a cost estimate will be supplied for both the additional study and Project Engineering and Design.

If it was found applicable to the Corps's MsCIP recovery mission, the remaining projects were incorporated, in some manner, into the previously discussed Recommended Plans. In addition, Turkey Creek: Mt. Pleasant UME Audubon site 41, tidal creek restoration of floodplain, Davis Bayou ER, Biloxi Back Bay, Turkey Creek watershed Greenway projects that are environmental in nature and are being recommended.

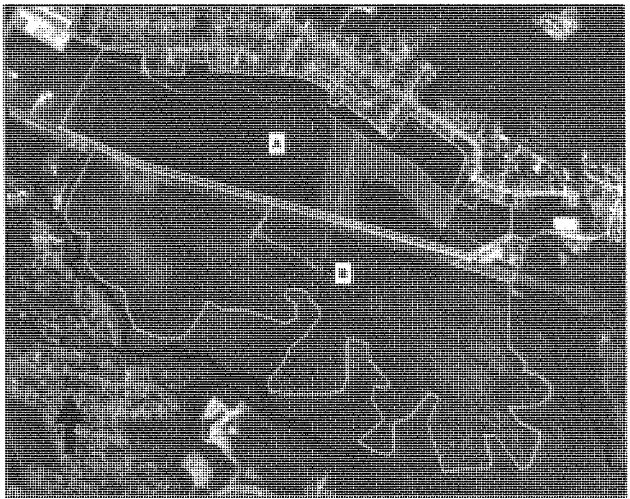
5.6.1 Construction

Two initial environmental restoration projects previously discussed – Turkey Creek and Bayou Cumbest – are being recommended for construction.

As previously discussed in *Section 4.1.5.5 State Initiative Projects*, the Governor of the State of Mississippi's *7-Point Strategy* for rebuilding coastal resources of the State is anticipated to be an on-going effort over the next 10 to 15 years and included 11 restoration projects. Of those, both Admiral Island and Dantzler were included in that list and were selected to be carried forward in as being recommended for construction.

State of Mississippi Initiative Plans – Dantzler, Jackson County

The original estimate for the Dantzler restoration site was 900 acres – 500 acres of marsh and 385 acres of wet pine savannah habitats (Figure 5.6.1-1). After much discussion between the Environmental PDT, it was decided that the marsh area did not need to be restored (i.e. elevations lowered, hydrology restored, and entire site replanted) but rather the site needed to be cleaned of debris. Therefore the Environmental PDT, then decided to restore only the 385 acres of wet pine savannah habitat.



Source: MDMR

Figure 5.6.1-1. Dantzler Restoration Site

The Dantzler restoration area contains 385 acres to be restored to wet pine savannah. The restorable area is split by a road, 151 of the acres are north of the road and the remaining 234 acres are south of the road. This area was planted in plantation pine during the 1960s and ditches and stormwater lines were constructed in the early 1970s in anticipation of residential development of the site. The long-term exclusion of fire and the invasion of non-native species, such as Cogon grass and Chinese Tallow tree, have severely degraded the site.

Objective:

1. Restore the natural hydrology.
2. Restore natural fire regime.
3. Restore native wetland plant communities.
4. Provide storm surge protection.
5. Provide fish and tidal wildlife habitat.

Measures:

1. Maintain native savanna vegetation. (Mandatory)
2.

Alternatives:

a) prescribed burning on a 3-5 year cycle.

b) mowing annually.

This measure affects the "area of contiguous fire-maintained landscape", as well as all plant related variables used in the model. It is assumed that these variables will recover to a score of 1.0 under the burn alternative. Under the mowing alternative, the "area of contiguous fire-maintained" landscape variable will score a 0.0 but the plant related variables will still score a 1.0, similar to burning.

2. 100% removal of exotics and plantation pine; maintain removal of exotic plant species in all areas over project lifetime. (Mandatory in all plans).

   This measure affects the "percent cover by invasive or exotic species" variable, and would raise the variable score to 1.0 under all plans

3. Filling in 100% of existing artificial ditches. (Mandatory)

If this measure is performed in addition to the mandatory measure 1, the hydrologic regime variable score would increase to 1.0 as there would be no more hydrologic alterations to the site.

Table 5.6.1-1.
Dantzler Restoration Measures

Plans 1-2.	Restoring areas both north and south of road (areas A and B)	
	Plan 1. 1a,2,3	Plan 2. 1b,2,3
Plans 3-4.	Restoring only area north of road (Area A)	
	Plan 3. 1a,2,3	Plan 4. 1b,2,3
Plans 5-6.	Restoring only area south of road (Area B)	
	Plan 5. 1a,2,3	Plan 6. 1b,2,3

Benefits:

The following table (Table 5.6.1-2) shows the AAFU benefit under each plan.

Table 5.6.1-2.
Summary of AAFU Benefits From Various Restoration Plans

Site	Restoration Acres	Plan	AAFU Benefit
Dantzler	385	No-action plan	0
Dantzler	385	Plan 1	1,244
Dantzler	385	Plan 2	943
Dantzler	151	Plan 3	488
Dantzler	151	Plan 4	370
Dantzler	234	Plan 5	756
Dantzler	234	Plan 6	573

The management measures were combined to create six plans that were analyzed to determine the cost-effectiveness of each. Economically ineffective plans are identified and eliminated to determine which plans are cost-effective. An economically ineffective plan is a plan that cost more or the same as a subsequent plan but produces less benefit than that subsequent plan. Of the six plans analyzed, three plans were eliminated because they produced less benefit at greater cost than a subsequent plan. Of the three remaining plans, one proved to be more cost-effective and consists of restoration of 385 acres of restoration maintained by burning.

The recommended plan requires filling ditches, maintaining vegetation growth by burning and mowing the project area in the initial year of construction as well as maintaining it by burning every three years over the life of the project, and excavating and removing existing roadbeds and any additional fill.

In order to restore this area to a wet pine savannah habitat, the higher areas will be designated as wet pine savannah. These areas have depression areas within them which will enable water to flow downward to the depression areas; thus, holding water. The wet pine savannah habitat will be restored with wet pine flatwoods, such as *P. elliotti, M. cerifera, L. glabra, S. patens and P. virgatum.*

Many species of wildlife are indigenous to the wet pine savannah habitat. Understory plant communities may contain wiregrass, sedges, orchids, American chaffseed and rough-leaved loosestrife. Insectivorous plants that may be found include pitcher plants, bladderworts, Venus flytrap, and sundews. Rare, threatened or endangered birds that may occur in these areas include Henslow's sparrow, Bachman's sparrow, red-cockaded woodpecker, and Mississippi sandhill crane. This ecosystem may also benefit the Mississippi gopher frog and in drier areas along ridges, the black pine snake and the gopher tortoise. The importance of this habitat and the need for burning has been previously described in the Turkey Creek discussion in *Section 5.1.1.1.2.1.2 Benefits.*

Benefits are measured in terms of AAFU. The HGM approach was used to assess wetland function similar to Turkey Creek. Table 5.6.1-3 shows the AAFU net benefit under each plan. The AAFU net benefit was calculated as the difference between the total functional units for the ecosystem restoration plan and the total functional units for the no action plan.

Table 5.6.1-3.
Summary of Benefits

Plan	Plan Description	AAFU Net Benefit
No Action	No Action	0
Plan 1	385 Acre Restoration Burn Remove Exotics Fill	1,244

Admiral Island, Hancock County

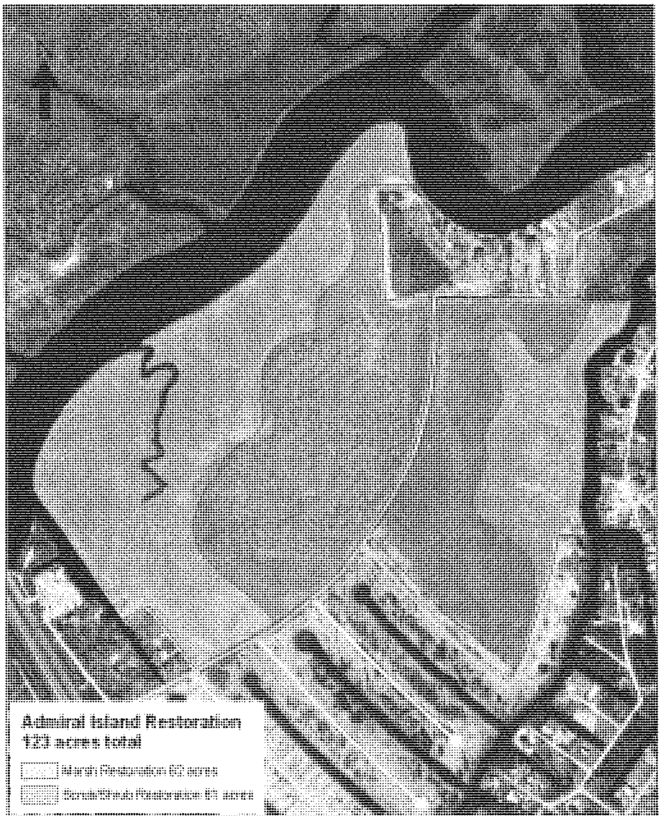
The Admiral Island restoration area contains 123 acres to be restored to 62 acres of emergent tidal marsh and 61 acres of scrub shrub habitats (Figure 5.6.1-2). Existing scrub shrub vegetation at the site supports natural propagation through removal of exotic species that currently outcompete native vegetation. The tidal marshes in this area were ditched during the 1960s causing changes in the natural hydrology and subsequent changes in the species composition. Hurricane Katrina left extensive debris fields and sedimentation in the area and destroyed many native trees and vegetation. Due to the loss of native species this area has a severe infestation of the invasive Chinese Tallow tree, which is invading the marshes and the adjacent flatwoods. For increased habitat diversity, the team proposed to leave some of the higher elevations as is and plant shrub/scrub species in order to enhance environmental benefits at the restoration site. The diverse habitat allows for a variety of fish and wildlife to utilize the area which increases the environmental benefits.

Objective:

1. Restore the natural hydrology.
2. Restore native wetland plant communities.
3. Provide storm surge protection.
4. Provide fish and tidal wildlife habitat.
5. Prevent saltwater intrusion

Measures:

1. Excavation of old fill material (includes 90-95% removal of existing exotic species in excavated areas) (Mandatory).



Source: MDMR

Figure 5.6.1-2. Admiral Island Restoration Site

This measure, in conjunction with measure 3, affects the hydrologic regime variable, which under existing conditions receives a score 0.25, on the assumption that greater than half the site has been filled above the normal tidal flooding zone. This measure by itself would raise the hydrologic regime variable to a 0.75.

2. 100% removal of exotics from non-excavated areas and maintain removal of exotic plant species in all areas over project lifetime. (Mandatory in all plans).

   This measure affects the "percent cover by invasive or exotic species" variable, and would raise the variable score to 1.0 under all plans

3. Filling in 100% of existing artificial ditches/channels.

   If this measure is performed in addition to the mandatory measure 1, the hydrologic regime variable score would increase to 1.0 as there would be no more hydrologic alterations to the site.

4. Native Vegetation Planting

Alternatives:

a) 0.5 meter spacing

b) 1 meter spacing

c) 2 meter spacing

This measure affects the "percent cover by woody plant species", "wildlife habitat diversity", "vegetation height", "wetland indicator status" and "mean percent cover emergent plant species" variables. The relevant vegetation variables are assumed to reach their highest potential score at year 5 under 0.5 meter spacing, year 7 with 1.0 meter spacing, and year 10 with 2.0 meter spacing, and then sustained at that level for the project life (50 years). Variable subindex scores are treated as increasing linearly from their value under the no-action plan up to their highest potential value obtained at year 5, 7, or 10, depending on the planting spacing, and then remaining constant thereafter (Tables 5.6.1-4 and 5.6.1-5).

Table 5.6.1-4.
Measures

Plan 1. 1,2,3,4a	Plan 2. 1,2,3,4b	Plan 3. 1,2,3,4c
Plan 4. 1,2,4a	Plan 5. 1,2,4b	Plan 6. 1,2,4c

Table 5.6.1-5.
Summary of AAFU Benefits From Various Restoration Plans

Site	Restoration Acres	Plan	AAFU Benefit
Admiral Island	62	No-action plan	0
Admiral Island	62	Plan 1	61
Admiral Island	62	Plan 2	60
Admiral Island	62	Plan 3	59
Admiral Island	62	Plan 4	51
Admiral Island	62	Plan 5	50.5
Admiral Island	62	Plan 6	49

The management measures were combined to create six plans that were analyzed to determine the cost-effectiveness of each. Economically ineffective plans are identified and eliminated to determine which plans are cost-effective. An economically ineffective plan is a plan that cost more or the same as a subsequent plan but produces less benefit than that subsequent plan. Of the six plans analyzed, two plans were eliminated because they produced less benefit at greater cost than a subsequent plan.

The recommended plan consists of restoring the study area by excavating old fill material, removing exotic plant species from non-excavated areas, planting native vegetation at a density of 1.0 meter, and filling existing artificial ditches. The planting of native vegetation consist of *S. alteniflora, J. roemerianus, and S. patens.*

Benefits are measured in terms of AAFU. The HGM approach was used to assess wetland function similar to Bayou Cumbest. Table 5.6.1-6 shows the total functional units under each implemented plan and the AAFU net benefit. To calculate the AAFU net benefit, it is assumed that benefits will be maximized at year 5 with 0.5 meter spacing of vegetation, at year 7 with 1.0 meter spacing of vegetation, and at year 10 with 2.0 meter spacing of vegetation. These benefits are estimated to be sustainable over the life of the project. Net AAFU benefits are calculated as the difference between the total functional units for the ecosystem restoration plan and the total functional units for the no action plan. The recommended plan was selected based on the criteria used for Bayou Cumbest.

Table 5.6.1-6.
Summary of Benefits

Plan	Plan Description	Net AAFU Net Benefits
No Action	No Action	0
Recommended Plan 2	Excavate Fill Remove Exotics Plant at Density 1.0m Fill Ditches	60

Franklin Creek Restoration Area

The project site is located in eastern Jackson County and has been funded for homeowners assistance and relocation as part of the MsCIP Interim Report and/or the 180 projects previously discussed. The restoration project consists of 149 acres located north and south of the CSX Railroad line, a major thoroughfare through the community. The site received severe flood damages from a decade of hurricanes. Historically, the site consisted of wet pine savannah wetlands. It is assumed that removal of utilities, building slabs, and roadways would be completed as part of the ongoing interim project. The following restoration measures were developed.

Objectives:

The following objectives were developed for ecosystem restoration:

1. Restore native vegetation

2. Restore natural hydrology

3. Restore fish and wildlife habitat

4. Provide storm water storage protection.

Assumptions:

1. Mandatory purchases of the residents as part of the MsCIP Interim Project.

Measures:

Proposed restoration management measures are listed in the following table. Narrative descriptions of each management measure follow this table.

1. Filling in ditches (Mandatory).

This measure affects the "Outflow of Water" variable, which measures the removal of water by ditches or drains. The variable score would increase from 0.1 to 1.0 under this measure.

2. Maintain vegetation (Mandatory).

Alternatives:

a. Burn (3 year cycle)

b. Mow (annual)

This measure affects the "area of contiguous fire-maintained landscape", as well as all plant related variables used in the model. It is assumed that these variables will recover to a score of 1.0 under the burn alternative. Under the mowing alternative, the "area of contiguous fire-maintained landscape variable will score a 0.05 but the plant related variables will still score a 1.0, similar to burning.

3. Excavate and remove existing roadbeds and any additional fill (Mandatory).

This measure affects the "surface water storage" variable, which measures the presence of excavation or fill, at the site. This variable score would increase from 0.1 to 1.0 in areas with existing roadbeds/fill.

4. Add culverts (Mandatory).

This measure increases the hydrologic connection between the two existing wetland areas separated by an elevated railway. The wetlands are primarily precipitation driven resulting in sheet flow drainage. Additional culverts will result in increased sheet flow drainage reducing standing surface water in the northern wetland area.

A combination of measures resulted in the following plan combinations and a summary of functional unit benefits are shown in the table below:

Table 5.6.1-7.
Measures

Plan 1. 1,2a,3,4	Plan 2. 1,2b,3,4
Plan 3. 1,2a,3	Plan 4. 1,2b, 3

Table 5.6.1-8.
Summary of AAFU Benefits From Various Restoration Plans

Site	Restoration Acres	Plan	Average Annual Functional Unit Benefit
Franklin Creek	149	No-action plan (plans 1-2)	0
Franklin Creek	56	No-action plan (plans 3-4)	0
Franklin Creek	149	plan 1	516
Franklin Creek	149	plan 2	399
Franklin Creek	56	plan 3	194
Franklin Creek	56	plan 4	150

Plan Selection:

The management measures were combined to create six plans that were analyzed to determine the cost-effectiveness of each. Economically ineffective plans are identified and eliminated to determine which plans are cost-effective. An economically ineffective plan is a plan that cost more or the same as a subsequent plan but produces less benefit than that subsequent plan. Of the six plans analyzed, three plans were eliminated because they produced less benefit at greater cost than a subsequent plan. Of the three remaining plans, one proved to be more cost effective and consists of restoration of 149 acres of restoration maintained by burning.

The recommended plan requires filling ditches, maintaining vegetation growth by burning and mowing the project area in the initial year of construction as well as maintaining it by burning every three years over the life of the project, and excavating and removing existing roadbeds and any additional fill.

Benefits:

In order to restore this area to a Wet Pine Savannah habitat, the higher areas will be designated as Wet Pine Savannah. These areas have depression areas within them which will enable water to flow down to the depression areas; thus, holding water. The Wet Pine Savannah habitat will be restored with Wet Pine Flatwoods as previously discussed.

Benefits are measured in terms of AAFU and HGM. Table 5.6.1-9 shows the AAFU net benefit under each plan. The AAFU net benefit was calculated as the difference between the total functional units for the ecosystem restoration plan and the total functional units for the no action plan. The recommended plan was selected based on previous criteria discussed.

Table 5.6.1-9.
Franklin Creek Benefits

Plan	Plan Description	AAFU Net Benefit
No Action	No Action (149 acres)	0
Recommended Plan	149 Acre Restoration Maintain by Burning	516

5.6.2 Longer Term Comprehensive Plan

Environmental Restoration Sites (i.e. 38 sites in the coastal counties – ex. Bayou Cumbest and Turkey Creek).

5.6.3 Preconstruction Engineering Design for specific features

State Initiative Plans:

- Wachovia, Hancock County – There are roadways to be removed.
- Ansley, Hancock County – There are roadways to be removed.
- DuPont, Harrison County – There are roadways to be removed.

5.6.4 Additional Feasibility Studies

State Initiative Plans:

- LaFrancis Camp Trenaisse, Hancock County (water modeling needed)
- Enhancement of the Barrier Islands – Restoring Vegetation and Dune systems
- SAV Restoration on the Northern Portions of the Barrier Islands

- Round Island, Jackson County
- Pascogoula River Marsh, Jackson County
- Twelve Oaks and Helmer's Lane, Jackson County

5.6.5 Advanced design studies for innovative concepts

- Freshwater Diversion Structures – Grand Bay, Pearl River, Escatawpa
- Biloxi Marsh Comprehensive Ecosystem Restoration
- West Pascagoula Delta Ecosystem Restoration
- Watershed Planning Approach
- Maximize Beneficial Use of Dredged Material
- Littoral Placement of Sandy Material adjacent to Barrier Islands
- Coastal Mississippi Artificial Reef Projects for Remediation of Hurricane Damage
- Oyster Reef Restoration
- Wetland Restoration along main drainage systems to increase capacity of flood storage during rainfall and storm events
- Prevention of coastal erosion of archaeological sites
- SAV long-term monitoring program (i.e. advanced technological mapping)

5.6.6 State of Mississippi Environmental Initiative

Several projects have been recommended for construction by the State of Mississippi.

5.7 Forrest Heights Levee, City of Gulfport, Harrison County

5.7.1 General

The culturally historical Forest Heights residential community in the City of Gulfport, Harrison County, Mississippi, has frequently been inundated by flood waters due to storm surges from Mississippi Sound and from inland flooding along the lower Turkey Creek. Water reached a depth of 2- to 8-foot over the entire community during Hurricane Katrina inundation. The Forest Heights levee is proposed to be constructed as a pilot project for the MsCIP comprehensive plan. The levee will address the combination of storm surge protection, inland flooding protection, and evacuation. The levee is intended to be constructed to a height, such that the levee might be certified under the National Flood Insurance Program. A preliminary engineering analysis suggests a levee built to approximately elevation 21 feet North American Vertical Datum (NAVD) 88 would satisfy or exceed certification elevation criteria.

Engineering performance and economic evaluations of protection options were done using the Hydrologic Engineering Center's (HEC) Flood Damage Analysis (FDA) computer application HEC-FDA. HEC-FDA modeling was done using variations in with-project conditions compared to the future without-project conditions for the Turkey Creek study. Details regarding the methodology are presented in the Economic Appendix. Additional evaluation to determine the precise levee height will be performed during final engineering and design based upon analyzing the risk and uncertainty associated with the coincident occurrence of inland flooding and storm surge impacts.

5.7.2 Location

The Forrest Heights community is located in an area known as North Gulfport within the City of Gulfport on the Mississippi Gulf Coast. The location of the levee at Forrest Heights is shown below in Figures 5.7.2-1 and 5.7.2-2. The community lies along the lower Turkey Creek floodplain, which has a tendency to frequently exceed its stream channel capacity and flood adjacent low-lying areas.

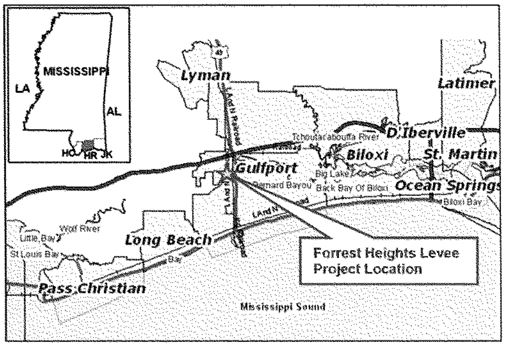
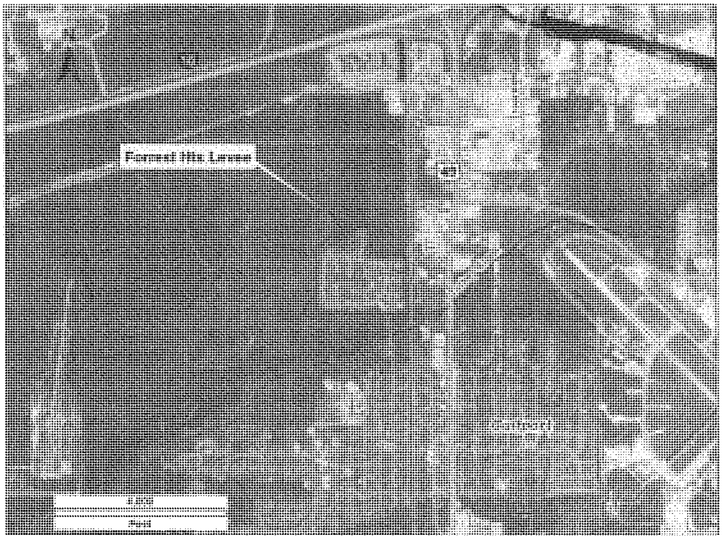


Figure 5.7.2-1. Vicinity Map



Source: Corps

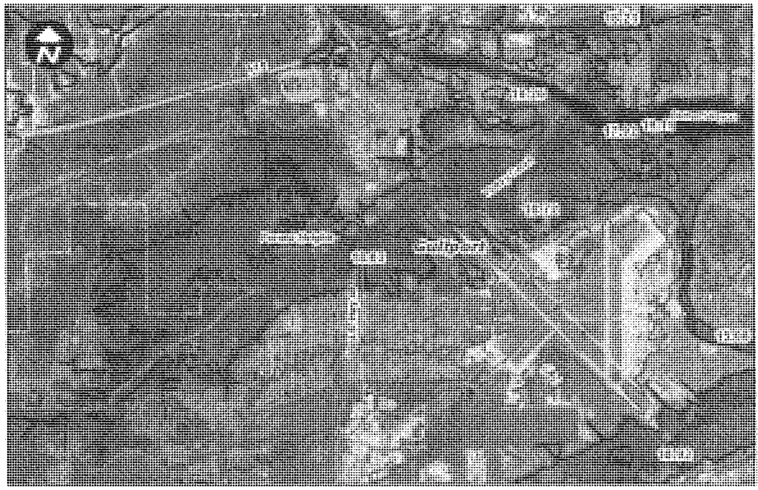
Figure 5.7.2-2. Forrest Heights Ring Levee Location

5.7.3 Existing Conditions

The community of Forrest Heights lies on the bank of Turkey Creek about 2.6 miles from the mouth at Bernard Bayou. Ground elevations over most of the residential area are between elevations 10-14-foot NAVD88. Drainage is mostly along streets and through natural drainage ways to the Turkey Creek. Impacts from flooding and hurricanes have been devastating. Hurricane Katrina in August, 2005 resulted in significant flood damages to residences in the Forrest Heights community. A levee with top width of 6 feet was constructed around the community to elevation 16.5 feet NGVD with sideslopes of 1 vertical to 1.5 horizontal in 1969, prior to Hurricane Camille. It has not had adequate maintenance and is a state of disrepair. It is scheduled to be restored to as-built condition by January of 2009. However, the restored levee will not be sufficient to meet the present day standard for certification according to the existing FEMA flood profiles in the vicinity. It is assumed that the as-built condition of this restored levee will be the existing condition for this report.

5.7.4 Coastal and Hydraulic Data

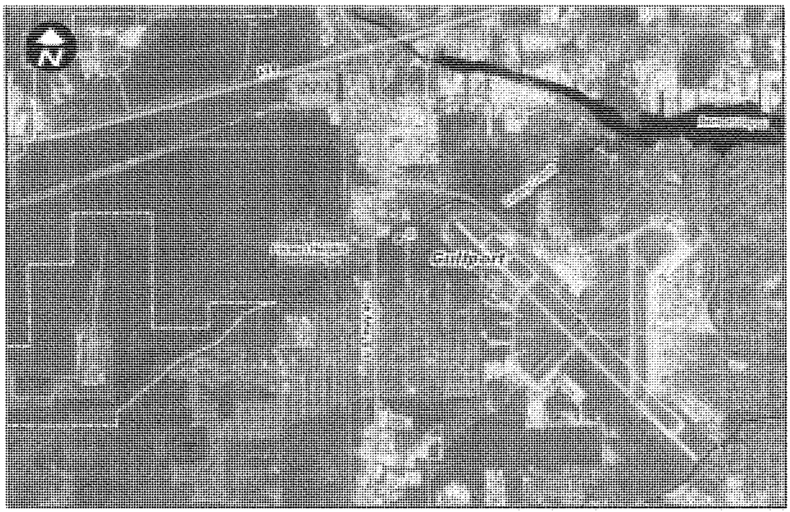
High water marks taken by FEMA after Hurricane Katrina in 2005 as well as the 4-foot (blue), 8-foot (dark green), 12-foot (green), 16-foot (brown), 20-foot (orange), and 20-foot (pink) ground contour lines and Hurricane Katrina inundation limits are shown below in Figure 5.7.4-1. The data indicates the water was as high as 18-20 feet NAVD88 near the site, totally inundating the entire area.



Source: Corps

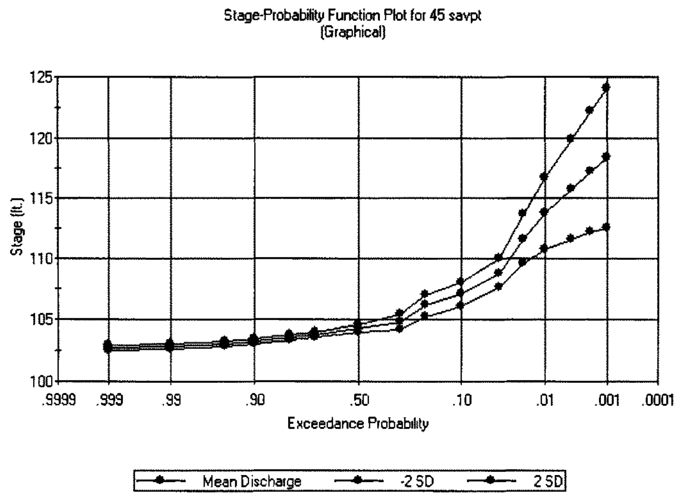
Figure 5.7.4-1. Hurricane Katrina Inundation and High Water, Forrest Heights

Stage-Frequency data for a suite of severe storms using Joint Probability Method (JPM) and hydrodynamic modeling were developed by ERDC for 80 locations along the study area. These data were combined with historical coastal tide gage frequencies for smaller storms to establish stage-frequency curves at 54 economic reaches in the study area. Points near Forrest Heights at which data from hydrodynamic modeling was saved are shown below in Figure 5.7.4-2, and the stage frequency curve for that location is shown in Figure 5.7.4-3. Hydrodynamic output stage-frequency pairs, with uncertainty, are displayed in Table 5.7.4-1.



Source: Corps

Figure 5.7.4-2. Hydrodynamic Modeling Save Point near Forrest Heights



Source: Corps

Figure 5.7.4-3. Surge-only Stage Frequency Curve, Vicinity of Forrest Heights

Table 5.7.4-1.
Surge Stage-Probability and Uncertainty

Annual Probability	Stage (Ft. NAVD88)	Standard Deviation (Feet)
0.04	8.8	0.6
0.02	11.6	1
0.01	13.7	1.5
0.002	17.2	2.5
0.001	18.3	2.9

It should be noted that the frequency curve reflects only that flooding resulting from storm surge in the Gulf. The Forrest Heights community is also subject to riverine flooding by Turkey Creek. The preliminary FEMA Harrison County Flood Insurance Study (FIS) dated November 2007 provides computed Turkey Creek flood profiles which appear to have been adjusted for the effects of coincident surge in Back Bay of Biloxi. Table 5.7.4-2 shows relevant discharge and stage information from the FIS for Turkey Creek at Ohio Avenue, the southern entrance to the Forrest Heights community. In comparison to the preliminary FEMA Flood Insurance Study dated November 2007, which is based on contemporary (post-Katrina) FEMA contractor hydrodynamic modeling, the ERDC frequency curve, which is based on surge alone, suggests a lower stage associated with the annual one in one hundred chance (0.01 exceedance probability) event.

Table 5.7.4-2.
Turkey Creek Flood Stages at Ohio Avenue, Harrison County FIS.

Exceedance Probability	Discharge (cfs)	Stage (ft. NAVD '88)
0.1	2600	12
0.02	3650	14.2
0.01	5500	15.5
0.002	7950	18.3

Figure 5.7.4-4 shows a portion of the preliminary Harrison County Flood Insurance Rate Map in the vicinity of Forrest Heights. Low-lying peripheral areas of the neighborhood are shown in a shaded blue field as being in the 1% annual chance ('100-yr') regulatory floodplain, with the remainder of the community occupying a shaded Zone X field, being areas subject to shallow flooding at annual probabilities of occurrence between 0.02 (2%) and 0.01 (1%).

Source: Corps

Figure 5.7.4-4. Preliminary FEMA Flood Insurance Rate Map, Vicinity of Forrest Heights.

Hydraulic data was developed for use in the HEC-FDA program. The HEC-FDA program uses risk-based analysis methods for evaluating flood damage and flood damage reduction alternatives. The program relies on hydrologic, hydraulic, and economic data input. Uncertainties in these data are input and used by the model for computing annual damages. Version 1.2.3b dated August 2007 was used. As described in Engineering Appendix - Chapter 2, this is a customized version of the current official release version 1.2 dated March 2000. This section describes the model's hydrologic and hydraulic input as applied to the Forrest Heights community. The Economic appendix describes the economic input and results. The Main Report describes how the model output was examined and used in the plan formulation process. Additional explanation is provided in the Engineering Appendix.

5.7.5 Engineering Performance

Project engineering performance was computed using HEC-FDA. Engineering performance was computed for the existing and future without project conditions; and a variety of existing and future with-project conditions. Performance was computed with risk and uncertainty. The base year was assumed to be 2012, and the future year was assumed to be 2061 (50 year period of analysis). Scenarios were also evaluated assuming (a) existing sea level, (b) expected sea level rise, and (c) high sea level rise.

The existing condition assumes that the NRCS has reconstituted their levee around the Forest Heights community to a crest elevation of 16.5 feet. The existing and future hydrologic and hydraulic conditions are presumed to be as represented by the FIS hydrology and flood profiles with uncertainty. Typically, one would consider increasing future flood discharges to account for possible increases in runoff due to development and urbanization. However, in this case, the underlying FIS hydrologic information is dated, being circa 1976, and subsequent studies have suggested that the effective tributary drainage area in this relatively flat and undifferentiated portion of the Turkey Creek watershed is less than the 25 or so square miles attributed to the creek at the location of Forest Heights. The existing hydrology is most likely conservative, and revisions downward for an un-gauged stream seem ill-advised. Additionally, the area in question benefits from an updated and contemporary FIS, where the Turkey Creek profiles have been adjusted for coincident surge elevations, and the floodplain has been re-mapped accordingly. In the end, it seems advisable to rely on the existing FIS profiles and hydrology for conservative results.

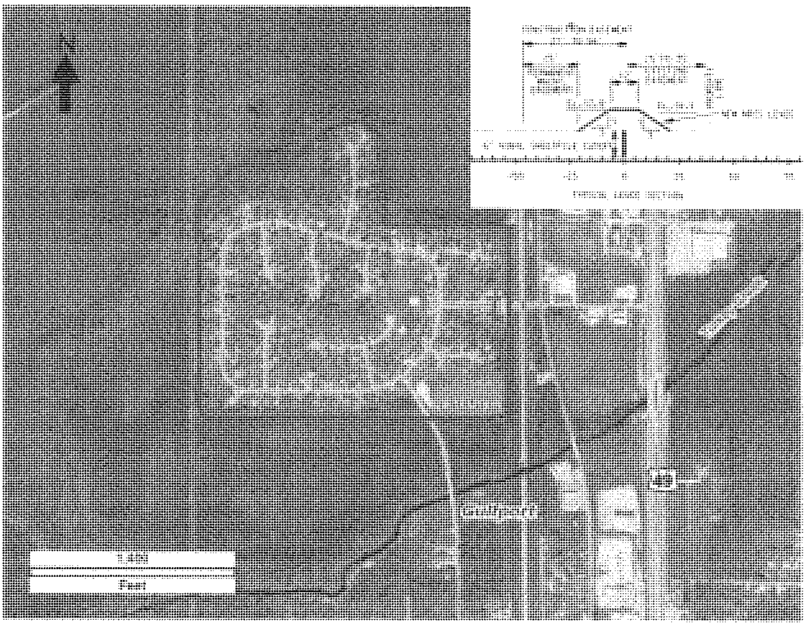
With-project conditions were evaluated for levees with crest elevations of 17 and 21 feet. The existing with-project condition assumes clearing and snagging of debris in Turkey Creek will counteract any local water surface profile impact due to flow obstruction by the levee. Future with-project conditions assume that the channel maintenance has been neglected, and thus the rating curve at Ohio Avenue is shifted upwards by 0.3 feet.

Performance was also evaluated assuming a levee built to the local Base Flood Elevation (BFE) - the regulatory one in one hundred annual chance water surface elevation plus three feet. Historically, FEMA required levees to be built to the BFE plus three feet for certification. This condition no longer in and of itself satisfies certification criteria, which now requires that risk and uncertainty also be considered. This condition was evaluated for the purposes of levee certification. Assuming the BFE is defined by the FIS water surface elevation at Ohio Avenue as described on the FIS Turkey Creek Flood Profile, this elevation is 15.5 feet plus 3 feet, or elevation 18.5 feet.

Forest Heights occupies a small fringe of the floodplain, and the FDA simulations assume that when the levee is overtopped, the interior floods to the exterior flood elevation.

5.7.5.1 Option A - Elevation 17 ft NAVD88

This option consists of an earthen dike around the Forrest Heights community as shown on the following Figure 5.7.5.1-1, along with the levee culvert/interior pump/detention location. The earth dike will be trapezoidal in shape with a 12-foot top width with one foot vertical to three foot horizontal slopes on both sides. For this option, the two existing roadway entrances will be ramped over the restored levee. The total length of the levee will be approximately 7,900 feet.



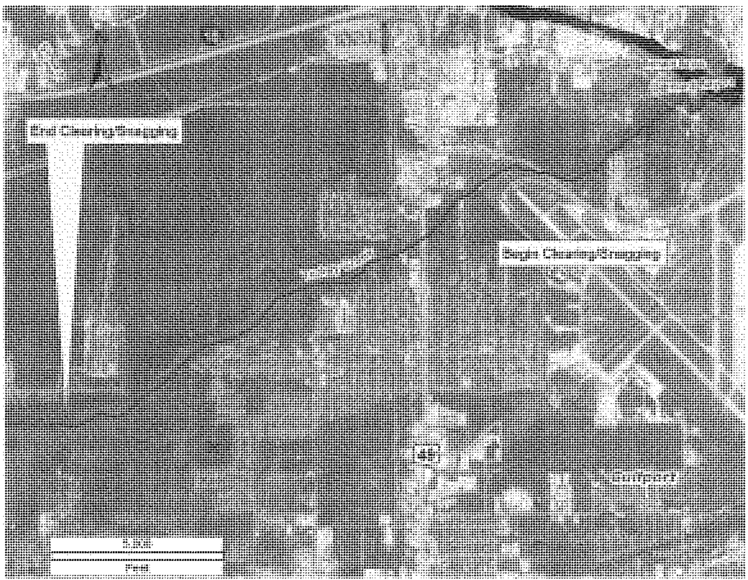
Source: Corps

Figure 5.7.5.1-1. 17-ft Elevation Levee Alignment with Culvert and Pump/Detention Basin Locations

Levees reduce the storage capacity and overbank flow conveyance of the adjacent floodplain. The reductions in overbank flow area could induce higher water levels upstream. An HECRAS model was used to evaluate the potential for induced damages and solutions. The modeling indicates that selective clearing and snagging would prevent increases in water surface elevations upstream that would occur due the placement of the levees in the floodplain.

The selective clearing and snagging would extend for approximately 4.5 miles from the mouth of Turkey Creek at Bernard Bayou to the upstream limits as shown in Figure 5.7.5.1-2. Selective clearing and snagging would remove obstructions such as debris dams and excessive sedimentation that hinders the flow through the Turkey Creek channel. While the selective clearing and snagging component of the plan does not eliminate flooding along Turkey Creek, the plan does reduce flood damages along the creek and at the upper end of the canals at 28th Street. The main purpose of the selective clearing and snagging is to make sure that induced damages do not occur due to the construction of the levee.

The selective clearing and snagging work will follow Stream Obstruction Removal Guidelines established by the American Fisheries Society. Only debris, snags and sediment that obstruct the flow will be removed. Material to be removed includes: 1) fine sediment accumulations that obstruct flows and alter flow patterns; 2) Debris blockages that currently or in the near future cause obstructed flow and altered flow patterns; and 3) Rooted trees that obstruct flow or need to be cleared for equipment access. Access areas that are cleared will be reestablished at the conclusion of the selective clearing and snagging activities. Some access points, however, may remain for the non-Federal sponsor to use for maintenance activity of the completed project. The existing bank alignment along the entire reach will not be changed, including the downstream reaches of Turkey Creek along the meander bends. Specific reaches to be cleared and snagged will be identified by an interdisciplinary team prior to construction.



Source: Corps

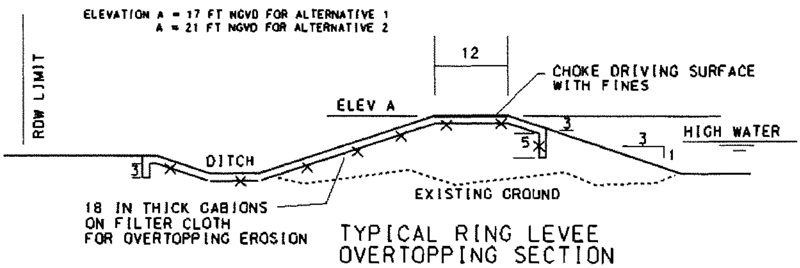
Figure 5.7.5.1-2. Channel Clearing and Snagging Limits

Damage and failure by overtopping of levees could be caused by storm surges greater than the levee crest. Overtopping failures are caused by the high velocity of flow on the top and back side of the levee. Although significant wave attack on the seaward side of some of the New Orleans levees occurred during Hurricane Katrina, the duration of the wave attack was for such a short time that major damage did not occur from wave action. The erosion shown below in Figure 5.7.5.1-3 was caused by approximately 1-2 foot of overtopping crest depth.

Source: Corps

Figure 5.7.5.1-3. Crown Scour from Hurricane Katrina at Mississippi River Gulf Outlet Levee in St. Bernard Parish, New Orleans, LA

An overtopping reach of the levee with a revetment at the detention/culvert location would be included in the levee design to prevent overtopping failure. The levee would be protected by gabions on filter cloth as shown in Figure 5.7.5.1-4, extending across a drainage ditch which carries water to nearby culverts and which would also serve to dissipate some of the supercritical flow energy during overtopping conditions.



Source: Corps

Figure 5.7.5.1-4. Typical Levee Overtopping Section

5.7.5.1.1 Interior Drainage

Drainage at the site is impacted by hurricanes in the Gulf and by adjacent flooding from Turkey Creek. Backwater from each of these sources prevents water from running off. The existing NRCS levee at elevation 16.5 NAVD 88 protects the neighborhood to some degree from these sources, but does not eliminate the flooding during times when the water outside the levee is up and there is rainfall inside the levee. This is the present condition at the site. Construction of the Corps levee will follow the footprint of the NRCS levee and provide additional protection from flooding from hurricanes and Turkey Creek. The interior flooding will be improved by adding a detention basin and pumping facility.

Flow within the levee interior was determined by subdividing the interior of the ring levee into major sub-basins shown below in Figure 5.7.5.1.1-1 and computing flow for each sub-basin by USGS computer application WinTR55. The method incorporates soil type and land use to determine a run-off curve number. The curve number was determined from previous studies done for Turkey Creek.

Source: Corps

Figure 5.7.5.1.1-1. 17-ft Elevation Levee Sub-basins

Peak flows for the 1-year to 100-yr storms were computed. Levee culverts were then sized to evacuate the peak flow from a 25-year rain in accordance with practice for new construction in the area using Bentley Culvert Master application. For the culvert design, headwater elevations at the culverts were maintained at an elevation no greater than 10 feet NAVD88 with a tailwater elevation of 6 feet NAVD 88 assumed. Drainage ditches along the toe of the levee will be required to assure that smaller basins can be drained to a culvert/pump site. These ditches were sized using a normal depth flow computation. Curve numbers and culvert capacity tables are not included in the report beyond that necessary to obtain a cost estimate. The data are considered beyond the level of detail required for this report.

During periods of high water in Turkey Creek or Mississippi Sound, pumping would be required to evacuate rainfall. Pump size was determined for the peak flow resulting from a 10-year rainfall.

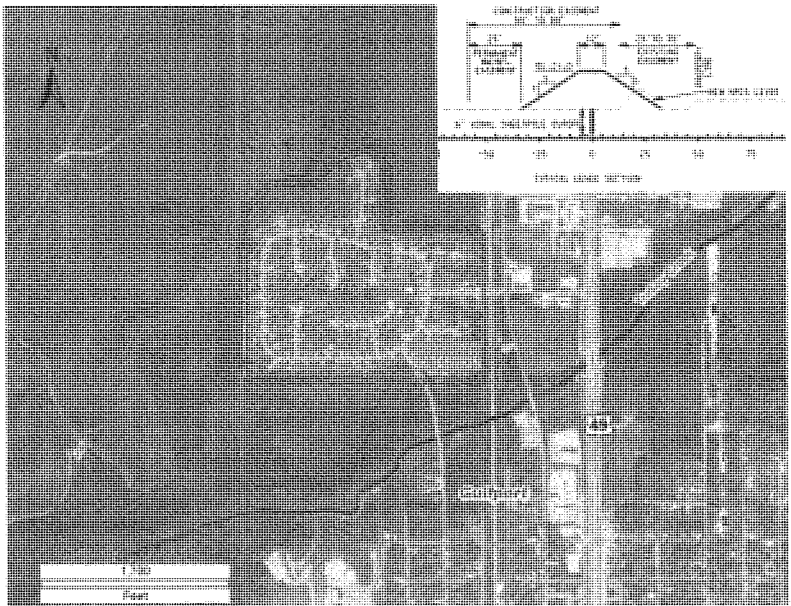
Additional information concerning this decision is included in the Engineering. During some hurricane events or high water in Turkey Creek, when the culvert gates are shut, and rainfall exceeds the average 10-year intensity over the basin, some ponding from rainfall will occur. A detention basin was added to help reduce the size of required pumps. The detention basin would have an area of approximately 3 acres but would not be excavated. The area is the lowest site in the subdivision and is presently used for recreation facilities, such as baseball and tennis. Detailed modeling of the area was not possible for this report; therefore, the exact extent of the detention basin is not precisely defined. Designing the pumps for the peak 10-year flow provides a significant pumping capacity. Further design during construction will refine the requirement for the appropriate detention area and pump sizes to provide protection from 100-year rainfall.

During non-hurricane periods of low water in the sound, when rainfall greater than the 25-year event occurs, the pump could also be used to augment the flow capacity of the levee culverts.

Additional details concerning the levee at Forest Heights are located in the Engineering Appendix.

5.7.5.2 Option B - Elevation 21 ft NAVD 88

This option consists of an earthen levee around northern, western, and southern sides of the Forrest Heights community. Because of the height of the levee, the eastern side will be constructed with a concrete "T"-wall structure. The "T" wall will take less space than an earthen levee and encroach less into property along the alignment. The alignment of the levee is generally the same as Option A, but is shown below in Figure 5.7.5.2-1. Closure gates across the two access roads to the subdivision will be required. The lengths of the levee culverts will be slightly longer than those used in Option A. Other features and methods of analysis are the same.



Source: Corps

Figure 5.7.5.2-1. 21-ft Elevation Levee Alignment with Culvert and Detention Basin/Pump Locations

5.7.5.2.1 Interior Drainage

Interior drainage analysis and culverts are the same as those for Option A, above, except that the culvert lengths through the levees would be longer.

5.7.6 Summary

The proposed action would consist of raising the existing levee to an elevation of 21 feet along the current alignment of the lower existing levee. Under this alternative, there is an expected loss of 3.62 acres of non-tidal wetland vegetation impacted by construction of the levee. Under the 17 feet raising alternative, there is an expected loss of 1.47 acres of non-tidal wetland vegetation impacted by construction of the levee. Although native vegetation under the levee footprint would be lost, the levee itself would be vegetated with non-native species for stabilization of the structure.

5.8 High Hazard Area Risk Reduction Plan (HARP)

Although the coastal areas of the nation are attractive to commercial, industrial, and residential developers, the consequences (as evidenced by Hurricane Katrina and past large hurricanes) associated with locating damageable property and unwary residents along the Gulf Coast can be extreme. Despite ongoing regulation through FEMA and other coastal zone management techniques, damageable property would still remain in high-hazard areas and people would still be in danger during hurricanes.

The non-structural team formulated a series of non-structural measures that would work either independently of structural measures or in concert with them to provide substantial reductions in flood damages due to surge inundation and waves associated with future hurricane or storm events. Additional information would need to be collected and analyzed in order to address uncertainties regarding the cost and effectiveness of non-structural measures; however the team identified primary measures that include permanent acquisitions, floodproofing by elevation and other means, relocations of public buildings, flood preparedness and evacuation planning, public education, changes in the current municipal and county National Flood Insurance Program and building codes, implementation of either a transfer of development rights or purchase of development rights program, potential changes in zoning ordinances, development impact fees, and redirection of new development. These measures have been combined into eight separate plans that could be implemented by either Federal, State, or local agencies, county and local governmental units, or some collaboration thereof. The following projects have been developed further for implementation under this MsCIP Comprehensive Plan and are discussed in the following paragraphs.

5.8.1 High Risk HARP

The HARP alternative would provide an effective means to induce and assist devastated and displaced property owners in relocating outside of high-hazard surge-plain throughout coastal Mississippi. Acquisition of those properties where the residential owners have not yet rebuilt and continue to be displaced presents a unique window of opportunity to assist landowners while minimizing cost to the U.S. Government. The HARP, a voluntary acquisition strategy, would provide a non-structural alternative for reducing property damage resulting from hurricanes, storm surge and flooding, and by extension, reducing threats to lives in those areas, in the most hazardous areas throughout coastal Mississippi.

5.8.2 Moss Point Municipal Relocation Component

This component consists of relocating the City of Moss Point's municipal buildings to a lower risk site with regards to flooding within the incorporated limits. This will aid the city in providing basic community services in a more timely fashion after future storm events, and further demonstrate the effectiveness of relocations projects as a hurricane and storm damage reduction measure along the Mississippi coast. These buildings include the city hall, police station, fire station and community services building and will be replaced to current standards and based upon the existing community needs. Implementation of this project would allow a demonstration of a relocation project in order to determine the effectiveness of the hurricane and storm damage reduction measure by relocation of the city's municipal services at a lower risk area.

5.8.3 Waveland Floodproofing

The City of Waveland is located in Hancock County, Mississippi and was directly in the path of Hurricane Katrina. Because of the critical habitat surrounding the city and its low lying areas, the only flood damage reduction measures available to a portion of Waveland are either acquisition or floodproofing the individual structures. In order to evaluate the different foundation and building types, 25 structures would be selected in the Waveland area that could be safely elevated out of the 1% chance storm event, and which could not be protected by any other structural measures evaluated as part of this study.

5.9 Deer Island Restoration

Deer Island is located within the boundaries of Harrison County, Mississippi near the mouth of the Biloxi Bay and offshore of the City of Biloxi. The island is considered a mainland remnant and is not part of the coastal barrier system of islands along the Mississippi coast. It is unique in that it is one of the only few islands along the Northern Gulf of Mexico, which are totally surrounded by an estuarine environment. The storms of 2005 and other past storm events have exacerbated an already eroding shoreline and degrading interior marshes and coastal maritime forest areas. The island contains a diverse habitat of beach/dunes, emergent tidal marshes, and coastal maritime forests. The island is protected under the Coastal Barrier Resources Act of 1990 which replaced and reauthorized the Coastal Barrier Resources Act of 1982.

Without intervention (i.e. the No Action Plan), Deer Island would continue its degradation and ultimately increased wave action would occur along the mainland at the City of Biloxi. The southern shorelines would continue to erode; thus, adversely impacting those dependant species, such as birds and crabs. Wave action from daily occurrences and storm events would eventually erode the beach and then begin eroding the emergent tidal marsh and coastal maritime forests. Furthermore, the Section 204 emergent tidal marsh restoration site would continue to degrade. Ultimately, this unique habitat would continue to change from a productive beach/dune, emergent tidal marsh, and coastal maritime forest habitat to stressed and non-functioning habitats.

Deer Island contains a diverse habitat of beach/dunes, emergent tidal marshes, and coastal maritime forests. Its proximity to the City of Biloxi provides a certain amount of protection to the city from waves generated by approaching hurricanes. Currently, the uninhabited island is part of the MDMR Coastal Preserves Program. Restoration efforts have been funded under the Section 528 of WRDA of 2000 for breaches at the west end and near Grand Bayou, and parts of the southern shoreline. Although a substantial restoration effort in its own right, there are significant opportunities to further restore the island and repair hurricane-caused damage to the islands' ecosystems. Deer Island restoration consists of a combination of the following alternatives to form the recommended plan:

- Continued restoration for the southern shoreline as part of the Section 528 of WRDA of 2000 project (assessed in the *Environmental Restoration in Coastal Mississippi: Deer Island Restoration Projects, Harrison County, Mississippi Environmental Assessment* dated September 2007);
- Repair/Replace the Section 204 containment dike (containment dike assessed in the *Section 204 Ecosystem Restoration Project In Connection with Construction, Operations, or Maintenance Dredging of a Federally Authorized Project, Environmental Restoration in Coastal Mississippi Marsh Re-Establishment Project, Harrison and Jackson Counties, Mississippi Environmental Assessment* dated July 2002);
- Add/Replace material in the Section 204 containment dike (placement of material assessed in the *Section 204 Ecosystem Restoration Project In Connection with Construction, Operations, or Maintenance Dredging of a Federally Authorized Project, Environmental Restoration in Coastal Mississippi Marsh Re-Establishment Project, Harrison and Jackson Counties, Mississippi Environmental Assessment* dated July 2002);
- Analyze new stone training dikes on the northern and southern ends of the islands as a result of Section 204 (requires minor additional study);
- Lengthen stone containment dikes on northern and southern ends as a result of Section 204 (various alignments assessed in the *Section 204 Ecosystem Restoration Project In Connection with Construction, Operations, or Maintenance Dredging of a Federally Authorized Project,*

Environmental Restoration in Coastal Mississippi Marsh Re-Establishment Project, Harrison and Jackson Counties, Mississippi Environmental Assessment dated July 2002 but requires some minor additional study); and

- Create additional marsh habitat area adjacent to the existing created marsh area (requires minor additional study).

Tables 5.9-1 and 5.9-2 provide an overview of benefits associated with implementation of the proposed project:

Table 5.9-1.
Functional Habitat Index Restoration of Grand Bayou, the West End Breach and Entire Southern Shoreline

							Proposed Alternative		Future Without	
Functions	**Shoreline Birds**	**Migratory Birds**	**Native Fish**	**Sport Fish**	**Macro Invertebrates & Primary Producers**	**Bivalves**	**Functional Habitat Index (FHI)**	**FHI 525 acres**	**Future w/o FHI**	**FHI 0 acres**
Restoration of Emergent Beach and Dune System	0.10	0.10	0.05	0.05	0.05	-	0.35	183.75	-	0.0
Restoration of Maritime Forest Habitat	0.10	0.10	-	-	0.05	-	0.25	131.25	-	0.0
Soft Substrate	0.05	0.05	0.10	0.10	0.05	0.05	0.40	210	-	0.0
Reestablishment of pre-disturbance shoreline	0.05	0.05	-	-	-	-	0.10	52.5	-	0.0
Reduced Wave Energy along Grand Bayou and the Southern Shoreline	0.10	0.10	0.05	0.05	0.05	0.05	0.40	210	-	0.0
Shoreline Stabilization	0.05	0.05	0.05	0.05	-	-	0.20	105	-	0.0
Roosting Habitat	0.10	0.10	-	-	-	-	0.20	105	-	0.0
Nesting Habitat	0.10	0.10	-	-	-	-	0.20	105	-	0.0
Native Vegetation Propagation	0.10	0.10	0.05	0.05	0.10	-	0.40	210	0.10	0.0
Shoreline Foraging Habitat	0.10	0.10	0.10	0.10	0.05	0.05	0.50	262.5	0.10	0.0
Erosion Control	0.05	0.05	0.05	0.05	0.05	0.10	0.35	183.75	-	0.0
Sediment Stabilization	0.05	0.05	0.05	0.05	0.05	0.10	0.35	183.75	-	0.0
Water Quality	-	-	0.05	0.05	0.05	0.05	0.20	105	-	0.0
Hard Substrate-ocean bottom or submerged rip-rap	-	-	0.05	0.05	-	0.10	0.20	105	-	0.0

Direct Benefit = 0.10 Indirect Benefit = 0.05

Table 5.9-2

Functional Habitat Index Re-establishment of marsh adjacent to Deer Island in conjunction either concrete rubble or riprap dike project

Functions	Shoreline Birds	Migratory Birds	Native Fish	Sport Fish	Macro Invertebrates & Primary Producers	Bivalves	FHI	FHI 15 acres	FHI 30-45 acres	FHI 90 acres
Hard Substrate – ocean bottom or submerged riprap	-	-	0.05	0.05	0.10	0.10	0.30	4.5	9-13.5	27
Soft Substrate	-	-	0.05	0.05	0.10	-	0.20	3	6-9	18
Containment Dike along the Northeast Portion of Deer Island	0.05	0.05	0.05	0.05	0.05	-	0.25	3.75	7.5-11.25	22.5
Breakwater along northeastern portion of Deer Island, (composed of riprap and within site sediment)	0.05	0.05	0.05	0.05	0.10	0.10	0.40	6	12-18	36
Reduced Wave Energy along Deer Island	0.05	0.05	0.05	0.05	0.05	0.05	0.30	4.5	9-13.5	27
Substrate Diversity	0.05	0.05	0.05	0.05	0.10	0.05	0.35	5.25	10.5-15.75	31.5
Nutrient Input	0.10	0.10	0.10	0.10	0.10	0.10	0.60	9	18-27	54
Nutrient Processing	0.05	0.05	0.05	0.05	0.05	0.05	0.30	4.5	9-13.5	27
Shoreline Stabilization	0.10	0.10	-	-	0.10	-	0.30	4.5	9-13.5	27
Roosting Habitat	0.10	0.10	-	-	-	-	0.20	3	6-9	18
Nesting Habitat	0.10	0.10	-	-	-	-	0.20	3	6-9	18
Native Vegetation Propagation	0.05	0.05	0.10	0.10	0.10	-	0.40	6	12-18	36
Shoreline Foraging Habitat	0.10	0.10	-	-	0.10	-	0.30	4.5	9-13.5	27
Erosion Control	0.05	0.05	-	-	0.05	-	0.15	2.25	4.5-6.75	13.5
Sediment Stabilization	0.05	0.05	0.05	0.05	0.05	0.05	0.30	4.5	9-13.5	27
Planted Vegetation Protection from Predation	-	-	0.10	0.10	0.10	-	0.30	4.5	9-13.5	27
400-foot long Breakwater Protection from Predation	-	-	0.10	0.10	0.10	0.10	0.40	6	12-18	36
Adjacent marsh re-establishment	0.05	0.05	-	-	0.05	-	0.15	2.25	4.5-6.75	13.5
Offset marsh re-establishment	-	-	-	-	-	-	0	0	0	0
Channel flow between Deer Island and marsh creation	-	-	-	-	-	-	0	0	0	0

Functions	Shoreline Birds	Migratory Birds	Native Fish	Sport Fish	Macro Invertebrates & Primary Producers	Bivalves	FHI	FHI 15 acres	FHI 30-45 acres	FHI 90 acres
Dissolved Oxygen Concentration in Channel	-	-	-	-	-	-	0	0	0	0
Erosion due to offset marsh	0.05	0.05	-	-	0.05	-	0.15	2.25	4.5-6.75	13.5

Direct Benefit = 0.10 Indirect Benefit = 0.05

5.10 Longer Term Comprehensive Effort For Environmental Restoration

5.10.1 Introduction

Development of the GIS based SDSS tool allowed the MsCIP environmental team, working in cooperation with the USFWS and MDMR, to identify and prioritize potential wetland restoration areas throughout Coastal Mississippi (Lin 2007). A detailed explanation of this GIS based SDSS tool has been discussed earlier and also is provided in ERDC's technical report included as part of this Environmental Appendix. Using Phase II - Longer Term Comprehensive Effort allows the Corps, Mobile District to approach environmental restoration throughout Coastal Mississippi holistically while evaluating the natural ecosystems using an overall systems wide approach. Establishment of a Longer Term Comprehensive Effort for environmental restoration would allow us to further evaluate the results and prioritize potential projects for construction as funding becomes available. Establishment of this program would ensure our commitment to restoration of the damaged and destroyed ecosystems in Coastal Mississippi; thus, allowing us to meet the overall objectives found in the Emergency Supplemental legislation authorizing this Comprehensive Report.

Unique habitats exist in Coastal Mississippi that are critical to the continued health of a number of fish and wildlife species. Most of these proposed restoration habitats have been impacted and/or destroyed nationally, regionally, and locally by development and/or natural events. These sites require man-intervention in order to restore to their historical environmental setting. Failure to restore these sites could impact all Coastal Mississippi.

5.10.2 Program Development

Using the GIS based SDSS model, the MsCIP environmental team was able to effectively analyze needs in Coastal Mississippi. A subset of potential restoration sites was identified by the SDSS tool and then ground-truthed by the MsCIP environmental team, including ERDC, Corps, MDMR, and USFWS. Using this interagency team allowed us to both confirm the accuracy of the SDSS results and to collect additional on-site information pertinent to restoration efforts. The MsCIP environmental team recommends immediate construction of the above 2 initial environmental restoration projects – Turkey Creek, Harrison County and Bayou Cumbest, Jackson County. In addition, the team recommends potential environmental restoration projects specified in *Table 5.1.1.1-1* that would be studied further and restored under a MsCIP Environmental Restoration Longer Term Comprehensive Effort. The Environmental PDT anticipates studies, such as Project Information Reports, would range from $100,000 to $500,000 depending upon the specific project complexness. This cost has been incorporated into the cost estimates. The Environmental PDT anticipates in order to accomplish the MsCIP Longer Term Comprehensive Effort for environmental restoration of Coastal Mississippi an upward estimated limit of $5,478,967,000 would be required. The Environmental PDT will utilize the SDSS tool to prioritize environmental restoration site construction. The Longer Term Comprehensive Effort for environmental restoration of Coastal Mississippi is anticipated to require $5,478,967,000.

5.10.3 Partnerships

Development of partnerships with Federal resource agencies, state agencies, and NGOs is crucial to the success of this program. These partnerships would provide opportunities to access local knowledge of the existing environment. Specialists in specific restoration techniques would be available as well as opportunities to build on existing programs.

5.10.4 Planning and Evaluation Teams

Development of teams would be necessary to organize the program, establish prioritization of projects, development and evaluation of project plans, and future monitoring. Development of assessment models as well as monitoring plans would be accomplished by various interdisciplinary planning and evaluation teams.

5.10.5 Projects

The SDSS model identified many potential restoration sites. The list was verified in the field and through existing partnerships with Federal and state agencies, and based on personal knowledge of the overall comprehensive natural system, these sites were screened further. A list of 38 restoration sites has been proposed. Two of the sites have been chosen as initial projects and have been recommended for construction through this technical report. Additionally, two state projects have been targeted for restoration through this technical report. The remaining projects are found in *Section 4.1.5.5 State Initiatives*. Further prioritization and ranking of importance would ensure best use of future funding.

5.10.6 Sequencing Plan

Once the restoration sites have been prioritized, a sequencing plan would need to be developed identifying the events necessary to accomplish restoration. This would ensure prioritized sites received immediate attention and further details developed for the required analysis. This plan would serve as an outline of the longer term comprehensive structure.

5.10.7 Project Information Reports

As projects are being developed, specific details would be necessary to ensure compliance with regulations, policies, and acts. This information would be complied in a Project Information Report (PIR) and would consist of NEPA documents, project designs and details, economic analysis including incremental cost analysis for use in selection of a best buy plan, and other necessary documentation for approvals. The level of detail contained in a PIR should be commensurate with the complexity and cost of the project while including the information necessary to meet requirements.

5.10.8 Costs

A rough order of magnitude cost estimate has been prepared for each project based on existing conditions and restoration measures. This would serve as an upward limit of funding for this longer term comprehensive effort. Cost covers site acquisitions including associated relocation costs, removal and site demolition activities, and planting activities. A summary of costs is provided in the Cost Appendix .

5.10.9 Construction

Once the PIR received approvals, a contracting mechanism would need to be put forward. The District Project Delivery Team would need to incorporate Contracting Division in order to establish the most efficient type and beneficial use of contracting options and/or existing construction contracts. Oversight and quality assurance would ensure restoration was accomplished as envisioned.

5.10.10 Adaptive Management

Monitoring project performance, followed by adaptive changes to the project if necessary, is a responsible means of ensuring project performance. Monitoring determines if the projected outputs are being achieved and provides feed back for future projects. Post-implementation monitoring of ecosystem restoration components of the Comprehensive Plan is projected to be conducted for no more than five years at a cost of less than 1% of the total first cost of the project's ecosystem restoration features.

Adaptive management of proposed comprehensive ecosystem restoration programs and projects is an important aspect of project success. It is generally anticipated that some post-implementation project modifications will be required based on the feed back provided by project monitoring. Because the nature of the recommended plans made in this Comprehensive Report is not extremely risky in terms of projected outputs, it is anticipated that adaptive management would not be a major project expense. Adaptive management of ecosystem restoration features is expected to cost no more than 3% of ecosystem restoration feature first costs, and may in some cases be less than that figure. Monitoring and adaptive management costs have been accommodated in the cost estimates for each potential ecosystem restoration component as part of the contingency estimate.

Information gained from post-implementation monitoring and adaptive management of recommended ecosystem restoration plans will be used to provide "lessons learned" for the design and implementation of future ecosystem restoration projects. These "lessons learned" will provide important information, which will be used to improve the effectiveness and reduce the costs of future ecosystem restoration components of the Comprehensive Plan.

5.10.11 Program Status Reports

Program Status Reports would accomplish a system-wide reevaluation that would consider program and project-level considerations, and the level of success of overall met program goals and objectives. Project level formulation activities would address optimization of the overall program's contribution to the system-wide goals and objectives in general, and project goals and objectives would be more specific. The individual project monitoring reports may result in project modifications that impact or modify system output, however, these modifications would not address system-wide issues within the comprehensive plan. Status reports would provide updates on the overall success of environmental restoration throughout Coastal Mississippi.

CHAPTER 6. CONCLUSIONS

The recommended MsCIP Environmental Plan has been developed and discussed during numerous interagency PDT workshops and online meetings. Further, this approach has been coordinated with MDEQ and MDMR.

The recommended plan has been determined to be suited for long-term implementation as a key component of the MsCIP Comprehensive Plan. The environmental restoration projects could be implemented within the near-term with longer term approval allowing for development of the remaining environmental restoration sites based on the SDSS results and as land becomes available. Additionally, the recommended approach establishes a program that would allow for important data collection in the expanse marsh systems located on the western and eastern portions of the state. Upon collection and further analysis of this data, appropriate freshwater diversions could be developed that would mitigate saltwater intrusion. Continued coordination and future partnering with the NPS and other Federal, state, and local NGOs allows us to establish a program to restore lost and damaged ecosystems found on the barrier islands and SAVs throughout Mississippi Sound. The recommended environmental approach allows for establishment of programs under longer term comprehensive effort or through existing authorities to partner with local efforts with ongoing restoration program.

The recommended plan also appears to be cost-effective in light of the risk and consequences of not implementing the project. The risks and consequences of *not* implementing this plan include:

- Continued flood and storm damages throughout the study area;
- Continued damage to fish and wildlife habitat;
- Continued coastal erosion and loss of valuable marsh systems;
- Continued saltwater intrusion and loss of valuable fisheries and oyster resources;
- Continued loss of barrier island exacerbating saltwater intrusion; and
- Change of Mississippi Sound estuarine conditions converting to marine conditions.

The recommended environmental plan addresses the following stated goals and objectives in the guidance of the Coastal Mississippi Comprehensive Hurricane Protection and Restoration effort:

a) future hurricane storm and flood damage reduction;

b) prevention of saltwater intrusion;

c) prevention of coastal erosion;

d) preservation of fish and wildlife; and

e) other water related resources (reduction of flooding).

Further, **the recommended plan complements and supports the objectives of the State and/or local plans and desires for this area**, including Governor Barbour's Seven Point Strategy for Coastal Recovery. This environmental approach allows us to establish a program for coastal wetland restoration. The 2 previously identified sites have been identified as initial environmental projects that will specifically depict problems and opportunities for restoration. By restoration of these sites, we will be able to ensure that homes will not be reconstructed within the 100-year floodplains, restore vital functions of historical wetlands, and remove people out of areas subject to future damaged by storm surge, erosion, flooding.

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1.2 CULTURAL RESOURCES

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TABLES

ACRONYMS

CFR	Code of Federal Register
FEMA	Federal Emergency Management Agency
MDMR	Mississippi Department of Marine Resources
NCPTT	National Center for Preservation Training and Technology
NEPA	National Environmental Protection Act
NHPA	National Historic and Preservation Act
NPS	National Park Service
NRHP	National Register of Historic Places
SHPO	State Historic Preservation Officer

CHAPTER 1. CULTURAL RESOURCES

1.1 Introduction

Cultural resources are pre-contact and historic sites, structures, districts, artifacts, or any other physical evidence of human activity considered important to a culture, subculture, or community for traditional, religious, scientific, or any other reason. Cultural resources are discussed here in terms of archaeological sites, including both pre-contact and historical occupations, architectural resources, and locations of concern to Native American groups, including Traditional Cultural Properties (Table 1.1-1).

Procedures for the identification, evaluation, and treatment of cultural resources are contained in a series of Federal and state laws and regulations and agency guidelines. Archaeological, architectural, and Native American resources are protected by a variety of laws and their implementing regulations: the National Historic Preservation Act (NHPA) of 1966 as amended in 2000; the Archeological and Historic Preservation Act of 1974; the Archaeological Resources Protection Act of 1979; the American Indian Religious Freedom Act of 1978; and the Native American Graves Protection and Repatriation Act of 1990. The Advisory Council on Historic Preservation further guides treatment of archaeological and architectural resources through the regulations, Protection of Historic Properties [36 Code of Federal Regulation (CFR) 800]. Historic properties, as defined by the NHPA, represent the subset of cultural resources listed on, or are eligible for, inclusion on the National Register of Historic Places (NRHP).

Table 1.1-1.
Federally-Recognized American Indian Tribes Associated with Southern Mississippi

Muscogee (Creek) Nation of Oklahoma
Choctaw Nation of Oklahoma
Tunica-Biloxi Tribe of Louisiana
Coushatta Tribe of Louisiana
Mississippi Band of Choctaw Indians
Miccosukee Tribe of Indians of Florida
Seminole Nation of Oklahoma
Seminole Tribe of Florida
Poarch Band of Creek Indians
The Chickasaw Nation
Thlopthlocco Tribal Town
Alabama-Coushatta Tribe of Texas
Alabama-Quassarte Tribal Town of the Creek Nation

1.2 Evaluation Criteria

The NRHP's standards for evaluating the significance of properties were developed to recognize the accomplishments of all peoples who have made a significant contribution to our country's history and heritage. The criteria are designed to guide State and local governments, Federal agencies, and others in evaluating potential entries in the NRHP.

1.2.1 Criteria for Evaluation

The quality of significance in American history, architecture, archeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:

A. That are associated with events that have made a significant contribution to the broad patterns of our history; or

B. That are associated with the lives of persons significant in our past; or

C. That embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

D. That have yielded or may be likely to yield, information important in prehistory or history.

1.2.2 Criteria Considerations

Ordinarily cemeteries, birthplaces, graves of historical figures, properties owned by religious institutions or used for religious purposes, structures that have been moved from their original locations, reconstructed historic buildings, properties primarily commemorative in nature, and properties that have achieved significance within the past 50 years shall not be considered eligible for the NRHP. However, such properties will qualify if they are integral parts of districts that do meet the criteria or if they fall within the following categories:

A. A religious property deriving primary significance from architectural or artistic distinction or historical importance; or

B. A building or structure removed from its original location but which is primarily significant for architectural value, or which is the surviving structure most importantly associated with a historic person or event; or

C. A birthplace or grave of a historical figure of outstanding importance if there is no appropriate site or building directly associated with his or her productive life; or

D. A cemetery which derives its primary importance from graves of persons of transcendent importance, from age, from distinctive design features, or from association with historic events; or

E. A reconstructed building when accurately executed in a suitable environment and presented in a dignified manner as part of a restoration master plan, and when no other building or structure with the same association has survived; or

F. A property primarily commemorative in intent if design, age, tradition, or symbolic value has invested it with its own exceptional significance; or

G. A property achieving significance within the past 50 years if it is of exceptional importance.

CHAPTER 2. MISSISSIPPI COAST CULTURAL RESOURCES OVERVIEW

2.1 Introduction

The Mississippi Gulf Coast is rich in history and as a result is rich in the resources left behind by past cultures. Mississippi's coastline has been home to some of America's earliest peoples, as well as the crossroads for several of the earliest European colonial efforts in North America. The accessibility and numerous natural resources that lured people here initially have kept people here to the present day. All of the comings and goings of these people left behind artifacts in the form of houses or buildings or tools and sometimes just articles of daily life. These artifacts that remain from human life and industry form cultural resources that can be honored and studied and maintained as sentimental reminders of the people who have come before us. The following discussion will briefly define what cultural resources are, how they are categorized in the disciplines of archaeology and history, and summarize the types and condition of the cultural resources that were known to exist along the Mississippi Coast prior to hurricane Katrina in August 2005.

Cultural resources can include buildings or other structures; historic or prehistoric districts, such as the historic districts in Biloxi and Ocean Springs; archaeological sites, such as Indian mounds or other remains of prehistoric life; objects, such as statues or paintings; or sunken vessels, such as those that have been found in Mississippi Sound. Traditional cultural properties can also be considered significant cultural resources because of their traditional religious or cultural importance to an Indian tribe or other traditional community. The NHPA of 1966 established the Federal government's policy on historic preservation, as well as the national historic preservation program through which that policy is implemented. The NHPA also established the NRHP, which is a list of important resources that experts have identified as significant to our national heritage. The NRHP is the nation's official list of buildings, structures, objects, sites, and districts considered worthy of preservation because of their significance in American history, architecture, archaeology, engineering, and culture. The National Park Service (NPS) maintains the list.

Resources on the NRHP must meet criteria for evaluation established by the NHPA. Nominations to the NRHP are submitted from each state by its State Historic Preservation Officer (SHPO). Resources are nominated and considered to be significant when they have integrity of location, design, setting, materials, workmanship, feeling, and association, and:

They are associated with events that have made significant contributions to the broad patterns of our history; They are associated with the lives of persons who are significant in our past; They embody the distinctive characteristics of a type, period, or method of construction, represent the work of a master, or have high artistic value, or they represent a significant and distinguishable entity whose components might lack individual distinction; or They have yielded, or might be likely to yield, information important in prehistory or history. Properties, such as cemeteries or buildings that are less than 50 years old, are usually not considered eligible for the NRHP, but there are exceptions. For example, certain buildings associated with the Cold War are considered so important to our history that they are eligible for the NRHP.

The National Environmental Policy Act (NEPA), under which this document is being prepared, states that potential effects on cultural resources that are listed or might be eligible for listing on the NRHP must be considered when Federal agencies are considering an action.

This section discusses the prehistoric and historic context of the cultural resources along the Mississippi coast, and provides a table that lists some of the area's historic structures. The project area for cultural resources analysis is bounded to the north by a line 2 miles north of Interstate-10 and on the south by the Mississippi border. It is bounded on the west by the Louisiana border and on the east by the eastern edge of the Biloxi Bay watershed. The area includes most of Hancock, Harrison, and Jackson Counties; part of the Mississippi Sound; and Cat, Ship, Horn, Round, and Deer Islands. The known cultural resources in the project area are discussed in this section.

2.2 Baseline Conditions

Cultural resources in the project area considered eligible for listing on the NRHP include historic standing structures, submerged shipwrecks, historic cemeteries, and prehistoric and historic archaeological sites. There are currently 298 known archeological sites within the project area (Tables 2.2-1 – 2.2.3), including submerged shipwrecks and historic cemeteries. Of these, 63 sites are listed on or are eligible for the NRHP, 80 have been determined ineligible by the Mississippi SHPO, and the remainders are potentially eligible. Sites whose NRHP status is listed as "unknown" in the appendix might be eligible for listing. Because of the risk of looting, the specific locations of cultural resource sites are not shown in this document.

The potential for identifying additional buried archaeological sites and submerged historic shipwrecks in the project area is considered high, based on the number of known resources (Mississippi SHPO, 2001).

Many of the cultural resource sites contain shell middens, which are mounds of discarded shells that offer evidence of the early use of certain shellfish (mollusks). Some of the sites are prehistoric Indian mounds. The sites also include the remains of ancient villages, historic forts, campsites, and cemeteries. The sunken vessels that have been found include schooners, barges, and sailing vessels.

Table 2.2-1.
Archaeological Sites Within the Hancock County Project Area

Site Number	Site Name	National Register Status	Site Description	Time Period
22-Ha-502	Lakeshore Midden	Eligible	Shell midden	Unknown Prehistoric
22-Ha-505	Cowand Point	Eligible	Shell midden	Late Woodland
22-Ha-510	Joe's Bayou	Unknown	Village site, Shell midden	Middle Woodland
22-Ha-510	Joe's Bayou	Unknown	Village site, Shell midden	Historic Indian
22-Ha-512	Campbell Bayou I	Unknown	Processing camp area, no kitchen midden	Unknown Prehistoric
22-Ha-512	Campbell Bayou I	Unknown	Processing camp area, no kitchen midden	Unknown Prehistoric
22-Ha-519	Owen Heitzman	Eligible	Shell midden	Mississippian
22-Ha-520	Cedar Island	Eligible	Shell midden	Woodland
22-Ha-521	Carver Site	Eligible	Shell midden	Late Woodland
22-Ha-522	Bryan Bayou	Eligible	Shell midden	Unknown Prehistoric
22-Ha-524	Brush Bayou	Eligible	Shell midden	Unknown Prehistoric
22-Ha-525	Redfisb Bayou	Eligible	Shell midden	Unknown Prehistoric
22-Ha-526	Ebeneezer Reese	Eligible	Shell midden	Unknown Prehistoric

Table 2.2-1.
Archaeological Sites Within the Hancock County Project Area (continued)

Site Number	Site Name	National Register Status	Site Description	Time Period
22-Ha-527	East Side Jourdan River	Unknown	Shell midden	Mississippian
22-Ha-528	Ramsay Mound	Eligible	Flat top mound. Sank pit in top 15 years ago.	Unknown Prehistoric
22-Ha-536		Ineligible		Late Archaic
22-Ha-541	Gibbens	Ineligible	Chenier	Unknown Prehistoric
22-Ha-542	Lambert Site	Unknown	Light disturbance	Unknown Prehistoric
22-Ha-542	Lambert Site	Unknown	Light disturbance	Woodland: Middle, Late
22-Ha-543		Unknown		Unknown Prehistoric
22-Ha-543		Unknown		Unknown Prehistoric
22-Ha-544		Ineligible	Chenier	Historic
22-Ha-545		Ineligible	Estuary	Mississippian
22-Ha-546	Schaefer Mound	Eligible	Small conical mound	Middle Woodland
22-Ha-550	Diamondhead	Eligible	Large shell midden	Woodland
22-Ha-550	Diamondhead	Eligible	Large shell midden	Woodland: Middle, Late
22-Ha-551		Ineligible	Estuary	Unknown Prehistoric
22-Ha-553	#GCS-21	Unknown		Woodland: Middle, Late
22-Ha-554		Unknown	Must be real location of Ha-518	Historic
22-Ha-555	1	Unknown		Mississippian
22-Ha-556		Unknown		Unknown Prehistoric
22-Ha-557		Unknown	Ammunition magazine	Historic
22-Ha-558		Unknown	Subdivision; British soldiers reputedly buried there during War of 1812	Historic
22-Ha-581		Eligible	*Rangia* (clam) shell midden	Early Woodland, 2680 +/- 75 years before present
22-Ha-591		Eligible	Mounds: conical, pyramidal, indeterminate	Middle Woodland
22-Ha-593		Ineligible		Woodland
22-Ha-593		Ineligible		Woodland: Early
22-Ha-597		Ineligible		Late Archaic
22-Ha-605	B.W.Y.C.	Unknown	Material on shoreline on north peninsula of Yacht Club	Unknown Prehistoric
22-Ha-605	B.W.Y.C.	Unknown	Material on shoreline on north peninsula of Yacht Club	Woodland
22-Ha-605	B.W.Y.C.	Unknown	Material on shoreline on north peninsula of Yacht Club	Unknown Prehistoric
22-Ha-606	Cuevas Home	Unknown	Found during street construction, Diamondhead subdivision	Historic: 19th century
22-Ha-608	Rotten Bayou West	Unknown	Material eroded and scattered along bayou bank	Woodland
22-Ha-613		Unknown		Unknown Prehistoric
22-Ha-614	Dix	Unknown		Woodland

Table 2.2-1.
Archaeological Sites Within the Hancock County Project Area (continued)

Site Number	Site Name	National Register Status	Site Description	Time Period
22-Ha-614	Dix	Unknown		Unknown Prehistoric
22-Ha-614	Dix	Unknown		Archaic: Late
22-Ha-626		Unknown		Woodland

Source: Mississippi SHPO, 2001.

Table 2.2-2.
Archaeological Sites Within the Harrison County Project Area

Site Number	Site Name	National Register Status	Site Description	Time Period
22-Hr-500	Deer Island Shell Midden	Eligible	Shell midden	Unknown Prehistoric
22-Hr-500	Deer Island Shell Midden	Eligible	Shell midden	Historic: Early
22-Hr-501	Bayou Park Mound	Eligible	Mound	Unknown Prehistoric
22-Hr-502	Oak Grove I, II, & II	Eligible	Shell midden, possible village or camp	Unknown Prehistoric
22-Hr-502	Oak Grove I, II, & II	Eligible	Shell midden, possible village or camp	Historic: 1719-1722
22-Hr-503		Eligible	Shell midden	Unknown Prehistoric
22-Hr-504	Irby	Eligible		Historic
22-Hr-504	Irby	Eligible		Unknown Prehistoric
22-Hr-505		Unknown	Eroded shell midden	Unknown Prehistoric
22-Hr-509	Back Bay Beach	Unknown	Shell ridge	Mississippian
22-Hr-510	Lopez Place	Unknown	Shell ridge	Unknown Prehistoric
22-Hr-511	Joe Moran	Unknown	Burials of Eastern European settlers	Historic
22-Hr-513	Old Fort Louis Site	Unknown	Old Fort Louis site	Unknown Prehistoric, Historic
22-Hr-515	Brodie II	Unknown		Unknown Prehistoric
22-Hr-516	Brodie I	Unknown		Unknown Prehistoric
22-Hr-517	O'Neal	Unknown		Unknown Prehistoric
22-Hr-518	Atcheson	Unknown		Unknown Prehistoric
22-Hr-520	Caron Site	Eligible	Dense *Rangia* (clam) midden, many sherds only	Mississippian
22-Hr-524	Fritz Site	Unknown		Mississippian
22-Hr-529	Jim Parker	Unknown		Woodland
22-Hr-531	Boiler Point, Cat Island	Unknown	Old village site	Unknown Prehistoric
22-Hr-532	Little Bay I, Cat Island	Unknown	Shell midden heap	Unknown Prehistoric
22-Hr-532	Little Bay I, Cat Island	Unknown	Shell midden heap	Woodland
22-Hr-533	Little Bay II, Cat Island	Unknown	Midden	Unknown Prehistoric

Table 2.2-2.
Archaeological Sites Within the Harrison County Project Area (continued)

Site Number	Site Name	National Register Status	Site Description	Time Period
22-Hr-533	Little Bay II, Cat Island	Unknown	Midden	Unknown Prehistoric
22-Hr-536	Brodie III	Unknown		Woodland
22-Hr-537	Williams	Unknown		Mississippian
22-Hr-538	Acadian Bayou I	Unknown	Shell midden	Middle Woodland
22-Hr-539	Discovery Bay	Unknown	Shell midden	Middle Woodland
22-Hr-540	Leon	Unknown	Shell midden	Middle Woodland
22-Hr-541	De Metz Site	Eligible	Shell midden	Middle Woodland
22-Hr-542	Sutter Site	Eligible	Shell midden	Woodland
22-Hr-543	Cedar Bayou	Unknown	Low shell midden	Middle Woodland
22-Hr-544	DeLisle	Unknown		Late Woodland
22-Hr-545	Diane	Eligible	Small clam shell midden	Historic: French- 19th and 20th century
22-Hr-546	Dupont	Eligible	Shell midden; possible mounds	Middle Woodland
22-Hr-550	Carron	Unknown	Probably Marksville permanent station	Late Archaic
22-Hr-554	Jaycee Hill	Unknown	Apparently once a large station	Historic: mid-19th century
22-Hr-556	Alpha	Ineligible	Camp site	Unknown Prehistoric
22-Hr-565	Rail Spur #1	Ineligible		Unknown Prehistoric
22-Hr-566	Rail Spur #2	Ineligible		Unknown Prehistoric
22-Hr-567	Wreck of the Pelican	Unknown	Shipwreck: 1848 steamboat, the Pelican	Historic
22-Hr-571		Ineligible		Late Mississippi
22-Hr-572		Ineligible		Early Woodland
22-Hr-573		Unknown	Shell midden	Early Mississippi
22-Hr-574	DeLisle Cemetery	Unknown	Shell midden	Early Mississippi
22-Hr-575	Tom Parker	Unknown		Early Archaic
22-Hr-576		Unknown		Late Woodland
22-Hr-577		Unknown		Early Archaic
22-Hr-578		Unknown	Shell midden	Early Woodland
22-Hr-579		Unknown	Shell midden	Middle Mississippian
22-Hr-591	Godsey	Unknown	Issaquena phase shell midden	Unknown Prehistoric
22-Hr-630		Ineligible		Woodland and Mississippian
22-Hr-630		Ineligible		Historic
22-Hr-631	Morse	Ineligible		Historic
22-Hr-632	AAA	Unknown	Shell midden	Woodland
22-Hr-633	AAE	Unknown	Shell midden	Late Archaic
22-Hr-634	AAD	Unknown	Shell midden	Woodland
22-Hr-635	Richard Site	Eligible	Burial and shell midden	Mississippian
22-Hr-636	Raymond Bass	Accepted 1987	Coal black midden and burial site	Historic: 1910-1920

Table 2.2-2.
Archaeological Sites Within the Harrison County Project Area (continued)

Site Number	Site Name	National Register Status	Site Description	Time Period
22-Hr-638	French Warehouse	Accepted 1991	French warehouse-keepers' house	Historic, Unknown Prehistoric
22-Hr-639	Quarantine Station	Unknown		Archaic: Middle, Late
22-Hr-640	Ship Island Lighthouse	Unknown		Paleo-Indian: Late
22-Hr-641	Ft. Massachusetts /GUIS 102	Unknown	Standing mid-19th century brick masonry fort	Historic
22-Hr-643		Ineligible	On small knoll adjacent to creek	Woodland
22-Hr-647	Biloxi Beach Loop	Unknown		Woodland: Middle, Late
22-Hr-647	Biloxi Beach Loop	Unknown		Unknown Prehistoric
22-Hr-647	Biloxi Beach Loop	Unknown		Woodland
22-Hr-659	Catchment No. 11	Ineligible		Woodland
22-Hr-673		Ineligible	1m2-pit dug; 12 sherds at ca. –10 cm	Woodland
22-Hr-683	DeLisle West Shell	Eligible	Shallow shell midden	Unknown Prehistoric
22-Hr-684	Rusty Skillet	Ineligible		Woodland
22-Hr-685	Pine Hill Northwest	Ineligible	Disturbed by bulldozing	Woodland
22-Hr-686	Pine Hill Central	Ineligible	Destroyed by bulldozing	Unknown Prehistoric
22-Hr-690		Ineligible		Unknown Prehistoric
22-Hr-691		Ineligible		Woodland
22-Hr-740		Ineligible		Early Archaic
22-Hr-741		Unknown	Reported by informant; not field checked	Paleo-Indian: Middle
22-Hr-831		Ineligible		Woodland
22-Hr-843	Wreck of the Josephine	Accepted 2000	Sunken iron-hull sidewheeler shipwreck	Historic
22-Hr-844		Unknown		
22-Hr-845	Holley Cemetery/ "Sunkist" Cemetery	Unknown	Mid to late 19th-century family cemetery	Historic
22-Hr-847		Ineligible		
22-Hr-848		Ineligible		
22-Hr-848		Ineligible		
22-Hr-857		Ineligible		Unknown Prehistoric
22-Hr-859	Schooner *Oleander*	Unknown	Sunken wreck of 1903 schooner *Oleander*	Historic
22-Hr-860	Cedar Lake 1	Unknown	Sunken vessel, possibly a schooner	Historic
22-Hr-861	Cedar Lake 2	Unknown	Sunken vessel, possibly a schooner	Historic
22-Hr-862	Cedar Lake 3	Unknown	Sunken wooden vessel, possibly a ferry barge	Historic
22-Hr-863	Schooner Graveyard	Unknown	10–15 sunken Biloxi-style schooner hulls	Historic
22-Hr 869		Ineligible		Unknown Prehistoric

Table 2.2-2.
Archaeological Sites Within the Harrison County Project Area (continued)

Site Number	Site Name	National Register Status	Site Description	Time Period
22-Hr-870		Ineligible		Unknown Prehistoric
22-Hr-871		Ineligible		Unknown Prehistoric
22-Hr-872	Hamilton Cemetery	Ineligible		Unknown Prehistoric
22-Hr-878		Ineligible		Late Archaic
22-Hr-879		Ineligible		Unknown Prehistoric
22-Hr-880		Ineligible		Unknown Prehistoric
22-Hr-897	Florence Garden # 1	Ineligible		Archaic: Early, Middle

Source: Mississippi SHPO, 2001.

Table 2.2-3.
Archaeological Sites Within the Jackson County Project Area

Site Number	Site Name	National Register Status	Site Description	Time Period
22-Ja-500	Point Aux Chenes	Unknown	3 mounds	Unknown Prehistoric
22-Ja-502	Green; Buena Vista	Eligible	Shell midden	Unknown Prehistoric
22-Ja-503	Graveline Mound	Accepted 1987	Rectangular ramped platform mound	Mississippian
22-Ja-503	Graveline Mound	Accepted 1987	Rectangular ramped platform mound	Unknown Prehistoric
22-Ja-504	Magnolia, Taneksanya	Eligible	Shell midden, at least 20 burials	Mississippian
22-Ja-504	Magnolia, Taneksanya	Eligible	Shell midden, at least 20 burials	Woodland: Middle, Late
22-Ja-504	Magnolia, Taneksanya	Eligible	Shell midden, at least 20 burials	Historic: 19th century
22-Ja-504	Magnolia, Taneksanya	Eligible	Shell midden, at least 20 burials	Unknown Prehistoric
22-Ja-504	Magnolia, Taneksanya	Eligible	Shell midden, at least 20 burials	Gulf Formational: Middle, Late
22-Ja-507	Gollotte, S.P. Starks~	Eligible	Low earth mound	Historic
22-Ja-530	Apple Street	Accepted 1985	Shell midden, no app. submidden feature	Woodland: Early, Late
22-Ja-530	Apple Street	Accepted 1985	Shell midden, app. no submidden feature	Unknown Prehistoric
22-Ja-530	Apple Street	Accepted 1985	Shell midden, app. no submidden feature	Historic: 18th century
22-Ja-530	Apple Street	Accepted 1985	Shell midden, app. no submidden feature	Mississippian
22-Ja-530	Apple Street	Accepted 1985	Shell midden, app. no submidden feature	Unknown Prehistoric
22-Ja-531	North Street; Elizabeth	Unknown		Late Mississippian
22-Ja-531	North Street; Elizabeth	Unknown		Historic: Early Colonial

Table 2.2-3.
Archaeological Sites Within the Jackson County Project Area (continued)

Site Number	Site Name	National Register Status	Site Description	Time Period
22-Ja-531	North Street; Elizabeth	Unknown		Unknown Prehistoric
22-Ja-531	North Street; Elizabeth	Unknown		Archaic: Middle, Late
22-Ja-532	Soy Caphil Point	Unknown		Woodland: Middle, Late
22-Ja-534	Fort Maurepas I, Old Fort	Unknown		Gulf Formational: Late
22-Ja-535	Lemon	Unknown		Early Woodland
22-Ja-538	Fort Maurepas IB	Eligible		Woodland: Early, Middle, Late
22-Ja-539	Maurepas II	Eligible	Stake roots of old wall or bulkhead	Historic Indian
22-Ja-540	Ocean Springs I			Protohistoric~
22-Ja-542	Biloxi Bay Shipwreck	Eligible	Sunken wreck of 18th-century sailing vessel	Historic
22-Ja-553	Stone Site	Unknown		Late Mississippian
22-Ja-554	Old Shell Landing	Unknown	Shell midden	Historic
22-Ja-554	Old Shell Landing	Unknown	Shell midden	Late Archaic
22-Ja-555	Shepards Island	Unknown	Elevated area covered with shell midden	Mississippian
22-Ja-555	Shepards Island	Unknown	Elevated area covered with shell midden	Woodland: Middle, Late
22-Ja-555	Shepards Island	Unknown	Elevated area covered with shell midden	Middle Mississippian
22-Ja-555	Shepards Island	Unknown	Elevated area covered with shell midden	Late Woodland
22-Ja-556	Mrs. C.M. Shepard, B	Unknown	Thin shell midden	Late Mississippian
22-Ja-556	Mrs. C.M. Shepard, B	Unknown	Thin shell midden	Late Mississippian
22-Ja-557	Steve's Site	Unknown	Scattered shell midden	Middle Woodland
22-Ja-558	Cedar Point, Seacliff	Unknown	Oyster shell midden	Woodland: Middle, Late
22-Ja-558	Cedar Point, Seacliff	Unknown	Oyster shell midden	Late Woodland
22-Ja-558	Cedar Point, Seacliff	Unknown	Oyster shell midden	Middle Woodland
22-Ja-558	Cedar Point, Seacliff	Unknown	Oyster shell midden	Middle Woodland
22-Ja-558	Cedar Point, Seacliff	Unknown	Oyster shell midden	Historic: 20th century
22-Ja-558	Cedar Point, Seacliff	Unknown	Oyster shell midden	Woodland
22-Ja-559	Camp Lamotte	Unknown	Heavy extensive oyster shell midden	Mississippian
22-Ja-559	Camp Lamotte	Unknown	Heavy extensive oyster shell midden	Late Woodland
22-Ja-569	Dolphin	Unknown		Mississippian

Table 2.2-3.
Archaeological Sites Within the Jackson County Project Area (continued)

Site Number	Site Name	National Register Status	Site Description	Time Period
22-Ja-572	Winchester	Unknown	Large Marksville campsite	Middle Woodland
22-Ja-573	Blue Heron Bayou	Unknown	Camping area	Mississippian
22-Ja-590	Debbie T.	Unknown		Middle Woodland
22-Ja-591	Shepherds' Tree Farm	Unknown		Early Mississippian
22-Ja-591	Shepherds' Tree Farm	Unknown		Early Woodland
22-Ja-594	Porteaux Bay I	Ineligible		Mississippian: Early, Middle, Late
22-Ja-595	Point Ascot, Porteaux Bay II	Ineligible		Late Woodland
22-Ja-596	Porteaux Bay III	Ineligible		Historic: 19th century
22-Ja-597	Caldwell Home, Porteaux Bay IV	Ineligible		Middle Mississippian
22-Ja-598	Dundolph Home, Porteaux Bay V	Ineligible		Woodland: Middle, Late
22-Ja-599	Albert Tiblier	Ineligible		Historic
22-Ja-600	Bijou Tiblier Home, Porteaux #7	Ineligible		Woodland: Early, Middle
22-Ja-601	Scarbrough Saw Mill, Porteaux 8	Ineligible		Middle Woodland
22-Ja-602	Graveline Mound #2	Unknown	Large sand mound	Historic
22-Ja-602	Graveline Mound #2	Unknown	Large sand mound	Early Woodland
22-Ja-602	Graveline Mound #2	Unknown	Large sand mound	Late Archaic
22-Ja-610	Buena Vista	Ineligible		Middle Woodland
22-Ja-610	Buena Vista	Ineligible		Middle Mississippian
22-Ja-611	Swetman	Ineligible		Woodland
22-Ja-611	Swetman	Ineligible		Early Woodland
22-Ja-612	Marlin	Ineligible		Middle Woodland
22-Ja-619	Janice–Gulf Hills	Ineligible		Middle Mississippian
22-Ja-622	Tiblier	Ineligible		Late Woodland
22-Ja-623	Gulf Hills	Ineligible		Late Woodland
22-Ja-624	Riviera I –II	Ineligible		Late Woodland
22-Ja-626	Magnolia Bank, Four H Club	Unknown		Unknown Prehistoric
22-Ja-628	Eagle Point	Unknown	Buried remnant of Chenier-Bayou site	Unknown Prehistoric
22-Ja-629	Aunt Jennys	Eligible	Aunt Jenny's, Marksville Period campsite possible Marksville	Historic Indian: Early to Middle 18th century
22-Ja-629	Aunt Jennys	Eligible	Aunt Jenny's, Marksville Period campsite	Mississippian: Late
22-Ja-630	Stark Bayou I	Eligible		Mississippian: Middle, Late
22-Ja-635	Morning Site	Ineligible	Shell midden	Middle Mississippian

Table 2.2-3.
Archaeological Sites Within the Jackson County Project Area (continued)

Site Number	Site Name	National Register Status	Site Description	Time Period
22-Ja-636	Picnic Site	Ineligible	Oyster shell midden	Protohistoric
22-Ja-637	Hilltop Site	Ineligible		Late Woodland
22-Ja-638	Upper Crossing Site	Ineligible		Late Mississippian
22-Ja-638	Upper Crossing Site	Ineligible		Middle Woodland
22-Ja-639	Office Site	Ineligible		Unknown Prehistoric
22-Ja-640	Desk Site	Ineligible		Unknown Prehistoric
22-Ja-641	Second Chance Site	Ineligible		Unknown Prehistoric
22-Ja-642	West Bank Site	Unknown		Woodland
22-Ja-643	Old Ladder Site	Unknown	Oyster shell midden	Archaic: Early
22-Ja-646		Unknown	Shell midden	Historic: 19th century
22-Ja-647	Belle Fountain Beach	Unknown		Historic Indian
22-Ja-648	Y	Unknown		Woodland
22-Ja-649	Tapp Site	Unknown		Woodland: Middle, Late
22-Ja-650	Brown Street Site	Ineligible		Late Woodland
22-Ja-651	Stone II	Eligible	Intact midden present	Unknown Prehistoric
22-Ja-651	Stone II	Eligible	Intact midden present	Late Woodland
22-Ja-651	Stone II	Eligible	Intact midden present	Woodland
22-Ja-651	Stone II	Eligible	Intact midden present	Historic
22-Ja-652	Seymour Lane	Ineligible	Small Late Woodland site	Late Woodland
22-Ja-653	Britt, Cedar Point	Unknown		Woodland, Historic
22-Ja-653	Britt, Cedar Point	Unknown		Unknown Prehistoric
22-Ja-654	Tyler Site	Unknown		Unknown Prehistoric
22-Ja-655	Carluse Bayou	Unknown		Unknown Prehistoric
22-Ja-656	Bilbo	Ineligible		Historic
22-Ja-657		Unknown		Mississippian
22-Ja-658		Unknown		Woodland: Middle, Late
22-Ja-658		Unknown		Gulf Formational: Late
22-Ja-659		Unknown		Historic
22-Ja-660		Unknown		Woodland
22-Ja-660		Unknown		Archaic
22-Ja-662	Guis 107	Ineligible		Late Woodland
22-Ja-663	Guis 106	Unknown		Woodland
22-Ja-672	CCC Training Camp	Unknown		Woodland
22-Ja-673	Magnolia Park	Unknown		Woodland
22-Ja-673	Magnolia Park	Unknown		Mississippian
22-Ja-687	Cooking Ball Corner	Unknown		Mississippian
22-Ja-688	Mary Mahoney	Unknown	Rangia (clam) and oyster shell midden	Mississippian
22-Ja-689	Point Clear Pier	Unknown	Material apparently washing down from bluff	Woodland
22-Ja-689	Point Clear Pier	Unknown	Material apparently washing down from bluff	Unknown Prehistoric
22-Ja-695		Ineligible		Unknown Prehistoric
22-Ja-696		Ineligible		Late Archaic

Table 2.2-3.
Archaeological Sites Within the Jackson County Project Area (continued)

Site Number	Site Name	National Register Status	Site Description	Time Period
22-Ja-697		Ineligible		Middle Archaic
22-Ja-697		Ineligible		Unknown Prehistoric
22-Ja-698		Ineligible	Material from eroded slope	Unknown Prehistoric
22-Ja-704		Ineligible		Early Archaic
22-Ja-704		Ineligible		Unknown Prehistoric
22-Ja-707		Unknown		Unknown Prehistoric
22-Ja-707		Unknown		Unknown Prehistoric
22-Ja-715		Ineligible		Woodland: Middle, Late
22-Ja-716		Ineligible		Mississippian
22-Ja-723	Oak North	Unknown	Intact deposits possible	Woodland
22-Ja-725		Unknown		Woodland
22-Ja-726		Unknown	Midden exposed in road cuts	Woodland
22-Ja-726		Unknown	Midden exposed in road cuts	Woodland
22-Ja-727		Unknown	Midden exposed in road cuts	Unknown Prehistoric
22-Ja-727		Unknown	Midden exposed in road cuts	Unknown Prehistoric
22-Ja-727		Unknown	Midden exposed in road cuts	Woodland
22-Ja-729	Graveline West Mounds	Eligible	2 mounds	Unknown Prehistoric
22-Ja-730	Graveline East Mounds	Eligible	3 mounds	Unknown Prehistoric
22-Ja-733		Ineligible		Unknown Prehistoric
22-Ja-734		Ineligible		Unknown Prehistoric

Source: Mississippi SHPO, 2001.

2.2.1 Prehistoric Period Resources

Archaeologists divide the prehistoric occupation in the Coastal Mississippi region into six major periods: the Paleo-Indian Period, which began around 10,000 B.C.; the Archaic Period; the Gulf Formational Period; the Woodland Period (Middle and Late); and the Mississippian Period, which ended in colonial times (the 1600s). Most of the resources from prehistoric times have been found along the rivers, especially the river mouths, and on the barrier islands. It is worth noting, though, that most of the known sites were identified in surveys conducted at only limited locations and, therefore, their locations cannot predict exactly where other (currently unknown) sites might exist.

2.2.1.1 Paleo-Indian Period (circa [ca.] 10,000 B.C. to ca. 8,000 B.C.)

The Paleo-Indian Period is the period with the earliest evidence of humans' existence in the North America. The climate during this time period was cooler than our present environment, and large animals, such as mammoth and sloth, flourished. Paleo-Indian peoples were nomadic hunters and gatherers who lived in small groups and ate wild plants and animals. This period is distinguished by a low population density with groups residing in seasonal or base camps. As a result, Paleo-Indian sites are rare and usually very small. The Paleo-Indian Period is also noted for diagnostic fluted projectile points and the exploitation of Pleistocene megafauna. Some artifacts from this period have been recovered from the Mississippi Sound area (Pearce and Mikell 2000).

2.2.1.2 Archaic Period (ca. 8,000 B.C. to ca. 1,000 B.C.)

The Archaic Period is divided into three time frames: Early, Middle, and Late. Between 10,000 B.C. and 5,000 B.C. substantial ecological changes occurred across the North American continent. These changes were accompanied by a shift from Paleo-Indian to Archaic traditions. During the Archaic Period the cold, dry climate that had existed during the Paleo-Indian Period changed to a warmer and wetter one. Deciduous (leafy) forests gradually replaced coniferous (evergreen) forests. Mammals present included white-tailed deer, turkey, bear, and smaller mammals and birds. Groups responded to these changes; archaeological evidence shows an increasing use of the new forested environment. Stone axes and fishing paraphernalia appear in larger numbers.

During the Late Archaic Period, the ecology and climate became much the same as they are today. The sea level rose, and the climate became wetter than that of the previous period. These changes led to greater floral and faunal diversity, accompanied by an increase in human population in response to this rich environment. Late Archaic sites are more common as a result of this population increase. Settlement patterns reconstructed by archaeologists indicate that sites were located on terraces, ridges, and bluffs above bodies of water that included rivers, creeks, and swamps. Sites are also found at the edges of floodplains and marshes, where edible plants and animals existed in large numbers and species were diverse. Some sites might now be submerged. Late Archaic sites can also include remains of larger "base camps" and shell middens. The Pearl River phase has been defined for the Late Archaic Period (Pearce and Mikell 2000).

2.2.1.3 Gulf Formational Period (ca. 2,000 B.C. to ca. 100 B.C.)

This period is identified by the first appearance of fired ceramics along the Gulf Coast, as well as the earliest mound construction. Based on size and artifacts recovered, some of the sites from this period represent a sedentary, possibly permanent, society. Two sites at the mouth of the Pearl River, the Claiborne and Cedarland Plantation sites, have large Early Gulf Formational components. Reflecting the Late Gulf Formational Period, the larger sites were replaced by more numerous but smaller sites representing smaller villages as well as food collection sites such as shellfish collection camps. Evidence of domesticated plants, including squash and bottle gourd, has been recovered at some sites dating to this period.

2.2.1.4 Woodland Period—Middle and Late (ca. 100 B.C. to A.D. 1100)

The Woodland Period is represented in the project area by artifacts from the Middle and Late Woodland Periods. This period was similar to the Late Archaic Period in climate and ecology. Dramatic changes in social structure occurred at this time from somewhat egalitarian, nomadic hunter-gatherers who relied primarily on wild plants and animals, to more settled villagers who practiced agriculture. The remains of large villages reflect the change from nomadic to settled life. Burial mounds as well as evidence of far-flung trade networks have been identified for this period. Archaeological remains include the appearance of stockaded villages, ceramic pottery, storage pits and hearths, and small triangular stone projectile points. According to Pearce and Mikell (2000, p. 16), the sites "are clustered along major rivers and usually located on high bluffs above the rivers or along tributary creeks above the floodplain and on coastal high ground near a freshwater source. Coastal sites are usually located in hardwood hammocks. Burial mounds are present on some larger village sites and isolated Woodland burial mounds are also known . . . ."

2.2.1.5 Mississippian Period (ca. A.D. 1200 to A.D. 1600)

To date no artifacts or sites from the Early Mississippian Period phase have been identified in the project area. The Middle Mississippian Period has been identified for the Gulf Coast area. Artifacts include shell-, sand-, or grog- (crushed ceramic fragments) tempered pottery. (Tempering material is added to the clay during the manufacturing process to strengthen it when fired.) The groups living in the project area at this time were mainly hunters and gatherers along the coast and river valleys; they probably practiced horticulture as well. Sites, including the remains of small villages and camps, have been found along the coast and along the major rivers. Most of the sites in the region are coastal shell middens. Although the Mississippian Period was generally one of stratified societies with chiefdoms, evidence of those types of such large-scale settlements has not been found in the Coastal Study Area.

2.2.2 Historic Period Resources

The historic time periods are the Protohistoric Period and Historic Period, which date from colonial times (1600s) forward.

2.2.2.1 Protohistoric Period

The first contact between the American Indians that lived in the project area and Europeans occurred during the Protohistoric Period. The first European to arrive was most likely Don Diego Miruelo, who probably sailed into the Mississippi Sound in 1516. Spanish explorers, likely including Cabeza de Vaca and Panfilo de Narvaez, were in the region during the 16th century as well.

2.2.2.2 Historic Period

In the 17th century French explorers began to arrive in the region, and soon French settlers also arrived, cleared the land, and built settlements. Pierre LeMoyne, Sieur d'Iberville, established the first French settlement at Old Biloxi (now Ocean Springs) in 1699. In 1723, Biloxi became the capital of the French colony. With the Treaty of Paris in 1763, the French abandoned the Mississippi coast to the English; in 1779 the English ceded the coast to Spain. With the Louisiana Purchase in 1812 the area became part of the United States; Mississippi became a state in 1817. The cultural influence of early French settlers continued over the years; a local form of French was spoken in the area until just before World War II (Moreton 1998).

Historic American Indians who lived in the region included the Pascagoula, Biloxi, Moctobi, Capinan, and Mobile peoples. The Apalachee also lived along the Pearl River during the 17th century (Pearce and Mikell, 2000). The American Indians were decimated by disease and warfare associated with European contact, and by the 19th century very few remained in the region.

Early French settlements grew up around the waterways and developed into thriving port towns. The economy was centered on agriculture, including dairy, cattle, and poultry; timber harvesting (primarily yellow pine) and charcoal and tar production; sheep and wool production; and commercial fishing and oyster and shrimp processing (Hancock Bank 1982; Sullivan 1985). Tremendous oyster reefs lay offshore. In the mid-19th century the region also began to develop as a resort area. For example, Pass Christian was a summer retreat for plantation owners and wealthy citizens of Louisiana, Mississippi, and Alabama (Ellis 1998). Many people came to escape yellow fever. In addition, seafood factories became a mainstay of the area. The area's seafood industry continues to be important, although it has experienced a significant decline in recent years (Ellis 1998).

During the Civil War the area's economy suffered because of the Federal blockade of southern ports. After the war, however, a number of transportation improvements were instituted. The New

Orleans, Mobile & Chattanooga Railroad was constructed through the project area. With the railroad, truck farming expanded and farmers prospered through the early part of the 20th century (Alexander 1998). A deep-water channel was completed at Gulfport in 1902 (Sullivan 1985). The seafood industry was also stimulated by post-Civil War innovations in preserving and exporting seafood. As a result, the shrimping industry boomed (Hancock Bank 1982). The region's lumbering business also thrived during this period. These traditional businesses continued into the present.

One nontraditional business that developed during the 1920s and continued through the Great Depression was bootlegging [Mississippi Department of Marine Resources (MDMR) 1998]. Bootlegging grew in part because those out of work during the Depression turned to this means of supporting their families. Liquor was made in stills in isolated areas along the coast and sold locally or to bootleggers that brought the alcohol up the coast and to the west (for example, deliveries to Chicago by truck and rail). In addition to the locally made alcohol, rumrunners smuggled alcohol, including rum, from Cuba and other Caribbean ports. According to M.H. Powell (1998), "by the mid-1920s more illegal alcohol entered the United States through the Gulf Coast than any other point of entry, including Canada." Along with the bootlegging, gambling casinos were built—in 1939, for example, the Broadwater Beach Hotel was constructed in Biloxi to accommodate gamblers. These hotels were the forerunners of today's coastal casinos and hotels.

2.2.3 Historic Architectural Resources

Numerous historic architectural resources are present in the project area. To date 62 standing structures, 14 historic districts, and one ship have been listed on the NRHP. Historic districts have been designated in Biloxi, Ocean Springs, and Bay St. Louis. Table 2.2.3-1 lists these resources and their locations.

Table 2.2.3-1.
NRHP Standing Structures and Historic Districts

Name	Address	Date Listed on NRHP	Description	Location / Multiple Listing Name	UTM Coordinates (Zone 16)
Hewes Building	2505 14th Street	10/7/1982		Gulfport	E298840 N3361212
Bailey House	1333 East Beach Blvd.	5/18/1984		Biloxi MRA	E321040 N3363630
E. Barq Pop Factory	224 Keller Ave.	5/18/1984		Biloxi MRA	E319590 N3363970
Biloxi's Tivoli Hotel	863 East Beach Dr.	5/18/1984		Biloxi MRA	E319980 N3363750
Bond House	925 West Howard Ave.	5/18/1984		Biloxi MRA	E318060 N3364110
Brunet-Fourchy House	138 Magnolia Street Mall	5/18/1984		Biloxi MRA	E318580 N3363805
Church of the Redeemer	Bellman Street	5/18/1984		Biloxi MRA	E319205 N3363725
Clemens House	120 West Water Street	5/18/1984		Biloxi MRA	E318650 N3363825
Gulf Coast Center for the Arts	138 Lameuse Street	5/18/1984		Biloxi MRA	E318740 N3363790

Table 2.2.3-1.
NRHP Standing Structures and Historic Districts (continued)

Name	Address	Date Listed on NRHP	Description	Location / Multiple Listing Name	UTM Coordinates (Zone 16)
House at 121 West Water Street	121 West Water Street	5/18/1984		Biloxi MRA	E318635 N3363800
Nativity BVM Cathedral	West Howard Ave. and Fayard Street	5/18/1984		Biloxi MRA	E318310 N3364120
Peoples Bank of Biloxi	318 Lameuse Street	5/18/1984		Biloxi MRA	E318740 N3363980
Redding House	126 West Jackson Street	5/18/1984		Biloxi MRA	E318640 N3363950
Saenger Theater	416 Reynoir Street	5/18/1984		Biloxi MRA	E318420 N3364100
Scherer House	206 West Water Street	5/18/1984		Biloxi MRA	E318600 N3363850
Seashore Campground School	Leggett Dr. and Chalmers Street	5/18/1984		Biloxi MRA	E315540 N3363990
Suter House	165 Suter Pl.	5/18/1984		Biloxi MRA	E317580 N3364140
Glenn Swetman House	2770 Wilkes Ave.	5/18/1984		Biloxi MRA	E314340 N3363990
U.S. Post Office and Customhouse	2421 13th Street	3/19/1984	Second Renaissance Revival	Gulfport	E298910 N3361080
Beauvoir	200 West Beach Blvd.	9/3/1971	Raised cottage	Biloxi	E310470 N3364271
Harbor Square Historic District	Roughly bounded by L & N Railroad, 23rd Ave., 13th Street, and 27th Ave.	8/13/1985	Georgian Revival	Gulfport	E299130 N3361430
West Beach Historic District	Roughly U.S. 90 between Rosell and Chalmers Ave.	5/18/1984		Biloxi MRA	E317300 N336428
Fort Massachusetts	South of Gulfport on Ship Island, in Gulf Islands National Seashore	6/21/1971		Gulfport	E309633
Louisville and Nashville Railroad Depot at Ocean Springs	1000 Washington Ave.	12/31/1979	Picturesque Eclecticism	Ocean Springs	E324520 N3366030
Biloxi Lighthouse	On U.S. 90 at Porter Ave.	10/3/1973		Biloxi	E317350 N3363815
U.S. Post Office, Court house, and Custom house	216 Lameuse Street	1/30/1978		Biloxi	E318850 N3364000

Table 2.2.3-1.
NRHP Standing Structures and Historic Districts (continued)

Name	Address	Date Listed on NRHP	Description	Location / Multiple Listing Name	UTM Coordinates (Zone 16)
Magnolia Hotel	137 Magnolia Street	3/14/1973		Biloxi	E318499 N3363826
Biloxi Garden Center	410 East Bayview Ave.	1/18/1973		Biloxi	E319145 N3365756
Beach Boulevard Historic District	Roughly bounded by Beach Blvd., Necaise Ave., Seminary Dr., 2nd and 3rd Streets	11/25/1980	Creole; shotgun	Bay St. Louis MRA	E276620 N3357610
Main Street Historic District	Main Street	11/25/1980	Creole; shotgun	Bay St. Louis MRA	E274660 N3355910
Sycamore Street Historic District	Sycamore Street	11/25/1980	Creole; shotgun	Bay St. Louis MRA	E274580 N3355140
W.J. Quarles House and Cottage	120 and 122 East Railroad Street	10/16/1980		Long Beach	E293260 N3359470
Scenic Drive Historic District	Scenic Drive	5/7/1979		Pass Christian	E280840 N3354730
Washington Street Historic District	Washington Street	11/25/1980	Creole; shotgun	Bay St. Louis MRA	E274820 N3354920
Toledano-Philbrick-Tullis House	947 East Beach Blvd.	11/5/1976		Biloxi	E320310 N3363660
Milner House	720 East Beach Blvd.	7/31/1972		Gulfport	E301643 N3361965
Gillis House	513 East Beach Blvd.	7/7/1978	French Colonial	Biloxi	E319270 N3363730
Taylor House	808 North Beach Blvd.	11/21/1986		Bay St. Louis MRA	E275910 N3357170
Glen Oak-Kimbrough House	806 North Beach Blvd.	11/21/1986		Bay St. Louis MRA	E275920 N3357130
House at 407 East Howard Avenue	407 East Howard Ave.	7/17/1986			E319100 N3363980
Webb School/Gulf Coast Community Action Agency	300 Third Street	11/21/1986		Bay St. Louis MRA	E275100 N3354620
Taylor School	116 Leonard Street	1/15/1987		Bay St. Louis MRA	E275660 N3357520
Building at 242 St. and Charles Street	242 Street and Charles Street	11/25/1980		Bay St. Louis MRA	E274670 N3354500
Carter-Callaway House	916 State Street	4/20/1987		Ocean Springs MRA	E324810 N3365850

Table 2.2.3-1.
NRHP Standing Structures and Historic Districts (continued)

Name	Address	Date Listed on NRHP	Description	Location / Multiple Listing Name	UTM Coordinates (Zone 16)
Cochran-Cassanova House	9000 Robinson Street	4/20/1987		Ocean Springs MRA	E324390 N3365870
Hansen-Dickey House	108 Shearwater Dr.	4/20/1987	Prairie Renaissance	Ocean Springs MRA	E325090 N3364460
House at 1112 Bowen Avenue	1112 Bowen Ave.	4/20/1987		Ocean Springs MRA	E324620 N3365610
House at 1410 Bowen Avenue	1410 Bowen Ave.	4/20/1987		Ocean Springs MRA	E324910 N3364570
Thomas Isaac Keys House	1017 DeSoto Ave.	4/20/1987		Ocean Springs MRA	E324630 N3365790
O'Keefe-Clark Boarding House	2122 Government Street	4/20/1987		Ocean Springs MRA	E325815 N3365660
Old Farmers and Merchants State Bank	998 Washington Ave.	4/20/1987		Ocean Springs MRA	E324440 N3365870
Vancleave Cottage	1302 Government Street	4/20/1987		Ocean Springs MRA	E324770 N3365700
Sullivan-Charnley Historic District	Shearwater Dr. and Holcomb Blvd.	4/20/1987		Ocean Springs MRA	E326095 N3364000
Hermann House	523 East Beach Blvd.	5/18/1984		Biloxi MRA	E319340 N3363740
Pleasant Reed House	928 Elmer Street	1/11/1979	Shotgun house	Biloxi	E318940 N3364820
Saint John's Episcopal Church	NW corner of Rayburn and Porter Ave.	4/20/1987		Ocean Springs MRA	E324090 N3365600
Indian Springs Historic District	Iberville Street, Church Street, and Washington Ave. ,N	4/20/1987		Ocean Springs MRA	E324460 N3366460
Lover's Lane Historic District	Lover's Lane	6/9/1987		Ocean Springs MRA	E322980 N3366520
Bertuccini House and Barbershop	619-619A Washington Ave.	6/9/1987		Ocean Springs MRA	E324420 N3365590
Marble Springs Historic District	Along Iberville Ave., between Washington Ave., N, and Sunset Ave.	4/20/1987		Ocean Springs MRA	E324760 N3366610
Miss La-Bama	243 Front Beach Dr.	4/20/1987		Ocean Springs MRA	E323580 N3365123
Elmwood Manor	902 North Beach Blvd.	11/21/1986	French Colonial	Bay St. Louis MRA	E275850 N3357610
Delcastle	4010 Government Street	4/20/1987	Spanish Eclectic	Ocean Springs MRA	E329270 N3364070

Table 2.2.3-1.
NRHP Standing Structures and Historic Districts (continued)

Name	Address	Date Listed on NRHP	Description	Location / Multiple Listing Name	UTM Coordinates (Zone 16)
Halstead Place	East Beach Dr.	4/20/1987		Ocean Springs MRA	E3 26970 N3363590
Shearwater Historic District	Shearwater Dr.	8/24/1989		Anderson, Walter, MPS	E325090 N3364880
Ocean Springs Community Center	Washington Ave.	8/24/1989		Anderson, Walter, MPS	E324460 N3365520
Old Ocean Springs Historic District	Roughly bounded by Porter and Dewey Aves., Front Beach Dr., Martin Ave., Cleveland Street, and Rayburn Ave.	10/7/1987		Ocean Springs MRA	E324310 N3365660
Margaret Emilie (schooner)	1036 Fred Haise Blvd.	5/30/1989			E317352 N3363876
G.B. Dantzler House	1238 East Beach Blvd.	12/1/1989		Biloxi	E300765 N3361650
Fisherman's Cottage	138 Lameuse St reet	3/9/1990	Creole Cottage	Biloxi MRA	E319190 N3365730
Old Ocean Springs High School	Magnolia and Government Street	8/2/1990	English Renaissance	Ocean Springs MRA	E325140 N3365660
Col. Alfred E. Lewis House	1901 Watersedge Dr.	10/16/1980		Walter Anderson MPS (AD) (Gautier)	E342400 N3359700
James Krebs House	4702 River Rd.	12/20/1991		Pascagoula MPS	E331575 N3361775
French Warehouse Site	Gulf Islands National Seashore	12/13/1991		Ocean Springs	E318150 N3346300
Brielmaier House	710 Beach Blvd.	9/28/1995		Biloxi MRA	E318830 N3363670
Onward Oaks	972 South Beach Blvd.	11/1/1996	Creole Cottage	Bay St. Louis MRA	E274730 N3353690
West Central Historic District	Roughly bounded by U.S. 90, Hopkins Blvd., Howard and Benachi Aves.	5/18/1984		Biloxi MRA	E317960 N3364195

Notes: MRA = multiple-resource area, a term used before 1984, when it was replaced with MPS.
MPS = multiple-property submission
Walter Anderson MPS = Walter Inglis Anderson (1903–1965) was a well-known artist who lived in the project area.
UTM = universal transverse mercator spatial coordinate system, serves to locate a place exactly in the world
Source: Mississippi SHPO, 2001.

2.2.4 Underwater Resources

Underwater resources in the project area include remains of prehistoric sites and of Protohistoric and Historic Period shipwrecks. To date, at least 13 shipwreck sites have been identified along the coast. One, the wreck of the *Josephine*, is listed on the NRHP. The others are potentially eligible for listing. Shipwrecks in the Coastal Study Area could date from the colonial period (French, Spanish, and English) through the Civil War and into the early 20th century (McGahey, personal communication, 2001).

2.3 Previous Cultural Resources Work Along the Mississippi Gulf Coast

Several cultural resource surveys have been conducted in the past for a variety of projects in the study area as summarized below.

In 1980, a survey was conducted for the route of proposed Interstate Highway 110, to be located between Chartres Street, Biloxi, and U.S. Highway 90, in Harrison County. No potentially significant cultural resources were identified in that project area (Hyatt 1980).

In 1987, a 75-mile-long cultural resources survey was conducted along a route paralleling the southern boundary of Interstate-10, across Hancock, Harrison, and Jackson counties (Lauro 1987 and Sims 1999). No cultural resources were identified.

In 1998, a reconnaissance-level survey of seven submerged vessels found in the Biloxi and Tchoutacabouffa Rivers, Harrison County, was conducted (Sims 1999).

In 1998, a cultural resources survey was conducted in the project area of the proposed Broadwater Beach Resort Complex, in Biloxi, Harrison County (Lauro 1998; U.S. Army Corps of Engineers, Mobile District 2000). The survey found no archaeological sites in the project area, in part because of extensive disturbance associated with previous construction, including offshore dredging projects. The survey identified four standing structures within the viewshed of the Broadwater Complex project area: Beauvoir, the last home of Jefferson Davis; the Southern Memorial Park Cemetery; the Broadwater Beach Hotel, constructed in 1937 and greatly altered since then; and the Old Brick House, a historic home constructed in about 1850. The Old Brick House and Beauvoir are listed on the NRHP; Beauvoir is also a National Historic Landmark.

The Mississippi Gulf Coast Research Project, conducted a survey in the eastern portion of Harrison County and in all of coastal Jackson County south of Interstate-10 (Mann 2000).

In 1999, a Phase I cultural resources survey was completed for five alternative routes proposed for the East Harrison County Connector (Mann 2000). The proposed routes are located in the current project area and run roughly north-south from Interstate-10 to Highway-90. Existing cultural resources site files were examined, and a total of about 22.4 miles were surveyed. The review of the site files identified a total of nine archaeological sites within 1 mile of the proposed alternative routes. Shovel tests were conducted at 30.48-meter intervals along the alternate routes; in areas with well-drained soils adjacent to flowing water, the spacing was 15 meters. Shovel tests were also conducted at 30-meter intervals along the centerline of each of the five routes. Structures identified in this survey include the Veterans Administration Center, which is eligible for the NRHP. The remaining structures were recommended as ineligible. Three new prehistoric archaeological sites (22-Hr-881, 22-Hr-882, and 22-Hr-883) and two isolated artifacts were identified within the alternative routes.

Finally, in 2000 a Phase IA survey (background/literature search, site file check) was conducted for a proposed fiber-optic line to run through Hancock, Harrison, and Jackson Counties (Pearce and Mikell, 2000). All together, 99 sites, including prehistoric shell middens, submerged vessels, and historic cemeteries were identified within a one-mile radius of that project area during the archival research. Six of the sites were adjacent to or within the cable corridor: 22-Ha-586, 22-Ha-527, 22-Hr-

524, 22-Ja-568, 22-Ja-586, and 22-Ja-608. Site 22-Ja-608 was ineligible. Information for 22-Ha-586 is missing. Site 22-Ha-586 is located near the Pearl River in a high-probability area. In a previous study, the remaining sites did not yield any cultural material. (The consultant completed a Phase I cultural resource excavation survey). Two high-probability areas were identified and one site was identified. One site was recommended as ineligible for NRHP listing. Site Ha-527 was identified as a Mississippian Period shell mound.

CHAPTER 3. EARLY DAMAGE ASSESSMENT EFFORTS FOLLOWING HURRICANE SEASON OF 2005

Cultural building and site assessments began almost immediately after the storm in early September 2005. The NPS and the Mississippi Department of Archives and History have led efforts in damage assessments to cultural properties and still have much work ahead of them. Additionally, the Mississippi Heritage Trust, and the National Trust for Historic Preservation have been working closely with assessment teams. The National Center for Preservation Training and Technology (NCPTT), a branch of the NPS, developed a series of checklists designed to be used by Federal Emergency Management Agency (FEMA) volunteers and professional preservationists to compile uniform data on the post-storm condition of cultural properties. The checklists, known as a "Rapid Building and Site Condition Assessment" and a "Detailed Building and Site Condition Assessment" incorporate information including the property description, potential safety hazards that would prevent someone from getting near the property, basic evaluations of structural integrity or the presence of exposed archaeological material, recommendations, and graphs for a field sketch of the site. These forms made it possible for a task force to gather enough data to create an initial status report for Hancock, Harrison, and Jackson counties as well as several other counties to the north. Although the report released by the NPS Task Force is general in nature, the extreme extent of the damage recorded is readily noticeable (Table 3-1). Most efforts have been directed at studying the architectural rather than archaeological resources, but the amount of damage suffered by both types is staggering. The efforts documented in Table 3-1 below are some of the earliest accounts, and much more work remains to be done to fully account for and assess the damage sustained to Mississippi's coastal cultural properties.

Table 3-1.
General Cultural Property Assessment for the Mississippi Coast
(NPS Status Report 30 December 2005)

State of Mississippi	Institution or Site	Status
Hancock County		
Bay St. Louis	Multiple properties	Two of 5 National Register Districts destroyed. 90% of remaining properties that were assessed are judged salvageable.
Harrison County		
Biloxi	Beauvoir, The Jefferson Davis Home and Presidential Library	Home: Aerial photo shows holes torn in slate roof and galleries (porches) missing. Library: Built to withstand category 5 hurricane; first floor washed out by storm surge. Portraits salvaged after event additional recovery of artifacts begun. Archeologist assisting in recovering artifacts from debris scattered over 60-acre site. Historic library pavilion, Hayes cottage, Soldier's Home Barracks replica, Confederate Soldier's Museum, Giftshop, and director's home destroyed. Replicas of destroyed buildings will be built after restoration of Beauvoir and Presidential Library. Sewage contamination to pond behind Beauvoir to be addressed (as of 11/14).
Biloxi	Breilmaier House (c. 1895)	Destroyed.
Biloxi	Biloxi Cemetery	Many trees uprooted; markers broken.
Biloxi	Dantzler House	Destroyed.
Biloxi	Maritime and Seafood	A portion of the building remains. Some artifacts salvaged,

State of Mississippi	Institution or Site	Status
	Industry Museum	including lens from Ship Island lighthouse.
Biloxi	Ohr-O'Keefe Museum of Art	Aerial photo shows two of five buildings in new museum complex left (JLH). Pleasant Reed House destroyed (DP).
Biloxi	Tullis-Toledano Manor	Aerial photo shows Tullis-Toledano House (c. 1860) destroyed (under the displaced casino barge); Tullis Slave Quarters (c. 1860) destroyed; Crawford House (c. 1850) destroyed
East Ship Island	Gulf Islands National Seashore, French Warehouse and associated cemetery, Quarantine Station	Quarantine Station site submerged, under 5-6 feet of water; French Warehouse site and cemetery sustained damage but are accessible.
Jackson County		
Ocean Springs	Gulf Coast Research Laboratory	Coast Guard permitted access to collections on 9/15/05. Collections flooded. NPS Incident Management Team assisting with recovery of herbarium and hazardous tree and debris removal.
Ocean Springs	Gulf Islands National Seashore	Storm surge flooded exhibits and museum collections at Davis Bayou Visitor Center. Museum Emergency Response Team is stabilizing collections. Collections moved to NPS Southeast Archeological Center and Timucuan Ecological and Historic Preserve. Frozen archives to be shipped and treated off-site. See report for Gulf Coast Research Laboratory where some park herbarium specimens are stored.
Ocean Springs	Shearwater	Most of the work of Anderson Family potters destroyed; 12 of 15 buildings destroyed
West Ship Island	Gulf Islands National Seashore Ft. Massachusetts; reconstructed Ship Island Lighthouse	Storm surge flooded and damaged fort: earthen berm damaged, large granite blocks dislodged and in moat, interior filled with mud and debris several inches thick. Most of the mud removed by 10/13/05. Extent of damage to Rodman cannon, artifacts and exhibits unknown. Conservator visit scheduled. Reconstructed lighthouse destroyed. Archeologist surveyed 9/19. Parts of the fort's rampart were breached by storm surge. Domed surface of casements exposed when earthen berm removed by storm. Sally Port damaged, extensive beach erosion. Cannon carriage flooded by salt water, but not cannon. Brick foundation and scattered brick, probably associated with archeological remains of lighthouse, identified.

3.1 Expected Impacts to Resources

Once a full assessment of damage is complete, we can expect to see the destructive impacts to cultural properties caused by Hurricane Katrina to fall under two categories: direct and indirect. Direct impacts should include damage directly caused during the storm by surging water, wind and flying debris, while indirect impacts would be those caused largely by the effects of standing water, exposure to the elements, or mold and decay due to water saturation. These impacts will differ slightly between archaeological and architectural resources.

3.1.1 Direct Impacts

Properties directly in the path of the storm surge appear to have suffered the most damage. Many of the historic homes and mansions that lined the shoreline highways were completely demolished. Some of the more well known historic properties along Beach Boulevard in Biloxi that are now completely gone include the Dantzler House, the Breilmaier House, the Pleasant Reed House, and the Tullis-Toledano mansion.

The Dantzler House lay in splinters behind the bronze statue of Pierre Le Moyne d'Iberville. The Breilmaier House, built in 1895, was reported missing and may have been sighted "floating down the street during the storm" (Williams 2005). The only remaining evidence of the Pleasant Reed House, a shotgun style house built in 1887, is the chimney (ibid). Also, the Tullis-Toledano mansion was found flattened under a casino barge (ibid). Reassuringly, the Beauvoir Mansion, Jefferson Davis's home designated as a National Historic Landmark is substantially damaged, but the main portion of the house remains standing. The first floor of the presidential library is destroyed as well as several cottages on the grounds, but many of the most valuable artifacts were removed prior to Katrina's landfall and survive. Additionally, because of Beauvoir's status as a National Historic Landmark, funds will be set aside eventually for its refurbishment.

Because archaeological sites are unique resources in that they cannot be recreated or restored, the damage many have sustained is irreparable. Several have had huge chunks gouged out by wayward fishing vessels beached on top of the remains of ancient American Indian coastal settlements. Wave scour, and giant uprooted trees have cleared 2,000 year old mounds immediately along the coastline of vegetation and exposed them for further erosion and looting. Shipwrecks that were once buried under several feet of sand have been exposed, and will suffer accelerated degradation as the wooden hull timbers dry into dust. The full extent of the loss is yet to be fully documented, and the work and funding required to salvage any remaining information is yet to be fully estimated.

3.1.2 Indirect Impacts

Archaeological resources where most of the resources lie below the ground or on the ground surface can be expected to suffer indirect effects from exposure of materials to sunlight that previously were kept in the dark moist earth. Materials, such as bone, oxidized metal, and organic remains, will dry and become brittle or may disintegrate. Also, the loss of vegetation that once held a site in place and obscured artifacts from view will cause site erosion. Other issues will occur as a result of materials becoming exposed that may be attractive to looters. Alternately, archaeological resources close to the shore that were on dry ground before the storm may now be permanently inundated, or in a surf zone and subject to constant erosion by sand and tidal action. Conversely, architectural resources where most of the resource lies above the ground can be expected to suffer from mold and mildew, and the rotting of wood and other materials. Additionally, sunlight and air can access portions of the structure and allow vegetation to take over and cause damage with the roots. Wood and cellulose eating insects will cause a loss of structural integrity and irreversible damage to furnishings that otherwise made it through the storm intact. As with archaeological resources, the threat of theft is present when objects of value are exposed to the outside or left unattended.

CHAPTER 4. MSCIP COMPREHENSIVE EFFORT RECOMMENDED PROJECTS

The Corps, Mobile District has a responsibility under the NHPA Section 106 process, to consider the effects that projects may have on Historic Properties [sites eligible for or listed on the NRHP]. The process involves a number of steps which include: establishing an undertaking has the potential to cause effects to historic properties; determination of the projects APE; determination of interested and consulting parties; creation of inventory strategy; completion of inventory (identification of cultural resources); identification of property NRHP eligibility; determination of effects; consultation; avoidance strategies (if needed); and resolution of adverse effects (if required).

As such, the Corps has been working to comply with Section 106 and its implementing regulations at 36 CFR 800 while moving forward with the mission of MsCIP. Initial plans as outlined for coastal recovery included a number of very large, complex projects. These projects, including ring levees, flood walls, and other massive civil works efforts, which would have involved huge impact areas and multiple state and Federal agencies. As such, the Corps recommended pursuing a Programmatic Agreement (PA) as an alternative method to Subpart B of 36CFR800, as outlined in 36CFR800.14(b). This would have allowed for greater involvement of interested parties and a streamlined process for compliance with NHPA. However, after consultation with the Mississippi SHPO and interested tribes (Mississippi Band of Choctaw Indians have responded to date), it was requested that the idea of approaching cultural compliance through the use of a PA be dropped for the MSCIP program.

There were two primary reasons for the dropping of the PA approach. First, the nature of the projects has become less complex from a cultural compliance standpoint than was first envisioned. Therefore, the PA approach was thought to be "overkill" for the most likely actions that would be approved for construction. Second, both the SHPO representatives and the tribal representatives expressed a reluctance to pursue a PA due to what they described as "PA overload". It was the thought of the participants that pursuing compliance on a project by project basis would be the most efficient and economical way to handle the program.

A list of those projects for which funding and authorization have been requested is provided below. Details of the plans for each project are available in Chapter 5 of the Environmental Appendix and in the Main report, in Chapter 4. Should funding be approved, these projects would be the first to be constructed. The list does not include all of the possible plans, since all of the possible plans have not been identified.

MsCIP Projects currently proposed or awaiting funding:

- Turkey Creek Environmental Restoration
- Bayou Cumbest Environmental Restoration
- Franklin Creek Environmental Restoration
- Coast-wide Beach/Dune
- Forrest Heights Levee
- Moss Point Municipal Relocation
- Admiral Island Ecosystem Restoration
- Barrier Island Restoration

- Deer Island Ecosystem Restoration
- HARP Buyout
- Waveland Flood proofing
- Mississippi Sound Sub-aquatic Vegetation (SAV) Restoration
- Violet Louisiana Freshwater Diversion

To date, since none of the listed projects has been fully authorized and funded, only preliminary cultural resources compliance work has taken place. This includes meeting with the Mississippi SHPO staff, with FEMA, and with some of the cultural resource consultants that are currently working on non-Corps recovery efforts on the coast. Discussions included the determination of APE, inventory strategy, and preferred consultation method. The Mississippi SHPO staff expressed concern that many of the current efforts the Corps, Mobile District is working on appear similar to those being worked on by other agencies from a cultural resource aspect. In the aftermath of the storm, a number of Federal agencies and federally funded state agencies have been conducting and proposing to conduct activities that have the potential to effect historic properties. As such, these agencies have been conducting cultural resources compliance work and are planning more work, in order to deal with their legal responsibilities. Agencies involved include, but are not limited to, the Corps (New Orleans District, Mobile District and Vicksburg District), FEMA, Coast Guard, MMS, HUD and the Mississippi Development Authority. In many cases, there is the potential for a "duplication" of efforts, such as creation of cultural histories; historical documentation scanning; creation of GIS data layers for archaeological sites, standing structures, monuments, cemeteries, etc.; inventory for cultural resources; site testing and evaluation of cultural properties; and consultation. As a proactive measure to reduce duplication, the Mobile District will continue coordination with these agencies on the proposed projects.

In addition to meeting with the SHPO and other agencies, the Corps, Mobile District has conducted a literature review for all the project locations. This includes the gathering of base line historic and archaeological information of the proposed above project sites. This could best be described in the BLM terminology as a "Class I survey" or as it is also called, a background search. This includes viewing local histories, historic maps, and gray literature for the project areas. Also checked were the state archaeological and architectural data bases. State site location and survey maps were checked. Previous surveys conducted in the areas were reviewed. Informal discussions were held with local informants as well.

As projects become authorized and funded, the Corps will proceed with Section 106 consultation. Project APE's will be formally identified. Through consultation, inventory strategies will be outlined. The resulting inventory work will identify potential historic properties. Determination of NRHP eligibility and project effects to historic properties will be made. Consultation with the SHPO and other agencies and interested tribes will be continued. Should historic properties be identified within the project APE, avoidance will be the preferred mitigation measure. Should avoidance not be possible, resolution of potential adverse effects to historic properties will be handled as outlined in 36CFR800. This will include requiring the signing of a Memorandum of Agreement, notification of Adverse Effect to historic properties, offering the Advisory Council on Historic Preservation an opportunity to participate in the process, and possibly archaeological mitigation or historic documentation.

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1.3 Impact Analysis of Alternatives Not Being Considered in Main Report

Contents

CHAPTER 1 ENVIRONMENTAL EFFECTS

The environmental effects section in the MsCIP Comprehensive Main Report/Integrated EIS provides an evaluation of proposed projects being recommended for construction or advanced engineering and design and their effects to the environment. The environmental effects analysis is conducted on two different levels which include an evaluation of the overall Comprehensive Plan and its components that require further study before being recommended for construction in the future. The second level of analysis considers effects of specific projects being recommended for construction and/or advanced engineering and design. Due to this complex nature, the projects screened out early during the plan formulation process are addressed for their environmental impacts in this attachment of the Environmental Appendix.

Hurricane Katrina caused tremendous damage to the overall natural environment within coastal Mississippi as documented in Chapter 2, Effected Environment Section in the MsCIP Comprehensive Main Report/Integrated EIS. The extent of the damage to many resources is still unknown and additional research, studies, surveys, etc, are ongoing. In some instances, the extent of damaged resources may never be known.

Many measures that may be recommended in the Comprehensive Plan have been categorized in either structural, non-structural, or environmental restoration types of projects; however, further study is needed in order to assess benefits, effects, and to obtain specific details needed for development of plans. Numerous projects have been developed to a feasibility-type level and are being recommended for construction although some will need advanced engineering and design prior to development of plans and specifications. Still other measures will establish a framework within which future projects have been identified under continuing authorities that would require specific Project Information Reports after development of plans and specifications.

As a result of the diversity of potential projects that have come forth from this Comprehensive Report, further environmental considerations and analyses will be required prior to projects being implemented. There could be supplemental EISs to evaluate projects that would result in significant impacts and further EAs for projects that are less complex in nature with less impacts associated with them. During development of NEPA documentation, detailed discussions of potential impacts and subsequent mitigation will be incorporated as measures and alternatives are being developed.

Provisions for "tiering" of EISs are found in 40 CFR 1502.20 whenever a broad EIS has been prepared (such as a program or policy statement) and a subsequent statement or EA would then be prepared on an action included within the entire program or policy. This EIS will serve as the basis from which further required environmental analyses and documentation could be tiered from. Additionally, the projects being recommended for construction or for advanced engineering and design will be evaluated for environmental impacts as part of this integrated EIS. These impacts are discussed in the following sections and paragraphs.

Due to the complexity of this comprehensive project for coastal Mississippi, the measures and alternatives that were screened out during the plan formulation effort have been included in the following information. This was done in order to allow the reader an easier path forward in this complex recovery approach of coastal Mississippi.

CHAPTER 2 BARRIER ISLAND ANALYSIS

2.1 Soils

Soils would persist as they are today.

2.2 Sediments

Re-suspension of sediments would likely occur within specific project sites. Silt fences and other BMPs would be used to minimize the adverse impacts to the environment during construction activities to the maximum extent practicable. Containment structures, silt curtains, and other BMPs would be used to contain sediment deposition at restoration sites. It is expected that solids that remain suspended in the water column would migrate by littoral drift. Any impacts that might occur would typically be isolated to each construction site, minor and of short duration.

2.3 Geology

There should be no effects to geology. Potential projects have been or would be designed to avoid impacts to current geological formations.

2.4 Climate

There should be no effects to the existing climate.

2.5 Air Quality

Currently all areas within coastal Mississippi are in attainment with the NAAQS. Air quality in the immediate vicinity of project construction would be slightly affected for a period of time by the fuel combustion and resulting engine exhausts. The standards would not be violated by the implementation of the proposed project.

2.6 Noise

Noise from the construction type equipment is expected to increase during the proposed operations in the project vicinities. Noise levels will resume to existing conditions as construction activities are completed. It is anticipated there would be no significant impacts to noise during implementation of these measures.

2.7 Vegetation

2.7.1 Line of Defense 1 – Barrier Island Restoration

Several measures have been developed which would allow for storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife habitats, and prevention of coastal erosion. Restoration of the barrier islands could provide a benefit to vegetation.

2.7.1.1 Option A: Restore Island Footprint

It is anticipated there would be no adverse impacts to vegetation from implementation of this measure because this would consist of open-water habitat to expand the actual islands' footprint. In fact, restoring the islands to historical footprints would provide a benefit to the existing vegetation already on the island due to it providing additional habitat for colonization.

2.7.1.2 Option B: Replenish Sand in Littoral Zone, Inland Source

It is anticipated there would be no impacts to vegetation from implementation of this measure. Addition of land to the barrier islands would provide a positive benefit to the vegetation through natural colonization.

2.7.1.3 Option C: Replenish Sand in Littoral Zone, Offshore Source

It is anticipated there would be no impacts to vegetation from implementation of this measure. Addition of land to the barrier islands would provide a positive benefit to the vegetation through natural colonization.

2.7.1.4 Option D: Environmental Restoration With 2-Foot Dune

This measure would involve environmental restoration of the barrier islands consisting of shaping existing sand into dunes on the beaches. Dune features would be planted with native vegetation. Planting of marshes, maritime forests, and sea grasses in the near-shore areas of the islands would serve to restore or enhance lost habitat. Implementation of this measure would provide significant benefits to the existing damaged vegetation as a result of the hurricanes of 2005. Further studies during project development would determine the specific benefits gained by implementation of this measure.

2.7.1.5 Option E: Environmental Restoration With 6-Foot Dune

This measure would involve environmental restoration of the barrier islands consisting of shaping existing sand into dunes on the beaches. Dune features would be planted with native vegetation. Planting of marshes, maritime forests, and sea grasses in the near-shore areas of the islands would serve to restore or enhance lost habitat. Implementation of this measure would provide significant benefits to the existing damaged vegetation as a result of the hurricanes of 2005. Further studies during project development would determine the specific benefits gained by implementation of this measure.

2.7.1.6 Option F: Environmental Restoration of Sea Grass Beds

This measure would involve enhancement and restoration of historical sea grasses located in Mississippi Sound. Implementation of this measure would provide significant benefits to the existing vegetation that has suffered as a result of the hurricanes of 2005. Further studies during project development would determine the specific benefits gained by implementation of this measure.

2.7.1.7 Option G: Restoration of Ship Island Breach

Implementation of this measure would provide a benefit to vegetation as a result of reforestation of the beach and dune system that once existed.

2.8 Fish and Wildlife

2.8.1 Line of Defense 1 – Barrier Island Restoration

Several measures have been developed which would allow for storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife habitats, and prevention of coastal erosion. Restoration of the barrier islands would require a large amount of high quality sand being placed on or around the sandy string of barrier islands.

2.8.1.1 Option A: Restore Island Footprint

Generally, restoration of the island footprint would entail filling of existing water bottoms to pre-Hurricane Camille conditions. The barrier islands currently provide essential fish habitat for managed fisheries, designated critical habitat for the threatened Gulf sturgeon, and designated critical habitat for piping plover. Several sea turtle species utilize the islands and adjacent water bottoms for nesting and foraging. It is anticipated additional sand along the shoreline would provide additional opportunities for nesting for sea turtles. Additionally, the potential measure would provide additional overwintering critical habitat for the piping plover. Many other shorebird species use the barrier islands for nesting and foraging. Filling of water bottoms would remove essential fish habitat, foraging areas for sea turtles and other marine species.

The sand would be obtained from an offshore source, St. Bernard Shoals, approximately 45 miles south of the islands. Dredging will impact essential fish habitat consisting of epibenthic crustaceans and infaunal polychaetes within the immediate area. However, the impacts are primarily short-term in nature and consist of a temporary loss of benthic invertebrate populations in the areas of dredging. Adjacent benthic communities are anticipated to move into the dredged site and begin recolonization. The area is characterized as a relic sand shoal approximately at elevation -60 NGVD 88 and once dredging is complete, will remain similar in character as dredged depths would not exceed 10 feet in depth. Therefore, because similar habitat, in terms of both sediment composition and depth will be present pre- and post dredging, it is anticipated the benthic biota in the dredging areas will recover and recolonize. Further study during project development would determine the extent of impacts and benefits associated with implementation of this measure.

2.8.1.2 Option B: Replenish Sand in Littoral Zone, Inland Source

This measure would result in less direct impacts to the islands themselves by introduction of sand into the littoral zone where the islands are located. A large amount of water bottoms would be filled as a result. These areas currently provide essential fish habitat for managed fisheries and designated critical habitat for the threatened Gulf sturgeon. Several sea turtle species utilize the islands and adjacent water bottoms for nesting and foraging. Filling of water bottoms would remove some foraging areas for sea turtles and other marine species including the Gulf sturgeon. Sand would be obtained from inland sources comprised of previous dredged river sands. Past analyses and comparisons have found the river sands are typically a finer grain size than native beach sands, which are mostly medium sized. Additionally, these comparisons determined the beach sands are slightly more rounded than river sands. One factor that would warrant further analysis is the differences in color of the two sands with the river sands having a slight brown tint compared to the beach sand samples which are described as white or light grey. It is believed the river sands would undergo bleaching from the ultraviolet radiation from the sun if the color variation was caused by a mineral staining. Adding this sand into the littoral system would diminish the differences between the natural sands by spreading it over large areas with shallow thicknesses. Although, the littoral zone placement via shallow thickness would increase the impact area to essential fish habitat, sea turtles' foraging, and Gulf sturgeon and/or its designated critical habitat, this impact would be temporary due to the sediment placement within the littoral zone and its associated movement. No significant impacts are anticipated either due to the other large total of acreages available in the region to these species. The natural sediment transport process would blend the two sands together while removing staining from the sand grains and rounding the individual particles through abrasion. Further study during project development would determine the extent of impacts of incorporating river sands into the marine system and filling of water bottoms.

2.8.1.3 Option C: Replenish Sand in Littoral Zone, Offshore Source

This measure would result in less direct impacts to the islands themselves by introduction of sand into the littoral zone where the islands are located. A large amount of water bottoms would be filled as a result. These areas currently provide essential fish habitat for managed fisheries and designated critical habitat for the threatened Gulf sturgeon. Several sea turtle species utilize the islands and adjacent water bottoms for nesting and foraging. Filling of water bottoms would remove foraging areas for sea turtles and other marine species including the Gulf sturgeon. Sand would be obtained from an offshore source and would consist of high quality beach sands. The natural sediment transport process would blend this sand into the existing littoral system. Further study during project development would determine the extent of impacts of filling of water bottoms and incorporation of the offshore sands.

The sand would be obtained from an offshore source, St. Bernard Shoals, approximately 45 miles south of the islands. Dredging will impact epibenthic crustaceans and infaunal polychaetes within the immediate area. However, the impacts are primarily short-term in nature and consist of a temporary loss of benthic invertebrate populations in the areas of dredging. Adjacent benthic communities are anticipated to move into the dredged site and begin recolonization. The area is characterized as a relic sand shoal approximately at elevation -60 NGVD 88 and once dredging is complete, will remain similar in character as dredged depths would not exceed 10 feet in depth. Therefore, because similar habitat, in terms of both sediment composition and depth will be present pre- and post dredging, it is anticipated the benthic biota in the dredging areas will recover and recolonize. Further study during project development would determine the extent of impacts and benefits associated with implementation of this measure.

2.8.1.4 Option D: Environmental Restoration With 2-Foot Dune

It is anticipated that implementation of this measure would provide significant benefits to fish and wildlife by restoration of existing damaged and lost habitat. Dunes provide natural island habitat and by restoration, the island dwelling species gain lost habitat. The barrier islands provide important stopover habitat for many species of migratory birds. The barrier islands currently provide essential fish habitat for managed fisheries, designated critical habitat for the threatened Gulf sturgeon, and designated critical habitat for piping plover. Several sea turtle species utilize the islands and adjacent water bottoms for nesting and foraging. It is anticipated additional sand along the shoreline would provide additional opportunities for nesting for sea turtles. Additionally, the potential measure would provide additional overwintering critical habitat for the piping plover. Many other shorebird species use the barrier islands for nesting and foraging. Further studies during project development would determine specific benefits resulting from implementation of this measure.

2.8.1.5 Option E: Environmental Restoration With 6-Foot Dune

It is anticipated that implementation of this measure would provide significant benefits to fish and wildlife by restoration of existing damaged and lost habitat. Dunes provide natural island habitat and by restoration, the island dwelling species gain lost habitat. The barrier islands provide important stopover habitat for many species of migratory birds. The barrier islands currently provide essential fish habitat for managed fisheries, designated critical habitat for the threatened Gulf sturgeon, and designated critical habitat for piping plover. Several sea turtle species utilize the islands and adjacent water bottoms for nesting and foraging. It is anticipated additional sand along the shoreline would provide additional opportunities for nesting for sea turtles. Additionally, the potential measure would provide additional overwintering critical habitat for the piping plover. Many other shorebird species use the barrier islands for nesting and foraging. Further studies during project development would determine specific benefits resulting from implementation of this measure.

2.8.1.6 Option F: Environmental Restoration of Sea Grass Beds

Many marine species depend on sea grass beds for foraging opportunities and cover. Restoration of this vital habitat would provide significant benefits to fish and wildlife and their habitats. Establishment of a comprehensive program would allow for further education regarding the sustainability of the resource.

2.8.1.7 Option G: Restoration of Ship Island Breach

Generally, restoration of the island footprint would entail filling of existing water bottoms to circa 1916-17 geomorphic conditions. These areas currently provide essential fish habitat for managed fisheries, designated critical habitat for the threatened Gulf sturgeon, and designated critical habitat for piping plover. Several sea turtle species utilize the islands and adjacent water bottoms for nesting and foraging. It is anticipated additional sand along the shoreline would provide additional opportunities for nesting for sea turtles. Additionally, the potential measure would provide additional overwintering critical habitat for the piping plover. Filling of water bottoms would remove foraging areas for sea turtles and other marine species. Further study during project development would determine the extent of impacts and benefits associated with implementation of this measure.

The sand would be obtained from an offshore source, St. Bernard Shoals, approximately 45 miles south of the islands. Dredging will impact epibenthic crustaceans and infaunal polychaetes within the immediate area. However, the impacts are primarily short-term in nature and consist of a temporary loss of benthic invertebrate populations in the areas of dredging. Adjacent benthic communities are anticipated to move into the dredged site and begin recolonization. The area is characterized as a relic sand shoal approximately at elevation -60 NGVD 88 and once dredging is complete, will remain similar in character as dredged depths would not exceed 10 feet in depth. Therefore, because similar habitat, in terms of both sediment composition and depth will be present pre- and post dredging, it is anticipated the benthic biota in the dredging areas will recover and recolonize. Further study during project development would determine the extent of impacts and benefits associated with implementation of this measure.

2.9 Threatened and Endangered Species

2.9.1 Line of Defense 1 - Barrier Island Restoration

Close coordination with resource agencies has allowed for better planning and development of alternatives in order to further avoid potential significant impacts to listed species. A more detailed assessment of these threatened and endangered species issues can be found in the Environmental Appendix. Adverse impacts to threatened and endangered species were part of an initial screening process used during early planning. Further consultation with appropriate resource agencies would occur during project development and subsequent biological opinions of the agency would be issued.

Overall implementation of this measure would benefit Piping Plover and its critical habitat by the increased amount of overwintering foraging areas. Temporary impacts could occur during construction but could be avoided during the times the Piping Plover are on the overwintering grounds. Impacts associated with construction activities should be temporary and isolated to actual construction limits. Brown Pelicans could utilize the project areas, however, it is anticipated these species would avoid the construction area due to noise and activity. These impacts would be temporary and isolated to actual construction limits. Surveys to determine if nesting brown pelicans are present could be conducted to avoid any impacts. If nests cannot be avoided during construction, a take could occur. Manatees, Gulf sturgeon and Sea Turtles could be in the project area and there is potential for adverse impacts to occur. It is anticipated these species would primarily avoid the construction areas due to noise and activity resulting in less risk for harm or harassment. Methods of dredging would be utilized to avoid adverse impacts to listed species. Placement activities would be accomplished using appropriate best management practices to reduce turbidity and other potential adverse impacts to species and its critical habitat. Further consultation would be required to determine adverse impacts to critical habitat for the Gulf sturgeon. Bald Eagles (recently de-listed) should avoid the project area during construction activities due to noise and activity. Surveys to determine if nesting bald eagles are present could be conducted to avoid any impacts. If nests cannot be avoided during construction, a take, under the Bald and Golden Eagle Protection Act (BGEPA), could occur. It is anticipated whale species would avoid the project area during construction activities due to noise and activity and no collisions should occur. Further consultation would occur to determine potential impacts to listed species. Biological Assessments of particular project components would need to be evaluated under future programmatic consultations.

2.10 Water Quality

2.10.1 Line of Defense 1 - Barrier Island Restoration

Water quality within coastal Mississippi is being evaluated as part of their ongoing program and monitoring data are compared to the "*State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters*" in order to make decisions on whether a water body is supporting or not supporting its designated uses such as aquatic life support, water contact recreation, fish/shellfish consumption, and drinking water. A more detailed assessment pertaining to water quality issues in coastal Mississippi can be found in the Environmental Appendix. There are specific problems in certain waterbodies throughout the study area; however, many are isolated associated with certain conditions due to industrial discharge, historical problems, and increased run-off in conjunction with development.

Restoration of the barrier islands would require a large amount of high quality sand being placed on or around the sandy string of barrier islands. Overall, this should not cause significant impacts to existing water quality within Mississippi Sound. Restoration of the barrier islands would actually ensure estuarine conditions within Mississippi Sound remain.

2.10.1.1 Option A: Restore Island Footprint

This would require direct placement of approximately 66 million cubic yards of sand dredged from St. Bernard Shoals. Approximately 31 million cubic yards would be placed within the breach (Camille Cut) on Ship Island with the remaining 20 million cubic yards to be placed along the island shorelines expanding the footprints causing many acres of waterbottoms to be filled. The sand found at St. Bernard Shoals is of a quality similar to what is found in the present day Mississippi islands and sufficient quantity to meet the need. There should be no problems associated with turbidity at the borrow site in association with the dredging. The sandy material should pose no turbidity problems during placement activities as sand settles quickly. BMPs would be utilized in order to decrease any impacts associated with Water Quality. It is expected no impacts to water quality would result from implementation of this measure.

2.10.1.2 Option B: Replenish Sand in Littoral Zone, Inland Source

This measure would result in less direct impacts to the islands themselves by introduction of sand into the littoral zone where the islands are located. The sand would not be placed on the islands, but in areas between the islands where the currents that make up the littoral drift zone could transport the sand to the islands. This would result in a large amount of water bottoms to be filled at shallow depths, up to one-foot thicknesses. Sand would be obtained from inland sources comprised of previous dredged river sands. BMPs would be utilized to reduce turbidity associated with placement activities. It is anticipated there would be little impacts to water quality in association with implementation of this measure.

2.10.1.3 Option C: Replenish Sand in Littoral Zone, Offshore Source

This measure would result in less direct impacts to the islands themselves by introduction of sand into the littoral zone where the islands are located. The sand would not be placed on the islands, but in areas between the islands where the currents that make up the littoral drift zone could transport the sand to the islands. This would result in a large amount of water bottoms to be filled at shallow depths, up to one-foot thicknesses. Sand would be obtained from St. Bernard Shoals which is of a quality similar to what is found in the present day Mississippi islands. BMPs would be utilized to reduce turbidity associated with placement activities. It is anticipated there would be minimal impacts to water quality in association with implementation of this measure.

2.10.1.4 Option D: Environmental Restoration With 2-Foot Dune

Implementation of this measure would provide positive impacts to water quality by restoration of existing wetlands and marshes on the islands. It is anticipated there would be a benefit to water quality as a result of this measure. Although there may be a slight increase in turbidity during construction, it is anticipated this would be localized and short in duration.

2.10.1.5 Option E: Environmental Restoration With 6-Foot Dune

Implementation of this measure would provide positive impacts to water quality by restoration of existing wetlands and marshes on the islands. It is anticipated there would be a benefit to water quality as a result of this measure. Although there may be a slight increase in turbidity during construction, it is anticipated this would be localized and short in duration.

2.10.1.6 Option F: Environmental Restoration of Sea Grass Beds

Improved water quality within Mississippi Sound would help to establish sea grasses.

2.10.1.7 Option G: Restoration of Ship Island Breach

This would require direct placement of approximately 13 million cubic yards of sand dredged from St. Bernard Shoals within the breach (Camille Cut) on Ship Island causing a large amount of water bottoms to be filled. BMPs would be utilized to reduce turbidity associated with placement activities. It is anticipated there would be minimal impacts to water quality in association with implementation of this measure.

2.11 Water Supply

There should be no effect on water supply. Potential projects have been or would be designed to avoid impacts to existing public water supply infra-structure and operating facilities.

2.12 Socio-Economics

2.12.1 Line of Defense 1 - Barrier Island Restoration

Several measures have been developed which would allow for storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife habitats, and prevention of coastal erosion. Restoration of the barrier islands would require a large amount of high quality sand being placed on or around the sandy string of barrier islands. It is anticipated there would be positive effects to socio-economics as a result of the implementation of this measure.

2.12.1.1 Population

It is anticipated there would be a positive benefit associated with this measure to the population within coastal Mississippi as restoration of the barrier islands would enhance the existing natural system and allow for sustainability of this natural resource that produces much of the quality of life that currently exists today, especially prior to Hurricane Katrina.

2.12.1.2 Employment and Income

Implementation of this measure could result in a positive increase to the income of the area and its residents. This measure could also result in the creation of numerous jobs, ranging from construction to retail and others, in order to accommodate the significant infrastructure investment. These jobs could potentially be long-term in nature given the size and scope of the measure. Refer to the Economic Appendix for more details on the increases to income and employment and the full extent of impacts.

2.12.1.3 Housing

It is anticipated this measure would have no effect to current housing within coastal Mississippi. There are no residential structures located on the barrier islands.

2.12.1.4 Quality of Life

Implementation of this measure would provide for a continuation and enhancement of the existing quality of life as much of the local economy is driven by the seafood industry. This measure would provide for sustainability and enhancement of the barrier islands and prevention of coastal erosion. Stabilization of the barrier islands will ensure the future of the estuary within Mississippi Sound by ensuring no additional saltwater intrusion occurs. This will ensure the productivity of Mississippi Sound, which provides the basis of the seafood driven economy as well as additional recreational opportunities.

2.12.1.5 Schools

It is anticipated there would be no effect to schools by implementation of this measure.

2.12.1.6 Public Safety

It is anticipated there would be no negative impacts to public safety by implementation of this measure. Additionally, it is expected implementation of this measure would provide significant benefits by a reduction of damages caused by waves and storm surge.

2.12.1.7 Recreation

Within 85 miles of Gulf of Mexico coastline, coastal Mississippi has many recreational opportunities for its residents and for potential tourists. Restoration of the barrier islands will ensure water sports, fresh and saltwater fishing, camping, historic tours, and cultural sites remain available for residents and tourists. The barrier islands are popular spots for swimming, wind surfing, parasailing, motor boating, water skiing, and sailing. Data from fiscal year 2000 depicts the Gulf Islands National Seashore had 875,000 visitors, and 26,000 of these visitors stayed overnight. There are 200 varieties of saltwater fish in and around the Mississippi Sound and the Gulf of Mexico. A climate suitable for year-round fishing makes this even more popular. More than 30 public boat ramps, marina slips, and an umber of private camps and launches provide rental boats, charger boats, and bait. A wide variety of charter boats were available prior to Hurricane Katrina, for small groups of one to six passengers or for large parties. Fishing trips could be scheduled for from 4 hours up to an overnight stay. Numerous fishing tournaments are held every year, including the Mississippi Deep Sea Fishing Rodeo, which is the large event of its kind in the world (Mississippi Gulf Coast, 2001). Restoration of the barrier islands would ensure the continuation of the recreational opportunities as well as its sustainability well into the future.

2.12.1.8 Transportation and Traffic

It is anticipated there will be no effect to transportation or traffic by implementation of this measure. There are two deepwater ports and one shallow water port located within the vicinity of the barrier islands.

2.13 Land Use

2.13.1 Line of Defense 1 - Barrier Island Restoration

Several measures have been developed which would allow for storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife habitats, and prevention of coastal erosion. Restoration of the barrier islands would require a large amount of high quality sand being placed on or around the sandy string of barrier islands. It is anticipated there would be no adverse effects to current or future land use as a result any potential projects.

2.13.1.1 Option A: Restore Island Footprint

This project would require direct placement of approximately 66 million cubic yards of sand dredged from St. Bernard Shoals. Approximately 21 million cubic yards would be placed within the breach (Camille Cut) on Ship Island with the remaining 45 million cubic yards to be placed along the island shorelines expanding the footprints. Alteration of land use is expected due to the change from filling in of water bottoms being converted to sandy barrier islands resulting in expanded acreage. It is anticipated this change in land use would be insignificant as the islands would be expanded to historical sizes and the relative size of the project to the surrounding land use.

2.13.1.2 Option B: Replenish Sand in Littoral Zone, Inland Source

A large amount of water bottoms would be filled at shallow depths up to one-foot in depth in association with implementation of this measure. There would be alteration of current land use due to the changes associated with filling in of water bottoms; however, it is anticipated the difference would be insignificant due to the relative size of the proposed project to the surrounding land use.

2.13.1.3 Option C: Replenish Sand in Littoral Zone, Offshore Source

A large amount of water bottoms would be filled at shallow depths up to one-foot in depth in association with implementation of this measure. There would be alteration of current land use due to the changes associated with filling in of water bottoms; however, it is anticipated the difference would be insignificant due to the relative size of the proposed project to the surrounding land use.

2.13.1.4 Option D: Environmental Restoration With 2-Foot Dune

Implementation of this measure would provide a benefit to current land use as restoration would provide enhancement to the existing environment.

2.13.1.5 Option E: Environmental Restoration With 6-Foot Dune

Implementation of this measure would provide a benefit to current land use as restoration would provide enhancement to the existing environment.

2.13.1.6 Option F: Environmental Restoration of Sea Grass Beds

The project would result in an enhancement of the water bottoms and existing sea grass beds as a result of implementation of this measure. The project would result in a positive benefit to land use.

2.13.1.7 Option G: Restoration of Ship Island Breach

This would require direct placement of approximately 21 million cubic yards of sand dredged from St. Bernard Shoals within the breach (Camille Cut) on Ship Island causing a large amount of water bottoms to be filled. Alteration of land use is expected due to the changes associated with filling in of water bottoms being converted to sandy barrier island resulting in expanded acreage. It is anticipated this change in land use would be insignificant as the island would be expanded to its historical size and the relative size of the project to the surrounding land use.

2.14 Aesthetic Resources

As restoration occurs, aesthetics would be temporarily reduced in the immediate vicinity of the proposed project sites. Many recreational vessels utilize Mississippi Sound within the project vicinities and it is believed some residents and visitors may be disturbed by the presence of required heavy equipment during any construction phases. However, construction activities would be temporary in nature so the disturbance would be anticipated to be minimal at each potential project site. There could be times when numerous projects throughout coastal Mississippi would be occurring at once or potential project phases could be scheduled upon completion of requisite projects which would take extended amounts of time. The projects should provide residents and visitors with an overall more aesthetically pleasing view as projects are completed.

The environmental restoration projects would provide additional fish and wildlife habitat to numerous shore birds and various wildlife species which would enhance coastal Mississippi and its diverse aquatic habitats while providing future sustainability of the natural system.

2.15 Cultural Resources

Significant cultural resources as defined by the NHPA are those sites that are considered eligible for or are included in the National Register. These sites are known as historic properties. Historic properties can include buildings or other standing structures; historic or prehistoric districts (such as the historic districts in Biloxi and Ocean Springs); archaeological sites, such as Indian mounds or other remains of prehistoric life; objects, such as statues or paintings; or sunken vessels. Traditional cultural properties can also be considered significant cultural resources because of their traditional religious or cultural importance to an Indian tribe or other traditional community.

Along the Mississippi Gulf Coast, historic properties can be roughly defined within two categories. The categories are the built environment (standing structures) and archaeological sites. The vast majority of historic properties listed on the National Register are those of the built environment. To date 62 standing structures, 14 historic districts, and one ship have been listed.

In contrast, very few archaeological sites have been formally nominated to the National Register. However, numerous sites still meet the criterion of definition as historic properties. These include prehistoric earthworks and mounds, shell middens, village sites, and historic occupation areas including extinct town sites. Currently, over 200 recorded archaeological sites are considered potential historic properties.

The vast majority of historic and prehistoric sites are found along the immediate coastal strand and adjacent to estuarine systems. Preference for well-drained, sandy soils adjacent to water sources is apparent. Coast wide survey work performed by both state (Giliberti n.d.) and private researchers (Blitz and Mann 2000) have found a distinctive focus on the immediate coastal and estuarine locations. Unfortunately, the geographic placement of these resources has made them extremely vulnerable to destruction from continued occupation and development, as well as vulnerable to the effects of tropical storms and hurricanes.

Previous archaeological and architectural studies along the Mississippi Gulf Coast have documented the destruction caused by natural forces, most notably hurricanes. Standing structures are often the most dramatic and visible witnesses to this destruction. However, prehistoric and historic archaeological sites are also extremely vulnerable. Shell middens, found along the immediate shoreline and within coastal marshes and estuaries, often are flipped and re-deposited by the storm surge and wave action of hurricanes. This effectively destroys much of the value of the sites. Sites, such as Indian villages, and historic town sites, such as those along the bluff on Bay St. Louis, can also be destroyed by such wave action. In addition, post storm activities offer many more mechanisms for site destruction. These include clearing of timber by use of skidders and other heavy equipment, debris removal, and reconstruction. The destructiveness of these activities is well documented from the years following Hurricane Camille which struck the area in 1969.

The Corps, Mobile District Archaeologists, through long standing coordination relationships developed throughout the years, coordinated closely with the Mississippi Department of Archives and History staff in determining effects of the storm event. Hurricane Katrina has been documented to have destroyed a vast majority of the standing historic properties within Hancock County, and a large number of those within Harrison and Jackson Counties. The size and strength of the storm surge has also undoubtedly had as much destruction on archaeological sites. Post hurricane activities have further impacted the remaining historic properties.

Historic Fort Massachusetts is on West Ship Island, a barrier island 12 miles off the Mississippi Coast. The fort is accessible only by private boat or passenger ferry with scheduled public tours given March through October.

Fort Massachusetts was built on Ship Island for national defense. Both domestic and foreign powers recognized the strategic significance of the natural deep water harbor on the north side of the island. After lengthy debate fort construction began in the summer of 1859. Storms, disease, climate, isolation and the Civil War made construction on this remote barrier island a challenge. Construction on Fort Massachusetts halted in 1866 although the fort was not fully completed.

The fort has not only withstood actions of war but also the more subtle enemies of time and neglect. The devastating and powerful Hurricanes Camille (1969) and Katrina (2005) washed over and through the building but failed to significantly undermine the structure. However, decades of salt air and wave action began to erode the historic mortar. Employees from the Historic Preservation Training Center came to the rescue in 2001 and repaired the 135-year old brick walls. In addition the remains of the French Warehouse are located east of the fort. Various ships could be located around the barrier islands.

Protection from the immediate and post-effects of hurricanes should be considered as beneficial to cultural resources. While some historic properties may be adversely affected by protection plans, long term prevention of damage should be considered a positive measure for historic properties, in particular standing structures. Mobile District archaeologists are closely coordinating with the State of Mississippi Department of Archives and History regarding potential impacts associated with potential measures being considered in the Comprehensive Plan.

2.16 Hazardous, Toxic, and Radioactive Wastes

Quickly after Hurricane Katrina, the EPA working with the National Strike Team and other national search and rescue teams began identification and cleanup of the Household Hazardous Wastes and other hazardous type debris. The EPA established partnerships with other national and local teams involved with debris cleanup. The Corps, Mobile District team coordinated with them regularly and provided coordinates/locations of HHW and HTRW that were located during vegetative and construction type debris cleanup. The EPA working with others were charged with the responsibility of final cleanup of this type debris after the storm event.

Site inspections would be conducted at and adjacent to the various components of the Comprehensive Plan during development of specific plans and specifications in accordance with the requirements of ER 1165-2-132 entitled, HTRW Guidance for Civil Works Projects, and the American Society of Testing and Materials Standard E 1527.

2.17 Environmental Justice

EO 12898, Federal Actions to address Environmental Justice in Minority and Low-Income Populations (February 11, 1994) requires that Federal agencies conduct their programs, policies, and activities that substantially affect human health or the environment in a manner that ensures that such programs, policies, and activities do not have the effect of excluding persons (including populations) from participation in, denying persons (including populations) the benefits of, or subjecting persons (including populations) to discrimination under such programs, policies, and activities because of their race, color, or national origin. On February 11, 1994, the President also issued a memorandum for heads of all departments and agencies, directing that EPA, whenever reviewing environmental effects of proposed actions pursuant to its authority under Section 309 of the CAA, ensure that the involved agency has fully analyzed environmental laws, regulations, and policies.

Any potential measures would not create disproportionately high or adverse human health or environmental impacts on minority or low-income populations within the study area. Review and evaluation of the overall comprehensive plan have not disclosed the existence of identifiable minority or low-income communities that would be adversely impacted by proposed measures. Further studies during project development would determine specific impacts associated with implementation of potential measures. The following analysis will serve as a beginning point from which further analyses can be built upon during the comprehensive plan components.

Historic and Existing Conditions Data from the U.S Department of Commerce, Census of Population and Housing were used for this Environmental Justice analysis. The population in 1990 for Mississippi was 2,573,216. Minority populations included in the census are identified as Black or African American, American Indian and Alaska Native, Asian, Native Hawaiian and other Pacific Islander, Hispanic, of two or more races, and other. Mississippi is only second to the District of Columbia as having the largest Black or African American population. Poverty status, used in this coastal Mississippi report to define low-income status, is reported as the number of persons with income below poverty level. The 2005 Census defines the poverty level as $9,973 of annual income, or less, for an individual, and $19,971 of annual income, or less, for a family of four. In 2005, Mississippi ranked number one out of the 50 states for individuals living below the poverty level in the past 12 months. Unfortunately, Mississippi had 21.3% of its population living in poverty in 2005.

Coastal Mississippi has a lower percentage of minority residents than the State of Mississippi and the U.S. In 2000 (the most up-to-date data available), 79.6 percent of the population was white and 16.3 percent was black. All other racial groups combined totaled approximately 4.1 percent of the population, while 2.2 percent were of Hispanic origin. In Mississippi, 61.4 percent of the population was white, 36.3 percent was black, 2.3 percent was of another minority racial group, and 1.4 percent was of Hispanic origin. For the U.S., 75.1 percent of the population was white, 12.3 percent was black, and 12.6 percent was of other minority racial groups. Approximately 12.5 percent of the U.S. population was Hispanic.

The Census Bureau bases the poverty status of families and individuals on 48 threshold variables, including income, family size, number of family members under the age of 18 and over the age of 65, and amount spent on food. In 1997, approximately 14.6 percent of the residents were classified as living in poverty, lower than the State of Mississippi but slightly higher than the poverty rate for the U.S. as a whole.

As of 2006, the population in Mississippi was 2,910,540 – of this 135,940 individuals live in Jackson County, 193,810 live in Harrison County, and at this time a population count for Hancock County was not available. Hurricane Katrina drew focus on the number of residents unable to flee the Gulf coast due to lack of funds. There is a longstanding legacy of unfair and disproportionate harmful exposures to low income, predominantly African American communities in much of Mississippi. Predominantly in the Biloxi area but also in other coastal Mississippi communities, there was a large population of Asian Americans that depended upon fishing for their livelihood. Adverse impacts from Hurricane Katrina have resulted in a large number of these individuals leaving the area.

Environmental Justices have resulted from years of industrial activity and waste disposal practices that hit these communities harder than higher income, predominantly white communities. Impacted areas, such as superfund facilities, are located more often in low-income areas and therefore are at greater risk to post-Katrina exposure. As clean-up proceeds and rebuilding begins, every effort must be made to remedy these environmental injustices through full clean-up, fair rebuilding practices, and full partnership with affected communities. Over 30,000 families are being helped through Administration on Children and Families TANF program by the provision of short term, non-recurrent cash benefits to families who traveled to another State from the disaster designated States. The hurricane-damaged States of Mississippi, Louisiana, and Alabama also received additional funding for the TANF program to provide assistance and work opportunities to needy families ($69 million for loan forgiveness and $25 million in contingency funds for State Welfare Programs.) Counties along the Mississippi Gulf coast lost a sizeable share of their white residents and homeowners immediately following Hurricane Katrina, while other Gulf Coast metropolitan areas, especially those that gained residents, experienced little overall shifts in their demographic profiles. Coastal counties of Mississippi, which include Gulfport-Biloxi and Pascagoula metropolitan areas, in contrast to New Orleans, were left with a population that had a larger share of minority residents, a lower level of homeownership, and no significant decline in poverty. In essence, while the poor and less well-off residents of New Orleans bore the greatest brunt of Katrina, the storm had a more egalitarian effect on the population of coastal Mississippi. Our examination of the data for other hurricane impacted areas in the Gulf Coast region reveals that while a great deal of population shifting had occurred, only minor changes have taken place in the race and ethnic, economic and socio-demographic profiles for most of these areas.

Specifically, restoration of the barrier islands would not adversely impact any minority or low-income populations because those individuals are not living within the island's vicinity. In fact, restoration of the barrier islands would indirectly benefit those individuals living on the mainland through the anticipated environmental benefits, such as fishing. Each and every measure or alternative (i.e. Forest Heights) examined in the MsCIP study was evaluated for its potential for adverse impacts to minority and/or low-income populations, in adherence with EO 12898. In no case was there any identified negative impact to any of these communities in regards to human health and environmental conditions, from any proposed actions or projects.

2.18 Protection of Children

EO 13045, Protection of Children from Environmental Health Risks and Safety Risks (April 21, 1997), recognizes a growing body of scientific knowledge that demonstrates that children may suffer disproportionately from environmental health risks and safety risks. These risks arise because children's bodily systems are not fully developed; because children eat, drink, and breathe more in proportion to their body weight; because their behavior patterns may make them more susceptible to accidents. Based on these factors, the President directed each Federal agency to make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children. The President also directed each Federal agency to ensure that its policies, programs activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.

It is anticipated that no disproportionate risks to children would occur as a result of implementation of the No Action Plan and any potential measures. Specifically, restoration of the barrier islands would not adversely impact children because those individuals are not living within the island's vicinity. In fact, restoration of the barrier islands would indirectly benefit those individuals living on the mainland through the anticipated environmental benefits, such as fishing. Further studies during project development phase would determine any activities that might pose any disproportionate environmental health risks or safety risks to children.

2.19 Unavoidable Adverse Environmental Effects

It is anticipated that any adverse environmental effects which could not be avoided should potential projects be implemented should be temporary and localized and would be minor individually and cumulatively.

2.20 Irreversible and Irretrievable Commitments of Resources

Any irreversible or irretrievable commitments of resources involved in any potential proposed projects have been considered and are either unanticipated at this time or will be considered to determine if any would present minor impacts.

CHAPTER 3 ENVIRONMENTAL RESTORATION ANALYSIS

A detailed analyses has been conducted for the following five environmental restoration plans to determine the impacts associated with alternatives that were considered during development of projects being recommended for construction. It is expected that no further environmental analysis is required prior to the projects being constructed. Full details of all alternative plan impacts are presented below.

3.1 Environmental Effects

The following recommended plan impacts are grouped together because the impacts are the same for each proposed restoration efforts.

- **Soils** - Alteration of soils is anticipated within environmental restoration projects; however, in some instances, old fill material would be removed for reestablishment of more native types soils generally found in the natural system.
- **Sediments** - Re-suspension of sediments would likely occur within specific project sites. Silt fences and other BMPs would be used to minimize the adverse impacts to the environment during construction activities to the maximum extent practicable. Containment structures, silt curtains, and other BMPs would be used to contain sediment deposition at construction and environmental restoration sites. It is expected that solids that remain suspended in the water column would migrate by littoral drift. Any impacts that might occur would typically be isolated to each construction site, minor and of short duration.
- **Geology** - There should be no effects to geology. Potential projects have been or would be designed to avoid impacts to current geological formations.
- **Climate** - There should be no effects to the existing climate.
- **Air Quality** - Currently all areas within coastal Mississippi are in attainment with the NAAQS. Air quality in the immediate vicinity of project construction would be slightly affected for a period of time by the fuel combustion and resulting engine exhausts. The standards would not be violated by the implementation of the proposed project.
- **Noise** - Noise from the construction type equipment is expected to increase during the proposed operations in the project vicinities. Noise levels will resume to existing conditions as construction activities are completed. It is anticipated there would be no significant impacts to noise during implementation of these measures.
- **Water Supply** - There should be no effect on water supply. Potential projects have been or would be designed to avoid impacts to existing public water supply infra-structure and operating facilities.
- **Socio-Economics** -

  Population - It is expected minimal impacts to population would occur by implementation.

  Employment and Income - Implementation of this measure could result in a positive increase to the income of the area and its residents. This effort could also result in the creation of jobs in order to accommodate the investment. Refer to the Economic

Appendix for more details on the increases to income and employment and the full extent of impacts.

Housing - Implementation of this measure would not impact housing within coastal Mississippi because most of the existing housing has been destroyed and only minimal impacts would occur in obtaining the property due to the hardships associated with rebuilding.

Quality of Life - Implementation of this measure could improve quality of life within coastal Mississippi as additional wetland restoration would benefit water quality, wildlife habitat, and various natural resource functions as a result of restoration activities.

Schools - Implementation of this measure would not impact schools within coastal Mississippi.

Public Safety - It is anticipated there would be intrinsically significant positive effects to public safety by implementation of this measure as wetland restoration would displace humans and capital improvements preventing loss of life and allowing "attractive nuisances" from luring people into high-risk areas and increasing the economic loss of capital improvements within high-risk areas. Wetland restoration would also benefit water quality, wildlife habitat, and various natural resource functions.

Recreation - It is anticipated there would be minimal benefits to recreation associated with implementation of this measure.

Transportation and Traffic - It is anticipated there would be no impacts associated with implementation of this measure.

- **Aesthetics** - As projects would be constructed, aesthetics would be temporarily reduced in the immediate vicinity of the proposed project sites. Many recreational vessels utilize Mississippi Sound within the project vicinities and it is believed some residents and visitors may be disturbed by the presence of required heavy equipment during any construction phases. However, construction activities would be temporary in nature so the disturbance would be anticipated to be minimal at each potential restoration project site. There could be times when numerous projects throughout coastal Mississippi would be occurring at once or potential project phases could be scheduled upon completion of requisite projects which would take extended amounts of time. The restoration projects should provide residents and visitors with an overall more aesthetically pleasing view as projects are completed.

  The environmental restoration projects would provide additional fish and wildlife habitat to numerous shorebirds and various wildlife species, which would enhance coastal Mississippi and its diverse aquatic habitats while providing future sustainability of the natural system.

- **Cultural Resources** - The vast majority of historic and prehistoric sites are found along the immediate coastal strand and adjacent to estuarine systems. Preference for well-drained, sandy soils adjacent to water sources is apparent. Coast wide survey work performed by both state (Giliberti n.d.) and private researchers (Blitz and Mann 2000) have found a distinctive focus on the immediate coastal and estuarine locations. Unfortunately, the geographic placement of these resources has made them extremely vulnerable to destruction from continued occupation and development, as well as vulnerable to the effects of tropical storms and hurricanes.

Modern development along the Mississippi coast has affected both archaeological sites and standing structures, including individual structures and historic districts in the project area. Key issues are soil disturbance and construction. Soil disturbance affects archaeological sites, and construction of new buildings and associated infrastructure can affect the view shed and "feel" of a historic building or district or cause demolition or alteration of historic buildings.

From the early 1970s to the present, construction in the project area has greatly increased. In fact, more development and construction has occurred in the three counties that are part of the project area than anywhere else in the state. Land use studies show that between 1972 and 2000 both medium-density and high-density urban land use areas increased by more than 90 percent in the study area; overall, developed land use increased by almost 70 percent during that period (MARIS 1992, 2000; USGS 1972; USGS and USEPA 1992). This sizeable increase in developed land is caused in part by the casinos and related infrastructure, residential, and commercial construction. The development involves large areas of soil disturbance, which destroys archaeological sites.

Previous archaeological and architectural studies along the Mississippi Gulf Coast have documented the destruction caused by natural forces, most notably hurricanes. Standing structures are often the most dramatic and visible witnesses to this destruction. However, prehistoric and historic archaeological sites are also extremely vulnerable. Shell middens, found along the immediate shoreline and within coastal marshes and estuaries, often are flipped and re-deposited by the storm surge and wave action of hurricanes. This effectively destroys much of the value of the sites. Sites such as Indian villages and historic town sites such as those along the bluff on Bay St. Louis can also be destroyed by such wave action. In addition, post storm activities offer many more mechanisms for site destruction. These include clearing of timber by use of skidders and other heavy equipment, debris removal, and reconstruction. The destructiveness of these activities is well documented from the years following hurricane Camille which struck the area in 1969.

Corps, Mobile District Archaeologists, through long standing coordination relationships developed throughout the years, coordinated closely with the Mississippi Department of Archives and History staff in determining effects of the storm event. Hurricane Katrina has been documented to have destroyed a vast majority of the standing historic properties within Hancock County, and a large number of those within Harrison and Jackson Counties. The size and strength of the storm surge has also undoubtedly had as much destruction on archaeological sites. Post hurricane activities have further impacted the remaining historic properties.

Protection from the immediate and post-effects of hurricanes should be considered as beneficial to cultural resources. While some historic properties may be adversely affected by protection plans, long term prevention of damage should be considered a positive measure for historic properties, in particular standing structures. Mobile District archaeologists are closely coordinating with the State of Mississippi Department of Archives and History regarding potential impacts associated with potential measures being considered in the Comprehensive Plan. Plans are underway to develop an overall Programmatic Agreement to address potential impacts to cultural and historic resources.

- **Hazardous, Toxic, and Radioactive Wastes** - Quickly after Hurricane Katrina, the EPA working with the National Strike Team and other national search and rescue teams began identification and cleanup of the Household Hazardous Wastes and other hazardous type debris. The EPA established partnerships with other national and local teams involved with debris cleanup. The Corps team coordinated with them regularly and provided coordinates/locations of HHW and HTRW that were located during vegetative and construction type debris cleanup. The EPA working with others were charged with the responsibility of final cleanup of this type debris after the storm event.

Site inspections would be conducted at and adjacent to the various components of the Comprehensive Plan during development of specific plans and specifications in accordance with the requirements of ER 1165-2-132 entitled, HTRW Guidance for Civil Works Projects, and the American Society of Testing and Materials Standard E 1527.

Inspections would be accomplished to determine the presence or evidence of landfills, surface areas unable to support vegetation, visible sheens of petroleum product, nearby contaminated industrial facilities, or any type of visible indication that HTRW concerns exist that may impact any component of the recommended plans during specific project development. Site inspections of adjacent properties, reviews of historic aerial photographs, on site interviews, and environmental database record searches would be conducted to determine any evidence of HTRW concerns that may impact any component of the recommended plans during specific project development.

Based on the findings of the HTRW site assessments, specific or unusual environmental concerns that are identified that could affect construction of any proposed projects would be addressed appropriately. Additional supplemental environmental impacts statements or environmental analyses may be necessary once specific projects have been identified and development of project plans has begun. HTRW issues and concerns would be addressed during the required NEPA compliance and documentation.

- **Environmental Justice** - EO 12898, Federal Actions to address Environmental Justice in Minority and Low-Income Populations (February 11, 1994) requires that Federal agencies conduct their programs, policies, and activities that substantially affect human health or the environment in a manner that ensures that such programs, policies, and activities do not have the effect of excluding persons (including populations) from participation in, denying persons (including populations) the benefits of, or subjecting persons (including populations) to discrimination under such programs, policies, and activities because of their race, color, or national origin. On February 11, 1994, the President also issued a memorandum for heads of all departments and agencies, directing that EPA, whenever reviewing environmental effects of proposed actions pursuant to its authority under Section 309 of the CAA, ensure that the involved agency has fully analyzed environmental laws, regulations, and policies.

The No Action and Comprehensive plan and potential measures are not designed to create a benefit for any specific group or individual. Any potential measures would not create disproportionately high or adverse human health or environmental impacts on minority or low-income populations within the study area. Review and evaluation of the overall comprehensive plan have not disclosed the existence of identifiable minority or low-income communities that would be adversely impacted by proposed measures. Further studies during project development would determine specific impacts associated with implementation of potential measures.

A detailed discussion on the *Historic and Existing Conditions Data from the U.S Department of Commerce, Census of Population and Housing* has been provided in Section 2.17. This analysis will serve as a beginning point from which further analyses can be built upon during the comprehensive plan components. Ultimately, the plan adopted for the Mississippi coast will not be a plan forced on them by the Corps or other Federal agencies, but a plan coordinated, discussed, and finally adopted by the numerous entities and individuals that will live with that plan, the residents and local government of coastal Mississippi.

- **Protection of Children** - The EO 13045, Protection of Children from Environmental Health Risks and Safety Risks (April 21, 1997), recognizes a growing body of scientific knowledge that demonstrates that children may suffer disproportionately from environmental health risks and safety risks. These risks arise because children's bodily systems are not fully developed; because children eat, drink, and breathe more in proportion to their body weight; because their behavior patterns may make them more susceptible to accidents. Based on these factors, the President directed each Federal agency to make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children. The President also directed each Federal agency to ensure that its policies, programs activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.

  It is anticipated that no disproportionate risks to children would occur as a result of implementation of the No Action Plan and any potential measures. Further studies during project development phase would determine any activities that might pose any disproportionate environmental health risks or safety risks to children.

- **Unavoidable Adverse Environmental Effects** - It is anticipated that any adverse environmental effects which could not be avoided should potential projects be implemented should be temporary and localized and would be minor individually and cumulatively.

- **Irreversible and Irretrievable Commitments of Resources** - Any irreversible or irretrievable commitments of resources involved in any potential proposed projects have been considered and are either unanticipated at this time or will be considered to determine if any would present minor impacts.

The following section provided completed detailed analysis of the alternatives considered for each restoration project during development of each proposed recommended plan.

3.2 Admiral Island

Tidal marshes in this area were ditched in the 1960s causing changes in the natural hydrology and subsequent changes in the species composition. Hurricane Katrina left extensive debris fields and sedimentation in the area destroying many native trees and vegetation. Due to the loss of native species this area has a severe infestation of the invasive Chinese Tallow Tree, which is invading the marshes and adjacent flatwoods.

3.2.1 Vegetation

3.2.1.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition.

3.2.1.2 Plan 1 – Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at .5 meter spacing.

There will be a benefit to vegetation as this plan will restore hydrology, remove exotics allowing native plants to become better established, and the planting density is such that ensures high rates of survival and increases percent cover. Planting of native species at such a high density ensures the native species will outcompete any exotic species that could be introduced or by seed germination in the future.

3.2.1.3 Plan 2 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

There will be a benefit to vegetation as this plan will restore hydrology, and remove exotics allowing native plants to become better established. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return.

3.2.1.4 Plan 3 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 2 meter spacing.

Implementation of this plan would provide a benefit to vegetation as this plan will restore hydrology, and remove exotics allowing native plants to become better established. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return.

3.2.1.5 Plan 4 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at .5 meter spacing.

Implementation of this plan would provide a benefit to vegetation as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. The planting density is such that ensures high rates of survival and increases per-cent cover. Planting of native species at such a high density ensures the native species will outcompete any exotic species that could be introduced or by seed germination in the future.

3.2.1.6 Plan 5 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

Implementation of this plan would provide a benefit to vegetation as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return.

3.2.1.7 Plan 6 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at 2 meter spacing.

Implementation of this plan would provide a benefit to vegetation as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return.

3.2.2 Fish and Wildlife

3.2.2.1 No Action

The invasive species would continue to thrive threatening to take over the site reducing available native forage for fish and wildlife species to use the area. Lack of available habitat could cause fish and wildlife species to move from the area seeking more suitable habitat.

3.2.2.2 Plan 1 – Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at .5 meter spacing.

There will be a benefit to fish and wildlife species, including essential fish habitat for managed species, as this plan would restore hydrology, remove exotics allowing native plants to become better established, and the planting density is such that ensures high rates of survival and increases percent cover. Planting of native species at such a high density ensures the native species will outcompete any exotic species that could be introduced or by seed germination in the future. This will provide valuable forage and cover for fish and wildlife species.

3.2.2.3 Plan 2 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

There will be a benefit to fish and wildlife species, including essential fish habitat for managed species, as this plan will restore hydrology, and remove exotics allowing native plants to become better established. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return and to provide necessary habitat for fish and wildlife species.

3.2.2.4 Plan 3 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 2 meter spacing.

Implementation of this plan would provide a benefit to fish and wildlife species, including essential fish habitat for managed species, as this plan will restore hydrology, and remove exotics allowing native plants to become better established. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return. Increased maintenance activities could disrupt established use patterns by species and increased spacing would reduce the overall quality of the habitat to support foraging and cover.

3.2.2.5 Plan 4 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at .5 meter spacing.

Implementation of this plan would provide a benefit to fish and wildlife species, including essential fish habitat for managed species, as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. Lack of natural hydrology would impact fish and wildlife species that would naturally use an intact habitat and could also limit resources available for their survival. The planting density is such that ensures high rates of survival and increases percent cover. Planting of native species at such a high density ensures the native species will outcompete any exotic species that could be introduced or by seed germination in the future. This will provide valuable forage and cover for fish and wildlife species.

3.2.2.6 Plan 5 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at 1 meter spacing.

Implementation of this plan would provide a benefit to vegetation as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. Lack of natural hydrology would impact fish and wildlife species, including essential fish habitat for managed species, that would naturally use an intact habitat and could also limit resources available for their survival. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return and to provide necessary habitat for fish and wildlife species.

3.2.2.7 Plan 6 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at 2 meter spacing.

Implementation of this plan would provide a benefit to vegetation as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. Lack of natural hydrology would impact fish and wildlife species, including essential fish habitat for managed species, that would naturally use an intact habitat and could also limit resources available for their survival. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return. Increased maintenance activities could disrupt established use patterns by species and increased spacing would reduce the overall quality of the habitat to support foraging and cover.

3.2.3 Threatened and Endangered Species

As these vital resources are restored, it is anticipated that various threatened and endangered species would begin to utilize those valuable habitats. Birds, such as piping plovers and brown pelicans, and sea turtles would likely begin to utilize the filled breached area at Ship Island and nourished mainland beaches. Protected species, such as the red-cockaded woodpeckers, Mississippi sandhill cranes, gopher tortoises and the Eastern indigo snakes, would likely benefit from the restored wet pine Savannah habitats.

3.2.3.1 No Action

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.2.3.2 Plan 1 – Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at .5 meter spacing.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.2.3.3 Plan 2 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.2.3.4 Plan 3 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 2 meter spacing.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.2.3.5 Plan 4 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at .5 meter spacing.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.2.3.6 Plan 5 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at 1 meter spacing.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.2.3.7 Plan 6 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at 2 meter spacing.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.2.4 Water Quality

3.2.4.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. Continued degradation of the site would further reduce any water quality functions that currently exist.

3.2.4.2 Plan 1 – Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at .5 meter spacing.

There will be a benefit to water quality as this plan will restore hydrology, remove exotics allowing native plants to become better established, and the planting density is such that ensures high rates of survival and increases per-cent cover. Planting of native species at such a high density ensures the native species will outcompete any exotic species that could be introduced or by seed germination in the future. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

3.2.4.3 Plan 2 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

There will be a benefit to water quality as this plan will restore hydrology, and remove exotics allowing native plants to become better established. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return. Once complete, the project would mature over a longer period of time; however, the project would provide for improved water quality functions. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

3.2.4.4 Plan 3 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 2 meter spacing.

Implementation of this plan would provide a benefit to water quality as this plan will restore hydrology, and remove exotics allowing native plants to become better established. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return. Although the project would provide benefits to water quality, the amount of time necessary would increase and a longer period of time would be needed in order for the wetland to reach maturity. The sustainability of the project remains unknown and it may become necessary for the introduction of additional native plants to provide the optimum percent cover necessary to reach a fully functional wetland.

3.2.4.5 Plan 4 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at .5 meter spacing.

Implementation of this plan would provide a benefit to water quality as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. The planting density is such that ensures high rates of survival and increases percent cover. Planting of native species at such a high density ensures the native species will outcompete any exotic species that could be introduced or by seed germination in the future. The reduced hydrology will reduce the overall water quality functions of the wetlands as compared to filling in the ditches proposed in plans 1 - 3.

3.2.4.6 Plan 5 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at 1 meter spacing.

Implementation of this plan would provide a benefit to water quality as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return. Once complete, the project would mature over a longer period of time; however, the project would provide for improved water quality functions. The reduced hydrology will reduce the overall water quality functions of the wetlands as compared to filling in the ditches proposed in plans 1 - 3.

3.2.4.7 Plan 6 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at 2 meter spacing.

Implementation of this plan would provide a benefit to water quality as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return. The sustainability of the project remains unknown and it may become necessary for the introduction of additional native plants to provide the optimum percent cover necessary to reach a fully functional wetland. The reduced hydrology will reduce the overall water quality functions of the wetlands as compared to filling in the ditches proposed in plans 1 - 3.

3.2.5 Land Use

3.2.5.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition; however there should be no change to current land use as the site is currently owned by the State of Mississippi and consists of a degraded wetland.

3.2.5.2 Plan 1 – Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at .5 meter spacing.

There would be no impacts to current land use as a result of construction of this alternative as the site is currently owned by the State of Mississippi and consists of a degraded wetland.

3.2.5.3 Plan 2 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

There would be no impacts to current land use as a result of construction of this alternative as the site is currently owned by the State of Mississippi and consists of a degraded wetland.

3.2.5.4 Plan 3 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 2 meter spacing.

There would be no impacts to current land use as a result of construction of this alternative as the site is currently owned by the State of Mississippi and consists of a degraded wetland.

3.2.5.5 Plan 4 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at .5 meter spacing.

There would be no impacts to current land use as a result of construction of this alternative as the site is currently owned by the State of Mississippi and consists of a degraded wetland.

3.2.5.6 Plan 5 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

There would be no impacts to current land use as a result of construction of this alternative as the site is currently owned by the State of Mississippi and consists of a degraded wetland.

3.2.5.7 Plan 6 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at 2 meter spacing.

There would be no impacts to current land use as a result of construction of this alternative as the site is currently owned by the State of Mississippi and consists of a degraded wetland.

3.3 Dantzler Environmental Restoration

The area was planted in plantation pines during the 1960s and ditches and stormwater lines were constructed in the 1970s in anticipation of residential development of the site. Long term exclusion of fire and the invasion of non-native species, Cogongrass and Chinese Tallow Trees have severely degraded the site.

3.3.1 Vegetation

3.3.1.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession and create a mixed pine/hardwood community.

3.3.1.2 Plan 1 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, 100% Removal of exotics and plantation pines over the project life, Fill in 100% artificial ditches.

Implementation of this plan will benefit vegetation. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain.

3.3.1.3 Plan 2 – Maintain Savannah Vegetation by Mowing Annually, 100% Removal of exotics and plantation pines over the project life, Fill in 100% artificial ditches.

Implementation of this plan will benefit vegetation. Restoration of hydrology by filling in of ditches will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease composition for native species.

3.3.2 Fish and Wildlife

3.3.2.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession, creating a mixed pine/hardwood forest community thus shifting the fish and wildlife species that would normally use the historical pine savannah habitat.

3.3.2.2 Plan 1 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, 100% Removal of exotics and plantation pines over the project life, Fill in 100% artificial ditches.

Implementation of this plan will benefit fish and wildlife species. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. Many fish and wildlife species depend on these disappearing habitats. Adequate restoration and fire management is necessary to ensure continued existence of species dependent on pine savannah habitats.

3.3.2.3 Plan 2 – Maintain Savannah Vegetation by Mowing Annually, 100% Removal of exotics and plantation pines over the project life, Fill in 100% artificial ditches.

Implementation of this plan will benefit fish and wildlife species. Restoration of hydrology by filling in of ditches will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease competition for native species. Mowing activities could impact ground nesting birds as well as other terrestrial mammals. Mowing creates additional ground litter that could inhibit daily activities of some species although maintenance of early successional habitat will benefit most species.

3.3.3 Threatened and Endangered Species

3.3.3.1 No Action

The invasive species would continue to thrive threatening to take over the site further degrading available habitat for use by the Mississippi sandhill crane.

3.3.3.2 Plan 1 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, 100% Removal of exotics and plantation pines over the project life, Fill in 100% artificial ditches.

Implementation of this plan will benefit the Mississippi sandhill crane by restoration of the savannah, the main habitat used by the species for nesting and foraging. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. The Alabama Red-bellied turtle has been documented in using channels within Mary Walker Bayou, adjacent to the project site. It is anticipated the species could use the project site for nesting. The Mississippi sandhill crane depends on this type habitat for its continued existence which has experienced declines due to development within coastal Mississippi.

3.3.3.3 Plan 2 – Maintain Savannah Vegetation by Mowing Annually, 100% Removal of exotics and plantation pines over the project life, Fill in 100% artificial ditches.

Implementation of this plan will benefit the endangered Mississippi Sandhill Crane and Alabama Red-bellied Turtle. Restoration of hydrology by filling in of ditches will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease competition for native species. Mowing activities could impact ground nesting birds such as the Mississippi sandhill crane. Mowing creates additional ground litter that could limit foraging efficiency of the Mississippi sandhill crane. The Alabama Red-bellied turtle has been documented in using channels within Mary Walker Bayou, adjacent to the project site. It is anticipated this species could use the project site for nesting.

3.3.4 Water Quality

3.3.4.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession and create a mixed pine/hardwood community.

3.3.4.2 Plan 1 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, 100% Removal of exotics and plantation pines over the project life, Fill in 100% artificial ditches.

Implementation of this plan will benefit water quality. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. It is anticipated that burning activities could have short term impacts to water quality due to runoff during rain events. This should be localized and short term in nature. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

3.3.4.3 Plan 2 – Maintain Savannah Vegetation by Mowing Annually, 100% Removal of exotics and plantation pines over the project life, Fill in 100% artificial ditches.

Implementation of this plan will benefit water quality. Restoration of hydrology by filling in of ditches will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease competition for native species. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

3.3.5 Land Use

3.3.5.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession and creating a mixed pine and hardwood community. There would be no impacts to current land use as a result of construction of this alternative as the site is currently owned by the State of Mississippi and consists of a degraded wetland.

3.3.5.2 Plan 1 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, 100% Removal of exotics and plantation pines over the project life, Fill in 100% artificial ditches.

There would be no impacts to current land use as a result of construction of this alternative as the site is currently owned by the State of Mississippi and consists of a degraded wetland.

3.3.5.3 Plan 2 – Maintain Savannah Vegetation by Mowing Annually, 100% Removal of exotics and plantation pines over the project life, Fill in 100% artificial ditches.

There would be no impacts to current land use as a result of construction of this alternative as the site is currently owned by the State of Mississippi and consists of a degraded wetland.

3.4 Turkey Creek Environmental Restoration

The site is primarily comprised of a pine savannah wetland. Several miles of ditches have been excavated throughout the site. Additionally, an elevated railway berm fragments the wetland habitat substantially altering hydrology of the wetlands located to the north.

3.4.1 Vegetation

3.4.1.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession and create a mixed pine/hardwood community.

3.4.1.2 Plan 1 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site.

Implementation of this plan will benefit vegetation. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain.

3.4.1.3 Plan 2 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site.

Implementation of this plan will benefit vegetation. Restoration of hydrology by filling in of ditches will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease composition for native species.

3.4.1.4 Plan 3 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area south of the railway berm.

Implementation of this plan will benefit vegetation. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain.

3.4.1.5 Plan 4 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area south of the railway berm.

Implementation of this plan will benefit vegetation. Restoration of hydrology by filling in of ditches will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease composition for native species.

3.4.1.6 Plan 5 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area north of the railway berm.

Implementation of this plan will benefit vegetation. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain.

3.4.1.7 Plan 6 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area north of the railway berm.

Implementation of this plan will benefit vegetation. Restoration of hydrology by filling in of ditches will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease composition for native species.

3.4.2 Fish and Wildlife

3.4.2.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession, creating a mixed pine/hardwood forest community thus shifting the fish and wildlife species that would normally use the historical pine savannah habitat.

3.4.2.2 Plan 1 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site.

Implementation of this plan will benefit fish and wildlife species. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. Many fish and wildlife species depend on these disappearing habitats. Adequate restoration and fire management is necessary to ensure continued existence of species dependent on pine savannah habitats. This plan would restore the entire area north and south of the railroad berm which would provide a contiguous fire maintained landscape. Larger blocks of habitat are more easily managed using fire and less fragmented landscapes provide more benefits to fish and wildlife species. Unfortunately the railroad berm presents a barrier to hydrology, fire and fish and wildlife species. To accommodate the barrier, additional culverts would be required as well as additional fire breaks for prevention of damages to the railroad berm by fire. Wildlife crossings would aid in dispersal of fish and wildlife species and would reduce train/wildlife collisions.

3.4.2.3 Plan 2 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site.

Implementation of this plan will benefit fish and wildlife species. Restoration of hydrology by filling in of ditches will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease competition for native species. Mowing activities could impact ground nesting birds as well as other terrestrial mammals. Mowing creates additional ground litter that could inhibit daily activities of some species although maintenance of early successional habitat will benefit most species. This plan would restore the entire area north and south of the railroad berm which would provide a contiguous habitat which would reduce fragmentation and the need for travel corridors. Unfortunately the railroad berm presents a barrier to hydrology and fish and wildlife species. To accommodate the barrier, additional culverts would be required as well as wildlife crossings. Wildlife crossings would aid in dispersal of fish and wildlife species and would reduce train/wildlife collisions.

3.4.2.4 Plan 3 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area south of the railway berm.

Implementation of this plan will benefit fish and wildlife species. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. Many fish and wildlife species depend on these disappearing habitats. Adequate restoration and fire management is necessary to ensure continued existence of species dependent on pine savannah habitats. This plan would only restore the area south of the railroad berm which would provide a contiguous fire maintained landscape. Larger blocks of habitat are more easily managed using fire and less fragmented landscapes provide more benefits to fish and wildlife species.

3.4.2.5 Plan 4 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area south of the railway berm.

Implementation of this plan will benefit fish and wildlife species. Restoration of hydrology by filling in of ditches will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease competition for native species. Mowing activities could impact ground nesting birds as well as other terrestrial mammals. Mowing creates additional ground litter that could inhibit daily activities of some species although maintenance of early successional habitat will benefit most species. This plan would restore the entire area south of the railroad berm which would provide a large contiguous habitat. Larger blocks of habitat are more easily managed and less fragmented landscapes provide more benefits to fish and wildlife species.

3.4.2.6 Plan 5 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area north of the railway berm.

Implementation of this plan will benefit fish and wildlife species. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. Many fish and wildlife species depend on these disappearing habitats. Adequate restoration and fire management is necessary to ensure continued existence of species dependent on pine savannah habitats. This plan would only restore the area north of the railroad berm which would provide a much smaller fire maintained landscape. Restoration of this habitat would provide benefits to fish and wildlife species even though the overall area is relatively smaller.

3.4.2.7 Plan 6 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area north of the railway berm.

Implementation of this plan will benefit fish and wildlife species. Restoration of hydrology by filling in of ditches will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease competition for native species. Mowing activities could impact ground nesting birds as well as other terrestrial mammals. Mowing creates additional ground litter that could inhibit daily activities of some species although maintenance of early successional habitat will benefit most species. This plan would restore the entire area north of the railroad berm which would provide a much smaller area for use as habitat. Restoration of this habitat would provide benefits to fish and wildlife species even though the overall area is relatively smaller.

3.4.3 Threatened and Endangered Species

3.4.3.1 No Action

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.4.3.2 Plan 1 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.4.3.3 Plan 2 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.4.3.4 Plan 3 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area south of the railway berm.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.4.3.5 Plan 4 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area south of the railway berm.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.4.3.6 Plan 5 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area north of the railway berm.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.4.3.7 Plan 6 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area north of the railway berm.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.4.4 Water Quality

3.4.4.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession and create a mixed pine/hardwood community.

3.4.4.2 Plan 1 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site.

Implementation of this plan will benefit water quality. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. It is anticipated that burning activities could have short term impacts to water quality due to runoff during rain events. This should be localized and short term in nature. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

3.4.4.3 Plan 2 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site.

Implementation of this plan will benefit water quality. Restoration of hydrology by filling in of ditches will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease composition for native species. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

3.4.4.4 Plan 3 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area south of the railway berm.

Implementation of this plan will benefit water quality. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. It is anticipated that burning activities could have short term impacts to water quality due to runoff during rain events. This should be localized and short term in nature. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

3.4.4.5 Plan 4 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area south of the railway berm.

Implementation of this plan will benefit water quality. Restoration of hydrology by filling in of ditches will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease composition for native species. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

3.4.4.6 Plan 5 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area north of the railway berm.

Implementation of this plan will benefit water quality. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. It is anticipated that burning activities could have short term impacts to water quality due to runoff during rain events. This should be localized and short term in nature. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi. This plan would restore the entire area north of the railroad berm which would provide a much smaller area providing water quality functions. Restoration of the water quality functions would replace lost functions even though the overall area is relatively smaller.

3.4.4.7 Plan 6 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area north of the railway berm.

Implementation of this plan will benefit water quality. Restoration of hydrology by filling in of ditches will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease composition for native species. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi. This plan would restore the entire area north of the railroad berm which would provide a much smaller area providing water quality functions. Restoration of the water quality functions would replace lost functions even though the overall area is relatively smaller.

3.4.5 Land Use

3.4.5.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area undergoes succession and creating a mixed pine and hardwood community. The No Action alternative being implemented would not preclude future development from occurring on the site as the site is owned by a private citizen.

3.4.5.2 Plan 1 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site.

Implementation of this plan would result in slight changes to current land use by restoration efforts. The site would continue to exist as a wetland with increased functions.

3.4.5.3 Plan 2 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site.

Implementation of this plan would result in slight changes to current land use by restoration efforts. The site would continue to exist as a wetland with increased functions.

3.4.5.4 Plan 3 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area south of the railway berm.

Implementation of this plan would result in slight changes to current land use by restoration efforts. The site would continue to exist as a wetland with increased functions.

3.4.5.5 Plan 4 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area south of the railway berm.

Implementation of this plan would result in slight changes to current land use by restoration efforts. The site would continue to exist as a wetland with increased functions.

3.4.5.6 Plan 5 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area north of the railway berm.

Implementation of this plan would result in slight changes to current land use by restoration efforts. The site would continue to exist as a wetland with increased functions.

3.4.5.7 Plan 6 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area north of the railway berm.

Implementation of this plan would result in slight changes to current land use by restoration efforts. The site would continue to exist as a wetland with increased functions.

3.5 Bayou Cumbest Environmental Restoration

The site consists of existing tidal marsh as well as filled and developed residential areas causing changes in the natural hydrology and subsequent losses and fragmentation to marsh. Hurricane Katrina left extensive debris fields and sedimentation in the area destroying many native trees and vegetation. Due to the loss of native species this area has a severe infestation of the invasive Chinese Tallow Tree, Cogongrass, and Phragmites which are invading the marshes and adjacent flatwoods.

3.5.1 Vegetation

3.5.1.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition.

3.5.1.2 Plan 1 – Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at .5 meter spacing.

There will be a benefit to vegetation as this plan will restore hydrology, remove exotics allowing native plants to become better established, and the planting density is such that ensures high rates of survival and increases per-cent cover. Planting of native species at such a high density ensures the native species will outcompete any exotic species that could be introduced or by seed germination in the future.

3.5.1.3 Plan 2 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

There will be a benefit to vegetation as this plan will restore hydrology, and remove exotics allowing native plants to become better established. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return.

3.5.1.4 Plan 3 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 2 meter spacing.

Implementation of this plan would provide a benefit to vegetation as this plan will restore hydrology, and remove exotics allowing native plants to become better established. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return.

3.5.1.5 Plan 4 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at .5 meter spacing.

Implementation of this plan would provide a benefit to vegetation as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. The planting density is such that ensures high rates of survival and increases percent cover. Planting of native species at such a high density ensures the native species will outcompete any exotic species that could be introduced or by seed germination in the future.

3.5.1.6 Plan 5 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

Implementation of this plan would provide a benefit to vegetation as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return.

3.5.1.7 Plan 6 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at 2 meter spacing.

Implementation of this plan would provide a benefit to vegetation as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return.

3.5.2 Fish and Wildlife

3.5.2.1 No Action

The invasive species would continue to thrive threatening to take over the site reducing available native forage for fish and wildlife species to use the area. Lack of available habitat could cause fish and wildlife species to move from the area seeking more suitable habitat.

3.5.2.2 Plan 1 – Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at .5 meter spacing.

There will be a benefit to fish and wildlife species, including essential fish habitat for managed species, as this plan would restore hydrology, remove exotics allowing native plants to become better established, and the planting density is such that ensures high rates of survival and increases percent cover. Planting of native species at such a high density ensures the native species will outcompete any exotic species that could be introduced or by seed germination in the future. This will provide valuable forage and cover for fish and wildlife species.

3.5.2.3 Plan 2 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

There will be a benefit to fish and wildlife species, including essential fish habitat for managed species, as this plan will restore hydrology, and remove exotics allowing native plants to become better established. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return and to provide necessary habitat for fish and wildlife species.

3.5.2.4 Plan 3 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

Implementation of this plan would provide a benefit to fish and wildlife species, including essential fish habitat for managed species, as this plan will restore hydrology, and remove exotics allowing native plants to become better established. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return. Increased maintenance activities could disrupt established use patterns by species and increased spacing would reduce the overall quality of the habitat to support foraging and cover.

3.5.2.5 Plan 4 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at .5 meter spacing.

Implementation of this plan would provide a benefit to fish and wildlife species, including essential fish habitat for managed species, as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. Lack of natural hydrology would impact fish and wildlife species that would naturally use an intact habitat and could also limit resources available for their survival. The planting density is such that ensures high rates of survival and increases percent cover. Planting of native species at such a high density ensures the native species will outcompete any exotic species that could be introduced or by seed germination in the future. This will provide valuable forage and cover for fish and wildlife species.

3.5.2.6 Plan 5 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

Implementation of this plan would provide a benefit to vegetation as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. Lack of natural hydrology would impact fish and wildlife species, including essential fish habitat for managed species, that would naturally use an intact habitat and could also limit resources available for their survival. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return and to provide necessary habitat for fish and wildlife species.

3.5.2.7 Plan 6 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at 2 meter spacing.

Implementation of this plan would provide a benefit to vegetation as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. Lack of natural hydrology would impact fish and wildlife species, including essential fish habitat for managed species, that would naturally use an intact habitat and could also limit resources available for their survival. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return. Increased maintenance activities could disrupt established use patterns by species and increased spacing would reduce the overall quality of the habitat to support foraging and cover.

3.5.3 Threatened and Endangered Species

3.5.3.1 No Action

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species, except for the Alabama Red-bellied Turtle as noted above.

3.5.3.2 Plan 1 – Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at .5 meter spacing.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.5.3.3 Plan 2 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.5.3.4 Plan 3 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.5.3.5 Plan 4 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at .5 meter spacing.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.5.3.6 Plan 5 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.5.3.7 Plan 6 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at 2 meter spacing.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.5.4 Water Quality

3.5.4.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition.

3.5.4.2 Plan 1 – Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at .5 meter spacing.

There will be a benefit to water quality as this plan will restore hydrology, remove exotics allowing native plants to become better established, and the planting density is such that ensures high rates of survival and increases per-cent cover. Planting of native species at such a high density ensures the native species will outcompete any exotic species that could be introduced or by seed germination in the future. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

3.5.4.3 Plan 2 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

There will be a benefit to water quality as this plan will restore hydrology, and remove exotics allowing native plants to become better established. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return. Once complete, the project would mature over a longer period of time; however, the project would provide for improved water quality functions. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

3.5.4.4 Plan 3 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 2 meter spacing.

Implementation of this plan would provide a benefit to water quality as this plan will restore hydrology, and remove exotics allowing native plants to become better established. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return. Although the project would provide benefits to water quality, the amount of time necessary would increase and a longer period of time would be needed in order for the wetland to reach maturity. The sustainability of the project remains unknown and it may become necessary for the introduction of additional native plants to provide the optimum percent cover necessary to reach a fully functional wetland.

3.5.4.5 Plan 4 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at .5 meter spacing.

Implementation of this plan would provide a benefit to water quality as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. The planting density is such that ensures high rates of survival and increases percent cover. Planting of native species at such a high density ensures the native species will outcompete any exotic species that could be introduced or by seed germination in the future. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

3.5.4.6 Plan 5 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

Implementation of this plan would provide a benefit to water quality as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return. Once complete, the project would mature over a longer period of time; however, the project would provide for improved water quality functions. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

3.5.4.7 Plan 6 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at 2 meter spacing.

Implementation of this plan would provide a benefit to water quality as this plan will partially restore hydrology, and remove exotics allowing native plants to become better established. Old fill material would be removed somewhat affecting the hydrologic regime. Due to the persistence of artificial ditches and channels, hydrology would not be completely restored at the site. The planting density is not at optimum level for expedited reestablishment of native species. This will reduce the percent cover which could allow for exotics to reestablish in the future. A higher degree of maintenance would be necessary over the life of the project to ensure exotic species do not return. Although the project would provide benefits to water quality, the amount of time necessary would increase and a longer period of time would be needed in order for the wetland to reach maturity. The sustainability of the project remains unknown and it may become necessary for the introduction of additional native plants to provide the optimum percent cover necessary to reach a fully functional wetland.

3.5.5 Land Use

3.5.5.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The site would remain a severely damaged residential community which may experience moderate rebuilding efforts in the future.

3.5.5.2 Plan 1 – Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at .5 meter spacing.

There would be a significant change in current land use as the existing site consists of a severely damaged residential community. Construction of this alternative would result in the removal of the residences and restoration of the area into a fully functional wetland.

3.5.5.3 Plan 2 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

There would be a significant change in current land use as the existing site consists of a severely damaged residential community. Construction of this alternative would result in the removal of the residences and restoration of the area into a fully functional wetland.

3.5.5.4 Plan 3 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

There would be a significant change in current land use as the existing site consists of a severely damaged residential community. Construction of this alternative would result in the removal of the residences and restoration of the area into a fully functional wetland.

3.5.5.5 Plan 4 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at .5 meter spacing.

There would be a significant change in current land use as the existing site consists of a severely damaged residential community. Construction of this alternative would result in the removal of the residences and restoration of the area into a fully functional wetland.

3.5.5.6 Plan 5 - Excavation of old fill material, Removal of exotics and maintenance over project life, Filling in 100% artificial ditches, Native Vegetation Plantings at 1 meter spacing.

There would be a significant change in current land use as the existing site consists of a severely damaged residential community. Construction of this alternative would result in the removal of the residences and restoration of the area into a fully functional wetland.

3.5.5.7 Plan 6 - Excavation of old fill material, Removal of exotics and maintenance over project life, Native Vegetation Plantings at 2 meter spacing.

There would be a significant change in current land use as the existing site consists of a severely damaged residential community. Construction of this alternative would result in the removal of the residences and restoration of the area into a fully functional wetland.

3.6 Franklin Creek Environmental Restoration

The site was identified as an interim project that consists of residential relocations which provides an opportunity for environmental restoration. The site currently consists of degraded pine flatwoods with numerous areas of fill as a result of residential development and the existing railroad which creates a hydrologic barrier between two separate areas.

3.6.1 Vegetation

3.6.1.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession and create a mixed pine/hardwood community.

3.6.1.2 Plan 1 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site, Add culverts under existing railroad berm.

Implementation of this plan will benefit vegetation. Restoration of hydrology by excavation of old roadbeds and any additional fill will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. Installation of culverts increases hydrologic connections between the two separate areas which will improve native vegetation.

3.6.1.3 Plan 2 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site, Add culverts under existing railroad berm.

Implementation of this plan will benefit vegetation. Restoration of hydrology by excavation of old roadbeds and any additional fill will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease competition for native species. Installation of culverts increases hydrologic connections between the two separate areas which will improve native vegetation.

3.6.1.4 Plan 3 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area southeast of railroad berm.

Implementation of this plan will benefit vegetation. Partial restoration of hydrology by removal of old fill will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain.

3.6.1.5 Plan 4 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area southeast of railroad berm.

Implementation of this plan will benefit vegetation. Partial restoration of hydrology by removal of old fill will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease composition for native species.

3.6.2 Fish and Wildlife

3.6.2.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession, creating a mixed pine/hardwood forest community thus shifting the fish and wildlife species that would normally use the historical pine savannah habitat.

3.6.2.2 Plan 1 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site, Add culverts under existing railroad berm.

Implementation of this plan will benefit fish and wildlife species. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. Many fish and wildlife species depend on these disappearing habitats. Adequate restoration and fire management is necessary to ensure continued existence of species dependent on pine savannah habitats. This plan would restore the entire area north and south of the railroad berm which would provide a contiguous fire maintained landscape. Larger blocks of habitat are more easily managed using fire and less fragmented landscapes provide more benefits to fish and wildlife species. Unfortunately the railroad berm presents a barrier to hydrology, fire, and fish and wildlife species. To accommodate the barrier, additional culverts would be required as well as additional fire breaks for prevention of damages to the railroad berm by fire. Wildlife crossings would aid in dispersal of fish and wildlife species and would reduce train/wildlife collisions.

3.6.2.3 Plan 2 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site, Add culverts under existing railroad berm.

Implementation of this plan will benefit fish and wildlife species. Restoration of hydrology by filling in of ditches will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease competition for native species. Mowing activities could impact ground nesting birds as well as other terrestrial mammals. Mowing creates additional ground litter that could inhibit daily activities of some species although maintenance of early successional habitat will benefit most species. This plan would restore the entire area north and south of the railroad berm which would provide a contiguous habitat which would reduce fragmentation and the need for travel corridors. Unfortunately the railroad berm presents a barrier to hydrology and fish and wildlife species. To accommodate the barrier, additional culverts would be required as well as wildlife crossings. Wildlife crossings would aid in dispersal of fish and wildlife species and would reduce train/wildlife collisions.

3.6.2.4 Plan 3 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area southeast of railroad berm.

Implementation of this plan will benefit fish and wildlife species. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. Many fish and wildlife species depend on these disappearing habitats. Adequate restoration and fire management is necessary to ensure continued existence of species dependent on pine savannah habitats. This plan would only restore the area south of the railroad berm which would provide a contiguous fire maintained landscape. Larger blocks of habitat are more easily managed using fire and less fragmented landscapes provide more benefits to fish and wildlife species.

3.6.2.5 Plan 4 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area southeast of railroad berm.

Implementation of this plan will benefit fish and wildlife species. Restoration of hydrology by filling in of ditches will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease competition for native species. Mowing activities could impact ground nesting birds as well as other terrestrial mammals. Mowing creates additional ground litter that could inhibit daily activities of some species although maintenance of early successional habitat will benefit most species. This plan would restore the entire area south of the railroad berm which would provide a large contiguous habitat. Larger blocks of habitat are more easily managed and less fragmented landscapes provide more benefits to fish and wildlife species.

3.6.3 Threatened and Endangered Species

3.6.3.1 No Action

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.6.3.2 Plan 1 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site, Add culverts under existing railroad berm.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.6.3.3 Plan 2 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site, Add culverts under existing railroad berm.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.6.3.4 Plan 3 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area southeast of railroad berm.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.6.3.5 Plan 4 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area southeast of railroad berm.

It is anticipated there will be no impacts to threatened and endangered species as the project area does not offer suitable habitat for any of the listed species.

3.6.4 Water Quality

3.6.4.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area would undergo succession and create a mixed pine/hardwood community.

3.6.4.2 Plan 1 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site, Add culverts under existing railroad berm.

Implementation of this plan will benefit water quality. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. It is anticipated that burning activities could have short term impacts to water quality due to runoff during rain events. This should be localized and short term in nature. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

3.6.4.3 Plan 2 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site, Add culverts under existing railroad berm.

Implementation of this plan will benefit water quality. Restoration of hydrology by filling in of ditches will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease composition for native species. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

3.6.4.4 Plan 3 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area southeast of railroad berm.

Implementation of this plan will benefit water quality. Restoration of hydrology by filling in of ditches will help reestablish native vegetation but more importantly the fire regime will clear out and open up the under and mid-stories which will allow native grasses to become established. Removal of exotic species will allow for native species to remain. It is anticipated that burning activities could have short term impacts to water quality due to runoff during rain events. This should be localized and short term in nature. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

3.6.4.5 Plan 4 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area southeast of railroad berm.

Implementation of this plan will benefit water quality. Restoration of hydrology by filling in of ditches will help reestablish native vegetation. Mowing will help maintain succession by removing brushy under and mid-stories but may not completely encourage establishment of native species as most are fire dependent for establishment. Removal of exotic species will decrease composition for native species. Once complete, the project would continue to mature resulting in additional water quality functions over time. It is expected the wetlands would be sustainable over an indefinite period of time replacing vital lost water quality functions throughout coastal Mississippi.

3.6.5 Land Use

3.6.5.1 No Action

The invasive species would continue to thrive threatening to take over the site. The area would continue to experience changes in hydrology due to excessive sedimentation and changes in native species composition. The area undergoes succession and creating a mixed pine and hardwood community. The No Action plan would result in no changes in current land use; although prior to implementation of the Interim Project, the area consisted primarily of a residential community.

3.6.5.2 Plan 1 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site, Add culverts under existing railroad berm.

Implementation of this plan would result in significant changes to current land use as the project consists of a prior developed residential community.

3.6.5.3 Plan 2 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over entire site, Add culverts under existing railroad berm.

Implementation of this plan would result in significant changes to current land use as the project consists of a prior developed residential community.

3.6.5.4 Plan 3 – Maintain Savannah Vegetation by Prescribed Burning on a 3-5 year cycle, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area southeast of railroad berm.

Implementation of this plan would result in significant changes to current land use as the project consists of a prior developed residential community.

3.6.5.5 Plan 4 – Maintain Savannah Vegetation by Mowing annually, Fill in 100% artificial ditches, Excavate and remove existing roadbeds and any additional fill material over area southeast of railroad berm.

Implementation of this plan would result in significant changes to current land use as the project consists of a prior developed residential community.

1.4 Environmental Restoration Being Considered for Construction

1.4.1 ADMIRAL ISLAND RESTORATION BENEFITS

Admiral Island, Hancock County

The Admiral Island restoration area contains 123 acres to be restored to 62 acres of emergent tidal marsh and 61 acres of scrub shrub habitats (Figure 5.6.1-2). The tidal marshes in this area were ditched during the 1960s causing changes in the natural hydrology and subsequent changes in the species composition. Hurricane Katrina left extensive debris fields and sedimentation in the area and destroyed many native trees and vegetation. Due to the loss of native species this area has a severe infestation of the invasive Chinese Tallow tree, which is invading the marshes and the adjacent flatwoods. For increased habitat diversity, the team proposed to leave some of the higher elevations as is and plant shrub/scrub species in order to enhance environmental benefits at the restoration site. The diverse habitat allows for a variety of fish and wildlife to utilize the area which increases the environmental benefits.

Objective:

1. Restore the natural hydrology.
2. Restore native wetland plant communities.
3. Provide storm surge protection.
4. Provide fish and tidal wildlife habitat.
5. Prevent saltwater intrusion

Measures:

1. Excavation of old fill material (includes 90-95% removal of existing exotic species in excavated areas) (Mandatory).

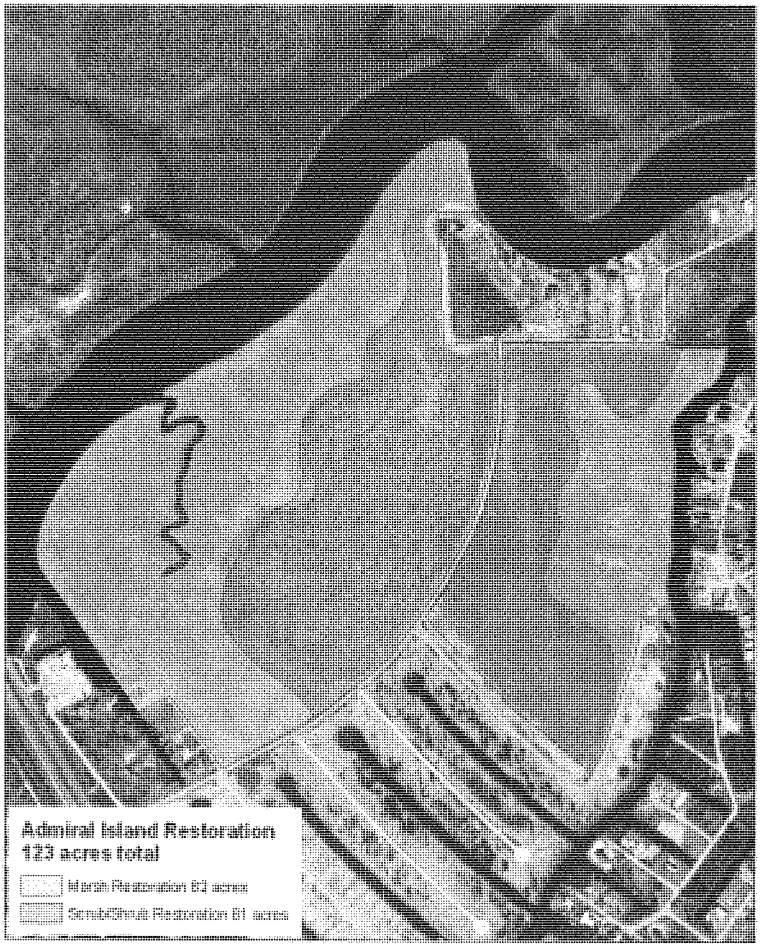


Figure 5.6.1-2. Admiral Island Restoration Site

This measure, in conjunction with measure 3, affects the hydrologic regime variable, which under existing conditions receives a score 0.25, on the assumption that greater than half the site has been filled above the normal tidal flooding zone. This measure by itself would raise the hydrologic regime variable to a 0.75.

2. 100% removal of exotics from non-excavated areas and maintain removal of exotic plant species in all areas over project lifetime. (Mandatory in all plans).

This measure affects the "percent cover by invasive or exotic species" variable, and would raise the variable score to 1.0 under all plans

3. Filling in 100% of existing artificial ditches/channels.

   If this measure is performed in addition to the mandatory measure 1, the hydrologic regime variable score would increase to 1.0 as there would be no more hydrologic alterations to the site.

4. Native Vegetation Planting

Alternatives:

a) 0.5 meter spacing

b) 1 meter spacing

c) 2 meter spacing

This measure affects the "percent cover by woody plant species", "wildlife habitat diversity", "vegetation height", "wetland indicator status" and "mean percent cover emergent plant species" variables. The relevant vegetation variables are assumed to reach their highest potential score at year 5 under 0.5 meter spacing, year 7 with 1.0 meter spacing, and year 10 with 2.0 meter spacing, and then sustained at that level for the project life (50 years). Variable subindex scores are treated as increasing linearly from their value under the no-action plan up to their highest potential value obtained at year 5, 7, or 10, depending on the planting spacing, and then remaining constant thereafter (Tables 5.6.1-4 and 5.6.1-5).

Table 5.6.1-4.
Measures

Plan 1. 1,2,3,4a	Plan 2. 1,2,3,4b	Plan 3. 1,2,3,4c
Plan 4. 1,2,4a	Plan 5. 1,2,4b	Plan 6. 1,2,4c

Table 5.6.1-5.
Summary of AAFU Benefits From Various Restoration Plans

Site	Restoration Acres	Plan	AAFU Benefit
Admiral Island	62	No-action plan	0
Admiral Island	62	Plan 1	61
Admiral Island	62	Plan 2	60
Admiral Island	62	Plan 3	59
Admiral Island	62	Plan 4	51
Admiral Island	62	Plan 5	50.5
Admiral Island	62	Plan 6	49

The management measures were combined to create six plans that were analyzed to determine the cost-effectiveness of each. Economically ineffective plans are identified and eliminated to determine which plans are cost-effective. An economically ineffective plan is a plan that cost more or the same as a subsequent plan but produces less benefit than that subsequent plan. Of the six plans analyzed, two plans were eliminated because they produced less benefit at greater cost than a subsequent plan.

The recommended plan consists of restoring the study area by excavating old fill material, removing exotic plant species from non-excavated areas, planting native vegetation at a density of 1.0 meter, and filling existing artificial ditches. The planting of native vegetation consist of *S. alteniflora, J. roemerianus, and S. patens.*

Benefits are measured in terms of AAFU. The HGM approach was used to assess wetland function similar to Bayou Cumbest. Table 5.6.1-6 shows the total functional units under each implemented plan and the AAFU net benefit. To calculate the AAFU net benefit, it is assumed that benefits will be maximized at year 5 with 0.5 meter spacing of vegetation, at year 7 with 1.0 meter spacing of vegetation, and at year 10 with 2.0 meter spacing of vegetation. These benefits are estimated to be sustainable over the life of the project. Net AAFU benefits are calculated as the difference between the total functional units for the ecosystem restoration plan and the total functional units for the no action plan. The recommended plan was selected based on the criteria used for Bayou Cumbest.

1.4.2 BAYOU CUMBEST RESTORATION BENEFITS

Environmental Benefits of Bayou Cumbest Restoration

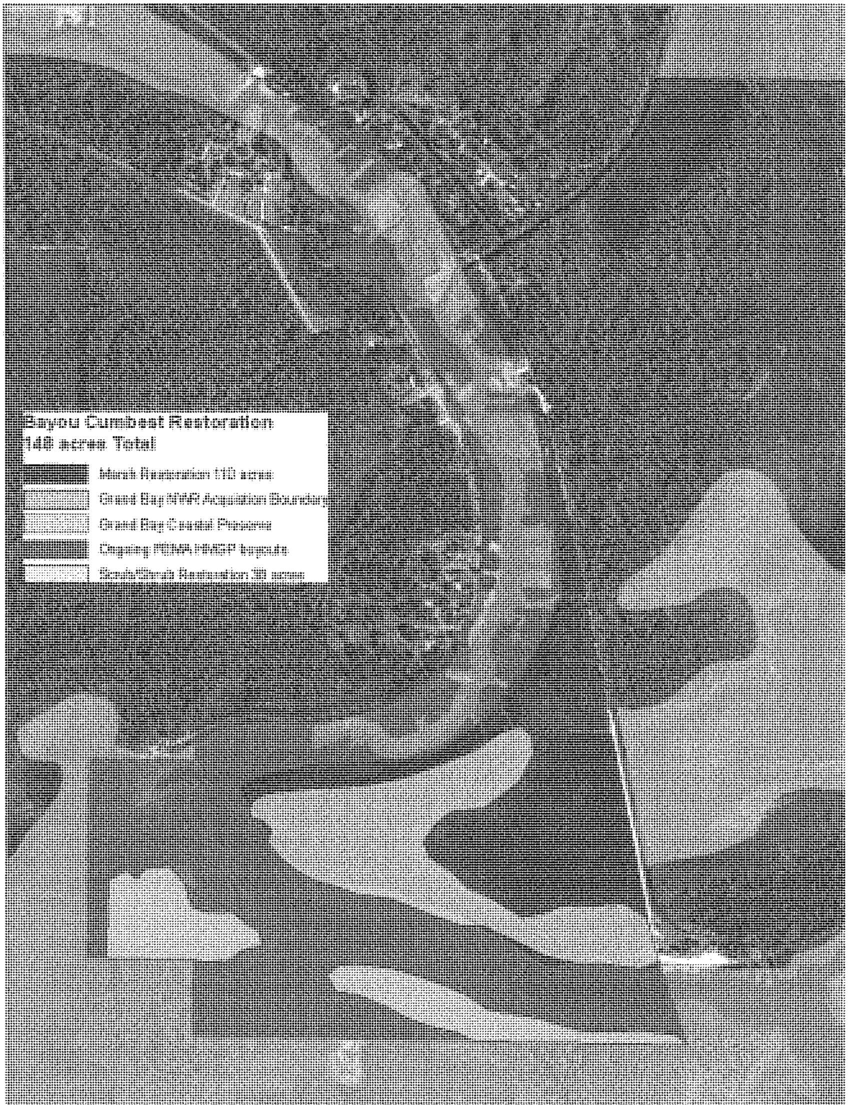


Figure 1. Bayou Cumbest restoration site.

The Bayou Cumbest restoration area (Figure 1) contains 148 acres, of which 110 acres would be restored to tidal marsh and the remaining 38 acres would remain scrub/shrub wetland habitat. The area presently consists of previously filled areas, some tidal marsh, and scrub shrub.

Objective:
1. Restore marsh to historical (pre-development ~1950's) conditions.
2. Provide storm surge protection.
3. Restore native tidal wetland plant community.
4. Provide fish and tidal wildlife habitat.
5. Prevent saltwater intrusion

Assumptions:
1. Mandatory buy-outs.
2. 100% removal of existing structures

Measures:
1. Excavation of old fill material (includes 90-95% removal of existing exotic species in excavated areas) (Mandatory)

This measure, in conjunction with measure 3, affects the hydrologic regime variable, which under existing conditions receives a score 0.50, on the assumption that approximately half the site has been filled above the normal tidal flooding zone. This measure by itself would raise the hydrologic regime variable to a 0.75.

2. 100% removal of exotics from non-excavated areas and maintain removal of exotic species (Chinese Tallow, Phragmites, Cogon Grass) in all areas over project lifetime. (Mandatory in all plans).

This measure affects the "percent cover by invasive or exotic species" variable, and would raise the variable score to 1.0 under all plans

3. Filling in 100% of existing artificial ditches/channels

If this measure is performed in addition to the mandatory measure 1, the hydrologic regime variable score would increase to 1.0 as there would be no more hydrologic alterations to the site.

4. Native Vegetation Planting

Alternatives

a) 0.5 meter spacing

b) 1 meter spacing

c) 2 meter spacing

This measure affects the "percent cover by woody plant species", "wildlife habitat diversity", "vegetation height", "wetland indicator status" and "mean percent cover emergent plant species" variables. The relevant vegetation variables are assumed to reach their highest potential score at year 5 under 0.5 meter spacing, year 7 with 1.0 meter spacing, and year 10 with 2.0 meter spacing, and then sustained at that level for the project life (50 years). Variable subindex scores are treated as increasing linearly from their value under the no-action plan up to their highest potential value obtained at year 5, 7, or 10, depending on the planting spacing, and then remaining constant thereafter.

Plans:
Plan 1: 1,2,3,4a
Plan 2: 1,2,3,4b
Plan 3: 1,2,3,4c
Plan 4: 1,2,4a
Plan 5: 1,2,4b
Plan 6: 1,2,4c

Benefits:

Table 1 shows the average annual functional unit (AAFU) benefit under each plan.

Table 1.
Summary of Average Annual Functional Unit Benefits From Various Restoration Plans

Site	Restoration Acres	Plan	Average Annual Functional Unit Benefit[1]
Bayou Cumbest	110	No-action plan	0
Bayou Cumbest	110	plan 1	191
Bayou Cumbest	110	plan 2	188
Bayou Cumbest	110	plan 3	184
Bayou Cumbest	110	plan 4	172
Bayou Cumbest	110	plan 5	169
Bayou Cumbest	110	plan 6	164

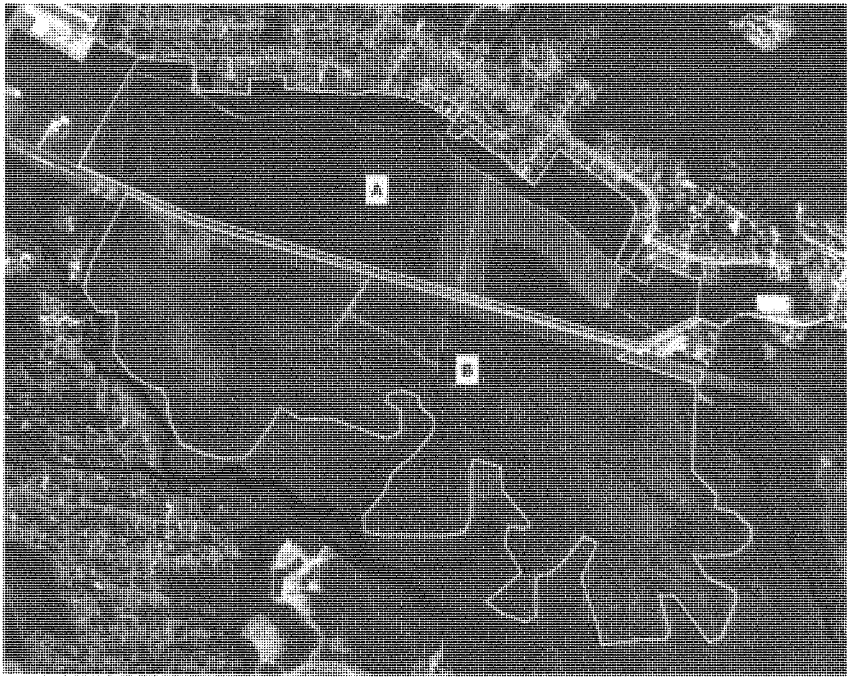
References

Shafer, D. J., T. H. Roberts, M. S. Peterson, and K. Schmid. (in press). "A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing the Functions of Tidal Fringe Wetlands Along the Mississippi and Alabama Gulf Coast." U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

1.4.3 DANTZLER RESTORATION BENEFITS

Environmental Benefits of Dantzler restoration

Source: Corps
Figure 1. Dantzler restoration site.



Source: Corps

The Dantzler restoration area (Figure 1) contains 385 acres to be restored to wet pine savanna. The restorable area is split by a road, 151 of the acres are north of the road and the remaining 234 acres are south of the road. This area was planted in plantation pine during the 1960s and ditches and stormwater lines were constructed in the early 1970s in anticipation of residential development of the site. The long-term exclusion of fire and the invasion of non-native species such as Cogongrass and Chinese Tallowtree have severely degraded the site.

Objective:

1. Restore the natural hydrology.
2. Restore natural fire regime.
3. Restore native wetland plant communities.
4. Provide storm surge protection.
5. Provide fish and tidal wildlife habitat.

Assumptions:

Measures:

1. Maintain native savanna vegetation. (Mandatory)
   Alternative:
   a. prescribed burning on a 3-5 year cycle.
   b. mowing annually.

This measure affects the "area of contiguous fire-maintained landscape", as well as all plant related variables used in the model. It is assumed that these variables will recover to a score of 1.0 under the burn alternative. Under the mowing alternative, the "area of contiguous fire-maintained" landscape variable will score a 0.0 but the plant related variables will still score a 1.0, similar to burning.

2. 100% removal of exotics and plantation pine; maintain removal of exotic plant species in all areas over project lifetime. (Mandatory in all plans).

This measure affects the "percent cover by invasive or exotic species" variable, and would raise the variable score to 1.0 under all plans

3. Filling in 100% of existing artificial ditches. (Mandatory)

If this measure is performed in addition to the mandatory measure 1, the hydrologic regime variable score would increase to 1.0 as there would be no more hydrologic alterations to the site.

Plans:
Plans 1-2: Restoring areas both north and south of road (areas A and B)
Plan 1: 1a,2,3
Plan 2: 1b,2,3
Plans 3-4: Restoring only area north of road (Area A)
Plan 3: 1a,2,3
Plan 4: 1b,2,3
Plans 5-6: Restoring only area south of road (Area B)
Plan 5: 1a,2,3
Plan 6: 1b,2,3

Benefits:

Table 1 shows the average annual functional unit (AAFU) benefit under each plan.

Table 1.
Summary of Average Annual Functional Unit Benefits From Various Restoration Plans

Site	Restoration Acres	Plan	Average Annual Functional Unit Benefit
Dantzler	385	No-action plan	0

Dantzler	385	plan 1	1,244
Dantzler	385	plan 2	943
Dantzler	151	plan 3	488
Dantzler	151	plan 4	370
Dantzler	234	plan 5	756
Dantzler	234	plan 6	573

References

Shafer, D. J., T. H. Roberts, M. S. Peterson, and K. Schmid. (in press). "A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing the Functions of Tidal Fringe Wetlands Along the Mississippi and Alabama Gulf Coast." U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

1.4.4 Franklin Creek Restoration Benefits

Environmental Benefits from Franklin Creek Restoration

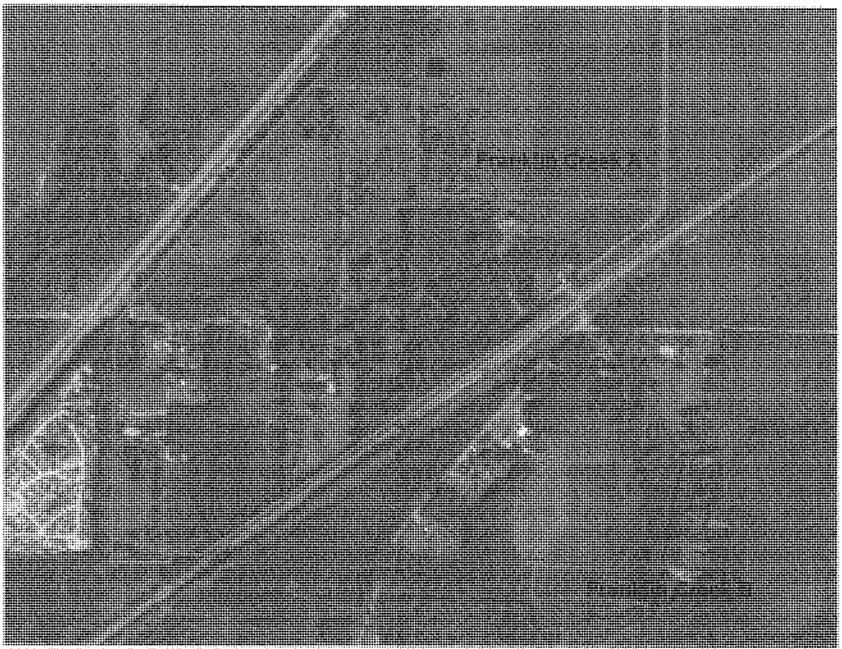


Figure 1. Franklin Creek restoration site, broken into assessment areas north (green border) and south (red border) of the railroad.

The Franklin Creek project site is located in eastern Jackson County and has been funded for homeowners assistance and relocation as part of the MsCIP Interim Report. The project consists of 149 acres located north and south of the CSX railroad.

Restoration Options: Franklin Creek (Pine Savanna)

Objectives:
1. Restore native vegetation
2. Restore natural hydrology
3. Restore fish and wildlife habitat
4. Provide storm water storage protection.

Assumptions:
1. Mandatory buy-outs.

Measures:

Listed below are the proposed restoration measures and their expected effect on variables used in the HGM model.

1. Filling in ditches (Mandatory)

This measure affects the "Outflow of Water" variable, which measures the removal of water by ditches or drains. The variable score would increase from 0.1 to 1.0 under this measure.

2. Maintain vegetation (Mandatory)

Alternatives

a. Burn (3 year cycle)

b. Mow (annual)

This measure affects the "area of contiguous fire-maintained landscape", as well as all plant related variables used in the model. It is assumed that these variables will recover to a score of 1.0 under the burn alternative. Under the mowing alternative, the "area of contiguous fire-maintained landscape variable will score a 0.05 but the plant related variables will still score a 1.0, similar to burning.

3. Excavate and remove existing roadbeds and any additional fill (Mandatory)

This measure affects the "surface water storage" variable, which measures the presence of excavation or fill at the site. This variable score would increase from 0.1 to 1.0 in areas with existing roadbeds/fill.

4. Add culverts (Mandatory)

This measure increases the hydrologic connection between the two existing wetland areas separated by an elevated railway. The wetlands are primarily precipitation driven resulting in sheet flow drainage. Additional culverts will result in increased sheet flow drainage reducing standing surface water in the northern wetland area.

Plans:

Plans 1-2 - Restoring areas A and B

Plan 1: 1, 2a, 3, 4

Plan 2: 1, 2b, 3, 4

Plans 3-4 Restoring just area B

Plan 3: 1, 2a, 3

Plan 4: 1, 2b, 3

Benefits:

Table 1 shows the total functional units of the site under each plan, and the average annual functional unit (AAFU) benefit. It is assumed here that functional units will remain the same under existing conditions and the no-action plan. To calculate the AAFU, it is assumed all benefits are immediately accrued following plan implementation, and that the benefits are sustainable over the life of the project. Therefore, the AAFU was simply calculated as the difference between the total functional units for the restoration plan the total functional units for the no-action plan.

Table 1.
Summary of Functional Unit Benefits From Various Restoration Plans

Site	Restoration Acres	Plan	Average Annual Functional Unit Benefit
Franklin Creek	149	No-action plan (plans 1-2)	0
Franklin Creek	56	No-action plan (plans 3-4)	0
Franklin Creek	149	plan 1	516
Franklin Creek	149	plan 2	399
Franklin Creek	56	plan 3	194
Franklin Creek	56	plan 4	150

References

Rheinhardt, R. D., Rheinhardt, M. C., and Brinson, M. M. (2002). "A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Wet Pine Flats on Mineral Soils in the Atlantic and Gulf Coastal Plains," ERDC/EL TR-02-9, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

1.4.5 Turkey Creek Restoration Benefits

Environmental Benefits from Turkey Creek Restoration

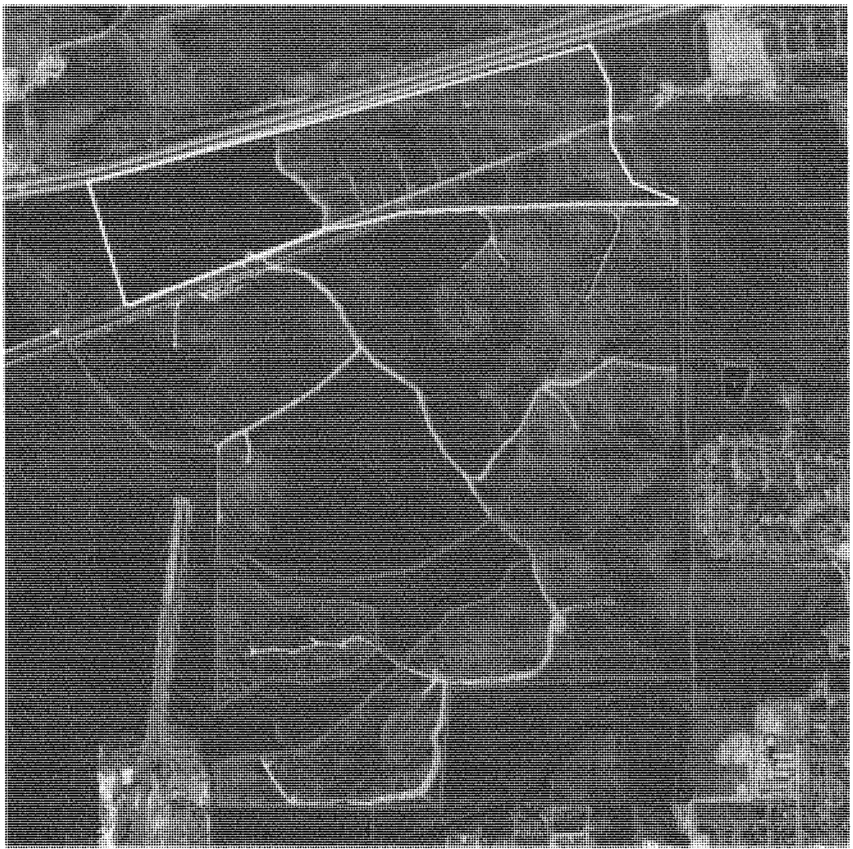


Figure 1. Turkey Creek restoration site, broken into assessment areas north (yellow border) and south (pink border) of the railroad.

The Turkey Creek site had an HGM assessment performed in 2000, using the Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Wet Pine Flats on Mineral Soils in the Atlantic and Gulf Coastal Plains (Rheinhardt et al 2002). Results from this earlier assessment are being used to establish baseline (current) conditions at the site. The site has been divided into 8 separate assessment areas (figure 1), as there were different baseline conditions for each area. The same HGM model is also being used to measure functional unit benefits at the site resulting from different restoration plans.

Restoration Options: Turkey Creek (Pine Savanna)

Objectives:
1. Restore native vegetation
2. Restore natural hydrology
3. Restore fish and wildlife habitat
4. Provide storm water storage protection.
5. Restore and maintain State water quality.

Assumptions:
1. Mandatory buy-outs.

Measures:
Listed below are the proposed restoration measures and their expected effect on variables used in the HGM model.

1. Filling in ditches (Mandatory)

This measure affects the "Outflow of Water" variable, which measures the removal of water by ditches or drains. The variable score would increase from 0.1 to 1.0 under this measure.

2. Maintain vegetation (Mandatory)

Alternatives

a. Burn (3 year cycle)

b. Mow (annual)

This measure affects the "area of contiguous fire-maintained landscape", as well as all plant related variables used in the model. It is assumed that these variables will recover to a score of 1.0 under the burn alternative. Under the mowing alternative, the "area of contiguous fire-maintained landscape variable will score a 0.0 but the plant related variables will still score a 1.0, similar to burning.

3. Excavate and remove existing roadbeds and any additional fill (Mandatory)

This measure affects the "surface water storage" variable, which measures the presence of excavation or fill at the site. This variable score would increase from 0.1 to 1.0 in areas with existing roadbeds/fill.

Plans:

Plans 1-2 - Restoring areas north and south of railroad
Plan 1: 1, 2a, 3
Plan 2: 1, 2b, 3

Plans 3-4 Restoring just areas south of railroad
Plan 3: 1, 2a, 3
Plan 4: 1, 2b, 3

Plans 3-4 Restoring just areas north of railroad
Plan 5: 1, 2a, 3
Plan 6: 1, 2b, 3

Benefits:

Table 1 shows the total functional units of the site under each plan, and the average annual functional unit (AAFU) benefit. It is assumed here that functional units will remain the same under existing conditions and the no-action plan. To calculate the AAFU, it is assumed all benefits are immediately accrued following plan implementation, and that the benefits are sustainable over the life of the project. Therefore, the AAFU was simply calculated as the difference between the total functional units for the restoration plan the total functional units for the no-action plan.

Table 1.
Summary of Functional Unit Benefits From Various Restoration Plans

Site	Restoration Acres	Plan	Total Functional Units	Average Annual Functional Unit Benefit
Turkey Creek	879	Existing Condition (plans 1-2)	1,222	-
Turkey Creek	689	Existing Condition (plans 3-4)	1,012	-
Turkey Creek	190	Existing Condition (plans 5-6)	210	-
Turkey Creek	879	No-action plan (plans 1-2)	1,222	0
Turkey Creek	689	No-action plan (plans 3-4)	1,012	0
Turkey Creek	190	No-action plan (plans 5-6)	210	0
Turkey Creek	879	plan 1	3,268	2,046
Turkey Creek	879	plan 2	2,574	1,352
Turkey Creek	689	plan 3	2,577	1,565
Turkey Creek	689	plan 4	2,037	815
Turkey Creek	190	plan 5	691	481
Turkey Creek	190	plan 6	537	327

References

Rheinhardt, R. D., Rheinhardt, M. C., and Brinson, M. M. (2002). "A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Wet Pine Flats on Mineral Soils in the Atlantic and Gulf Coastal Plains," ERDC/EL TR-02-9, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

1.4.6 DEER ISLAND RESTORATION BENEFITS

FUNCTIONAL HABITAT INDEX

Future Without Project Condition

Functions	Shore line Birds	Migratory Birds	Native Fish	Sport Fish	Macro Invertebrates & Primary Producers	Bivalves	Future Without Project Functional Habitat Index (FHI)	Future Without Project FHI 525 acres
Restoration of Emergent Beach and Dune System	-	-	-	-	-	-	-	0.0
Restoration of Maritime Forest Habitat	-	-	-	-	-	-	-	0.0
Soft Substrate	-	-	-	-	-	-	-	0.0
Reestablishment of pre-disturbance shoreline	-	-	-	-	-	-	-	0.0
Reduced Wave Energy along Grand Bayou and the Southern Shoreline	-	-	-	-	-	-	-	0.0
Shoreline Stabilization	-	-	-	-	-	-	-	0.0
Roosting Habitat	-	-	-	-	-	-	-	0.0
Nesting Habitat	-	-	-	-	-	-	-	0.0
Native Vegetation Propagation	0.05	0.05	-	-	-	-	0.10	52.5
Shoreline Foraging Habitat	-	-	0.05	0.05	-	-	0.10	52.5
Erosion Control	-	-	-	-	-	-	-	0.0
Sediment Stabilization	-	-	-	-	-	-	-	0.0
Water Quality	-	-	-	-	-	-	-	0.0
Hard Substrate-ocean bottom or submerged rip-rap	-	-	-	-	-	-	-	0.0
Direct Benefit = 0.10 **Indirect Benefit = 0.05**							**Total FHI = 0.20**	**105**

Total Table FHI = 105

FUNCTIONAL HABITAT INDEX

Restoration of Grand Bayou (Proposed-Profile 1) and The West End Breach (Proposed) and Entire Southern Shoreline

Functions	Shore line Birds	Migratory Birds	Native Fish	Sport Fish	Macro Invertebrates & Primary Producers	Bivalves	Proposed Alternative Functional Habitat Index (FHI)	Proposed Alternative FHI 525 acres	Future Without Future w/o FHI	Future Without FHI 0 acres
Restoration of Emergent Beach and Dune System	0.10	0.10	0.05	0.05	0.05	-	0.35	183.75	-	0.0
Restoration of Maritime Forest Habitat	0.10	0.10	-	-	0.05	-	0.25	131.25	-	0.0
Soft Substrate	0.05	0.05	0.10	0.10	0.05	0.05	0.40	210	-	0.0
Reestablishment of pre-disturbance shoreline	0.05	0.05	-	-	-	-	0.10	52.5	-	0.0
Reduced Wave Energy along Grand Bayou and the Southern Shoreline	0.10	0.10	0.05	0.05	0.05	0.05	0.40	210	-	0.0
Shoreline Stabilization	0.05	0.05	0.05	0.05	-	-	0.20	105	-	0.0
Roosting Habitat	0.10	0.10	-	-	-	-	0.20	105	-	0.0
Nesting Habitat	0.10	0.10	-	-	-	-	0.20	105	-	0.0
Native Vegetation Propagation	0.10	0.10	0.05	0.05	0.10	-	0.40	210	0.10	0.0
Shoreline Foraging Habitat	0.10	0.10	0.10	0.10	0.05	0.05	0.50	262.5	0.10	0.0
Erosion Control	0.05	0.05	0.05	0.05	0.05	0.10	0.35	183.75	-	0.0
Sediment Stabilization	0.05	0.05	0.05	0.05	0.05	0.10	0.35	183.75	-	0.0
Water Quality	-	-	0.05	0.05	0.05	0.05	0.20	105	-	0.0
Hard Substrate-ocean bottom or submerged rip-rap	-	-	0.05	0.05	-	0.10	0.20	105	-	0.0
Direct Benefit = 0.10										
Indirect Benefit = 0.05							**Total FHI = 4.1**	**2152.5**	**0.20**	**0.0**

Total Table FHI = 2152.5

1.4.7 BARRIER ISLANDS RESTORATION BENEFITS

Littoral Zone Placement & Fill of Breach Between West & East Ship Islands

	Habitat Units									
Assessment Variables	*Shorebirds*	*Waterfowl*	*Migratory Birds*	*Raptors*	*Beach Fauna*	*Dune Flora and Fauna*	*Oysters*	*Estuarine Fish*	*Threatened and Endangered Species*	***Functional Habitat Unit***
Island Persistence	10	8	10	8	10	10	10	10	10	86
Shoreline Stabilization	10	8	8	8	10	10	10	6	10	80
Reproduction Habitat	10	0	0	0	8	10	10	10	10	58
Feeding Habitat	10	6	10	8	8	10	10	10	10	82
Roosting Habitat	10	6	8	6	10	10	10	10	10	80
Wintering Habitat	10	6	8	6	10	10	10	10	10	80
Dune Habitat	10	10	10	10	10	10	10	10	10	90
Beach Habitat	10	10	10	10	10	10	10	10	10	90
Water Column Habitat	8	8	8	8	8	8	10	10	10	78
Water-Land Interface Habitat	10	10	10	10	10	10	10	10	10	90
Fishery Habitat	10	10	10	10	10	10	10	10	10	90
Oyster Habitat	6	6	6	6	6	8	10	8	8	64
									TOTAL FHI	**968**

NO ACTION

	Habitat Units									
Assessment Variables	*Shorebirds*	*Waterfowl*	*Migratory Bi*	*Raptors*	*Beach Fa*	*Dune Flora and Fauna*	*Oysters*	*Estuarine Fish*	*Threatened and Endangered Species*	***Functional Habitat Unit***
Island Persistence	0	0	0	0	0	0	0	0	0	***0***
Shoraline Stabilization	0	0	0	0	0	0	0	0	0	0
Reproduction Habitat	0	0	0	0	0	0	0	0	0	0
Feeding Habitat	0	0	0	0	0	0	0	0	0	0
Roosting Habitat	0	0	0	0	0	0	0	0	0	0
Wintering Habitat	0	0	0	0	0	0	0	0	0	0
Dune Habitat	0	0	0	0	0	0	0	0	0	0
Beach Habitat	0	0	0	0	0	0	0	0	0	0
Water Column Habitat	2	2	2	2	2	2	2	2	2	18
Water-Land Interface Habitat	0	0	0	0	0	0	0	0	0	0
Fishery Habitat	2	2	2	2	2	2	2	2	2	18
Oyster Habitat	2	2	2	2	2	2	2	2	2	18
									TOTAL FHI	**54**

1.4.8 BAYOU CUMBEST SUBMERGED AQUATIC VEGETATION BENEFITS

Species of fishes commonly found in Submerged Aquatic Vegetation Habitats in the Grand Bay National Estuarine Research Reserve.

Scientific Name	Common Name
Anchoa mitchilli	Bay anchovy
Archosargus probatacephalus	Sheepshead
Bairdiella chrysoura	Silver perch (drum family)
Brevoortia patronus	Gulf menhaden
Chasmodes saburrae	Florida blenny
Citharichthys spilopterus	Bay whiff (flounder)
Ctenogobius boleosoma	Darter goby
Cynoscion nebulosus	Spotted seatrout
Eucinostomus argenteus	Spot-fin mojarra
Lagodon rhomboides	Pinfish
Leiostomus xanthurus	Spot
Lucania parva	Rainwater killifish
Lutjanus grisues	Grey snapper (mangrove snapper)
Menidia beryllina	Inland silverside
Mugil cephalus	Striped mullet
Mycteroperca microlepis	Gag grouper
Oligoplites saurus	Leatherjack
Orthopristis chrysoptera	Pigfish
Sphoeroides parvus	Least puffer
Sphyraena guachancho	Guaguanche (barracuda family)
Sygnathus louisianae	Chain pipefish
Sygnathus scovelli	Gulf pipefish
Symphurus plagiusa	Black cheeked tonguefish
Synodus foetens	Inshore lizardfish

SECTION 2
ENVIRONMENTAL AGENCY SUPPORT DOCUMENTS

FISH AND WILDLIFE COORDINATION ACT REPORT AND BIOLOGICAL OPINIONS

PLANNING AID ASSISTANCE LETTER

The U.S. Army Corps of Engineers (Corps), Mobile District coordinated the identified proposals with the U.S. Fish and Wildlife Service (USFWS), Jackson, Mississippi. The USFWS has provided its Planning Aid Assistance (PAL) letter dated June 12, 2007 concerning the Mississippi Coastal Improvements Program (MsCIP) effort.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Mississippi Field Office
6578 Dogwood View Parkway, Suite A
Jackson, Mississippi 39213

June 12, 2007

Dr. Susan Rees
U.S. Army Corps of Engineers
Mobile District
109 St. Joseph St.
Mobile, AL 36602

Dear Dr. Rees:

As you are aware, the U.S. Fish and Wildlife Service (Service) has agreed to be a cooperating agency during the environmental review process of the Mississippi Coastal Improvements Program (MsCIP). In this capacity, we have assisted in drafting the Environmental Impact Statement (EIS) and Environmental Appendix. We have provided input on modeling schemes and selection of potential restoration sites to the Engineering Research and Development Center in Vicksburg, Mississippi. We have also made recommendations regarding potential impacts to wetlands, National Wildlife Refuge lands, Coastal Barrier Resources Act (CBRA) units, and fish and wildlife resources.

This planning aid letter (PAL) is provided to give additional information regarding federally listed species and their habitats that may be adversely affected by some of the program activities. This PAL is submitted under the Endangered Species Act (ESA)(87 Stat. 884, as amended 16 U.S.C. 1531 et seq.) and the Fish and Wildlife Coordination Act (16 U.S.C. 661-667e) but does not constitute the report of the Secretary of the Interior as required by Section 2(b) of the Act.

The program purpose, as authorized by the Department of Defense Appropriations Act 2006 (P.L. 109-148) dated December 30, 2005, is to conduct an analysis and design for comprehensive improvements or modifications to existing improvements in the coastal area of Mississippi in the interest of hurricane and storm damage reduction, prevention of salt water intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resource purposes.

The Service has determined that the following federally listed species and/or their habitats could be located within the project area and should be considered:

The threatened gopher tortoise (*Gopherus polyphemus*) inhabits well-drained sandy soils, especially in areas of longleaf pine. The gopher tortoise digs a burrow used as a shelter and nesting area. Groups of these tortoises dig burrows in the same location forming a colony. In addition, the threatened eastern indigo snake (*Drymarchon corais couperi*) is known to inhabit gopher tortoise burrows.

The endangered red-cockaded woodpecker (*Picoides borealis*) (RCW) is a species of southern pine forests. RCW's excavate nesting cavities in mature pine trees (60+ years old). The preferred nesting habitat is open, park-like, mature pine woodlands with few or no hardwood trees present. A mated pair of birds and all helper birds forms a clan. A cluster of cavity trees where the clan nests and roosts is called a colony. All cavity trees, active and inactive, are important to the colony and should therefore be avoided. Preferred feeding habitats are pine stands with trees 23 cm (9in.) and greater in diameter. Therefore, pine stands with this diameter and greater within a half-mile of a colony should be considered foraging habitat and should not be disturbed. These areas may or may not include a significant hardwood component.

The endangered plant, Louisiana quillwort (*Isoetes louisianensis*), is a nonflowering grasslike plant that lives in or near shallow, blackwater streams in riparian woodland and bayhead forests of pine flatwoods and upland pine forests. Mature plants are six to ten inches high, mostly evergreen, with spore-bearing structures below the ground.

The black pine snake (*Pituophis melanoleucus* ssp. *lodingi*) a candidate species, prefers uplands with well-drained sandy soils in areas of longleaf pine and hardwood tree species.

The endangered Alabama red-bellied turtle *(Pseudemys alabamensis)* is found in the lower Pascagoula River and its tributaries: Bluff Creek and the Escatawpa River. It is also found in Old Fort Bayou, the Tchoutacabouffa River, the Biloxi River, and the Back Bay of Biloxi. Destruction of nesting areas along river banks and feeding areas of submerged aquatic vegetation, and reduced water quality have impacted this species. Red-bellied turtles in Mississippi are somewhat different from those in Alabama, having fewer or less conspicuous head-stripes, a narrower head, less-conspicuous cusps (particularly on hatchlings), darker background color on the carapace and skin, and a relatively longer, narrower shell.

The federally listed threatened Louisiana black bear (*Ursus a. luteolus*) occurs primarily in bottomland hardwood and floodplain forests along the Mississippi River and the southern part of the state. Although the bear is capable of surviving under a range of habitat types, some necessary habitat requirements include hard mast, soft mast, escape cover, denning sites, forested corridors, and limited human access. Forest management practices, agricultural, commercial and industrial development, and highways can cause adverse impacts to bear habitat by increasing human disturbance, fragmenting forests, and removing den trees.

The threatened bald eagle (*Haliaeetus leucocephalus*) is the only species of sea eagle regularly occurring on the North American continent. The bald eagle is predominantly a winter migrant in the southeast; however, increasing occurrences of nesting have been observed. The bald eagle nests in the transitional area between forest and water. They construct their nests in dominant living pines or bald cypress trees. Eagles often use alternate nests in different years with nesting activity beginning between September and January of each year. Young are usually fledged by midsummer.

The endangered Mississippi gopher frog (*Rana sevosa*), requires two distinct habitats: temporary pools for breeding and upland foraging sites with a subterranean refuge (tortoise burrows, crawfish burrows, or stumpholes). The only population currently known to exist is located in Harrison County, Mississippi.

The threatened Gulf sturgeon (*Acipenser oxyrhynchus desotoi*) is found in the Pearl, Leaf, and Pascagoula Rivers. Gulf sturgeons are primitive, anadromous fish that annually migrate from the Gulf of Mexico into freshwater streams. Subadults and adults spend eight to nine months each year in rivers. Although Gulf sturgeon activity is not well documented, the species has been found in the Pearl River as far north as the Jackson metropolitan area. The decline of the Gulf sturgeon is primarily due to limited access to migration routes and historic spawning areas, habitat modification, and water quality degradation. Critical Habitat has been designated along the Mississippi Gulf Coast, and the Pearl, Leaf, and Pascagoula Rivers.

The threatened yellow-blotched map turtle (*Graptemys flavimaculata*) is found in the Chickasawhay, Leaf, and Pascagoula Rivers. The yellow-blotched map turtle prefers river stretches with moderate currents, abundant basking sites, and sand bars. Stream modification has significantly contributed to the decline of the species.

The endangered Brown pelican *(Pelecanus occidentalis)* nests mostly on offshore islands, but has been known to nest in onshore estuaries. Nesting areas are usually in low shrubs, trees or on the ground, and contain groups of 25-250 birds. They also congregate to feed near coastal wharves and pilings. Disturbance of nesting areas should be avoided.

The threatened Piping Plover *(Charadrius melodus)* does not nest in Mississippi but winters along the coastal beaches and barrier islands. These feeding areas have been threatened by urban development. Hence, Critical Habitat has been designated along several areas of the Mississippi Gulf Coast.

The endangered Mississippi Sandhill Crane *(Grus canadensis pulla)* is found only in a small area west of the Pascagoula River in Jackson County. Critical Habitat has been established on and adjacent to the Mississippi Sandhill Crane National Wildlife Refuge.

Kemp's ridley, Green, and Loggerhead sea turtles are also listed species found along the coast of Mississippi. The Service has jurisdiction over these species whenever there may be impacts to nesting sea turtles.

Once final project proposals are available, areas of potential habitat for listed species should be surveyed to determine presence or absence. The results of the survey will be included in a Biological Assessment to be provided to the Service as part of ongoing consultation under the ESA.

In addition, we recommend that your agency coordinate with National Marine Fisheries Service (NMFS), which also has jurisdiction for listed marine species, including sea turtles and gulf sturgeon.

We are aware that the Corps is considering structural, non-structural, and environmental approaches to the MsCIP program. Although we understand the need for structural measures in certain circumstances, we recommend that environmental and non-structural measures be utilized wherever practicable. However, minimization and avoidance of impacts should be considered on all project elements.

Upon receipt of the Draft Integrated Comprehensive Report/EIS, the Service will provide comments and recommendations on the projects. We understand that many of the projects plans will be conceptual in nature and therefore, our recommendations will only be as specific as the plans allow.

The Service looks forward to continuing to work with the Corps on the MsCIP program. Should you have any further questions or concerns, please contact Paul Necaise at 228-493-6631 or Sabrina Chandler at 601-321-1135.

Sincerely,

Ray Aycock
Field Supervisor

cc: NMFS, Panama City, FL
MSDMR, Biloxi, MS
MDEQ, Jackson, MS
EPA, Atlanta, GA
NPS, Gulf Breeze, FL

1 FISH AND WILDLIFE COORDINATION REPORT

The Corps, Mobile District coordinated with the USFWS concerning the MsCIP effort. The USFWS provided its final Draft Fish and Wildlife Coordination Act Report on June 12, 2008 and its Final Fish and Wildlife Coordination Act Report on April 23, 2009. The Corps utilized the USFWS' recommendations, shown below, in the developments of the MsCIP effort. In fact, the Corps had assistance from the USFWS staff member in the actual preparation of this MsCIP documentation.

1. Incorporate sediment control measures during construction including timely revegetation of disturbed areas.
2. Maintain disturbed areas with the use of native vegetation if at all possible. Clean equipment prior to transport to prevent contamination by exotic species such as cogon grass to other sites.
3. Place restrictive easements or covenants on all preserved and restored project areas to prevent future development.
4. Account for secondary development and indirect effects associated with projects during advanced design and feasibility studies.
5. Environmental and non-structural measures should be utilized in place of hard structures wherever practicable.
6. Minimization and avoidance of impacts should be considered on all project elements.
7. Consultation as required by Section 7 of the Endangered Species Act will be completed as necessary.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Mississippi Field Office
6578 Dogwood View Parkway, Suite A
Jackson, Mississippi 39213

April 23, 2009

Colonel Peter F. Taylor, Jr.
District Engineer, Mobile District
U.S. Army Corps of Engineers
P.O. Box 2288
Mobile, AL 36628-0001

Dear Colonel Taylor:

Enclosed is our final Fish and Wildlife Coordination Act (FWCA) report for the Mississippi Coastal Improvements Program (MsCIP), Hancock, Harrison, and Jackson Counties, Mississippi. The Mississippi Department of Wildlife, Fisheries, and Parks and National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NOAA-NMFS) have participated in the environmental planning phase of this program.

The program is authorized to conduct an analysis and design for comprehensive improvements or modifications to existing improvements in the coastal area of Mississippi in the interest of hurricane and storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resources. Numerous projects are being recommended under various authorities. Many projects require further design and study.

Our report concluded that implementation of this program will impose both adverse and favorable impacts to fish and wildlife resources. Once more detailed information is available, addendums to the report will be incorporated. We have provided preliminary measures and recommendations that could reduce impacts to fish and wildlife resources. In accordance with provisions of the FWCA, this report should be attached to and made an integral part of your final Comprehensive Report. Thank you for the opportunity to comment on this program.

Sincerely,

Cary Norquist
Acting Field Supervisor

cc:
Environmental Protection Agency, Atlanta, GA
Miss. Dept. of Wildlife, Fisheries, and Parks, Jackson, MS
Miss. Dept. of Environmental Quality, Jackson, MS
Miss. Dept. of Marine Resources, Biloxi, MS
National Marine Fisheries Service, Panama City, FL
National Park Service, Gulf Breeze, FL

FISH AND WILDLIFE COORDINATION ACT REPORT

MISSISSIPPI COASTAL IMPROVEMENTS PROGRAM (MsCIP)

Prepared by:

U.S. Fish and Wildlife Service
Ecological Services
Mississippi Field Office
Jackson, Mississippi
April 2009

EXECUTIVE SUMMARY

The purpose of the Mississippi Coastal Improvements Program (MsCIP) is to identify risk reduction measures that can be integrated to form a system that will address the Congressional mandates authorized in response to Hurricane Katrina by Public Law 109-148 (30 December 2005). The scope of the proposed project is to address the full range of structural, non-structural, and ecosystem restoration measures available to provide short term, as well as, comprehensive solutions. The study area includes the three coastal counties along the northern Gulf of Mexico within the State of Mississippi: Hancock, Harrison, and Jackson. Also included in the project is the offshore ecosystem of the Mississippi Sound and its barrier islands.

Proposed projects include numerous environmental restoration projects, restoration of the barrier islands, beach and dune construction, submerged aquatic vegetation restoration, freshwater diversions, ring levees, elevated roadways, seawalls, inland barriers and surge gates, residential buyouts and relocations, and retreat and/or relocation of critical facilities. These projects would have both adverse and favorable impacts to fish and wildlife resources. However, in order to provide an adequate evaluation of impacts for some projects, more information and further study is needed. Supplemental Environmental Impact Statements (EIS) will be provided to address impacts in those cases. Additional Fish and Wildlife Coordination Act (FWCA) reports will be prepared based on those Supplemental EIS's. Our preliminary recommendations are:

1. Incorporate sediment control measures during construction including timely revegetation of disturbed areas with native plant species.

2. Maintain disturbed areas with the use of native vegetation if at all possible. Clean equipment prior to transport to prevent contamination by exotic species such as cogon grass to other sites.

3. Place restrictive easements or covenants on all preserved and restored project areas to prevent future development.

4. Account for secondary development and indirect effects associated with projects during advanced design and feasibility studies.

5. Environmental and non-structural measures should be utilized in place of hard structures wherever practicable.

6. Minimization and avoidance of impacts should be considered on all project elements.

7. Consultation as required by section 7 of the Endangered Species Act will be completed as necessary.

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INTRODUCTION

This final Fish and Wildlife Coordination Act (FWCA) report provides planning input and recommendations for the U.S. Army Corps of Engineers Mississippi Coastal Improvements Program (MsCIP) in, Hancock, Harrison, and Jackson Counties, Mississippi. The proposed project is authorized in response to Hurricane Katrina by Public Law 109-148 (30 December 2005) to:

> "Conduct an analysis and design for comprehensive improvements or modifications to existing improvements in the coastal area of Mississippi in the interest of hurricane and storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resources..."

This FWCA report is to accompany your Integrated Comprehensive Report/Environmental Impact Statement (EIS) and is submitted in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended: 16 U.S.C. 661 et seq.) and the Endangered Species Act (16 U.S.C. 1531 *et seq.*). This final report constitutes the report of the Secretary of the Interior as required by Section 2(b) of the Act. Additional FWCA reports will be provided to evaluate Supplemental EIS's where they may be warranted.

The purpose of the proposed program is to identify risk reduction measures that can be integrated to form a system that will address the interests expressed in the authorization. The scope of the proposed project includes the full range of structural, non-structural, and ecosystem restoration measures available to provide short term, as well as, comprehensive solutions.

The U.S. Fish and Wildlife Service (Service) is a cooperating agency for this project and has had a representative co-located with the U.S. Army Corps of Engineers (Corps), Mobile District throughout the planning process. Other cooperating agencies include over 30 Federal, State, and local governments, Non-Governmental Organizations (NGO's), and business and industries, as well as several private citizens. An environmental team was established to formulate environmental restoration projects and complete the EIS portion of the Comprehensive Report. Representatives on the environmental team include individuals from National Marine Fisheries Service (NOAA-NMFS), National Park Service (NPS), U.S. Geological Survey (USGS), Environmental Protection Agency (EPA), Mississippi Department of Environmental Quality (MDEQ), Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP), and Mississippi Department of Marine Resources (MDMR, the local sponsor). Since April 2006, the Corps Mobile District has hosted 12 formal public and agency meetings, a 2-day Regional coordination meeting, a Public Scoping workshop, 3 online meetings, a Public Hearing workshop, and numerous internal meetings in which the Service participated as a full member of the MsCIP planning team. The Corps also launched a website enabling user downloads, project team collaboration, and improved communication and coordination among agencies and the public.

Public Law 109-148 also authorized the Corps to provide interim recommendations for near term improvements. The Corps solicited project proposals from agencies and the public, by which they identified 180 projects that could be classified as hurricane and storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife, or prevention of coastal erosion. Those projects were evaluated, screened, and refined into a list of 15 projects that could be recommended for construction. These 15 projects were included in the MsCIP interim report that was submitted to Congress in August 2006. Together these projects will restore 35 miles of beach and dune systems; protect/enhance 3,300 acres of coastal wetlands; restore 2.5 miles of seawall systems; restore flood storage capacity and circulation in 11 miles of streams/canals; potentially reduce storm damage to over 41,000 structures, and provide $11 million in annual recreation benefits. Congress appropriated $107,000,000 for these recommendations as part of an emergency supplemental bill on May 25, 2007.

The numerous meetings and coordination workshops have allowed the Corps to eliminate some projects based on lack of support or major impacts. The project components found within Chapter 8 of the current Integrated Comprehensive Report/EIS (ICR/EIS) are a result of this input. This report will address those remaining projects in this report.

The Service provided the Corps with a Planning Aid Letter (PAL) dated June 12, 2007 with initial recommendations as well as a list of federally protected threatened and endangered (T&E) species that may be impacted by the proposed project. The Service recommended in the PAL that environmental and non-structural measures be utilized wherever practicable, and that minimization and avoidance of impacts should be considered on all project elements.

A draft FWCA was provided on November 20, 2007 and provided additional recommendations. That report was written based on an earlier version of the ICR/EIS that did not contain all of the components that would be recommended for construction. This final FWCA addresses all of the components that will be recommended for construction. Additional components that are mentioned, but will not be recommended for construction in the ICR/EIS will be evaluated and presented in future Supplemental EIS's which will require an additional FWCA report.

DESCRIPTION OF STUDY AREA

The study area includes the three coastal counties along the northern Gulf of Mexico within the State of Mississippi: Hancock, Harrison, and Jackson. Also included in the project is the offshore ecosystem of the Mississippi Sound and its barrier islands. Areas in Louisiana and Alabama that would be affected by actions considered for improvements to the Mississippi coast will be discussed, if applicable.

The 75-mile coastal area is bounded on the west by the Pearl River, on the east by the Alabama state line, and to the south by the Gulf of Mexico. The Mississippi Sound is a partially protected body of water averaging 8 to 10 miles wide separated from the Gulf of Mexico by a series of barrier islands (Cat, Ship, Horn, and Petit Bois Island). The Gulf Intra-coastal Waterway encompasses deep water in the Mississippi Sound a few miles from the mainland shore. The mainland shore is broken by the entrances to Bay of St. Louis between Bay St. Louis and Pass Christian, and Biloxi Bay between Biloxi and Ocean Springs. U.S. Highway 90 traverses the area a few miles inland except in Harrison County, where it closely borders the coastline. Two major rivers empty into Mississippi Sound. The Pearl River, which forms the boundary between Mississippi and Louisiana, and the Pascagoula River, which travels North to South through Jackson County and enters the sound at Pascagoula. Major towns along the coast are, from west to east, Waveland, Bay St. Louis, Pass Christian, Long Beach, Gulfport, Biloxi, Ocean Springs, and Pascagoula. This area ranges in elevation from sea level to about 30 feet. The essentially flat to gently undulating, locally swampy Coastal Lowlands are underlain by alluvial, deltaic, estuarine, and coastal deposits and merge with the fluvial-deltaic, plains of the streams of the area. This portion of Coastal Mississippi has been classified as an alluvial coast, and terraced, deltaic plain. This area is illustrated in Figure 1.

Coastal Mississippi was the point of impact of the greatest tidal surge that has hit the mainland of the United States (U.S.) in its recorded history. Hurricane Katrina affected over 90,000 square miles (m2) of the Gulf Coast region. It caused nearly complete destruction of several large coastal communities while seriously damaging numerous others. The destruction was on a scale unmatched by any natural disaster in U.S. history. Losses to Coastal Mississippi were unprecedented and have presented a high cost to the nation with a complete fisheries failure being declared by the Commerce Secretary. Hurricane Katrina produced marine debris covering valuable productive water bottoms, exacerbated coastal erosion, loss to maritime forests, degraded water quality, increased pollution, created widespread debris fields throughout coastal wetlands, degraded coastal preserve lands owned and maintained by the State of Mississippi, increased risks to infrastructure and human life, danger to fish and wildlife including T&E species and their critical habitats, and the loss of an entire way of life. Losses to many commercially important fisheries stock, foraging areas, and nurseries have been felt economically throughout the region. Spawning, breeding, and foraging grounds of fish and shellfish were severely impacted resulting in rising prices, and once readily available resources are in limited supply. The ability of wetlands to enhance protection from future storm surges, coastal erosion, and flooding has been greatly reduced. Human activities can also inhibit the natural processes of coastal lands. Urban and residential development is often conducted without an adequate understanding of coastal geology and processes. There have been an increased number of wetland fill permits due to the apparent need for housing in the area, post-Katrina, that can also impact the coastal area's natural defenses against storm surge. As a result, they can lead to cumulative degradation of coastal resources. Cooperative scientific investigations are starting to provide the crucial information needed to minimize the unintended effects of human disturbances along coasts.

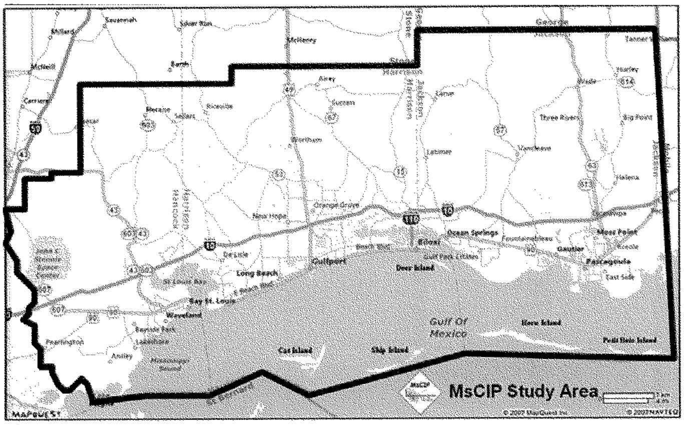

Figure 1. MsCIP Study Area

FISH AND WILDLIFE CONCERNS AND PLANNING OBJECTIVES

The primary responsibility of the Service is the identification of fish and wildlife habitats and identification of preservation and restoration opportunities for the Mississippi Gulf Coast. Specifically the Service has identified the following needs of the Study Area:

1. Preservation of wetlands and associated fish and wildlife resources found within the Mississippi Gulf coastal area.

2. Restoration of the hydrology and vegetation found within the degraded portions of the Mississippi Gulf coastal area.

3. Minimization of structural measures by optimizing environmental and non-structural measures, such as wetland restoration, residential buyouts and floodproofing.

EVALUATION METHODOLOGY

Projects were evaluated for wetland impacts (acres) and restoration benefits in the form of Functional Capacity Indices (FCI) and Functional Habitat Indices (FHI). The FCI for each function is readily used to evaluate impacts, compare project alternatives, and help design and evaluate mitigation plans. Sites proposed for residential buyout and/or relocation and environmental restoration were selected using the Spatial Decision Support System (SDSS). More information on the SDSS tool can be found in the Environmental Appendix of the Comprehensive Report. This information is summarized in Table 1 below.

Table 1. Summary of models used in evaluation and analysis of environmental project proposals included in the MsCIP Comprehensive Plan.

Model	Description/Purpose	Use in MsCIP
Spatial Decision Support System	GIS based decision system to identify & evaluate potential sites	Selection of potential Wetland restoration sites
AL/MS Gulf Coast Tidal Fringe HGM Model	Perform functional assessment of tidal fringe wetlands	Evaluate positive/negative impacts to tidal fringe wetlands
MS Wet Pine Savannah HGM Model	Perform functional assessment of wet pine savannah habitats	Evaluate positive/negative impacts to wet pine savannah habitats
Functional Habitat Index Spreadsheet	Assess the environmental values of beach and dune habitat	Evaluate positive/negative impacts to beach and dune habitats

The methodology used for riparian and coastal wetlands is the Hydrogeomorphic Model (HGM) developed by EPA, NOAA-NMFS, Corps, and Service personnel, and is calibrated for wetlands ecosystems found in coastal Mississippi, as used in many prior studies (Shafer et al. 2007). HGM is a science-based quantitative and replicable methodology that establishes functions and values at a variety of sites and reference points that are then used to establish functional values for sites within the area be analyzed. HGM was applied at a landscape-level, using numerous reference sites in the area in the establishment of without-project conditions. The HGM model was used for the functional assessment of Tidal Fringe wetlands and Wet Pine Savannahs within the study area. Because HGM has not been calibrated for use in Maritime Forest or beach and dune analysis in this area, an alternative methodology was used for the small number of these sites. The methodology chosen for this application was FHI.

FISH AND WILDLIFE RESOURCES

Although no site specific sampling of terrestrial or aquatic resources has been completed for this study, fish and wildlife resource estimates are based upon past reports and data pertinent to the study area. Existing fish and wildlife resources along the Mississippi Gulf Coast are a product of the area's response to human alteration and impact.

Many species of invertebrates and vertebrates make up the fauna population along the Mississippi Gulf Coast. Invertebrate populations in Mississippi Sound and the nearshore area of the Gulf of Mexico transfer energy through the coastal food web. Microscopic estuarine zooplankton live throughout the water column with limited mobility. Zooplankton includes such organisms as copepods, protozoans, chaetognaths, pteropods, tunicates, ctenophores, and siphonophores. Larval stages of benthic forms and eggs and larval stages of many fish species are often interspersed throughout zooplankton. Many important commercial fish species feed upon zooplankton.

Vittor and Associates (1982) investigated the macrofauna of Mississippi Sound and selected areas in the Gulf of Mexico. Over 532 taxa from offshore Mississippi and Alabama and 437 taxa from the Mississippi Sound were identified. Densities of individuals varied from 910 to 19,536 individual/ yard^2 for the offshore and 1,200 to 38,863 individual/ yard^2 for the Sound area. Abundance of macrofauna is temporal with greatest densities occurring from fall to spring.

Oyster production in Mississippi depends on public reefs managed by the Mississippi Department of Marine Resources (DMR). The State of Mississippi accounts for about 13% to 17% of Gulf oyster landings. Reefs are located along the coast across the entire state with the largest reefs near the western boundary. According to W.J. Demoran (1979), there were 9,934 acres of oysters. At that time, that number included 582 acres of planted oyster beds. Additional acreage has been planted. A few small areas of oyster bottom have been leased for private development; however, production from these areas has been negligible. There have been considerable annual variations in size of productive areas due to natural environmental fluctuations, such as freshwater flow into the oyster beds. Many of Jackson County's most productive areas have been closed to harvest due to increased pollution associated with coastal development.

Many commercially important species of crustaceans are harvested in Mississippi Sound and the nearshore of the Gulf of Mexico. Brown shrimp (*Penaeus aztecus*) is the main shrimp species harvested by commercial fishermen in the Gulf of Mexico and is the most important commercial species in the Mississippi Sound and Mobile Bay area. White shrimp (*Litopenaeus setiferus*) and blue crab (*Callinectes sapidus*) are also harvested within the study area. In addition to those commercial species, there is a very diverse community of crustaceans within Mississippi Sound and adjacent waters including a wide variety of forms and habitat preferences. Epibenthic crustaceans dominate the diet of flounder, catfish, croaker, porgy, and drum. Christmas and Waller (1973) reported 138 fish species in 98 genera and 52 families taken from areas across Mississippi Sound. The major fisheries landed along the Mississippi Gulf coast are anchovies, menhaden, mullet, croakers, shrimp, and oyster. Jackson County, primarily the ports of Pascagoula and Moss Point, receives greater than 85% of all Mississippi landings, including all industrial fish (menhaden), 95% of the mullet, trout, and red snapper, and 74% of the croaker landed (Corps 1992).

Coastal wetlands of Mississippi Sound, St. Louis Bay, Biloxi Bay, Pascagoula Bay, and the tidal Pascagoula River provide the resource base for commercial and marine recreational fishing and tourism in Mississippi. The dockside value of commercial fish landings in Mississippi neared $42 million in 1995. Recreational fisheries also play an important role in the state's economy. In 1991, 500,000 people spent more than $236 million fishing in Mississippi's waters, generating almost $14 million in state sales tax, resulting in $131 million in earnings, and supporting more than 8,000 jobs. Approximately one-quarter of the recreational fishing occurs in coastal waters.

Communities such as Moss Point, Pascagoula, Gautier, Ocean Springs, Biloxi, Long Beach, Gulfport, Pass Christian and Bay St. Louis all depend on fishing to support their local economies.

Coastal Mississippi habitats support an array of reptiles, amphibians, birds, and mammals. There is a great diversity of reptiles including 23 species of turtles, 10 species of lizards, 39 species of snakes, and the American alligator. Eighteen species of salamanders and 22 species of frogs and toads are indigenous to the coastal region.

Mammals occur within all habitats of the coastal system, using underground burrows, the soil surface, vegetative strata, the air, and the water for feeding, resting, breeding, and bearing and rearing young. There are 57 species of mammals found in the area (Corps 2005). Several species of mammals include the raccoon, river otter, gray fox, striped skunk, mink, white-tailed deer, bottlenose dolphin, beaver, possum, and nine-banded armadillo. A number of whales are known to occur offshore and occasionally are sighted within the Mississippi Sound.

Over 300 species of birds have been reported as migratory or permanent residents within the area. Several of these species also breed there. Shorebirds and wading birds include osprey, great blue heron, great egret, piping plover, sandpiper, gulls, brown and white pelicans, American oystercatcher, and terns. These birds eat a great variety of foods and exhibit a diversity of nesting behaviors.

Loss of these habitats is increasing throughout coastal Mississippi largely due to development and habitat degradation. Urban encroachment on fish and wildlife habitats has created direct and indirect affects. Impacts to habitats can include direct loss due to construction, but also come from the inability to properly manage existing habitats. Fire management is a necessary tool in wet pine savannahs, a dominant habitat type across the local landscape. Increased wildland-urban interface (WUI), where forests meet development, prohibits the use of prescribed fire in many cases due to liability associated with fire.

Fish and wildlife habitats within the project area are diverse. Wet pine savannah is a dominant wetland type with the Mississippi Coastal area. A dominant upland habitat type is mixed pine-hardwood forest. Remaining habitats include: fresh and saltwater tidal marsh, non-tidal freshwater marsh, beach and dune, riparian forest, and bottomland hardwood forest. The Service Mitigation Policy (CFR 46(15):7644-7663; Appendix I) classifies wet pine savannah, fresh and saltwater tidal marsh, non-tidal freshwater marsh, bottomland hardwoods, and beach and dune habitats as a Resource Category 2. These habitats are "of high value for evaluation species and is relatively scarce or becoming scarce on a national basis or in the ecoregion section." The mitigation goal for a Resource Category 2 habitat is "no net loss of in-kind habitat value." Mixed-pine hardwood and riparian forests are classified as a Resource Category 4. These habitats are "of medium to low value for evaluation species." The mitigation goal for Resource Category 4 habitat is "minimization of loss of habitat value."

Invasive exotic species are also of increasing concern especially in coastal areas. Chinese tallow tree (*Sapium sebiferum*) and Cogongrass (*Imperata cylindrica)* are two major pest plant problems that land managers face. Faunal invasives also persist along the coast. Wild hogs (*Sus scrofa*) and red imported fire ants are two examples of invasive fauna that impact native species and their habitats.

THREATENED AND ENDANGERED SPECIES

There are nineteen (19) species listed under the Endangered Species Act within the project study area (Table 2). These species include both aquatic and terrestrial fauna, as well as one plant species. National Marine Fisheries Service has jurisdiction over off shore species and critical habitat, including sea turtles, Gulf sturgeon, and some whale species.

Due to the scope of this project and associated unknown factors, consultation as required by section 7 of the Endangered Species Act (16 U.S.C. 1531 *et seq.*) will be addressed at least initially through this report. It is the opinion of the Service that some of the "Tentatively Selected Comprehensive Plan Components" may warrant Formal Consultation once more specific plans are available for each project and supplemental EIS documents are prepared. Therefore, the Service reserves the right to request formal consultation if necessary. Affects to T&E species and other fish and wildlife resources associated with each component are listed in the section titled "Description of Project Impacts."

Table 2.Threatened and Endangered Species with Associated Habitat Descriptions.

Common Name	Scientific Name	Status	County	Habitat
Alabama red-bellied turtle	Pseudemys alabamensis	E	Harrison, Jackson	Submerged aquatic vegetation in brackish coastal rivers; freshwater reaches
Bald eagle	Haliaeetus leucocephalus	Delisted*	Hancock, Harrison, Jackson	Shorelines near open water
Black pine snake	Pituophis melanoleucus ssp. lodingi	C	Harrison, Jackson	Fire-dependent, upland longleaf pine forests
Brown pelican	Pelecanus occidentalis	E	Hancock, Harrison, Jackson	Feeds over water in coastal areas, nests on small islands.
Gopher tortoise	Gopherus polyphemus	T	Hancock, Harrison, Jackson	Fire-dependent, upland longleaf pine forests
Green sea turtle	Chelonia mydas	T	Hancock, Harrison, Jackson	Shallow coastal waters with SAV and algae, nests on open beaches.
Gulf sturgeon,	Acipenser oxyrhynchus desotoi	TCH	Hancock, Harrison, Jackson	Migrates from large coastal rivers to coastal bays and estuaries
Inflated Heelsplitter	Potamilus inflatus	T	Hancock	Soft, stable substrata in slow to moderate currents of tributaries and large rivers
Kemp's Ridley sea turtle	Lepidochelys kempii	E	Hancock, Harrison, Jackson	Nearshore and inshore coastal waters, often in salt marshes
Loggerhead sea turtle	Caretta caretta	T	Hancock, Harrison, Jackson	Open ocean; also inshore areas, bays, salt marshes, ship channels, and mouths of large rivers
Louisiana black bear	Ursus americanus luteolus	T	Hancock, Harrison, Jackson	Bottomland hardwood forest; frequently ranges into other habitats
Louisiana quillwort	Isoetes louisianensis	E	Hancock, Harrison, Jackson	Small blackwater streams with sand and gravel substrate and forest cover
Mississippi gopher frog	Rana capito sevosa	E	Harrison, Jackson	Fire-dependent, upland longleaf pine forests; open, ephemeral upland pools
Mississippi sandhill crane	Grus canadensis pulla	ECH	Jackson	Wet pine savannah
Pearl darter (Pascagoula River System)	Percina aurora	C	Jackson	Rivers and large creeks with sand and gravel bottoms and flowing water.
Piping Plover	Charadrius melodus	TCH	Hancock, Harrison, Jackson	Barrier islands and coastal beaches
Red-cockaded woodpecker	Picoides borealis	E	Harrison, Jackson	Fire-dependent, upland longleaf pine forests
West Indian or Florida Manatee	Trichechus manatus	E	Hancock, Harrison, Jackson	Fresh and salt water in large coastal rivers, bays and estuaries.
Yellow-blotched map turtle	Graptemys flavimaculata	T	Jackson	Rivers and large creeks with habitat suitable for basking

E = endangered T= threatened C= candidate CH= designated critical habitat
*The Bald Eagle continues to be protected under the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act

COASTAL BARRIER RESOURCES ACT

The Coastal Barrier Resources Act (CBRA) of 1982 established the John H. Chafee Coastal Barrier Resources System (CBRS), comprised of undeveloped coastal barriers along the Atlantic, Gulf, and Great Lakes coasts. The law encourages the conservation of hurricane prone, biologically rich coastal barriers by restricting Federal expenditures that encourage development, such as Federal flood insurance through the National Flood Insurance Program. CBRA is a free-market approach to conservation. These areas can be developed, but Federal taxpayers do not underwrite the investments. CBRA saves taxpayer dollars and encourages conservation at the same time. CBRA has saved over $1 billion and will save millions more in the future. Approximately 3.1 million acres of land and associated aquatic habitat are part of the CBRS. The Fish and Wildlife Service maintains the repository for CBRA maps enacted by Congress that depict the CBRS. The Service also advises Federal agencies, landowners, and Congress regarding whether properties are in or out of the CBRS, and what kind of Federal expenditures are allowed in the CBRS.

The Coastal Barrier Resources Act and its amendments prohibit most new Federal expenditures that tend to encourage development or modification of coastal barriers. The laws do not restrict activities carried out with private or other non-Federal funds and only apply to the areas that are within the defined John H. Chafee Coastal Barrier Resource System (CBRS).

Examples of prohibited Federal assistance within System units include subsidies for road construction, channel dredging, and other coastal engineering projects. Federal flood insurance through the National Flood Insurance Program is available in a CBRS unit if the subject building was constructed (or permitted and under construction) before the CBRS unit's effective date. If an existing insured structure is substantially improved or damaged, the Federal flood insurance policy will not be renewed.

Federal monies can be spent within System units for certain exempted activities, after consultation with the U.S. Fish and Wildlife Service. Examples of such activities include emergency assistance, military activities essential to national security, exploration and extraction of energy resources, preservation of fish and wildlife resources, and maintenance of existing Federal navigational channels.

The Coastal Barrier Improvement Act of 1990 expanded the CBRS and created a new category of lands known as otherwise protected areas (OPAs). OPA designations add a layer of Federal protection to coastal barriers already held for conservation or recreation, such as national wildlife refuges, national parks and seashores, state and county parks, and land owned by private groups for conservation or recreational purposes, and discourage development of privately owned inholdings. The only Federal funding prohibition within OPAs is Federal flood insurance. The CBRS currently includes 271 OPAs which add up to approximately 1.8 million acres of land and associated aquatic habitat. These units are designated by the letter 'P' found at the end of the unit identifier.

There are seven CBRA units within the MsCIP project area (Table 3). Petit Bois, Horn, and Ship Islands which are part of the Gulf Islands National Seashore (GUIS) are all considered one unit

(MS-01P). This unit falls into the category of OPAs, thus the letter 'P' found at the end of the unit identifier. The remaining island within GUIS is Cat Island which has a separate designation. Those portions of Cat Island that are owned and managed by the National Park Service are designated as unit R03. Note that even though Cat Island could be designated as an OPA this designation was not made due to the fact that the remainder of the island is under private ownership which is not considered a part of CBRA.

Table 3. Coastal Barrier Resources Act units within the Mississippi Coastal Improvement Program Area

Unit Identifier	County	Description
MS-01P	Jackson	Gulf Islands
MS-01P	Jackson	Gulf Islands
MS-01P	Jackson	Gulf Islands
MS-01P	Jackson	Gulf Islands
MS-01P	Harrison	Gulf Islands
R01	Jackson	Round Island
R01A	Jackson	Belle Fontaine Point
MS-02	Jackson	Marsh Point
R02	Harrison	Deer Island
R03	Harrison	Cat Island
MS-04	Hancock	Heron Bay Point

DESCRIPTION OF TENTATIVELY SELECTED COMPREHENSIVE PLAN COMPONENTS

Components of MsCIP can be grouped into five categories. Only those components that are recommended for construction authorization will be addressed within this Report. Other components that require additional engineering and design or study will be addressed in FWCA reports that will correspond with Supplemental EIS's provided by the Corps upon authorization. Categories of selection of recommended measures are listed below.

- Projects recommended for construction authorization
- Projects recommended for additional pre-construction engineering and design
- Studies recommended for finalization under programmatic plan authorization
- Studies recommended for additional feasibility-level study
- Studies recommended for inclusion as requiring advanced design studies

It is important to note that many measures that may be recommended will be grouped in categories that include projects that will require minimal additional information during preparation of plans and specifications. Many measures will be recommended as potential actions that will need advance design prior to development of plans and specifications and others will establish a framework in which future projects will be identified under continuing authorities that would require specific Project Information Reports (PIR) after development of plans and specifications. There are certain measures that will require additional studies to determine problems and opportunities in order to address any concerns.

As a result of the numerous categorizations of potential projects that might come forth from the MsCIP Comprehensive Report, further environmental considerations and analyses will be required for some projects. There will be additional coordination and consultation on supplemental EIS's for projects that would result in significant impacts to the environment and further environmental assessments for projects that are less complex in nature with less significant impacts associated with them.

This final FWCA report serves as coordination of the current draft EIS, and will serve as the basis from which further required environmental analyses and documentation could be tiered.

Comprehensive plan components have been tentatively selected and are determined to be 'keystone' pieces on which later recommendations would be built. These plan elements have been determined to be engineeringly feasible, environmentally acceptable and beneficial, and cost effective. Each of the tentatively selected plan components have been designed to function as stand alone units that will act independently should additional time be required for design or other components be determined to not be cost effective. Descriptions of tentatively selected components of the comprehensive plan can be found in Chapter 8 of the Main Report.

DESCRIPTION OF PROJECT IMPACTS

Hurricane and Storm Damage Reduction Plan Components

The plan components described below will singly or in combination assist in the reduction of risk to the maximum extent practicable. Other options, both structural and nonstructural, present opportunity for additional risk reduction but are not able to be evaluated in the Comprehensive report at a level required to determine feasibility, acceptability, or cost effectiveness. Potential impacts associated with each project are presented below, however due to the vast number of properties involved and the uncertainties associated with some project footprints, specific affects may not be available at this time.

1. Hurricane Risk Reduction Education

This component is not likely to adversely affect fish and wildlife resources, including T&E species.

2. Hurricane and Storm Warning

This component is not likely to adversely affect fish and wildlife resources, including T&E species.

3. Hurricane Evacuation Planning

This component is not likely to adversely affect fish and wildlife resources, including T&E species.

4. Floodplain Management

Better management of the floodplain could benefit fish and wildlife resources by restricting impacts of associated with development within the floodplain. This component could also benefit wetlands by reducing the amount hazardous waste, un-anchored structural components, and other infrastructure that is allowed within the floodplain, as well as reduce the amount of fill necessary for development in these areas. This component is not likely to adversely affect fish and wildlife resources, including T&E species.

5. Building Code Update

Updated building codes could reduce the number of structures that would be destroyed during a hurricane or storm event. Fewer structures impacted would reduce the amount of storm debris and hazardous materials that would likely impact surrounding wetlands and other fish and wildlife habitats. This component is not likely to adversely affect fish and wildlife resources, including T&E species.

6. Zoning Code Update

Updated zoning regulations support both the floodplain management and building code update components, by further prohibiting certain types of development and structures from high hazard areas. This component is not likely to adversely affect fish and wildlife resources, including T&E species.

7. Long-term Critical Infrastructure and Services Relocation (LOD 5)

This component would encourage relocation or designation of critical infrastructure outside of the Maximum Probable Intensity (MPI) boundary. This line is drawn based on elevation related to the maximum storm surge inundation depth and can be used as a guide for local county and municipal governments when locating critical facilities. As facilities are relocated and constructed northward of this planning line, losses to existing habitats would occur. Potential impacts could also result from secondary development associated with relocation of infrastructure into undeveloped areas. This component could impact T&E species, specifically the threatened gopher tortoise; however this possibility cannot be assessed at this time and would have to be evaluated on a case by case basis. Due to the vast number of properties involved and the uncertainties associated with project footprints, specific impacts to fish and wildlife resources cannot be determined at this time. Future studies during project development would determine specific impacts associated with implementation of this measure.

8. Homeowner Assistance and Relocation Program (HARP)

The most effective alternative for reducing the risk from future hurricane surge events is to relocate all structures and population centers from the high risk zones. Formulation of alternatives included those which would provide for minimum level of risk reduction (approximate base flood elevation) up to those that would provide for risk reduction from increasing levels of inundation. In addition a smaller alternative concentrating on voluntary acquisition in the high to moderately high hazard areas is being evaluated.

Temporary and minimal effects could occur during implementation of this measure; however, properties that would be purchased as part of a buy-out program would be restored to historical conditions providing potential benefits to fish and wildlife and their habitats. Floodproofing may temporarily impact fish and wildlife species during construction, but should have no long term impacts once projects are completed. Potential impacts could also result from secondary development associated with relocation of infrastructure into undeveloped areas. This component could impact T&E species, specifically the threatened gopher tortoise; however this possibility cannot be assessed at this time and would have to be evaluated on a case by case basis. Due to the vast number of properties involved and the uncertainties associated with project footprints, specific impacts to fish and wildlife resources cannot be determined at this time. Future studies during project development would determine specific impacts associated with implementation of this measure.

9. Moss Point Municipal Relocation Component

Since relocation of facilities is proposed only within the incorporated limits, there are no negative impacts anticipated as a result of this project. Fish and wildlife resources could benefit from additional greenspace that will be created along the riverfront as a result of this relocation proposal. This component is not likely to adversely affect fish and wildlife resources, including T&E species.

10. Waveland Floodproofing

Temporary and minimal impacts may be encountered during construction of floodproofing components; however no major negative impacts are anticipated as this project will involve currently developed areas within an existing footprint. This component is not likely to adversely affect fish and wildlife resources, including T&E species.

11. Forrest Heights Hurricane and Storm Damage Reduction Component

Due to a pre-existing disturbed condition created by the presence of the residential development and partial levee system currently in place, this component would result in minimal impacts to fish and wildlife species from levee expansion. Continued maintenance of the levee reduces natural habitats that are currently available for numerous wildlife species. This component is not likely to adversely affect fish and wildlife resources, including T&E species. It would however require fill of 19.85 acres of non-tidal wetlands due to expansion of the levee footprint. The entire footprint of the levee at elevation 21 feet would total 23 acres. The 19.85 acres of wetlands are classified as wet pine savannah habitats.

12. Evaluation of Structural Measures

While large structural solutions such as surge gate barriers did not garner much local support, there were viable alternatives, such as smaller ring levees that have the potential of providing cost effective solutions. Possible ring levee alternatives are being evaluated as part of this study including ring levees at: Belle Fontaine, Gulf Park Estates, Pascagoula/Moss Point, Pearlington, Gautier, Ocean Springs, and Bay St. Louis. The development of cost effective, acceptable alternatives however will require additional study and coordination. Because these components will undergo further study and coordination, only a brief overview of potential impacts has been provided below. All of these structural measures will likely impact fish and wildlife resources and potentially affect T&E species.

Ring Levees

Approximately 265 acres of wetland vegetation could be lost based on some alignments (Lin and Shafer 2007). Although impacts to fish and wildlife resources would depend on the exact footprint of the levee, adverse impacts are not expected due to continuous coordination throughout the planning process. The Belle Fontaine ring levee comes close to falling within CBRA Unit R01A, however, through early consultation with the engineering team this was addressed as a potential conflict and should be revisited if there are changes to the alignment.

Line of Defense 4 – Inland Barrier and Surge Gates

The general alignment of the inland barrier would be along the path of the existing railway that crosses the coast of Mississippi. This railway is located atop of a constructed berm. In order to protect much of the developed areas around Biloxi and St. Louis Bays, the inland barrier would need to cross the mouths of these bays which would necessitate construction of structural surge barriers.

Hancock County Inland Barrier (LOD 4)

Impacts to fish and wildlife resources could be avoided or minimized by alternate alignments and/or elevations of the proposed structure. Native vegetation under the levee footprint would be lost, and the levee itself would likely be vegetated with non-native species for stabilization of the structure. Approximately 300 acres of wetlands would be impacted based on some potential alignments and/or elevations (Lin and Shafer 2007). Specific losses would be field verified prior to construction and during project development to determine wetland functions lost. Specific impacts to fish and wildlife species would not be evaluated until final plans are available. Surveys of potential habitats for threatened and endangered species would be required in order to determine impacts to listed species.

St. Louis Bay Surge Barrier

Further studies would be needed during project development to determine the full extent of impacts, to fish and wildlife species, submerged aquatic vegetation (SAV), and other estuarine organisms associated with implementation of this measure.

Harrison County Inland Barrier (LOD 4)

Impacts to fish and wildlife resources could be avoided or minimized by alternate alignments and/or elevations of the proposed structure. Native vegetation under the levee footprint would be lost, and the levee itself would likely be vegetated with non-native species for stabilization of the structure. Approximately 45 acres of wetlands would be impacted based on some potential alignments and/or elevations (Lin and Shafer 2007). Specific losses would be field verified prior to construction and during project development to determine wetland functions lost. An alternate alignment along Menge Ave. in Gulfport would eliminate the need for the Biloxi Bay Surge Barrier. The Service recommends that the Menge Ave. alignment be used in order to avoid the need for that component. Specific impacts to fish and wildlife species would not be evaluated until final plans are available. Surveys of potential habitats for threatened and endangered species would be required in order to determine impacts to listed species.

Biloxi Bay Surge Barrier

Further studies would be needed during project development to determine the full extent of impacts, to fish and wildlife species, SAVs, and other estuarine organisms associated with implementation of this measure. An alternate alignment of the Harrison County Inland Barrier (LOD 4) along Menge Ave. in Gulfport would eliminate the need for this component. The Service recommends that the Menge Ave. alignment be used in order to avoid the need for this component.

Jackson County Inland Barrier (LOD 4)

Impacts to fish and wildlife resources could be avoided or minimized by alternate alignments and/or elevations of the proposed structure. Native vegetation under the levee footprint would be lost, and the levee itself would likely be vegetated with non-native species for stabilization of the structure. Approximately 79 acres of wetlands would be impacted based on some potential alignments and/or elevations (Lin and Shafer 2007). Specific losses would be field verified prior to construction and during project development to determine wetland functions lost. Specific impacts to fish and wildlife species would not be evaluated until final plans are available. Surveys of potential habitats for threatened and endangered species would be required in order to determine impacts to listed species.

<u>Ecosystem Restoration Plan Components</u>

1. Turkey Creek

The Turkey Creek Restoration project will restore 689 acres of wet pine savannah habitat in a severely impaired watershed within an urbanized area in North Gulfport. This area suffers from altered hydrology and habitat degradation through lack of fire and an abundance of invasive exotic species. By restoring this habitat, this watershed will regain much needed flood storage capacity and regain its natural wetland function, and will also be protected from development. The HGM approach was used to measure benefits resulting in a total of 2,577 functional units with a net AAFU benefit of 1,565. There will be temporary, localized impacts to fish and wildlife species during construction, but the benefits gained greatly outweigh these impacts. This component is not likely to adversely affect fish and wildlife resources, including T&E species.

2. Dantzler

This 385 acre site owned by the State of Mississippi and managed by the Department of Marine Resources is located in central Jackson County near the Pascagoula River and the Mississippi Sandhill Crane National Wildlife Refuge (NWR). The site currently consists of plantation pine and includes drainage ditches and stormwater lines that were added in anticipation of residential development, and therefore does not provide the benefits that a naturally functioning wet pine savannah should. Hurricane Katrina also introduced an enormous amount of debris to this site. By thinning the pines, removing invasive species, filling ditches to restore hydrology, and implementing a natural fire regime this site could benefit the endangered Mississippi Sandhill Crane found on adjacent Refuge lands. The HGM approach was used to measure benefits resulting in a total of 604 functional units with a net AAFU benefit of 1,244. There will be temporary, localized impacts to fish and wildlife species during construction, but the benefits gained greatly outweigh these impacts. This component is not likely to adversely affect fish and wildlife resources, including T&E species.

3. Franklin Creek

This project is located near the communities of Orange Grove and Pecan in eastern Jackson County, MS. This area has already been funded for acquisition and demolition of 30 structures as part of the MsCIP Interim Report. This restoration will supplement that project by restoring 149 acres of former residential development to wet pine savannah. This site is located adjacent to the Grand Bay NWR /National Estuarine Research Reserve (NERR) and would compliment the management of those protected areas and add to available fish and wildlife habitat in the area. The HGM approach was used to measure benefits resulting in a total of 596 functional units with a net AAFU benefit of 516. There will be temporary, localized impacts to fish and wildlife species during construction, but the benefits gained greatly outweigh these impacts. This component is not likely to adversely affect fish and wildlife resources, including T&E species.

4. Bayou Cumbest

The Bayou Cumbest restoration area contains approximately 348 acres to be restored to tidal marsh and scrub/shrub habitats. This site currently consists of residential development severely damaged by Hurricane Katrina as well as abundant fill material which inhibits the natural ebb and flow of the wetlands in the area. This restoration project would benefit fish and wildlife species as this plan would restore hydrology, remove exotics, and allow for more contiguous suitable habitat. This will provide valuable forage and cover for fish and wildlife species. This project would also remove structures that currently fragment adjacent undeveloped habitat. This site is adjacent to the Grand Bay NWR/NERR and is also near the site of the proposed submerged aquatic vegetation pilot project discussed below. This component is not likely to adversely affect fish and wildlife resources, including T&E species.

5. Admiral Island

The Admiral Island restoration project consists of 123 acres of state owned property managed by the Mississippi Department of Marine Resources (DMR). This site has been degraded over the years and suffered major damage from Hurricane Katrina. The restoration of this site would benefit fish and wildlife resources as this plan would restore hydrology, remove exotics species, and clean up profuse debris that was deposited as a result of Hurricane Katrina. This will provide valuable forage and cover for fish and wildlife species. This component is not likely to adversely affect fish and wildlife resources, including T&E species.

6. Submerged Aquatic Vegetation (SAV) Pilot project

Implementation of this pilot project would provide much needed research and information necessary to restore SAVs and determine the effectiveness of subsequent restoration projects and experimental techniques. Additionally, the project will provide an opportunity to replace SAVs lost as a result of Hurricane Katrina. The functions and resultant values help to sustain productive foraging and refugia habitat for various lifestages of aquatic species. Many fish and wildlife species depend on these seagrasses during different stages of their life cycles. This project would benefit fish and wildlife resources by restoring a quickly diminishing, but necessary, habitat.

7. Additional Ecosystem Restoration Studies

Development of the Spatial Decision Support System (SDSS) tool allowed the MsCIP environmental team, including the Service and DMR, to identify and prioritize potential wetland restoration areas throughout coastal Mississippi (Lin 2007). The SDSS produced numerous areas that qualified for restoration, based on the fact that most of them have been impacted and/or destroyed nationally, regionally, and locally by development and/or natural events. These sites were determined unable to repair themselves therefore, requiring human intervention to restore their historical values and functions. Restoration and protection of these sites are essential to healthy fish and wildlife populations all along the Mississippi Gulf coast. Thirty-eight (38) additional sites were evaluated, screened and selected from the results of the SDSS tool and have been proposed for restoration. These sites will be prioritized and specific details will be developed and integrated into a programmatic type authority. Habitats that would be restored through this component range from emergent aquatic vegetation to wet pine savannah to bayhead swamps and beach and dune systems. Some of the proposed projects fall within CBRA units, however these projects would likely be exempt from CBRA prohibitions based on Section 6 of the Act which allows federal funding for projects that would enhance or preserve fish and wildlife resources. This component is not likely to adversely affect fish and wildlife resources, including T&E species. However, complete site assessments should be conducted prior to work to ensure no federally protected species, such as Louisiana quillwort, are present.

8. Violet Freshwater Diversion Project Engineering and Design

The Mississippi Department of Marine Resources (DMR) has been working with the Mississippi congressional delegation in order to address impacts from saltwater intrusion and degradation of the oyster resources found within the Mississippi Sound, primarily those associated with Hancock County. Through collaboration with Louisiana, the two states have agreed on a mutually beneficial proposal for a diversion at or near Violet, Louisiana. Modeling efforts have been ongoing and although a version of the project has been authorized through the Water Resources and Development Act of 2007 (WRDA), no specific plans have been agreed upon. The project may impact the federally listed Pallid and Gulf sturgeon however the extent of those impacts will remain unknown until specific details are available and adequate studies performed. Other fish and wildlife resources may also be affected by the implementation of this project. Further research would be required to determine exact impacts associated with this component.

9. Escatawpa River Diversion – Grand Bay Marsh Ecosystem Restoration

Human disturbances have impacted the Grand Bay marsh ecosystem by altering historic sheet water flows into the area, as well as the natural migration of the Pascagoula and Escatawpa Rivers. These rivers flow into marshes and other wetlands that make up the Grand Bay NWR/NERR. Lack of sheet water flow into the area has caused a loss of valuable pine savannah wetlands that under optimum conditions would provide abundant habitat for numerous fish and wildlife species. Saltwater intrusion due to lack of freshwater input into the system has also degraded available fish and wildlife habitats. Shoreline erosion has also contributed to the increased salinity in the area, as well as a loss of fish and wildlife habitats with the total erosion of landmasses such as the Grand Batture Islands. This project may impact federally listed species however the extent of those impacts will remain unknown until specific details are available and adequate studies performed. Other fish and wildlife resources may also be affected by the implementation of this project. Further research would be required to determine exact impacts associated with this component.

10. Coastwide Beach and Dune Ecosystem Restoration

The man-made beaches that exist along the Mississippi Gulf coast have become the winter home to more than just the human population. These beaches and dune systems were designated critical habitat for the threatened Piping plover in 2002. These birds only overwinter along these beaches, while many other species of shorebirds depend on these habitats for nesting and other life stages. Most of the dunes that previously existed along these beaches were destroyed by

Hurricane Katrina along with much of the beach, leaving numerous species of wildlife without adequate foraging and nesting habitat. Because restoration of these beaches would greatly benefit the fish and wildlife species that depend on them, the temporary and minimal impacts associated with construction should not adversely impact these species. However, time of year and duration of each project should be considered when planning these projects to avoid impacts to fish and wildlife species. Borrow areas should also be evaluated prior to excavation to avoid impacting areas such as mud flats, on which these birds also depend for forage areas.

11. Comprehensive Barrier Island Restoration

The Service agrees that the selected alternative Barrier Island Comprehensive plan (G) described in Section 8.1.2.11.2 of the Main Report would be the most efficient and least damaging alternative. However this alternative will impact fish and wildlife resources and habitats in the vicinity of the project area. These impacts are both positive and negative. The barrier islands are designated critical habitat for wintering Piping Plovers. Direct sand placement in Camille cut and reintroduction of sandy sediments to the littoral zones of Ship, Horn, and Petit Bois Islands could provide additional wintering habitat for this threatened shorebird. However, this option would alter waters within the project area, which are designated critical habitat for the threatened Gulf sturgeon. Federally protected sea turtles also inhabit the area and have the potential to nest on the islands. Sea turtles fall under the jurisdiction of the Service when onshore during nesting. NOAA-NMFS has jurisdiction over listed species and critical habitat offshore. Because restoration and enhancement of these islands would greatly benefit the fish and wildlife species that depend on them, the temporary and minimal impacts associated with construction should not adversely impact terrestrial species found within the project area. However, time of year and duration of each project should be considered when planning these projects to avoid impacts to fish and wildlife species. Changes to water bottoms and introduction of sediments into the system will likely affect aquatic species, such as the Gulf sturgeon. A final project proposal would be required to perform an adequate evaluation of impacts to listed species and habitats.

12. Deer Island Ecosystem Restoration

Deer Island is located within the boundaries of Harrison County, Mississippi near the mouth of the Biloxi Bay and the City of Biloxi, and falls within CBRA unit R02. It is managed by DMR as a coastal preserve. The lands within the interior are privately owned while the State of Mississippi owns much of the property considered tidal wetlands. This island has suffered damage from many storms which was exacerbated by Hurricane Katrina. A breach from previous storms was significantly widened, coastal marshes were impacted by debris and sedimentation, and the maritime forest was killed by saltwater overtopping and wind damage. The island, prior to Hurricane Katrina, was the subject of a restoration project through the beneficial use of dredged material, and the restoration area seems to have faired well under the circumstances. A second restoration effort is currently underway to repair the breach on the western end as well as selective restoration to critical areas on the southern shoreline. Deer Island contains a diversity of habitats valuable to wildlife which would be protected from erosion by the proposed restoration plan. This project would likely be exempt from CBRA prohibitions based on Section 6 of the Act which allows federal funding for projects that would enhance or preserve fish and wildlife resources. This option could alter waters within the project area, which are designated critical habitat for the threatened Gulf sturgeon. Changes to waterbottoms and introduction of sediments into the system could affect aquatic species, such as the Gulf sturgeon.

Summary of Impacts

Impacts and effects listed for each component are preliminary in nature and could change with new information as projects go through the planning process. Further study would be required for some of the proposed components. The Service may issue addendums to this FWCA to address concerns, in addition to requesting further consultation under section 7 of the ESA, if warranted. Additional FWCA reports will be issued in the event of Supplemental Environmental Impacts Statements.

FISH AND WILDLIFE CONSERVATION MEASURES

The Service has provided preliminary conservation measures for mitigation of losses and/or restoration of fish and wildlife resources below. More specific measures may be provided in addendums to this report once specific plans are available and plans and/or alternatives are selected.

The Service and the Corps, working together during the MsCIP planning process, have managed to avoid many potential fish and wildlife resource conflicts within project proposals (i.e., National Wildlife Refuges and Coastal Barrier Resources Act (CBRA) units). The Corps invited the Service to participate in the planning process as a full member of the project planning team. The Service applauds the Corps, Mobile District, for the opportunity to actively participate and provide input throughout the process.

Although many major wetland areas were avoided during the planning process, some impacts to wetlands, primarily associated with levee construction, still remain. Overall preliminary estimates suggest that up to approximately 726 acres could be impacted if all projects were constructed at the maximum proposed footprint. The Service suggests avoiding, minimizing, or rectifying this acreage by constructing projects that have the least impact while continuing to meet objectives set forth in the Congressional mandate. The wetland areas that may potentially be impacted by proposed projects are designated as Resource Category 2 under the Service Mitigation Policy. The mitigation goals for Resource Category 2 are physical modification of replacement habitat to convert it to the same type lost; restoration or rehabilitation of previously altered habitat; increased management of similar replacement habitat so that the in-kind value of the lost habitat is replaced, or; a combination of these measures. Specific losses should be field verified prior to construction and during project development to determine functions of wetlands lost. Restoration and enhancement of fish and wildlife habitats within the project area could reduce these impacts, as well as provide benefits to the resource. In addition, restoration and protection of habitats along the Mississippi Gulf Coast could increase overall fish and wildlife resources within the area and improve water quality.

Care should be taken to ensure use of native species to re-vegetate disturbed areas. Precautions should also be taken to prevent the distribution of invasive exotics such as cogon grass (*Imperata cylindrica*) during ground disturbing activities. Cogon grass in rampant across vitually every habitat on the Mississippi Gulf Coast and can outcompete native vegetation if not controlled or prohibited from spreading.

Proposed surge barriers could induce major impacts to fish and wildlife resources. These projects should be adequately studied to determine potential impacts throughout the entire basin.

Secondary development and indirect effects could be associated with several project proposals and would have to be evaluated and in the case of impacts, mitigation would be necessary. By encouraging development in previously undeveloped areas, impacts to fish and wildlife resources and federally listed species (gopher tortoise), as well as the ability to properly manage habitats (prescribed fire), are likely.

The Service recommends that the Planning division and the Regulatory division within the Corps, Mobile District continue to coordinate their activities as they relate to MsCIP. Areas delineated by the SDSS for environmental restoration and/or buyouts should not be eligible for permits for authorized fill under Section 404 of the Clean Water Act. Coordination such as this could potentially be considered a flood damage reduction measure.

RECOMMENDATIONS

Based on information currently available the Service makes the following recommendations to minimize impacts to fish and wildlife resources:

1. Incorporate sediment control measures during construction including timely revegetation of disturbed areas with native plant species.

2. Maintain disturbed areas with the use of native vegetation if at all possible. Clean equipment prior to transport to prevent contamination by exotic species such as cogon grass to other sites.

3. Place restrictive easements or covenants on all preserved and restored project areas to prevent future development.

4. Account for secondary development and indirect effects associated with projects during advanced design and feasibility studies.

5. Environmental and non-structural measures should be utilized in place of hard structures wherever practicable.

6. Minimization and avoidance of impacts should be considered on all project elements.

7. Consultation as required by section 7 of the Endangered Species Act will be completed as necessary.

SUMMARY OF FINDINGS AND SERVICE POSITION

The Service has determined based on preliminary information, that the Mississippi Coastal Improvements Program would have both adverse and favorable impacts to existing fish and wildlife resources. The majority of the tentatively selected components are environmentally sound projects that would provide a benefit to fish and wildlife resources and preserve habitat by preventing potential future development. These projects also meet the objectives of flood damage reduction and hurricane and storm damage reduction.

Non-structural programs such as buyouts would also likely benefit fish and wildlife resources. However, relocation programs that would encourage development in previously undeveloped areas could create direct and indirect adverse impacts to fish and wildlife resources as well as T&E species. Nevertheless, these relocations would likely have a less damaging effect than other structural options. Major impacts associated with relocations could be avoided by wise selection of relocation areas.

It is unknown at this time how projects such as freshwater diversions and surge barriers will impact fish and wildlife resources. Projects such as these will require much more study than what has been afforded by Congress. These projects will be evaluated once more information is available.

It is the opinion of the Service that some of the "Tentatively Selected Comprehensive Plan Components" may warrant Formal Consultation once more specific plans are available for each project and supplemental EIS documents are prepared. Therefore, the Service reserves the right to request formal consultation if necessary.

The Service recommends that structural measures be avoided such as surge barriers, inland levees, and ring levees. The need for these projects could be avoided by the use of more efficient, less damaging non-structural alternatives, such as environmental restoration and relocations.

This final Fish and Wildlife Coordination Act Report will be programmatic in nature. Consequently, once formal project proposals are received and supplemental EIS's as required for some projects are received, they will be addressed in additional FWCA reports. These additional reports will contain all requirements for the Secretary of the Interior as required by Section 2(b) of the Act.

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BIOLOGICAL ASSESSMENT AND BIOLOGICAL OPINIONS

The Corps coordinated with both the USFWS and National Marine Fisheries Service, Protected Resource Division concerning the anticipated formal consultation and subsequent preparation of a Biological Assessment under Section 7 of the Endangered Species Act. Both agencies concurred that the MsCIP Programmatic Integrated Programmatic Environmental Impact Statement (EIS) would serve also as the Biological Assessment (BA). This decision was reached by the agencies due to the prepared MsCIP Programmatic Integrated EIS document already containing all necessary information required in the BA already. The USFWS provided a letter, dated June 24, 2008, stating its use of the MsCIP Programmatic Integrated EIS as a supplement for the Corps' BA. Future BAs and Biological Opinions could be possibly required on projects being tentatively selected for additional study.

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
Mississippi Field Office
6578 Dogwood View Parkway, Suite A
Jackson, Mississippi 39213

June 24, 2008

Dr. Susan I. Rees
Mississippi Coastal Improvements Program
U.S. Army Corps of Engineers
Mobile District
PO BOX 2288
Mobile, AL 36628-0001

Dear Dr. Rees:

The U.S. Fish and Wildlife Service (Service) has been coordinating with you and your team to accomplish the mandates authorized by Congress through the Mississippi Coastal Improvements Program (MsCIP). The MsCIP team, of which the Service has been a full member, is currently working to complete an Integrated Comprehensive Report/Environmental Impact Statement (ICR/EIS). This report will address numerous projects that have been proposed and evaluated as a means of helping the Mississippi Gulf Coast not only recover from Hurricane Katrina, but also become better prepared and to be more resilient in the event of future storms.

The Service provided a final draft Fish and Wildlife Coordination Act (FWCA) Report (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) to the Corps on June 12, 2008. This FWCA Report not only provided recommendations for projects, but also addressed potential impacts to threatened and endangered species that are protected by the Endangered Species Act of 1973 (16 U.S.C. 1531 *et seq.*). Due to the broad scope of MsCIP and associated unknown factors, consultation as required by section 7 of the ESA was addressed initially through the FWCA report. Once a Final ICR/EIS has been provided, the Service believes that document will be sufficient for continuation of consultation.

We believe that this is the most efficient way to achieve our common goals of recovery and resiliency throughout the entire Mississippi Gulf Coast. Thank you for the opportunity to work with you on this very important program.

Sincerely,

Ray Aycock

Ray Aycock
Field Supervisor

SECTION 3
ENVIRONMENTAL COMPLIANCE DOCUMENTATION

3.1 SECTION 404(B)(1) EVALUATION REPORT FOR THE MISSISSIPPI COASTAL IMPROVEMENTS PROGRAM (MSCIP), HANCOCK, HARRISON, AND JACKSON COUNTIES, MISSISSIPPI

SECTION 404(b)(1) EVALUATION REPORT FOR THE COASTAL MISSISSIPPI IMPROVEMENTS PROGRAM (MsCIP) HURRICANE RESTORATION EFFORT

HANCOCK, HARRISON, AND JACKSON COUNTIES, MISSISSIPPI

I. **PROJECT DESCRIPTION**:

A. **Location**. The Hurricanes of 2005 created unprecedented destruction within the Gulf Region of the United States (U.S.) of America. Beginning with Hurricane Cindy on July 6th 2005, which made landfall near Waveland, Mississippi, peaking with Hurricane Katrina, which made landfall on the 29th of August on the Louisiana-Mississippi border, and ending with Hurricane Rita on the 24th of September, which also caused additional damage to the coastline of Mississippi, this series of tremendous storms caused unparalleled devastation to homes and businesses, industry, livelihoods, regional economies, environmental resources, and most importantly, dealt a life-changing blow to the people that call this region home.

Hurricane Katrina made landfall on August 29, 2005 near Buras-Triumph, Louisiana. Hurricane force winds extended outward 120 statute miles. Landfall of this storm placed Coastal Mississippi in the northeast quadrant, the most destructive quadrant. Destruction spans along all three coastal counties – Hancock, Harrison, and Jackson. Most, if not all, of the infrastructure was destroyed by the hurricane south of Highway 90. South of Interstate-10 had massive flooding and infrastructure damage. Hurricane Katrina destroyed coastal regions of Louisiana, Mississippi, and Alabama making it the most destructive and costliest natural disaster in the history of the U.S. Coastal Mississippi was the point of impact of the greatest tidal surge that has hit the mainland of the U.S. in its recorded history.

B. **General Description**. The U.S. Army Corps of Engineers (Corps), Mobile District has been authorized by Congress to investigate expedited studies of flood and storm damage reduction. These studies will address hurricane and storm damage reduction, flood control, and ecological restoration as well as other related water resource purposes. With the assistance of Federal, State of Mississippi, and local government agencies, private entities, and other interest groups, the Corps, Mobile District developed measures and specific projects that contribute to the reduction of storm surge, preservation of fish and wildlife, prevention of saltwater intrusion, prevention of coastal erosion, and reduction of coastal flooding. The MsCIP Comprehensive Plan and Integrated Programmatic EIS develop measures and projects for recommended in the following categories:

- Construction;
- Preconstruction Engineering Design for Specific Features;
- Additional Feasibility Studies; and
- Advanced Design Studies for Innovative Concepts.

The potential measures and projects are addressed in the MsCIP Comprehensive Report and Integrated Programmatic EIS. The Corps, Mobile District will coordinate with Federal, state, and local agencies during the required environmental compliance process. This Section 404(b)(1) Evaluation Report addresses potential water quality impacts that could potentially result from constructing the following measures and/or projects in Coastal Mississippi. Each of the measures and/or projects has been fully discussed in the MsCIP Comprehensive Report and Integrated Programmatic EIS to address the potential environmental impacts associated with their implementation. There may be additional analyses required prior to construction of specific components of recommended measures and projects. This would entail development of additional Section 404(b)(1) Evaluations that would assess potential environmental impacts associated with the specific proposed action within a measure or project. All of the potential measures and projects are located in Coastal Mississippi either in Hancock, Harrison, or Jackson County and are referenced in the attached MsCIP Comprehensive Report and Integrated Programmatic EIS.

C. **Authority and Purpose**. The MsCIP was authorized by Congress in the Department of Defense Appropriations Act, 2006 (Public Law 109-359) 30 December 2005. A description of the analysis and design authority contained in the aforementioned act reads as follows:

> *For an additional amount for "investigations" to expedite studies of flood and storm damage reduction related to the consequences of hurricanes in the Gulf of Mexico and Atlantic Ocean in 2005, $37,300,000, to remain available until expended: Provided, That using $10,000,000 of the funds provided, the Secretary shall conduct an* ***analysis and design*** *for comprehensive improvements or modifications to existing improvements in the coastal area of Mississippi in the interest of hurricane and storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resource purposes* ***at full Federal expense****: Provided further, That the Secretary shall recommend a cost-effective project, but* ***shall not perform an incremental benefit-cost analysis*** *to identify the recommended project, and shall not make project recommendations based upon maximizing net national economic development benefits: Provided further, That interim* ***recommendations for near term improvements shall be provided within 6 months*** *of enactment of this Act* ***with final recommendations within 24 months of enactment: (emphasis added)***

The National Environmental Policy Act (NEPA) of 1969 excuses or excludes the Corps from the preparation of any formal environmental analysis with respect to actions that result in minor or no environmental effects, which are known as "categorical exclusions." An intermediate level of analysis, an Environmental Assessment (EA), is prepared for an action that is not clearly categorically excluded, but does not clearly require an EIS [40 Code of Federal Regulations (CFR) §1501.3 (a) and (b)]. Based on the EA, the Corps either prepares an EIS, if one appears warranted, or issues a "Finding of No Significant Impact" (FONSI), which satisfies the NEPA requirement. This document is prepared according to the Engineer Regulation (ER) 200-2, *Procedures for Implementing NEPA, and the Council on Environmental Quality (CEQ) Regulations (40 CFR § 1508.27) for Implementing the Procedural Provisions of NEPA (40 CFR § 1500-1508).*

D. **General Description of Dredged or Fill Material**.

(1) **General Characteristics of Material.** Materials used for barrier island restoration and beach/dune nourishment actions would consist of fine to medium grained sand that would be compatible with existing sediments. Material with a mixture of silts, sands and some clay component will be used where sediment is required for marsh/scrub/shrub restoration. Levee construction will require the use of clay fill material. The material will be obtained from either commercial sources, trucked in, and/or existing borrow areas near the project sites. The substrate that will be used as a restoration site for submerged aquatic vegetation (SAV) at Bayou Cumbest would consist of primarily sands with some silts. The freshwater diversion substrate would be similar to that of the marsh restoration and SAVs.

(2) **Quantity of Material**. For the barrier island restoration efforts, it is estimated that a total of up to approximately 31 million cubic yards (cys) of sandy material may be required for the filling of Ship Island Breach. A quantity of sandy material yet to be determined could be used as a feeder source to supplement natural migration of material within the littoral zone. Exact quantities are dependent upon which measure that would be implemented. The volume of material dredged and excavated in association with the ring levee around Forest Heights is yet to be determined. Quantities associated with environmental restoration sites (i.e. filling and excavation) are calculated to rough order of magnitude. No additional fill material would be required for the restoration of SAV.

(3) **Source of Material**. Sand used for barrier island restoration would be obtained from the St. Bernard Shoals, a natural sand deposit located in the Gulf of Mexico south of Mississippi and Louisiana or from river sources (i.e. upland dredged material disposal sites) located along the Black Warrior – Tombigbee River system and the Tennessee – Tombigbee Waterway would be further evaluated for compatibility with existing barrier island beach sand composition, including acceptable grain size, color, and texture. Sources required for ecosystem restoration have yet to be determined. No sources will be used for the SAV restoration.

E. **Description of the Proposed Discharge Site**.

(1) **Location**. The locations of any discharge areas associated with measures and projects described herein are addressed in Section B (General Description) of this report.

(2) **Size**. The sizes of the potential discharge areas associated with measures vary with each component of a measure and/or specific projects. The sizes of these sites may range from approximately 25 acres up to approximately 500 acres.

(3) **Type of Site**. Site types for the variety of projects described herein consist the barrier islands, open-water of Mississippi Sound and the coastal mainland of the State of Mississippi. The types of sites consists of beach and dunes, marine, estuarine, and freshwater marsh, SAVs, wet pine savannah, upland forests, urbanized areas (i.e. residential and commercial), fringes, rivers, and bays.

(4) **Type of Habitat**. The types of habitats consists of beach and dunes, coastal maritime forests, marine, estuarine, and freshwater marsh, scrub/shrub, SAVs, wet pine savannah, urbanized areas (i.e. residential and commercial), fringes, and bays.

(5) **Timing and Duration of Discharge**. Timing and duration of the proposed actions are dependent upon approval and funding of the projects. Beach projects along the mainland could take up to 2 years. Restoration of the barrier islands could take up to 15 years for completion. Ring levee construction would take up to 1 year for completion. The non-structural and environmental component features timeframe will vary from 180 days to several years.

F. **Description of Disposal Method**. Methods of placement and disposal for these projects will utilize a variety of dredges including hydraulic cutterhead, hopper, and mechanical, deep draft, scow, and various shallow draft barges. In addition, track hoes, bulldozers, dump trucks, backhoes, marsh buggies, and other similar earthmoving construction equipment will be utilized dependent on the scope of each project.

II. **Factual Determinations (Section 230.11)**:

A. **Physical Substrate Determinations.**

(1) **Substrate Elevation and Slope.** The barrier islands restoration project would consist of beach/dune restoration projects and would be designed to sustain elevations and slopes consistent with similar habitat types in the vicinity that has been sustained under the typical energy climate. Potential marsh and coastal maritime forest restoration components on the barrier islands will also be further evaluated in accordance with and conformity with the Organic Act, National Park Service (NPS) mission, and NPS management policies. The beach could be constructed to between approximately 0 to 2-foot elevation with a 1:10 slope on the foreshore. Dune elevations along the mainland could be constructed to a maximum height of 6 feet with 1:3 slope. Marsh habitat would be constructed between -0.5 and 2-foot while the scrub/shrub would be constructed to between approximately 4 to 6 feet. The ring levee around Forest Heights would be constructed up to a 12- or 16-foot elevation. The ecosystem restoration projects would be constructed at the appropriate elevations to ensure hydrology at the site. The SAV restoration project would be constructed at about -5 to -10 feet water depth.

(2) **Sediment Type.** Materials used for the beach restoration actions will consist of fine to medium grained sand that is compatible (grain size, color, and texture) with existing beach sediments. Sandy material with a small silty component will be used where sediment is required for marsh restoration. Materials dredged from drainage channels and canals will likely contain soft, fine-grained, organic silts and clays with some fraction of sand. This material will be disposed in approved upland sites.

(3) **Dredged/Fill Material Movement.** Fill material would be pumped or trucked directly onto the beach sites. It is expected that a readjustment phase will occur and sand materials redistributed to form a more natural profile. Restoration areas will utilize material that may contain a higher percentage of fine grained materials. Silt fences/curtains and other best management plans (BMPs) will be utilized to reduce material movement during heavy equipment operations. It is believed that no adverse impacts would occur from movement of materials.

Physical Effects on Benthos. No impacts to benthos are anticipated in the upland areas. There would be temporary disruption of the aquatic community as a result of the proposed projects being constructed. Areas where sand and sediments are laid directly upon the bottom open-water habitat to create marsh or restore barrier islands and/or beaches may result in destruction of sessile benthic fauna. Non-motile benthic fauna within the project sites would be lost as a result of the organisms not being able to penetrate through the thick layer of material that will be used to construct the tidal marsh and sand placement for restoration. This loss of sessile benthic fauna would be minor due to the tidal marsh area and other restoration area sites encompassing only a small percentage of the entire Mississippi Sound. Benthic fauna, such as crabs, are anticipated to re-colonize the area upon restoration and in addition, should provide aquatic habitat for various motile and non-motile benthic fauna. The intertidal zone and sub-tidal zones along the restored beaches should provide rapid recovery of and recruitment of benthos. The marsh would provide additional nursery area along the outer fringes suitable for fishes following the proposed activities. Non-motile benthic fauna within the project area may be destroyed by the proposed operations, but should repopulate within several months after construction activities are completed.

Physical Effects on Wetlands. Restoration projects would restore damaged and filled wetlands providing an overall benefit to wetlands. Implementation of the proposed levee at Forest Heights would not require fill in wetlands. It is anticipated that relocation of city facilities in Moss Point and homeowner assistance relocations would be located in uplands and any required fill material would be obtained from upland sources.

(4) **Other effects.** No other effects are anticipated.

(5) **Actions Taken to Minimize Impacts (Subpart H).** Actions will be taken to minimize

impacts to all project areas during the construction activities. BMPs and/or silt curtains will be used at the construction sites, where applicable, to minimize turbidity and curtail material migration. Borrow material used in construction will be utilized in such a manner to minimize impacts to surrounding areas.

B. **Water Column Determinations**.

(1) **Salinity**. Projects that are being recommended for construction should have minimal impacts to salinity as a result of its implementation. In fact, the filling of Ship Island breach is anticipated to have a positive benefit to salinity in Mississippi Sound.

(2) **Water Chemistry (pH, etc.)**. All sediment and material used in the construction of the identified projects will be clean materials removed from sources of contamination and considered contaminant free. Such material will have no effect on surrounding water chemistry.

(3) **Clarity**. Construction activities in association with beach nourishment and dune construction and tidal marshes will reduce water clarity due to elevated suspended sediments in the water column; however, BMPs and/or silt curtains will be used, where applicable, to minimize impacts to the project area. Minor increases in turbidity may be experienced in the immediate vicinity of the project areas during construction operations. However, these increases will be temporary and would return to pre-project conditions shortly after completion. In fact, several components of the proposed project may improve water clarity because particles tend to settle out of the water column at tidal marsh areas.

(4) **Color**. No effect.

(5) **Odor**. No effect.

(6) **Taste**. No effect

(7) **Dissolved Gas Levels**. Temporary decreases in dissolved oxygen will likely result from some of the construction activities, but this will only be of a short duration. The construction activities and the return water are not anticipated to adversely impact dissolved gas levels.

(8) **Nutrients**. Slight increases in nutrient concentrations may occur from the proposed construction activities; however, these concentrations would be rapidly dispersed. These described increases would have no significant effect to the water column. Further studies prior to construction and implementation of certain measures would be conducted to determine possible impacts.

(9) **Eutrophication**. The projects recommended for construction would have minimal impacts to eutrophication effects.

C. **Water Circulation, Fluctuation, and Salinity Gradient Determinations**:

(1) **Current Patterns and Circulation.**

(a) **Current Patterns and Flow**. Restoration of the barrier islands would be modeled to determine effects of filling the breach between East and West Ship Islands, creating a feeder source of sand to supplement littoral drift and migration, and filling of water bottoms in order for expansion of the island footprints. The subsequent return water flow is also not anticipated to affect current patterns and flow in the vicinity of the mainland. The environmental restoration sites would restore historic water flow patterns. Levee construction would likely divert water away from the urbanized areas. The non-structural plan would also help restore historic water flow patterns by removing structures all together or raising them from their base elevation.

(b) **Velocity**. No Effect.

(2) **Stratification**. No Effect.

(3) **Hydrologic Regime**. Environmental restoration would result in a benefit to the hydrologic regime as the lost hydrology is restored to historical wetlands.

(4) **Normal Water Level Fluctuations**. No Effect.

(5) **Salinity Gradient**. Salinity in Mississippi Sound is highly variable due to the inflow of freshwater from surrounding rivers and the tidal influence from the Gulf of Mexico. Restoration of barrier islands would affect salinity gradient and further analysis would be conducted to determine the effects of these measures.

D. **Suspended Particulate/Turbidity Determination**:

(1) **Expected Changes in Suspended Particulates and Turbidity Levels in Vicinity of Placement Site**. The placement of fill material at the proposed project sites within Mississippi Sound and within the vicinity of the barrier islands would reduce light penetration through the water column, thereby reducing photosynthesis and surface water temperatures. Although it is expected an initial high volume loss of sand from the restoration projects at the barrier islands would occur, it is expected that sand movement would decrease once equilibrium is naturally achieved. These conditions could potentially alter visual predator-prey relations in the immediate project vicinity. In addition, sediment adheres to fish gills, resulting in respiratory stresses, and natural movement of eggs and larvae could be potentially altered as a result of the sediment adherence. These are minor, short-term impacts due to the short duration of construction activities. It is expected that distinct bars would develop nearshore by the nature of the waves and depths within the project vicinity and could potentially result in a seaward expansion.

Construction of the levee around Forest Heights, and environmental restoration sites could cause sediment movement and isolated increased turbidity around the construction sites. Changes in substrate are not expected nor will any deleterious materials be added to the sediment during construction activities.

(2) **Effects on Chemical and Physical Properties of the Water Column.**

(a) **Light Penetration**. Light penetration through the water column at the proposed sites may be temporarily affected but is anticipated to return to previous conditions upon completion of construction activities.

(b) **Dissolved Oxygen**. Future studies would be conducted prior to construction and implementation of certain measures to determine impacts within the bays and Mississippi Sound.

(c) **Toxic Metals and Organics**. Sites have been picked to avoid any potential toxic metals and organics.

(d) **Pathogens**. No effect.

(e) **Esthetics**. Esthetics would be reduced within construction areas, due to the physical presence of the heavy equipment used in the construction process; however, these impacts would be temporary and insignificant. Once the construction is complete, the esthetic values provided by barrier island restoration, a restored beach-dune system, and environmental restoration of wetlands would have many beneficial impacts. Construction of the projects would actually result in an improvement to aesthetic quality as coastal Mississippi was devastated as a result of Hurricane Katrina. No adverse impacts are anticipated from the ring levee around Forest Heights and the non-structural plan.

(3) **Effects on Biota.** The proposed beach and ecosystem restoration projects are designed to enhance the barrier island ecosystems. These actions would increase valuable habitat resulting in an overall improvement and continued health of the local wildlife. No adverse impacts are anticipated from the ring levee around Forest Heights and the non-structural plan due to its existing urbanization.

(a) **Primary Production Photosynthesis.** No impacts to primary production photosynthesis are anticipated.

(b) **Suspension/Filter Feeders.** It is anticipated a temporary impact to suspension/filter feeders would occur as a result of the construction activities; however, no long-term impacts are anticipated.

(c) **Sight Feeders.** Shorebirds tend to be attracted to established beach/dune systems. Construction activities (i.e. dredging and subsequent placement to restore the barrier islands) are sometimes attractive sites to many sight feeders due to the presence of food items in the material. Impact of these activities along uplands, beaches, and ecosystem restoration sites on sight feeders is expected to be a beneficial, short-term effect. No adverse impacts are anticipated to occur to sight feeders as they would avoid construction areas.

(4) **Actions Taken to Minimize Impacts (Subpart H).** BMPs would be incorporated into project designs and specifications during project development.

E. **Contaminant Determinations**. Materials used in the construction of the proposed measures would consist of marine and/or river sand and sediments from sources removed from contamination. Previous construction activities and water quality certifications of these type projects in this region has found that the materials are free of contaminants.

F. **Aquatic Ecosystem and Organism Determinations**.

(1) **Effects on Plankton.** It is anticipated a temporary impact to plankton would occur as a result of the construction activities; however, no long-term impacts are anticipated.

(2) **Effects on Benthos.** Temporary disruption of the aquatic community is anticipated at the beach, dune, and marsh restoration sites. Non-motile benthos at areas where materials will directly covering water bottom would be destroyed. Non-motile benthic fauna within these areas will be lost as a result of the organisms not being able to penetrate through the thick layer of fill material that will be used to construct the tidal marsh and beaches. This loss would be minor due to the project areas encompassing only a small percentage of the entire Mississippi Sound (approximately 750,000 acres). Benthic fauna, such as crabs, are anticipated to rapidly re-colonize these areas upon construction completion. Non-motile benthic fauna within other construction areas may be destroyed by the proposed operations, but should repopulated within several months after completion. Motile benthic and pelagic fauna, such as crabs, shrimp, and fishes, are able to avoid the disturbed area and should return shortly after the activity is completed. Larval and juvenile stages of these forms may not be able to avoid the activity due to limited mobility. Construction activities at the proposed sites are anticipated to have no significant effects to the benthos.

(3) **Effects on Nekton**. No Effect.

(4) **Effects on Aquatic Food Web**. No Effect.

(5) **Effects on Special Aquatic Sites**. No Effect.

(a) **Sanctuaries and Refuges**. The measures have been developed in such a way as to avoid direct impacts to sanctuaries and refuges. The Sandhill Crane Wildlife Refuge and the Grand Bay National Estuarine and Research Reserve are both located in Jackson County. Numerous measures, particularly ecosystem restoration sites, would provide additional wetland functions nearby existing refuges.

(b) **Wetlands**. The ecosystem restoration sites would result in numerous acres of wetland restoration which would provide numerous positive benefits. Under the current Forrest Heights 21-foot levee alignment alternative, there is an expected loss of 3.6 acres of wetland vegetation impacted by construction of the levee. Although native vegetation under the levee footprint would be lost, the levee itself would be vegetated with non-native species for stabilization of the structure. The compensatory mitigation would be incorporated in the project plan development phase.

(c) **Mud Flats**. No Effect.

(d) **Vegetated Shallows**. The measures have been developed in such a way as to avoid vegetated shallows directly; however, the indirect and cumulative effects are unknown and further studies would need to be conducted to determine the full level of impacts prior to project development and construction.

(e) **Coral Reefs**. Not applicable.

(f) **Riffle and Pool Complexes**. The measures have been developed in such a way as to avoid direct impacts.

(6) **Effects on Threatened and Endangered Species**. The Corps, Mobile District is currently coordinating with the U.S. Fish and Wildlife Service and the National Oceanic and Atmospheric Administration Fisheries concerning the proposed MsCIP Comprehensive Report and Programmatic EIS impacts to any threatened and endangered species. Protective measures will be implemented in order to reduce impacts to listed species.

(7) **Effects on Other Wildlife**. Hurricane Katrina and the associated storm surge resulted in numerous adverse impacts to existing wildlife and wildlife habitat. The proposed projects should enhance overall wildlife and associated habitats. Construction activities may result in temporary impacts to existing vegetation in the immediate areas; however it is expected all impacts would be short-term and minor, and in some cases discountable. Urbanization of rural lands could occur and cumulative impacts of this relocation would need to be evaluated to determine the full level of impacts to wildlife habitat.

(8) **Actions to Minimize Impacts**. BMPs would be incorporated into project designs and specifications during project development. Further studies would be conducted prior to implementation of certain measures and prior to specific project development.

G. **Proposed Disposal Site Determinations**:

(1) **Mixing Zone Determination.** The State of Mississippi will specify a mixing zone not to exceed ambient turbidity by more than 50 nephelometric turbidity units at the outer limits of 750 feet for turbidity compliance. Turbidity from material placed in or near the water is anticipated to quickly settle out of the water column. Thus, not exceeding the proposed water quality criteria issued. No adverse impacts are anticipated from construction sites located at upland sites. Thus, no mixing violations are expected.

(a) **Depth of water at the disposal site.** Placement of material associated with beach and marsh restorations will be along the shoreline or nearshore waters.

(b) **Current velocity, direction, and variability at disposal sites.** Further studies would be conducted to determine the impacts in conjunction with implementation of certain measures, such as restoration of Ship Island and placement of sand into the littoral zone around other barrier islands.

(c) **Degree of turbulence.** No impacts are anticipated.

(d) **Stratification attributable to causes such as obstructions, salinity or density profiles at the disposal site.** No impacts are anticipated.

(e) **Discharge vessel speed and direction, if appropriate.** Further studies during project development would determine impacts.

(f) **Rate of discharge.** Rate of discharge will vary according to the particular type of equipment placing materials.

(g) **Ambient concentrations of constituents of interest.** Not applicable.

(h) **Dredged material characteristics, particularly concentrations of constituents, amount of material, type of material (sand, silt, clay, etc.) and settling velocities.** Materials used for the beach restoration actions will consist of fine to medium grained sand that is compatible with existing beach sediments. Sandy material with a small silty component will be used where sediment is required for marsh restoration. Sandy clay fill material would be used to construct the levee around Forest Heights.

(i) **Number of discharge actions per unit of time.** The number of discharge actions per unit of time will vary depending upon particular project activity.

(2) **Determination of Compliance with Applicable Water Quality Standards.** Coordination will be conducted with the appropriate regulating agencies to ensure compliance with all applicable water quality standards.

(3) **Potential Effects on Human Use Characteristics.**

(a) **Municipal and Private Water Supply.** It is anticipated implementation of any measures would have no effect.

(b) **Recreational and Commercial Fisheries.** Recreational and commercial fishing would be temporarily impacted primarily as a result of the physical presence of heavy equipment during operation activities. Limited navigation would occur at the offshore borrow sites.

(c) **Water Related Recreation**. Water related recreation would be temporarily reduced in the immediate vicinity of project sites during construction.

(d) **Esthetics**. Esthetics will be temporarily reduced in the immediate vicinity of the proposed project sites. Many recreational vessels utilize Mississippi Sound within the project vicinities and it is believed some residents and visitors may be disturbed by the presence of the heavy equipment during construction. However, construction activities are temporary in nature so the disturbance is anticipated to be minimal. Furthermore, upon project completion, the restoration projects should provide residents and visitors with a more esthetically pleasing view. The proposed marsh creation and beach restoration projects would provide additional habitat to numerous marine birds.

(e) **Parks, National and Historical Monuments, National Seashores, Wilderness Areas, Research Sites, and Similar Preserves**. Further studies and coordination with resource agencies would need to be conducted to determine the full level of impacts of certain measures. Gulf Island National Seashore, administered by the National Park Service, including Petit Bois, Horn, East Ship, West Ship, and a portion of Cat Island are included within the scope of the restoration plan. The National Park Service is currently providing input regarding the feasibility of restoration involving the barrier islands in compliance with existing agency programs, management policies, and enabling legislation. Petis Bois and Horn Islands are also congressionally designated wilderness areas.

(f) **Other Effects**. No effect.

H. **Determination of Cumulative Effects on the Aquatic Ecosystem**. Further studies would need to be conducted to determine the cumulative impacts of certain measures.

I. **Determination of Secondary Effects of the Aquatic Ecosystem**. Further studies would need to be conducted to determine the cumulative impacts of certain measures.

III. **Finding of Compliance With the Restrictions on Discharge**.

A. No significant adaptations of the Section 404(b)(1) guidelines were made relative to this evaluation.

B. Further studies would need to be conducted to determine that any proposed project in conjunction with implementation of certain measures would represent the least environmentally damaging practicable alternative.

C. The planned construction activities and placement of dredged materials would not violate any applicable State water quality standards; nor will it violate the Toxic Effluent Standard of Section 307 of the Clean Water Act (CWA). Appropriate evaluation of analytical and ecotoxicological testing of sediments, site water, and elutriates results would reveal if any adverse impacts would result from the proposed disposal actions.

D. It is believed that use of the proposed disposal sites will not jeopardize the continued existence of any Federally-listed endangered or threatened species or their critical habitat.

E. It is anticipated construction of the proposed projects and placement of dredged material would not contribute to significant degradation of waters of the United States or result in significant adverse effects on human health and welfare, including municipal and private water supplies; recreation and commercial fishing; life stages of organisms dependent upon the aquatic ecosystem; ecosystem diversity, productivity and stability; or recreational, aesthetic or economic values.

F. Appropriate and practicable steps would be taken to minimize potential adverse impacts of the discharge on the aquatic ecosystem.

DATE: ____________________

____
Byron Jorns
Colonel, Corps of Engineers
District Engineer

3.2 Coastal Zone Management Program Federal Consistency Determination

The National Coastal Zone Management (CZM) Program is a voluntary partnership between the Federal government and United States (U.S.) coastal states and territories authorized by the Coastal Zone Management Act (CZMA) of 1972. The Coastal Programs Division, within the National Oceanic and Atmospheric Administration's (NOAA), Office of Ocean and Coastal Resource Management, administers the program at the Federal level and works with state coastal zone management partners to:

- Preserve, protect, develop, and, where possible, restore and enhance the resources of the nation's coastal zone for this and succeeding generations;
- Encourage and assist the states to exercise effectively their responsibilities in the coastal zone to achieve wise use of land and water resources, giving full consideration to ecological, cultural, historic, and aesthetic values, as well as the need for compatible economic development;
- Encourage the preparation of special area management plans to provide increased specificity in protecting significant natural resources, reasonable coastal-dependent economic growth, improved protection of life and property in hazardous areas and improved predictability in governmental decision-making; and
- Encourage the participation, cooperation, and coordination of the public, Federal, state, local, interstate and regional agencies, and governments affecting the coastal zone.

To comprehensively manage our coastal resources and balance often competing land and water uses while protecting sensitive resources, state CZM programs are expected to:

- Protect natural resources;
- Manage development in high hazard areas;
- Manage development to achieve quality coastal waters;
- Give development priority to coastal-dependent uses;
- Have orderly processes for the siting of major facilities;
- Locate new commercial and industrial development in, or adjacent to, existing developed areas;
- Provide public access for recreation;
- Redevelop urban waterfronts and ports, and preserve and restore historic, cultural, and aesthetic coastal features;
- Simplify and expedite governmental decision-making actions;
- Coordinate state and Federal actions;
- Give adequate consideration to the views of Federal agencies;
- Assure that the public and local governments have a say in coastal decision-making; and
- Comprehensively plan for and manage living marine resources.

A unique aspect of CZM is "Federal Consistency," which ensures that Federal actions that are reasonably likely to affect any land or water use or natural resource of the coastal zone will be consistent with the enforceable policies of a coastal state's or territory's federally approved CZM Program. Federal consistency is the CZMA requirement where Federal agency activities that have reasonably foreseeable effects on any land or water use or natural resource of the coastal zone (also referred to as coastal uses or resources and coastal effects) must be consistent to the maximum extent practicable with the enforceable policies of a coastal state's federally approved coastal management program. (Federal agency activities, including federally permitted activities, are activities and development projects performed by a Federal agency, or a contractor for the benefit of a Federal agency.)

The Mississippi Coastal Program, approved by NOAA in 1980, is comprised of a network of agencies with authority in the coastal zone. The Mississippi Department of Marine Resources (MDMR), through the Office of Ecology, serves as the lead agency. MDMR is governed by a Commission on Marine Resources appointed by the Governor. The primary authority guiding the Coastal Program is the Coastal Marshlands Protection Act, which includes a wetlands plan designating the allowable use of the state's tidal wetlands. The Mississippi coastal zone includes the three coastal counties as well as all adjacent coastal waters and the barrier islands of the coast.

The Coastal Program is responsible for permitting, Federal consistency review, and the Coastal Nonpoint Pollution Control Program. Through the Coastal Preserves Program, MDMR protects and restores coastal habitats. The Comprehensive Resource Management Plan is the primary program through which MDMR provides technical assistance for managing coastal development, with a focus on stormwater management, smart growth, and GIS training.

The MsCIP environmental team has been working closely with the MDMR technical staff throughout the entire planning process. The Corps, Mobile District has determined that the MsCIP effort described in the MsCIP Comprehensive Report and Integrated Programmatic EIS to be consistent with the requirements of the CZM Act to the maximum extent practicable. The Corps, Mobile District requested formal concurrence with our determination following the completion of the comment period the EIS. Concurrence from MDMR was received in a letter dated May 5, 2009.

STATE OF MISSISSIPPI
Haley Barbour
Governor

MISSISSIPPI DEPARTMENT OF MARINE RESOURCES
William W. Walker, Ph.D., Executive Director

May 5, 2009

Dr. Susan Rees
U.S. Army Corps of Engineers, Mobile District
Planning and Environmental Division
Coastal Environment Team
109 St. Joseph Street
Mobile, AL 36602

Re: DMR-060871; Mississippi Coastal Improvements Program; Hancock, Harrison and Jackson Counties, Mississippi

Dear Dr. Rees:

The Department of Marine Resources (DMR) in cooperation with other state agencies is responsible under the Mississippi Coastal Program (MCP) for managing the coastal resources of Mississippi. Proposed activities in the coastal area are reviewed to ensure that the activities are in compliance with the MCP.

The DMR has reviewed the Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan and Integrated Programmatic Environmental Impact Statement (EIS) dated February 2009. We concur that the projects discussed in the referenced document are consistent with the approved MCP and that these actions will not have adverse environmental effects on Mississippi's coastal resources.

If you have any questions regarding this letter, please contact Willa Brantley with the Bureau of Wetlands Permitting at 228-523-4108 or willa.brantley@dmr.ms.gov.

Sincerely,

William W. Walker, Ph.D.
Executive Director

WWW/wjb

cc: Mr. Robert Seyfarth, OPC
Mr. Jason Steele, USACE

1141 Bayview Avenue• Biloxi, MS 39530-1613 • Tel: (228) 374-5000 • www.dmr.state.ms.us
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3.3 AIR QUALITY

The Mississippi Department of Environmental Quality (MDEQ) is responsible for protecting the state's air, land, and water. The MDEQ, Air Division is responsible for ensuring that air quality within Mississippi is protective of public health and welfare. This division is charged with controlling, preventing, and abating air pollution to achieve compliance with air emission regulations pursuant to the Mississippi Air and Water Pollution Control Act, applicable regulations promulgated by the U.S. Environmental Protection Agency (USEPA), and the Federal Clean Air Act.

The Ambient Air Quality Standards for Mississippi are in Regulation APC-S-4 as described in the following:

MISSISSIPPI COMMISSION ON ENVIRONMENTAL QUALITY
REGULATION APC-S-4: AMBIENT AIR QUALITY STANDARDS

Adopted February 9, 1983
Last Amended June 27, 2002

Except for odor, as covered below, the ambient air quality standards for Mississippi shall be the Primary and Secondary National Ambient Air Quality Standards as duly promulgated by USEPA in (or to be printed in) 40 Code of Federal Regulation (CFR) Part 50, pursuant to the Federal Clean Air Act, as amended. All such standards promulgated by USEPA as of June 22, 1988, are hereby adopted and incorporated herein by the Commission by reference as the official ambient air quality standards of the State of Mississippi and shall hereafter be enforceable as such (except that the word "Administrator" in said standards shall be replaced by the words "Executive Director" and the word "Agency" in said standards shall be replaced by the word "Department").

There shall be no odorous substances in the ambient air in concentrations sufficient to adversely and unreasonably:

(1) affect human health and well-being;
(2) interfere with the use or enjoyment of property; or
(3) affect plant or animal life.

In determining that concentrations of such substances in the ambient air are adversely and unreasonably affecting human well-being or the use or enjoyment of property of plant or animal life, the factors to be considered by the Commission will include, without limiting the generality of the foregoing, the number of complaints or petitioners alleging that such a condition exists, the frequency of the occurrence of such substances in the ambient air as confirmed by the MDEQ staff, and the land use of the affected area.

Mississippi has adopted Federal Standards (New Source Performance Standards, National Emissions Standards for Hazardous Air Pollutants, etc.) by reference. State specific emissions standards for Mississippi are in:

- Regulation APC-S-1 - Air Emission Regulations for the Prevention, Abatement, and Control of Air Contaminants; and
- Regulation APC-S-8 - Air Toxic Regulations.

Jackson, Harrison, and Hancock Counties have been designated in attainment with the National Ambient Air Quality Standards. The proposed Mississippi Coastal Improvement Program effort will be in attainment with the State of Mississippi's Air Quality Standards.

3.4

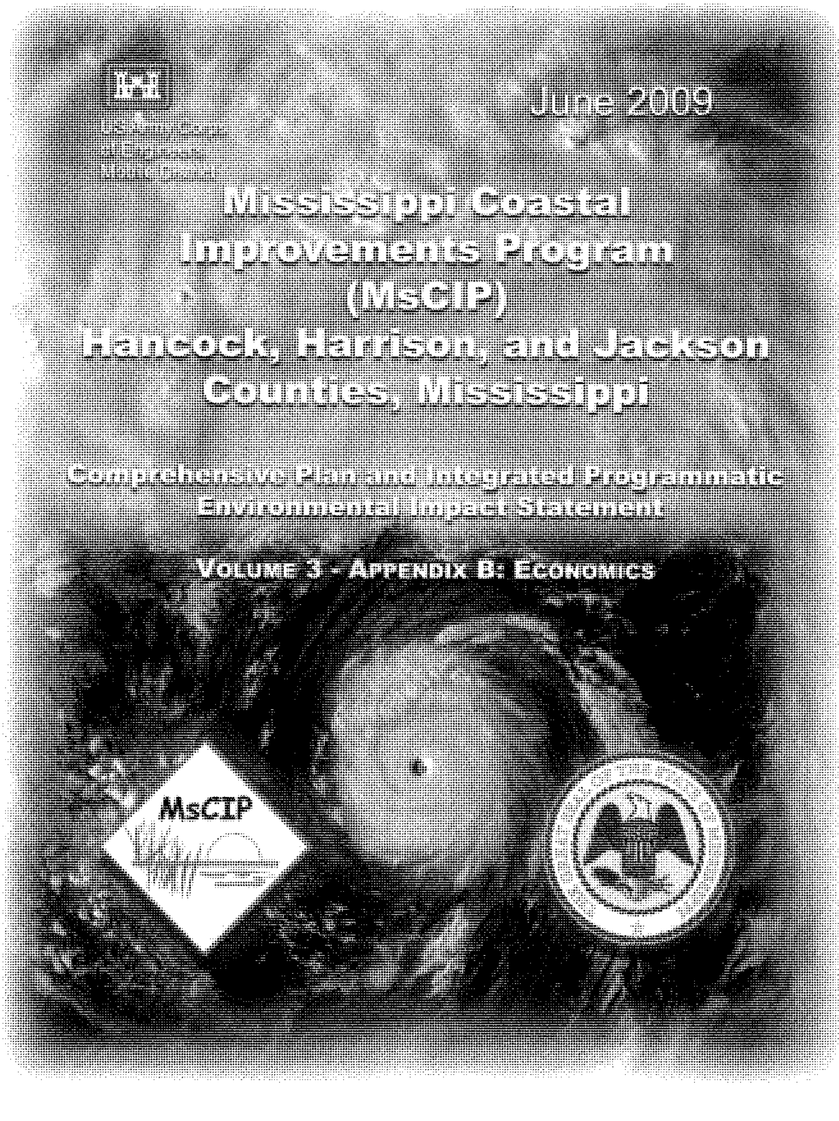
COMPLIANCE WITH ENVIRONMENTAL LAWS AND REGULATIONS

Environmental Laws and Regulations

Law/Regulation/ Executive Order (EO)	Description	Principal Federal Responsible Agency(s)
Endangered Species Act (ESA) of 1973	Establishes a national policy designed to protect and conserve threatened and endangered (T&E) species and the ecosystems upon which they depend	U.S. Fish and Wildlife Service (USFWS) National Oceanic and Atmospheric Administration (NOAA) Fisheries
Marine Mammal Protection Act of 1972 (MMPA)	Prohibits the take (i.e., hunting, killing, capture, and/or harassment) of marine mammals, and enacts a moratorium on the import, export, and sale of marine mammal parts and products	NOAA Fisheries USFWS
National Historic Preservation Act of 1966 (NHPA) and EO 11593	Seeks to preserve the historical and cultural foundation of the U.S. EO 11593 of 1991 states the Federal Government will provide leadership in preserving, restoring, and maintaining the historic and cultural environment	Mississippi State Historic Preservation Officer (SHPO)
Clean Water Act (CWA)	Regulates activities resulting in a discharge to navigable waters Section 401 (33 U.S.C. 1341) of the CWA specifies that any applicant for a Federal license or permit to conduct any activity that may discharge into the navigable waters shall obtain a certification that the discharge complies with applicable sections of the CWA Section 402 established the National Pollutant Discharge Elimination System (NPDES), which regulates discharges into waters of the U.S. Section 404 established a program to regulate the discharge of dredged or fill material into waters of the U.S. to include tributaries to navigable waters, interstate wetlands which could affect interstate or foreign commerce, and wetlands adjacent to waters of the U.S.	U.S. Environmental Protection Agency (USEPA)
Clean Air Act (CAA)	Establishes limits on how much of an air pollutant can be present in an area anywhere in the U.S. to promote uniformity in basic health and environmental protections	USEPA
Coastal Zone Management Act (CZMA)	Establishes a national coastal management program that comprehensively manages and balances competing uses of and impacts to any coastal area or resource	NOAA, National Ocean Service
Farmland Protection Policy Act (FPPA)	Minimizes the extent to which Federal programs contribute to the unnecessary conversion of farmland to nonagricultural uses	U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS)
Wild and Scenic Rivers Act of 1968	Establishes a National Wild and Scenic Rivers System to protect and preserve the free-flowing waters of the nation's most spectacular rivers. The act safeguards the special character of these rivers while striving to balance river development with permanent protection. The act prescribes the methods and standards through which additional rivers may be identified and added to the system to study areas and submit proposals to the President and Congress for addition to the system.	Secretary of the Interior and the Secretary of Agriculture
Estuary Protection Act	Authorizes study and inventory of U.S. estuaries, including	Secretary of the Interior

of 1968	land and water of the Great Lakes, to determine whether such areas should be acquired by the Federal Government for protection	
Federal Water Project Recreation Act of 1965	Declares recreation and fish and wildlife enhancement be given full consideration as purposes of Federal water development projects if non-Federal public bodies agree to: (1) bear not less than one-half the separable costs allocated for recreational purposes or twenty-five percent of the cost for fish and wildlife enhancement; (2) administer project land and water areas devoted to these purposes; and (3) bear all costs of operation, maintenance and replacement	Secretary of the Interior
Resource Conservation and Recovery Act (RCRA) of 1976	Provides for comprehensive 'cradle-to-grave' regulation of hazardous waste and authorizes environmental agencies to order the cleanup of contaminated sites	USEPA
Toxic Substances Control Act (TSCA) of 1976	Enacted by Congress to give USEPA the ability to track the 75,000 industrial chemicals currently produced or imported into the U.S.	USEPA
Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA)	Regulates ocean dumping in the territorial seas or the contiguous zone of the U.S. and provides for general research on ocean resources (includes designation of marine sanctuaries) and ocean disposal activities	USEPA/NOAA
Section 9 of the Rivers and Harbors Act of 1899	Prohibits the construction of any bridge, dam, dike, or causeway over or in any port, roadstead, haven, harbor, canal, navigable river, or other navigable water of the U.S. until receiving consent of Congress	Corps
Coastal Barrier Resources Act (CBRA)	Designated various undeveloped coastal barrier islands, depicted by specific maps, for inclusion in the Coastal Barrier Resources System (System). Areas so designated were made ineligible for direct or indirect Federal financial assistance that might support development, including flood insurance, except for emergency life-saving activities. Exceptions for certain activities, such as fish and wildlife research, are provided, and National Wildlife Refuges and other, otherwise protected areas are excluded from the System.	Department of Interior, USFWS
EO 11988, Floodplain Management	Requires Federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative	Federal Emergency and Management Agency (FEMA)
EO 11990, Protection of Wetlands	Minimizes the destruction, loss or degradation of wetlands and preserves and enhances the natural and beneficial values of wetlands	USFWS
EO 12114, Environmental Effects Abroad of Major Federal Actions	Enables Federal agencies responsible for authorizing and approving actions to be informed of pertinent environmental considerations and to take such considerations into account, with other pertinent considerations of national policy, in making decisions regarding such actions	All Federal agencies
EO 12898: Environmental Justice	Requires Federal agencies to incorporate into NEPA documents an analysis of the environmental effects of their proposed programs on minorities and low-income	USEPA

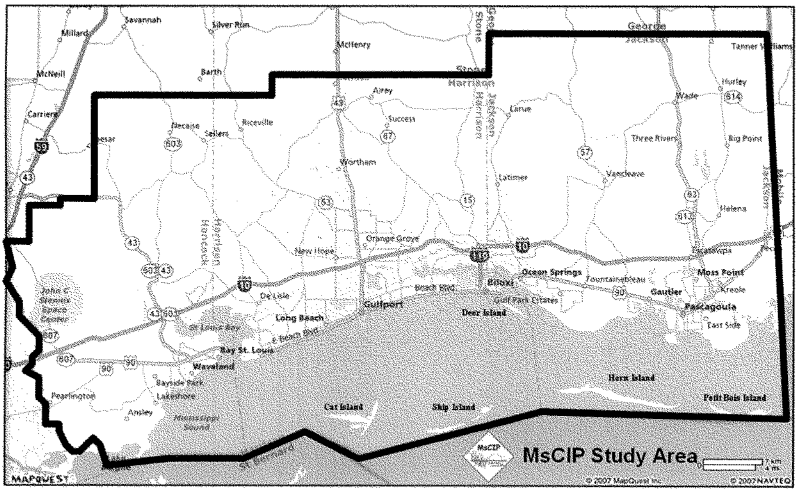
	populations and communities.	
EO 13045: Protection of Children from Environmental Health Risks and Safety Risks	Each Federal agency is to make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children. The President also directed each Federal agency to ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.	USEPA
Wilderness Act of 1964	Assures that an increasing population, accompanied by expanding settlement and growing mechanization, does not occupy and modify all areas within the U.S. and its possessions, leaving no lands designated for preservation and protection in their natural condition, it is hereby declared to be the policy of the Congress to secure for the American people of present and future generations the benefits of an enduring resource of wilderness.	All Federal agencies
Magnuson Fishery Conservation and Management Act and Essential Fish Habitat (EFH)	Establishes and delineates an area from the states' seaward boundary out 200 nautical miles as a fisheries conservation zone for the U.S. and its possessions Established national standards for fishery conservation and management, and created eight regional Fishery Management Councils (FMCs) to apply those national standards in FMCs EFH is defined as the water and substrate necessary for fish spawning, breeding, feeding, and growth to maturity.	NOAA Fisheries


June 2009
Mississippi Coastal
Improvements Program
(MsCIP)
Hancock, Harrison, and Jackson
Counties, Mississippi
Comprehensive Plan and Integrated Programmatic
Environmental Impact Statement
VOLUME 3 - APPENDIX B: ECONOMICS
MsCIP

FOREWORD

This document is one of a number of technical appendices to the Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan and Integrated Feasibility Report and Environmental Impact Statement.

The Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan Integrated Feasibility Report and Environmental Impact Statement provides systems-based solutions and recommendations that address: hurricane and storm damage reduction, ecosystem restoration and fish and wildlife preservation, reduction of damaging saltwater intrusion, and reduction of coastal erosion. The recommendations contained in the Main Report/EIS also provide measures that aid in: greater coastal environmental and societal resiliency, regional economic re-development, and measures to reduce long-term risk to the public and property, as a consequence of hurricanes and coastal storms. The recommendations cover a comprehensive package of projects and activities that treat the environment, wildlife, and people, as an integrated system that requires a multi-tiered and phased approach to recovery and risk reduction, irrespective of implementation authority or agency.



The MsCIP Study Area

The purpose of the Comprehensive Plan Report is to present, to the Congress of the United States, the second of two packages of recommendations (i.e., the first being the "interim" recommendations funded in May 2007, and this "final" response, as directed by the Congress), directed at recovery of vital water and related land resources damaged by the hurricanes of 2005, and development of recommendations for long-term risk reduction and community and environmental resiliency, within the three-county, approximately 70 mile-long coastal zone, including Mississippi Sound and its barrier islands, of the State of Mississippi.

This appendix, the Main Report/EIS, and all other appendices and supporting documentation, were subject to Independent Technical Review (ITR) and an External Peer Review (EPR). Both review processes will have been conducted in accordance with the Corps "Peer Review of Decision Documents" process, has been reviewed by Corps staff outside the originating office, conducted by a Regional and national team of experts in the field, and coordinated by the National Center of Expertise in Hurricane and Storm Damage Protection, North Atlantic Division, U.S. Army Corps of Engineers.

The report presents background on the counties that comprise the Mississippi coastline most severely impacted by the Hurricanes of 2005, their pre-hurricane conditions, a summary of the effects of the 2005 hurricane season, problem areas identified by stakeholders and residents of the study area, a summary of the approach used in analyzing problems and developing recommendations directed at assisting the people of the State of Mississippi in recovery, recommended actions and projects that would assist in the recovery of the physical and human environments, and identification of further studies and immediate actions most needed in a comprehensive plan of improvements for developing a truly resilient future for coastal Mississippi.

This appendix contains detailed technical information used in the analysis of existing and future without-project conditions, in the development of problem-solving measures, and in the analysis, evaluation, comparison, screening, and selection of alternative plans, currently presented as recommendations contained in the Main Report/EIS.

Each appendix functions as a complete technical document, but is meant to support one particular aspect of the feasibility study process. However, because of the complexity of the plan formulation process used in this planning study, the information contained herein should not be used without parallel consideration and integration of all other appendices, and the Main Report/EIS that summarizes all findings and recommendations.

The intent of the economic appendix is to outline the economic evaluation conducted for the Mississippi Coastal Improvements Programs (MsCIP) Comprehensive Plan. This appendix will display the National Economic Development (NED) benefits, Regional Economic Development (RED) benefits, Environmental Quality (EQ) benefits, Other Social Effects (OSE), and costs that were evaluated for the various Comprehensive Plan measures. The intent of this appendix is to demonstrate the cost effectiveness of measures. recommendations of cost effective plans are outlined in the MsCIP Main Report, and are based on the data from this appendix, other technical appendices, and the results of the Risk Informed Decision Framework (RIDF) evaluations.

Contents

Figures

Tables

LIST OF ACRONYMS

AAFU – Average Annual Functional Units

ABFE – Advisory Base Flood Elevation

BFE – Base Flood Elevation

CEFIT – Corps of Engineers Flood Inventory Tool

EAD – Equivalent Annual Damages

EIFS – Economic Impact Forecast System

EGM – Economic Guidance Memorandum

EM – Engineering Manual

EQ – Environmental Quality

ER – Engineering Regulation

ERDC – Engineer Research and Development Center

FEMA – Federal Emergency Management Agency

FHI – Functional Habitat Unit

HEC-FDA – Hydrologic Engineering Centers - Flood Damage Analysis

IWR – Institute for Water Resources

LaCPR – Louisiana Coastal Protection and Restoration

MEMA – Mississippi Emergency Management Agency

MPI – Maximum Probable Intensity

MsCIP – Mississippi Coastal Improvements Program

NAVD88 – North American Vertical Datum 1988

NED – National Economic Development Benefits

NFIP –National Flood Insurance Program

OSE – Other Social Effects

P&G – Planning and Guidance

RED – Regional Economic Development

ROM Costs – Rough Order Magnitude Costs

USACE – US Army Corps of Engineers

EXECUTIVE SUMMARY

General

The intent of the economic appendix is to outline the economic evaluation conducted for the Mississippi Coastal Improvements Programs (MsCIP) Comprehensive Plan. This appendix will display the National Economic Development (NED) benefits, Regional Economic Development (RED) benefits, Environmental Quality (EQ) benefits, Other Social Effects (OSE), and costs that were evaluated for the various Comprehensive Plan measures. The intent of this appendix is to demonstrate the cost effectiveness of measures. Plan features of cost effective plans are outlined in the MsCIP Main Report, and are based on the data from this appendix, other technical appendices, and the results of the Risk Informed Decision Framework (RIDF) evaluations.

Authorizing Language

The Coastal Mississippi Comprehensive Plan Report was authorized by the Department of Defense Appropriations Act, 2006 (P.L. 109-148) 30 December 2005, which states: ***"For an additional amount for "investigations" to expedite studies of flood and storm damage reduction related to the consequences of hurricanes in the Gulf of Mexico and Atlantic Ocean in 2005, $37,300,000 to remain available until expended: Provided, that using $10,000,000 of the funds provided, the Secretary shall conduct an analysis and design for comprehensive improvements or modifications to existing improvements in the coastal area of Mississippi in the interest of hurricane and storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resource purposes at full Federal expense; Provided further, that the Secretary shall recommend a cost-effective project, but shall not perform an incremental benefit-cost analysis to identify the recommended project, and shall not make project plan features based upon maximizing net national economic development benefits; Provided further, that interim plan features for near term improvements shall be provided within 6 months of enactment of this act with final plan features within 24 months of this enactment."***

The requirements laid out in this authorizing language are unique in their direction that the study team use neither incremental cost-benefit analysis nor maximization of net national economic development (NED) benefits in the selection of plan features. This provided a unique opportunity, but also the requirement that the team very carefully describe the plan formulation and selection process developed for this study effort.

Study Purpose and Scope

The purpose of the comprehensive study is to present the second of two packages of recommended plan features, the "final" response requested by Congress, directed at recovery of vital water and related land resources damaged by the hurricanes of 2005 within the three-county coastal region of the State of Mississippi. The report presents background on the three coastal counties that comprise the Mississippi coastline most severely impacted by the Hurricanes of 2005, their pre-hurricane conditions, a summary of the effects of the 2005 hurricane season, problem areas identified by stakeholders and residents of the study area, a summary of the approach used in analyzing problems and developing plan features directed at assisting the people of the State of Mississippi in recovery, recommended actions and projects that would assist in the recovery of the physical and human environments, and identification of further studies and immediate actions most needed in a comprehensive plan of improvements for coastal Mississippi.

Study Area

Delineation of the study area is critical for the evaluation of benefits and for their aggregation to determine the economic value of proposed measures. The over all study area for this analysis is the three coastal Mississippi counties; Hancock, Harrison, and Jackson from west to east respectively. The area was further delineated into planning zones, planning units, and planning sub-units.

The first delineation in the hierarchy of segregating the study area was the creation of four planning zones, as shown below in figure 1. The planning zones span the width of Mississippi from state line to state line, and run from south to north. The four zones have been titled the Off-shore Zone, the Coastal Zone, the Inland Zone, and the Upland Zone from south to north respectively. The Off-shore zone includes all areas south of the Mississippi Sound shoreline. The Coastal Zone includes all areas generally from the shoreline North to the CSX railroad and terminating at the Port Bienville railroad spur in Hancock County and Hwy 52 in Jackson County. The Inland Zone accounts for all areas north of the Coastal Zone to the MPI storm surge limit, and the Upland Zone extends from north of the MPI storm surge limit to the County lines.

For the comprehensive plan, the three coastal counties were divided into three planning units based on watershed boundaries which, coincidentally, align with the county jurisdictions. Planning unit one begins at the western state boundary, or the east bank of the Pearl River, and continue to the midpoint of St. Louis Bay. Planning unit two begins at the midpoint of St. Louis Bay and continues east to the midpoint of Biloxi Bay. Planning unit three extends from the midpoint of Biloxi Bay east to the border of Mississippi and Alabama.

Further delineation of the area required breaking the planning units into fifty-four planning sub-units based on hydrologic characteristics, population centers, and economic considerations of potential measure. For hydraulic considerations, Hurricane Surge Atlas maps were evaluated. These maps were prepared by FEMA and the Corps of Engineers, Mobile District from **SLOSH** (Sea, Lake, and Overland Surges from Hurricanes) programming done by the National Oceanic &Atmospheric Administration (NOAA). Sub-units were delineated so that the maximum storm surge difference between sub-units was approximately two-feet. Planning unit one includes ten sub-units, planning unit two eighteen sub-units, and planning unit three twenty-six sub-units. Figure 2 depicts the 54 planning sub-units.

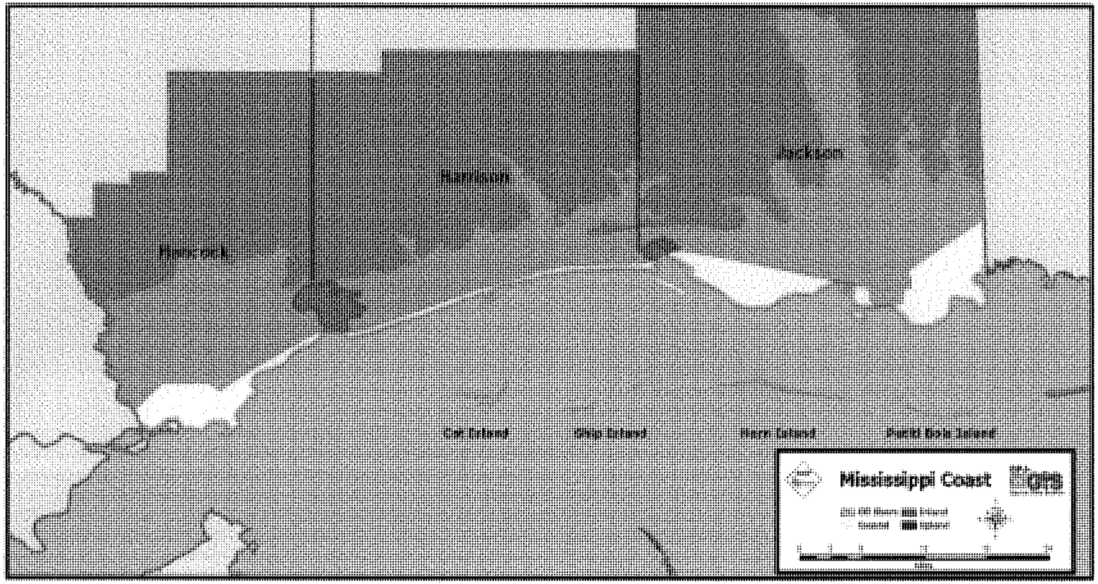


Figure 1. MsCIP Planning Zones

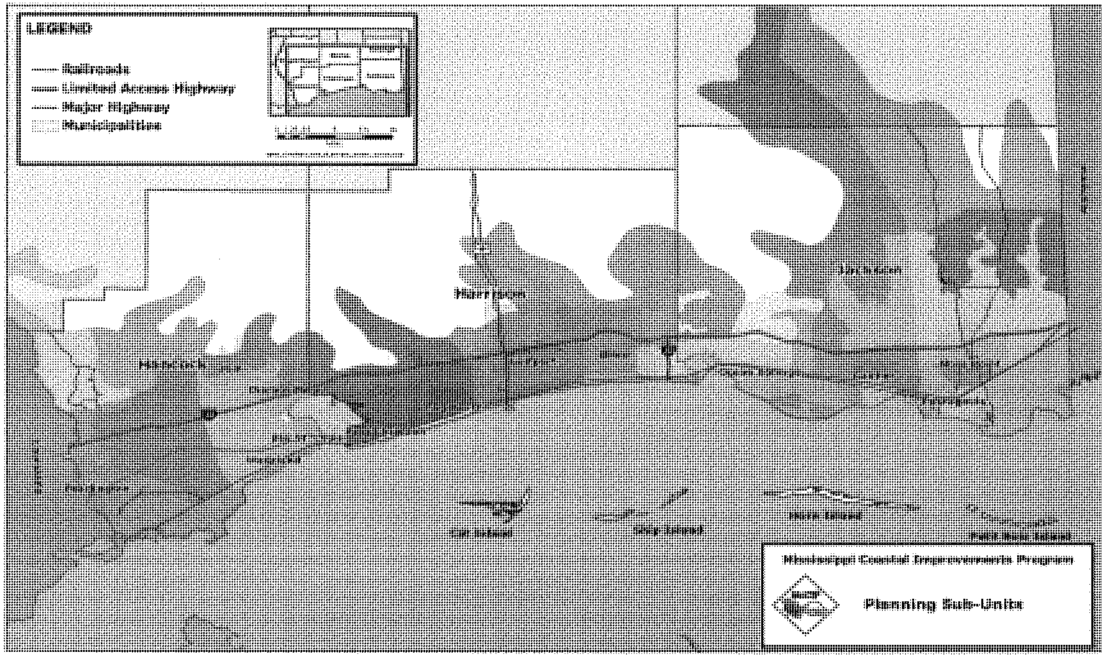


Figure 2. Overview of 3 planning units 54 planning sub-units

Economic Methodology

The economic methodology was developed to seamlessly fit into the six step planning process and current Corps guidance. The six step planning process, as defined by the Engineering Regulation (ER) 1105-2-100; Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (U.S. Water Resources Council 1983), referred to as the P&G, is:

1/ Identify Problems and Opportunities
2/ Inventory and Forecast Conditions
3/ Develop Alternatives
4/ Evaluate Alternatives
5/ Compare Alternatives
6/ Select the Recommended Plan

The Mississippi Gulf Coast is a complex system that is made up of a diverse blend of ecological and human habitats. Given those complexities, a fluid and flexible process was needed to evaluate and aggregate the benefits of potential measures and measures. The process incorporates data collection, forecasting techniques, scenario planning, cost effective evaluation using state of the art modeling techniques, and the communication of both benefits and risks associated with potential measures and measures. Figure 3 outlines the process used for this analysis.

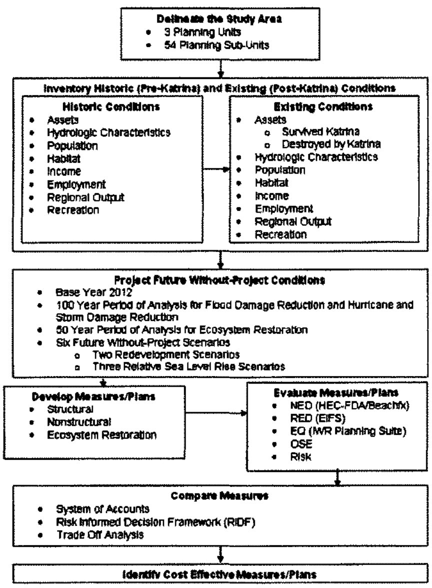


Figure 3. Overview of Economic Methodology

Historic Conditions

The Mississippi Gulf Coast is no stranger to large storm surge events. On August 17, 1969, Hurricane Camille impacted the area in a similar fashion to Hurricane Katrina. Hurricane Camille made landfall at Bay St. Louis, Mississippi only miles way from Hurricane Katrina's landfall path. The total surge area ranged from lower Plaquemines Parish in Louisiana to Perdido Pass, Alabama. Maximum surge from Hurricane Camille on the Mississippi coast ranged from 21.7-feet above m.s.l. in planning unit one, to 24.2-feet above m.s.l. in planning unit two, and 15.8-feet above m.s.l. in planning unit 3.

Damage to the Mississippi Coast from Hurricane Camille was extensive. Federal relief expenditures topped 100 million dollars at 1970 prices, over 600 million dollars when accounted for inflation. The magnitude of this number is astounding considering that many of the relief programs that exist today did not exist for Hurricane Camille. Table 1 shows selected Hurricane Camille damage statistics. Tables 2 and 3 show damage to residential and commercial structures caused by Hurricane Camille surge.

Table 1.
Select Hurricane Camille Statistics.

Camille Statistics	Mississippi	Louisiana	Alabama
Persons Dead	135	9	Unknown
Persons Missing	27	0	Unknown
Families Suffering Loss	63,665	9,442	750
Dwellings Destroyed	3,881	1,771	10
Dwellings with major damage	12,112	1,753	50
Dwellings with minor damage	29,736	3,697	500
Trailers destroyed	406	664	12
Trailers with major damage	325	290	6
Farm buildings destroyed	645	114	5
Farm buildings with major damage	2,002	97	5
Small businesses destroyed or with major damage	569	110	14
Damage to public property	$200,000,000	$10,000,000	$500,000
Damage to private property	$750,000,000	$312,000,000	$7,500,000

1 Source: Report on Hurricane Camille U.S. Army Corps of Engineers – MOBILE DISTRICT
2 These dollars reflect a 1970 price level.

Table 2.
Damage to Structures Caused by Hurricane Camille Surge.

County	Destroyed	Damaged	Total Homes Impacted
Hancock	988	4,217	**5,205**
Harrison	2,608	8,983	**11,591**
Jackson	280	1,289	**1,569**
Total	3,876	14,489	**18,365**

1 Source: Report on Hurricane Camille U.S. Army Corps of Engineers – MOBILE DISTRICT

The 1950-2000 population levels and growth for the U.S., Mississippi, the three-county study area, and each county are presented in Table 3. During this fifty year period, the population of the three-county study area grew by 186.6 percent. This is 5.6 times the Mississippi percentage population growth of 33.2 percent and 2.2 times the U.S. percentage population growth of 86.0 percent for the same timeframe. The three-county area accounted for 32.7 percent of the nominal population growth for Mississippi from 1950 to 2000.

Table 3.
1950-2000 Population Levels and Growth (in thousands)

	United States	Mississippi	Three-County Study Area	Hancock County	Harrison County	Jackson County
1950	151,326	2,179	127	12	84	31
1960	179,323	2,178	189	14	119	56
1970	203,212	2,217	239	17	134	88
1980	226,546	2,521	301	25	158	118
1990	248,710	2,573	312	32	165	115
2000	281,421	2,903	364	43	190	131
50 Year Nominal Change	130,095	724	237	31	106	100
50 Year Percentage Change	86.0%	33.2%	186.6%	258.3%	126.2%	322.5%

Source: U.S. Census Bureau, 2000 Census

Existing Conditions

On August 29, 2005, Hurricane Katrina made land fall in Hancock County, Mississippi just east of the Pearl River. By virtually all accounts, it was the single largest disaster in U.S. history. Storm surge from Hurricane Katrina was the largest that has ever hit the continental United States. The surge inundated approximately 484 square miles of southern Mississippi. The relief expenditures in Mississippi alone have totaled in the billions of dollars.

The three planning units suffered tremendous devastation from Hurricane Katrina's surge. It is estimated that 32,446 structures were significantly destroyed (at least fifty-percent or more), with another 15,000 to 25,000 suffering moderate to minimal inundation damage. Of the structures sustaining significant destruction, 9,555 were in planning unit one, 16,528, in planning unit two, and 6,363 in planning unit three. Of those significant loss structures, approximately 19,000 claims were paid out by the Federal Emergency Management Agency's (FEMA's) National Flood Insurance Program (NFIP) totally over $2.3 Billion dollars, with the average claim around $137,000. Currently, no accurate data exists for uninsured losses, but estimates also range in the billions of dollars. Table 4 displays the significantly damaged structures by planning unit and by structure category. Figure 4 shows an example of the destruction caused by Hurricane Katrina in the planning unit one.

Table 4.
Structures Damaged 50% or More by Planning Unit and by Category

	Planning Unit One	Planning Unit Two	Planning Unit Three	Total
Commercial	1,267	1,794	378	**3,439**
Residential	8,099	14,500	5,780	**28,379**
Municipal	127	89	136	**352**
Mobile Home	62	145	69	**276**
Total	**9,555**	**16,528**	**6,363**	**32,446**

Source: U.S. Census Bureau. Population Division

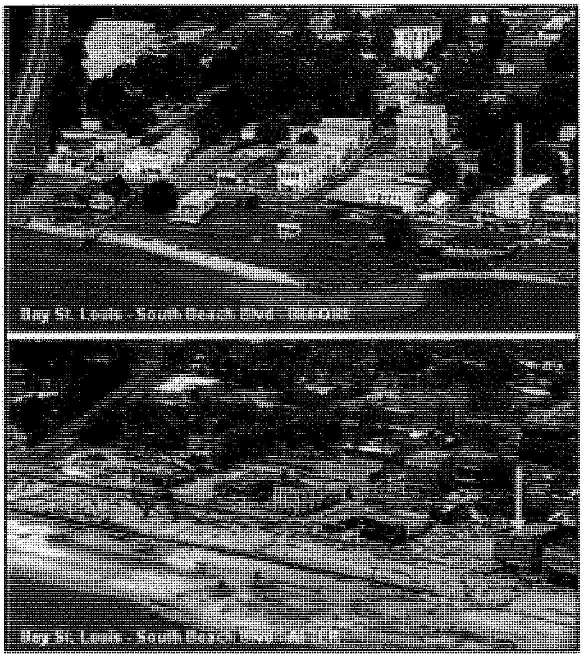


Figure 4. Example of the extent of Hurricane Katrina Surge Damage – Planning Unit One

The 2000-2005 population level and growth estimates for the U.S., Mississippi, the three-county study area, and each county are displayed in Table 5.

Table 5.
2000-2005 Estimates of Population Levels and Growth

	United States	Mississippi	Three-County Study Area	Hancock County	Harrison County	Jackson County
July 1, 2000	282,216,952	2,848,634	364,863	43,283	189,699	131,881
July 1, 2001	285,226,284	2,856,108	366,362	43,944	189,512	132,906
July 1, 2002	288,125,973	2,863,091	367,498	44,607	189,996	132,895
July 1, 2003	290,796,023	2,874,171	367,790	45,166	189,189	133,435
July 1, 2004	293,638,158	2,892,668	372,885	45,821	192,129	134,935
July 1, 2005	296,507,061	2,908,496	375,304	46,546	193,187	135,571
5 Year Nominal Change	14,290,109	59,862	10,441	3,263	3,488	3,690
5 Year Percentage Change	5.06%	2.10%	2.86%	7.54%	1.84%	2.80%

Source: U.S. Census Bureau, Population Division

Future Without-Project Conditions

Forecasting future "without-project" conditions is an important part of the Corps planning process. In order to evaluate the true economic value of potential measures over the project life, a forecast is created based on the historic and existing information, as well as quantitative and qualitative assumptions about what may happen within the study area in the future. In addition to forecasting of future "without-project" conditions, this study also evaluated alternative re-development and relative sea-level rise scenarios. This "Scenario Forecasting" technique was used for the MsCIP Comprehensive Plan in an attempt to capture uncertainty pertaining to these two key variables. For this purpose, six future "without-project" scenarios were developed and are summarized in Table 6.

Table 6.
Overview of Future Scenarios

Future Scenario	Redevelopment Type	Relative Sea Level Rise	Description
Future Scenario 1	Residential	Historical Only	Rebuild structures as existed pre-Hurricane Katrina with no relative sea level rise over the period of analysis. This future scenario applies to all three planning units.
Future Scenario 2	Mixed Residential & Commercial	Historical Only	Rebuild structures as existed pre-Hurricane Katrina except at water front where condo/casino rebuild will occur. Also, no relative sea level rise over the period of analysis. This future scenario applies only to planning units one and two. Planning unit three would not allow commercial type redevelopment based on local ordinances.
Future Scenario 3	Residential	Expected	Rebuild structures as existed pre-Hurricane Katrina with up to 2.4-feet relative sea level rise over the 100-year period of analysis. This future scenario applies to all three planning units.
Future Scenario 4	Mixed Residential & Commercial	Expected	Rebuild structures as existed pre-Hurricane Katrina except at water front where condo/casino rebuild will occur. Also, an up to 2.4-feet relative sea level rise over the period of analysis. This future scenario applies only to planning units one and two. Planning unit three would not allow commercial type redevelopment based on local ordinances.
Future Scenario 5	Residential	High	Rebuild structures as existed pre-Hurricane Katrina with up to 3.4-feet of relative sea level rise over the period of analysis. This future scenario applies to all three planning units.
Future Scenario 6	Mixed Residential & Commercial	High	Rebuild structures as existed pre-Hurricane Katrina except at water front where condo/casino rebuild will occur. Also, up to3.4-feet of relative sea level rise over the period of analysis. This future scenario applies only to planning units one and two. Planning unit three would not allow commercial type redevelopment based on local ordinances.

Future Scenarios One and Two are included only to evaluate the effects of relative sea level rise. These Future scenarios will not be used in the evaluation of potential measures. Futures Three, Four, Five, and Six will be the future scenarios by which potential measures will be evaluated depending on the planning unit.

Structure inventory data was developed for the six future without-project scenarios including structure categories, structure value, content value, and other characteristics, which were input into the HEC-FDA program. Tables 7, 8, and 9 show a summary of select structure characteristics by future without-project scenario and table 10 summarizes the average annual without-project damages by future without-project scenario.

Table 7.
Future Without-Project Scenarios One, Three, and Five Inventory Parcels by Planning Unit and by Structure Category

Structure Categories	Planning Unit One	Planning Unit Two	Planning Unit Three	Total
Residential	17,907	49,121	49,688	**116,716**
Mobile Homes	498	2,497	3,553	**6,548**
Commercial	3,255	5,618	4,266	**13,139**
Municipal	653	351	763	**1,767**
Vacant Land	22,843	29,984	29,779	**82,606**
Total	**45,156**	**87,571**	**88,049**	**220,776**

Table 8.
Future Without-Project Scenarios Two, Four, and Six Inventory Parcels by Planning Unit and by Structure Category

Structure Categories	Planning Unit One	Planning Unit Two	Planning Unit Three	Total
Residential	17,757	48,636	49,688	**69,942**
Mobile Homes	498	2,497	3,553	**52,687**
Commercial	3,408	6,101	4,266	**13,775**
Municipal	651	381	763	**1,795**
Vacant Land	22,842	29,956	29,779	**82,577**
Total	**45,156**	**87,571**	**88,049**	**220,776**

Table 9.
Structure and Content Values by Category and Planning Unit

	Planning Unit One	Planning Unit Two	Planning Unit Three	Total
Future Without-Project Scenarios One, Three, and Five Inventory				
Structure Value Subtotal	**$3,370,979,973**	**$9,284,611,429**	**$5,605,921,896**	**$18,261,513,298**
Content Value Subtotal	**$2,565,304,099**	**$7,011,916,003**	**$3,808,364,637**	**$13,385,584,739**
Total	**$5,936,284,072**	**$16,296,527,432**	**$9,414,286,533**	**$31,647,098,037**
Future Without-Project Scenarios Two, Four, and Six Inventory				
Structure Value Subtotal	**$4,234,629,816**	**$8,944,955,778**	**$5,605,921,896**	**$18,785,507,490**
Content Value Subtotal	$4,012,724,707	$7,074,305,948	$3,808,364,637	**$14,895,395,292**
Total	**$8,247,354,523**	**$16,019,261,726**	**$9,414,286,533**	**$33,680,902,782**

Table 10.
Equivalent Annual Without-Project Damages by Planning Unit and Future Scenario

Without-Project Damages	Future 1[2] Damages	Future 2[2] Damages	Future 3 Damages	Future 4 Damages	Future 5 Damages	Future 6 Damages
Planning Unit One	$198,960,000	$202,060,000	$218,050,000	$222,220,000	$237,310,000	$241,520,000
Planning Unit Two	$91,260,000	$94,680,000	$103,280,000	$107,120,000	$115,470,000	$119,760,000
Planning Unit Three	$88,670,000	$88,670,000	$104,700,000	$104,700,000	$122,420,000	$122,420,000
Total	**$378,890,000**	**$385,410,000**	**$426,030,000**	**$434,040,000**	**$475,200,000**	**$483,700,000**

Damages are rounded to the nearest ten thousand.

Evaluation of Measures and Alternatives

Initial analysis yielded an extensive list of potential measures that were appropriate to a given site or problem area. The sites/problem areas are illustrated in the Main Report. The development of preliminary measures for structural and non-structural damage reduction is discussed in detail in the Engineering Appendix. The development of preliminary measures for ecosystem restoration and saltwater intrusion remediation is discussed in detail in the Environmental Appendix.

Many measures were initially evaluated and screened, based on technical or environmental criteria, and are not discussed here. Those measures that were found to be technically sound for a particular application, and environmentally sound, in regards to potential impacts to environmental resources, were forwarded for evaluation. The development of more detail included preliminary design and cost estimation, coastal, hydrologic and/or hydraulic analysis and design, environmental analysis, and determination of potential damages prevented, residual damages, and other factors. Models used to evaluate the benefits of the measures included the Corps of Engineers Flood Inventory Tool (CEFIT), the Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA) program, the Beach-FX program, the Institute for Water Resources (IWR) Plan program, and the Economic Impact Forecasting System (EIFS).

Recommended Plan features

The system wide plan features for the MsCIP Comprehensive plan, explained in more detail in the Main Report, have multiple levels. Some of the features will be recommended as work for entities other than the Corps of Engineers, some will be recommended for further construction, and some will be recommended for implementation. The list of measures in this appendix which are recommended for further study include the ring levee and nonstructural measures at the Pearlington, Ocean Springs, Gautier, Gulf Park Estates, Belle Fontaine, and Pascagoula/Moss Point areas, as well as further inquiry into the coast wide 20-foot, 30-foot, and 40-foot elevation nonstructural measures. Among the list of recommended plan features for construction that were analyzed in this appendix include barrier island restoration, beach and dune placement, ecosystem restoration at the Admiral Island, Turkey Creek, Bayou Cumbest, Dantzler, and Franklin Creek areas, the 21-foot elevation levee at the Forrest Heights area, and the acquisition of parcels within high risk areas.

For planning and screening purposes, the analysis in this appendix used a 100-year period of analysis for measures that were determined to be complex in nature such as the barrier island restoration or measures that had a high risk of residual damages due to relative sea level rise such as flood risk management measures. Other measures that were not as complex in nature, such as the beach and dune placement and the ecosystem restoration measures were evaluated at the traditional 50-year period of analysis used in Corps of Engineers studies. In order to show consistency among the plans recommended for construction, those measures that were initially screened at a 100-year period of analysis have been converted to a 50-year period of analysis for costs and benefits and are summarized in table 11. The costs in table 11 represent Rough Order Magnitude (ROM) utilized for screening. Detailed Micro-Computer Aided Cost Estimating System (MCACES) costs can be found in the cost estimating appendix.

Table 11.
Summaries of Benefits and Costs for Measures Recommended for Implementation[1]

	Equivalent annual damages Reduced Future 3 (Annual $)	Recreation (Annual $)	Environmental Impacts	Changes in Sales Volume ($)	Changes in Income ($)	Changes in Employment	Total First Cost with IDC[2] ($)	Average Annual Cost (Annual $)
Barrier Island Restoration	$18,028,000	$466,000	$43,618,000 Fishery Losses Avoided	$798,984,000	$167,850,000	4,920	$551,134,800	$29,608,000
Beach and Dune Placement	Moderate Reduction	N/A	736 Functional Habitat Index (FHI) Score	$33,413,200	$7,307,000	208	$25,192,300	$1,353,000
Acquisition in High Risk Areas	$22,000,000 to $33,000,000	Potential Recreational Opportunities	Potential Restoration Opportunities	$3,238,602,000	$706,330,000	19,452	$459,442,100	$24,682,000
Forrest Heights 21-FT Ring Levee	$89,000	N/A	3.6 Acres Impacted	$30,425,000	$6,440,000	193	$14,482,500	$778,000
Admiral Island Ecosystem Rest.	Increased Surge Storage	N/A	60 Average Annual Functional Units (AAFU)	$49,750,000	$ 11,996,000	301	$22,997,000	$1,235,000
Turkey Creek Ecosystem Rest.	Increased Surge Storage	N/A	1,565 Average Annual Functional Units (AAFU)	$15,237,000	$3,226,000	97	$7,206,300	$387,000
Bayou Cumbest Ecosystem Rest.	Increased Surge Storage	N/A	188 Average Annual Functional Units (AAFU)	$54,073,000	$ 10,546,000	306	$26,917,800	$1,446,000
Dantzler Ecosystem Rest.	Increased Surge Storage	N/A	1,244 Average Annual Functional Units (AAFU)	$ 5,054,000	$ 986,000	29	$2,331,800	$125,000
Franklin Creek Ecosystem	Increased Surge Storage	N/A	516 Average Annual Functional Units (AAFU)	$3,890,000	$ 759,000	22	$1,960,500	$105,000

1/ These measures were analyzed for economic benefits and do not represent the entire recommended plan features for implementation. See the main report for more detail.
2/ Implementation costs are based on ROM cost estimates and an FY 08 price level and do not include escalation. See the engineering appendix for more details on the costs.
3/ Average annual damages reduced and costs are based on a 50-year period of analysis and an FY 08 discount rate of 4.875-percent. Dollar values are rounded to the nearest thousand.

CHAPTER I. DEFINING THE STUDY AREA

This section describes the location and delineation of the study area used in this analysis. Delineation of the study area is critical for the evaluation of benefits and for their aggregation to determine the economic value of proposed measures. The over all study area for this analysis is the three coastal Mississippi counties; Hancock, Harrison, and Jackson from west to east respectively. The area was further delineated into planning zones, planning units, and planning sub-units which are detailed in the following subsections. Figure 1-1 shows the congressionally mandated study area for the Mississippi Coastal Improvements Program.

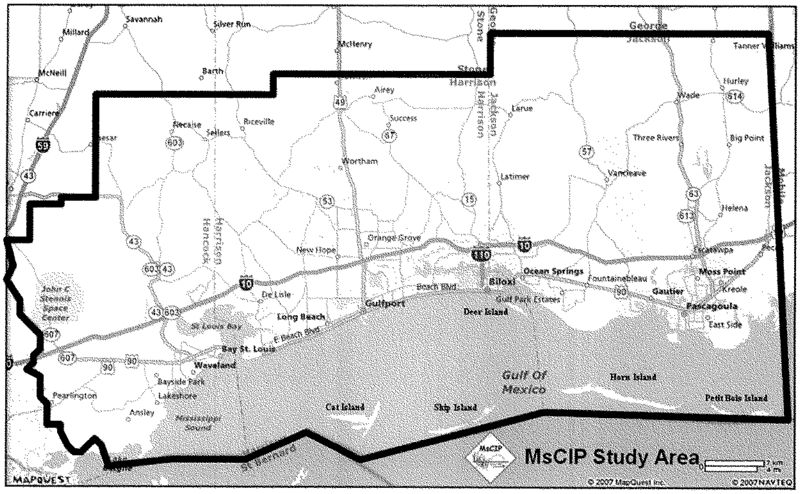


Figure 1-1. Congressionally authorized study area

1.3.1 Planning Zones

The first delineation in the hierarchy of segregating the study area was the creation of four planning zones. The planning zones span the width of Mississippi from state line to state line, and run from south to north. The four zones have been titled the Off-shore Zone, the Coastal Zone, the Inland Zone, and the Upland Zone from south to north respectively. The Off-shore zone includes all areas south of the Mississippi Sound shoreline. The Coastal Zone includes all areas generally from the shoreline North to the CSX railroad and terminating at the Port Bienville railroad spur in Hancock County and Hwy 52 in Jackson County. The Inland Zone accounts for all areas north of the Coastal Zone to the MPI storm surge limit, and the Upland Zone extends from north of the MPI storm surge limit to the County lines. Figure 1-2 depicts the four planning zones.

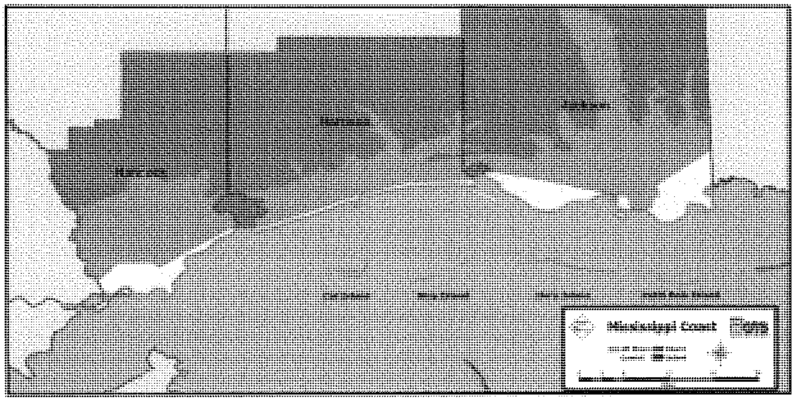


Figure 1-2. Planning Zones

1.3.2 Planning Units

For the comprehensive plan, the three coastal counties were divided into three planning units based on watershed boundaries which, coincidentally, align with the county jurisdictions. Planning unit one begins at the western state boundary, or the east bank of the Pearl River, and continue to the midpoint of St. Louis Bay. Planning unit two begins at the midpoint of St. Louis Bay and continues east to the midpoint of Biloxi Bay. Planning unit three extends from the midpoint of Biloxi Bay east to the border of Mississippi and Alabama. Figure 1-3 shows the planning unit boundaries.

1.3.3 Planning Sub-Units

Further delineation of the area required breaking the planning units into fifty-four planning sub-units based on hydrologic characteristics, population centers, and economic considerations of potential measure. For hydraulic considerations, Hurricane Surge Atlas maps were evaluated. These maps were prepared by FEMA and the Corps of Engineers, Mobile District from **SLOSH** (Sea, Lake, and Overland Surges from Hurricanes) programming done by the National Oceanic &Atmospheric Administration (NOAA). Sub-units were delineated so that the maximum storm surge difference between sub-units was approximately two-feet. Planning unit one includes ten sub-units, planning unit two eighteen sub-units, and planning unit three twenty-six sub-units. Figures 1-4 shows all the sub-units and figures 1-5, 1-6, and 1-7 illustrate the planning units one, two, and three and their sub-units, respectively.

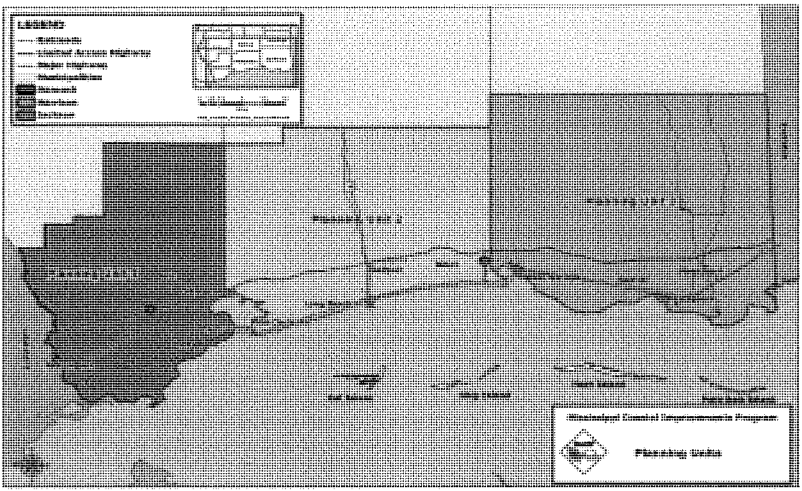


Figure 1-3. Planning Units

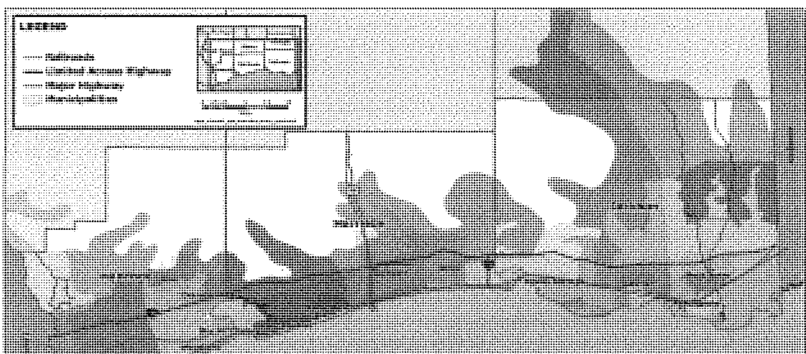
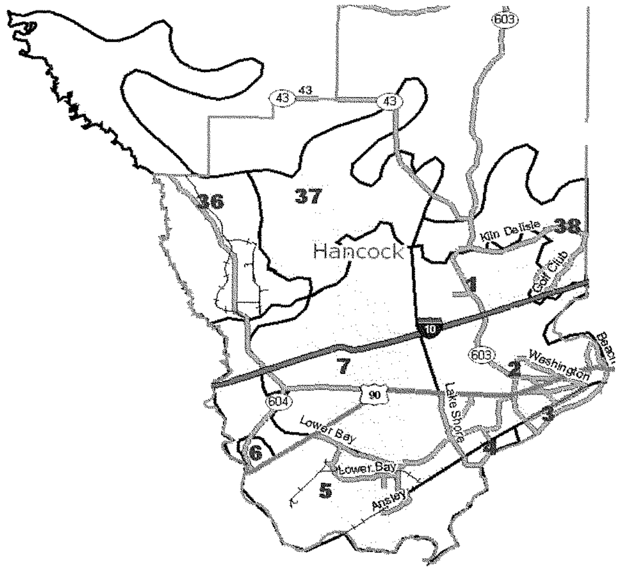


Figure 1-4. Overview of 54 planning sub-units



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2 **Figure 1-5. Sub-units for Planning Unit One**

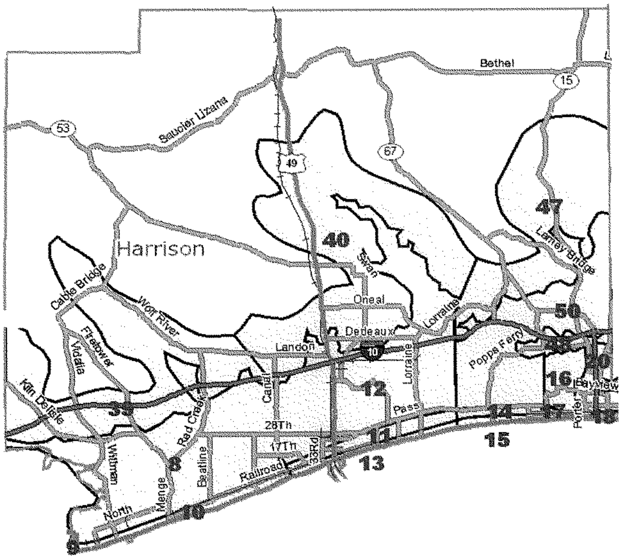

Figure 1-6. Sub-units for Planning Unit Two

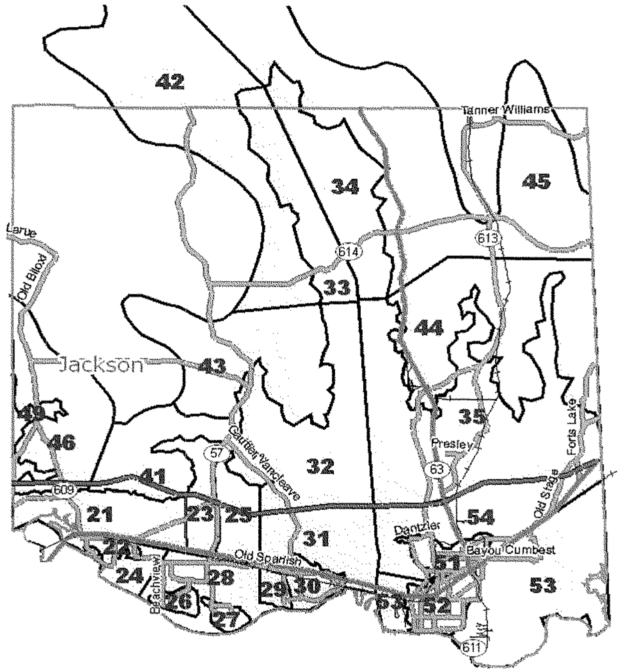

Figure 1-7. Sub units for Planning Unit Three

CHAPTER II. OVERVIEW OF ECONOMIC METHODOLOGY

This section describes the methodology for the evaluation of economic impacts of potential solutions for the Mississippi Gulf Coast under the Mississippi Coastal Improvements Program (MsCIP) Comprehensive Report. It is intended to be an outline of the process used to determine the economic impacts that are fully detailed throughout this appendix and in the main report. The methodology was developed to seamlessly fit into the six step planning process and current Corps guidance. The six step planning process, as defined by the Engineering Regulation (ER) 1105-2-100; Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (U.S. Water Resources Council 1983), referred to as the P&G, is:

1/ Identify Problems and Opportunities
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The Mississippi Gulf Coast is a complex system that is made up of a diverse blend of ecological and human habitats. Given those complexities, a fluid and flexible process was needed to evaluate and aggregate the benefits of potential measures and measures. The process incorporates data collection, forecasting techniques, scenario planning, cost effective evaluation using state of the art modeling techniques, and the communication of both benefits and risks associated with potential measures and measures. Figure 2-1 outlines the process used for this analysis.

The first step in the process was to delineate the study area. The overarching study area, as defined by Congress, is the three coastal counties in Mississippi; Hancock, Harrison and Jackson from west to east respectively. For purposes of system wide evaluation and aggregating benefits, the study area was divided into four planning zones, three planning units, and fifty-four sub-planning units. These are described in more detail in the following section.

Once the planning zones, planning units, and planning sub-units were identified, the next step was inventorying the economic, social, and environmental characteristics of the area. Data from Local, State, and Federal government agencies was utilized to determine the Historic (Pre-Hurricane Katrina) Condition, including data from the U.S. Census Bureau, the Federal Emergency Management Agency (FEMA), U.S. Fish and Wildlife, the Mississippi Emergency Management Agency (MEMA), the Mississippi Governor's Recovery Office, County Tax Assessors, previously conducted Corps of Engineers studies conducted in the area, and other valuable data sources. Historic data included economic structures (structures, content, and critical infrastructure), social and regional indicators (population, income, and employment), topographic and hydrologic characteristics, acreage of habitat, and etc.

With the historic data serving as a foundation, the next step was to determine the impacts of surge inundation from Hurricane Katrina. The team developed an inventorying methodology that was a combination of sampling and field verification. Every street within the fifty-four planning sub-units was driven over the course of four months from June to October, 2006, for purposes of determining the existing (Post-Hurricane Katrina) conditions and characteristics of structures. The findings of this work were put into a structure database that included over 200,000 tax parcels, 138,000 of which contained structures. Hydrologic programming was used to evaluate the surge inundation of each planning sub-unit and a combination of Geographical Information System (GIS) data and ground truthing was used for habitat evaluation.

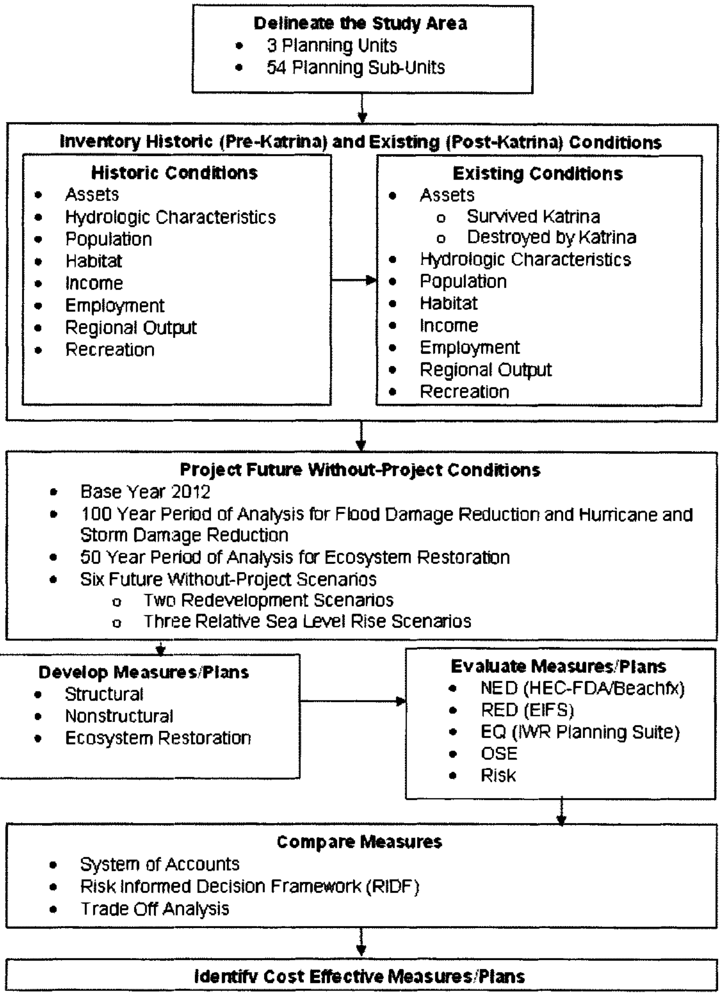

Figure 2-1. Overview of Economic Methodology

Six future without-project scenarios were developed, based on the existing condition characteristics, for the evaluation of future without-project conditions. In order to address sensitivity issues, the six scenarios were initially evaluated over a 100-year period of analysis from the base year 2012 (2012–2111) and using the FY08 federal discount rate of four-and-seven-eighths (4.875) percent. The six future scenarios include two redevelopment scenarios (residential and mixed-residential and commercial) and three relative sea level rise scenarios (existing, moderate, and high relative sea level rise) for a total of six different future scenarios. Scenario one is a residential redevelopment with no relative sea level rise over the 100-year period of analysis, scenario two is a mixed residential and commercial redevelopment with no relative sea level rise, scenario three is a residential redevelopment with a maximum relative sea level rise depending on location of 2.0-feet over the period of analysis, scenario four is a mixed residential and commercial redevelopment and a maximum relative sea level rise of a 2.0-foot, scenario five is a residential redevelopment with a relative sea level rise depending on location of 3.4-feet, and scenario six is a mixed residential and commercial redevelopment with a maximum relative sea level rise depending on location of 3.4-feet. All plans recommended for construction in the Comprehensive Plan were adjusted to a 50-year period of analysis per Corps Policy. The detailed evaluation of these scenarios is outlined below in the Future Without-Project section, and a technical description of the calculation of relative sea level can be found in the engineering appendix.

The next step, identified as step three in the planning process, was to develop measures that relate to the planning objectives for this study, which are detailed in section 2.3 of this document. An measure is something that can be implemented to directly address a problem within the study area. Some examples of measures include levees and acquisitions for flood damage reduction, beach and dune construction for flood damage reduction and ecosystem restoration, excavation and planting of native species for ecosystem restoration. These measures can be stand alone or may be able to be combined like a system.

For the Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan Report, multiple measures were developed under structural, nonstructural, and ecosystem restoration categories. The project delivery team applied a screening process based on engineering, environmental, and economic feasibility to narrow the list of viable measures. The full list of measures and how they were screened can be found in the MsCIP Comprehensive Plan Main Report.

The result of the screening was a list of measures that were fully evaluated as compared to the future without-project conditions. These measures were evaluated using the four systems of accounts, outlined in ER 1105-2-100, which include National Economic Development (NED) benefits, Regional Economic Development (RED) benefits, Environmental Quality benefits, and Other Social Effects (OSE). Evaluations of the various metrics that make up these four accounts were conducted using multiple economic programs, expert opinion, and other sources where available. The main economic programs used for the evaluation of measures include the Corps of Engineers Flood Inventory Tool (CEFIT), the Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA) program, the Beach-FX program, the Institute for Water Resources (IWR) Planning Suite, and the Economic Impact Forecasting System (EIFS). Outputs from these programs were carried forward for the comparison of the measures.

The final two steps of the process include a comparison of measures/plans and the identification of cost effective plans. A comparison of the evaluated measures was conducted using the System of Accounts (SOA) table and the Risk Informed Decision Framework (RIDF) process developed specifically for the MsCIP and LaCPR studies. Detailed descriptions of these two comparison methods and a list of recommended plan features can be found in Chapter Eight of this appendix and in the main report.

CHAPTER III. MODELING EFFORTS

3.1 Corps of Engineers Flood Inventory Tool (CEFIT)

3.1.1 Program Overview

The Corps of Engineers Flood Inventory Tool (CEFIT) program allows users to calculate replacement estimates for a variety of structures and replacement cost of commercial inventory. The CEFIT program is a proprietary program produced by Marshall and Swift in coordination with the Institute for Water Resources (IWR). The program consists of two components: a Residential Estimator component and a Commercial Contents Inventory component. The program allows for user inputs to define the type of structure that is being evaluated and provides outputs based on observed data collected by Marshall & Swift.

- Residential Estimator

The Residential Estimator component is a program that allows the user to calculate replacement cost for a variety of structures. It will calculate the depreciated replacement cost for single family residential, schools, and churches.

It has a variety of inputs that allow for a realistic estimate of depreciated replacement cost. It incorporates the location of the structure (by zip code), age, square footage, quality of construction, exterior wall material, roof type etc. All of these inputs increase the accuracy in gauging a correct estimate. The required inputs are location, age, square footage, quality of construction, and exterior wall material. Residential Estimator allows you to input your own depreciation factor or it allows the user to use program defined depreciated replacement factors based on data collection efforts for the defined area and other inputs.

The outputs for the Residential Estimator include a list of the inputs, total replacement cost of a new structure, depreciation on the structure due to age and quality, and the total depreciated replacement cost for the structure. Age and quality are the most influential factors in determining the amount of depreciation.

- Commercial Contents Inventory (CCI)

The Commercial Contents Inventory component is a program that allows the user to calculate depreciated replacement cost for inventory and equipment for various businesses. This program will calculate the depreciated replacement cost for a variety of business types. There are over 975 industry categories and 12 sales-size groupings.

There are 4 required inputs for CCI. They include: the sic code for primary and secondary operation, projected annual revenue for upcoming year, square footage of occupied building or portion of occupied building, and the number of full and part-time employees. CCI also has an input for the number of production shifts. However, the users manual recommend that the user should leave the production shifts at 1.

CCI has built in checkpoint procedures when it appears that certain inputs are outside the bounds of typical industry experience. When this happens inputs will be highlighted in red. The program also notes that it does not capture the value of leased or rented equipment. The program only captures the value on solely owned property and equipment.

The program recommends, for accurate results, to use current information, search for the closet sic code for the specific business type, use company specific data for optional items, and modify the quality and density level of equipment as appropriate.

The program returns three output values. It returns an inventory replacement value, an industry-norm equipment replacement value, and a company specific equipment replacement value. All of these values are depreciated replacement costs. The accuracy of the company specific depreciated replacement cost depends on the confidence level of input values.

3.1.2 Extent of Use

Where available, data from field interviews was utilized in estimating depreciated replacement cost for structure and content values. This was done by comparing tax data to data that was collected in the field and applying comparison percentages to different structure types. A detailed explanation of this process can be found below in chapter IV.

For those structure types, such as municipal and commercial and industrial structures, the CEFT program was employed for the estimation of depreciated replacement cost of structures and their contents. Specifically, the CEFIT program was used to estimate depreciated replacement cost of public structures and their contents, such as schools and churches, as well as to estimate the value of inventory within commercial and industrial structures. Data used as input for the program came from a variety of sources including field interviews of businesses, available financial statements of publicly traded companies, and existing data from previous Corps of Engineers studies. Outputs from the program were incorporated into the structure database described in detail in a later section of this appendix, and ultimately incorporated as inputs into the Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA) and Beach-FX programs for evaluation of damages and damages reduced.

3.1.3 Uncertainty

The CEFIT program does not contain a direct mechanism for addressing any uncertainty that exists in the estimation of the program's outputs. Since the output values, which include the depreciated replacement cost of schools and churches and of commercial and industrial structures, of the CEFIT program are an input for the HEC-FDA and Beach-FX programs, uncertainty is addressed within those program frameworks. Both programs allow you to input the uncertainty around the depreciated replacement cost of the structure and inventory values derived by the CEFIT program. The programs account for two standard deviations of uncertainty, or approximately the ninety-five percent confidence level. A detailed description of how the HEC-FDA and Beach-FX programs address uncertainty regarding these and other variables is described below in greater detail.

3.2 Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA)

3.2.1 Program Overview

The Hydrologic Engineering Center's-Flood Damage Analysis (HEC-FDA) program is the standard analytical tool for calculating equivalent annual damages (EAD) from flood inundation. As per the user's manual, the HEC-FDA program "Provides the capability to perform an integrated hydrologic engineering and economic analysis during the formulation and evaluation of flood damage reduction plans. The program follows functional elements of a study involving coordinated study layout and configuration, hydrologic engineering analyses, economic analyses, and plan formulation and evaluation…the procedures are consistent with federal and Corps of Engineers policy regulations (ER-1105-2-100 and ER 1105-2-101)."

"Both economic flood damage and hydrologic engineering analyses are performed using a consistent study configuration (streams, damage reaches, plans, and analysis years). Two types of evaluations are available: analysis of damage and project performance by analysis year: and equivalent annual damage. Many Output tables and plots are used for reporting results. Computations and display of results are consistent with technical procedures described in EM 1110-2-1619."

The steps for evaluation using HEC-FDA are:

- Define Study Parameters
  - Study Stream(s) – defines the source of the water
  - Analysis Years - defines the base year and most likely future year
  - Survey Year – the year the data was initially collected
  - Update Year - allows for an update of data in the future
- Define Damage Reaches (Planning sub-units)
  - Reach Name – the limits of an area that share hydrologic and economic similarities
  - Beginning and Ending stations – the start and finish points of a reach
  - Index Location – a point between the beginning and ending stations of a reach where the greatest confidence in data is located for that reach (e.g. At a stream gage location)
- Define Plans
  - Existing Condition – typically the defined study area at the point in time the data was collected
  - Without-Project Condition – defines the study area with the assumptions made regarding the hydrologic and economic characteristics expected in the future if nothing were to be done
  - With-Project Conditions – defines each of the potential measures that could be implemented and how it acts (reduces damages) as compared to the without-project condition
- Enter Hydrologic Data
  - Water Surface Profile
  - Stage-Discharge Functions
  - Exceedance-Probability Functions
- Enter Economic Data
  - Structure Inventory Data – compiled database that includes structure characteristics such as location, structure and content value, first floor elevation, etc.
  - Depth Damage Relationships – defined relationships between the depth of water and the damage to each of the structures and their respective contents

- Assign Structure Inventories to Plans – each plan has its own specific structure inventory that is defined specifically for that plan and attributed to that plan
- Compute Aggregated Stage Damage with Uncertainty and Equivalent Annual Damages – this is the first computational step in the HEC-FDA model. It evaluates the damage at the various stages of the stage frequency curves and determines the damages attributed to each of the stage intervals. This step can be computed with or without uncertainty.
- Evaluation of Plans by Analysis Years – evaluates a plan and its performance reaches based on target standards defined for the without project conditions for the study. These standards are based on the residual damages associated with a specific exceedance probability event.
- Equivalent Annual Damage Analysis – computes the equivalent annual damages for each plan based on the pre-defined period of analysis years (e.g. 100-years) and the desired discount rate (e.g. 4.875-percent). Figure 3.2-1 shows the traditional EAD computation process.

EM 1110-2-1619
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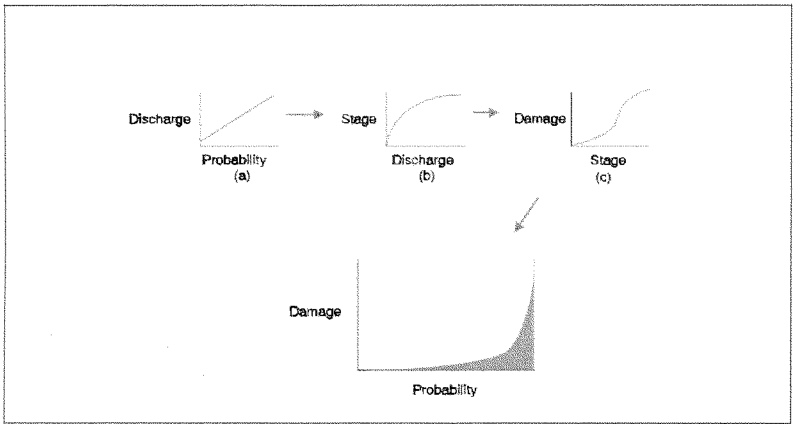


Source: Engineering Manual (EM) 1110-2-1619

Figure 3.2-1. Illustration of transformation for traditional equivalent annual damage computation

3.2.2 Depth Damage Relationships

The depth damage relationships used for the HEC-FDA analysis are based on expert elicitation and observation of damages from flood events. Generic curves for residential one-story and two-story structures and their contents are from *Corps of Engineers Economic Guidance Memorandum (EGM) 01-03, Generic Depth Damage Relationships*. Commercial, municipal, and mobile home structure and content curves are from the July 1997 final Report entitled *Depth-Damaged Relationships for Structures, Contents, and Vehicles and Content-To-Structure Value Ratios (CSVR) in Support of the Lower Atchafalaya Reevaluation and Morganza to the Gulf, Louisiana Feasibility Studies* prepared for New Orleans District Corps of Engineers. Addendum A to this appendix describes the HEC-FDA damage curves in detail.

3.2.3 Extent of Use

For the MsCIP Comprehensive Plan Report, the HEC-FDA model was used to evaluate the without-project flood damages of the study area and the respective damages reduced of various measures in the coastal and inland planning zones. The use of this model for the MsCIP Comprehensive Plan Report is slightly different than the typical riverine application of the model, but it is still an appropriate tool for the evaluation of measures under MsCIP. The Hydrologic Engineering Center (HEC) made several modifications to the model specifically for this study. Both modifications were with respect to the uncertainty bounds around the stage frequency curves and the first floor elevations of structures.

3.2.4 Uncertainty

The HEC-FDA model allows for the quantification of uncertainty pertaining to hydrologic characteristics, such as the exceedance probability functions, and economic characteristics such as first floor elevation, structure value, content value, and depth-damage relationships. Uncertainty regarding these parameters, and their effect on EAD, are captured by using Monte Carlo simulation. Monte Carlo simulation samples the parameters from a range, typically two standard deviations, and incorporates the potential variance in the values that may occur in the real world.

3.3 Beach-FX

3.3.1 Program Overview

Beach-FX is an engineering-economic program that simulates beach response over time, as storms, natural recovery, and management methods alter the beach profile. The model estimates expected structural damages expressed as losses due to flooding, erosion and waves. It is an event-based, data-driven Monte Carlo simulation program. This structure has been used successfully in the past in a large number of U.S. Corps of Engineers (USACE) studies.

The program is an event-driven life-cycle Monte Carlo simulation program. A shore protection project life cycle (e.g. 100-years) is simulated by determining the beach and structure response to a set of storms (the events driving the process). The associated damages are determined for each structure that is programmed. This simulation is repeated for many different sets of storms, and the results averaged. Input data to the program is stored in databases, and, wherever possible, information needed to localize, parameterize, and modify program behavior is also stored as data (data-driven programming).

The program simulates beach response over time as storms, natural recovery, and management methods alter the beach profile. Events of interest (storms, beach nourishment) take place at calculated times. As each event takes place, the program simulates the physical and economic responses associated with that event. Structural damages include losses due to flooding, erosion, and wave impact. Simplified beach profiles, as defined by key data points, are tracked as the beach profile evolves over time.

The program makes use of a Shoreline Response Database (SRD). The SRD is a pre-generated set of beach profile responses to storms, for a range of storms and profiles. The program uses "plausible storms", based on historic storms, as initiating events. The procedure for developing plausible storms is described in Appendix A. The shoreline modification due to a storm is determined through use of a shoreline response program, in this case SBeach, a cross-shore storm response program developed by the Waterways Experiment Station (WES) of the Corps. The SRD contains information on the input (pre-storm) profile, the storm, and the response (post-storm) profile, for many combinations of storms and pre-storm profiles. The Monte Carlo simulation program then reads information from the SRD as needed to determine shoreline change following a storm event.

As each storm is processed, the shoreline response is determined, and a post-storm beach configuration is calculated, as well as profiles of maximum water level, wave height, and erosion during the storm. This information is used to determine economic damages, based on empirical curves (damage functions) relating the percentage loss of value of structure and contents to "damage-driving parameters" calculated from the aforementioned profiles and characteristics of the structure. The nature of the data used by the program is shown in Figure 3.3.1.

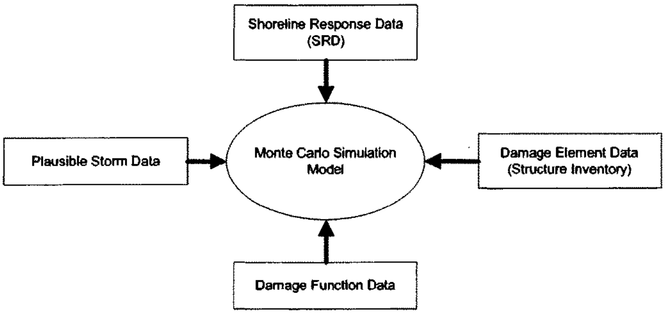


Figure 3.3-1. Data used for Beach-FX Program

3.3.2 Depth Damage Functions

Depth damage functions used within the Beach-FX simulations are based on expert elicitation and are broken into several damage categories. These damage categories include inundation damages, wave's damage, wave run-up (wave set-up) damages, and erosion damages. Addendum B to this appendix is an abstract of how the damage functions were developed and Addendum C describes in detail the damage functions used for Beach-FX.

3.3.3 Extent of Use

For the MsCIP Comprehensive Plan Report, the Beach-FX program was set up to be used to evaluate without-project damages and damages reduced for commercial structures that are physical located south (Gulf Side) of the major roadways in the three planning units. Those structures north of the major roadways in each of the planning units are evaluated using HEC-FDA (see previous section). Each of the beach and dune placement measures, described in detail later in this appendix, were evaluated against two future without-project scenarios: 1/ a future scenario with n expected relative sea level rise of 2.0-feet and 2/ a future scenario with a with an expected relative sea level rise of 3.4-feet. Section 6.2 of this appendix describes the Beach-FX evaluation in greater detail.

3.3.4 Uncertainty

The complexities of the combined engineering-economic problem of risk-based analysis, in which there are uncertainties associated with the physical performance of systems and the economic consequences of that performance, are typically addressed through the use of Monte Carlo simulation techniques. Monte Carlo simulation is particularly useful for physically based real-world problems, where the results of the simulation can be tested against historical and reasonable behaviors.

Beach-FX uses Monte Carlo simulation to sample variable values within a range in order to capture uncertainty. Variables such as structure value, content and inventory, first floor elevation, and days to rebuild the structure when it is destroyed are given an upper and lower limit, which the simulation selects from each time a lifecycle is run.

3.4 Institute for Water Resources (IWR) Planning Suite

3.4.1 Program Overview

The US Army Corps of Engineers Institute for Water Resources (IWR) has developed IWR-PLAN Decision Support Software to assist with the formulation and comparison of alternative plans. While IWR-PLAN was initially developed to assist with environmental restoration and watershed planning studies, the program can be useful in planning studies addressing a wide variety of problems. IWR-PLAN can assist with plan formulation by combining solutions to planning problems and calculating the additive effects of each combination, or "plan." IWR-PLAN can assist with plan comparison by conducting cost effectiveness and incremental cost analyses, identifying the plans which are the best financial investments and displaying the effects of each on a range of decision variables.

IWR-PLAN builds upon the basic plan formulation and comparison framework of the DOS program ECO-EASY: Cost Effectiveness and Incremental Cost Analyses for Environmental Planning developed within the Corps Evaluation of Environmental Investments Research Program. The IWR-PLAN system transforms ECO-EASY to a Windows95 or Windows NT operating environment while adding new functions. Development of IWR-PLAN has been carried out within the Corps Decision Support Technologies Research Program, conducted at IWR. The Corps of Engineers and the Social Sciences Institute of the Natural Resources Conservation Service cosponsor IWR-PLAN development. To aid new users along the IWR-PLAN learning curve, a checklist of steps for applying the software is included under the section Getting Started.

IWR-PLAN takes user-defined solutions to planning problems and externally-generated estimates of each solution's effects and can formulate all possible combinations of those solutions, considering user-defined relationships between solutions. IWR-PLAN will then identify which combinations are the best financial investments through cost effectiveness and incremental cost analyses. Each combination of solutions is an alternative plan. If alternative plans have already been formulated outside IWR-PLAN, the user can bypass the routine for building combinations and still use IWR-PLAN to assist in identifying which plans are the best investments.

IWR-PLAN includes many new functions. An important one is that IWR-PLAN will keep track of the effects on up to ten user-defined variables. This makes IWR-PLAN a useful tool in watershed scale studies where there are likely to be a wide range of effects under consideration.

Other new functions include the ability to set constraints for all variables, to define derived variables (weighted combinations of other variables), to conduct sensitivity analysis, to examine different scenarios with different assumptions from one set of input data, to make comparisons across different scenarios, to track user defined "plans of interest", to export all IWR-PLAN data with direct links to other software, to view results through a variety of reporting and graphing measures, and to access on-screen help.

IWR-PLAN's context-sensitive on-screen help system is available on each screen to define terms and explain how to use the screen's functions. This Online help, together with the Getting Started checklist and accompanying operating instructions, should provide enough information to operate IWR-PLAN successfully. Additional background information is provided by the procedures manual Cost Effectiveness and Incremental Cost Analyses published by IWR in 1995 (IWR Report 95-R-1). This manual is recommended reading - especially for new users without previous ECO-EASY experience. The manual is available by download from the section "Current Reports Online" on IWR's home page.

3.4.2 Extent of Use

IWR Plan was used to conduct a cost effectiveness analysis for each of the measures and alternatives that were formulated for ecosystem restoration (see Chapter VI). The analyses followed the methodologies established in the US Army Corps of Engineers Institute for Water Resources publications, Evaluation of Environmental Investment Procedures Manual, Interim: Cost Effectiveness and Incremental Analyses, May 1995, IWR Report #95-R-1 and Cost Effectiveness Analysis for Environmental Measuring: Nine Easy Steps, October 1994, IWR Report 94-PS-2. The nine steps outline in the cited IWR report have become the standard practice for identifying what are known as "Best Buy" ecosystem restoration measures, or those measures that yield the greatest 'bang for the buck' at various levels of output.

The IWR Measure model was developed based on these nine steps and is the preferred Corps of Engineers model for the evaluation for ecosystem restoration measures. For the MsCIP Comprehensive Plan Report, Congressional Authority stated, "...but shall not perform an incremental benefit-cost analysis to identify the recommended project...." Following this authorization, only the first five steps of the nine easy steps, which are bolded below, were used in the IWR Plan evaluation, resulting in the identification of cost effective plans for restoration purposes. The nine steps are:

- Formulation of combinations:
  Step 1 - Display Outputs and Costs
  Step 2 – Identify Combinable Management Measures
  Step 3 – Calculate Outputs and Costs
- Cost Effective Analysis:
  Step 4 – Eliminate Economically Inefficient Solutions
  Step 5 – Eliminate Economically Ineffective Solutions
- Development of Incremental Cost Curve
  Step 6 – Calculate average costs
  Step 7 – Recalculate average costs for additional output
- Incremental Cost Analysis:
  Step 8 – Calculate incremental costs
  Step 9 – Compare successive outputs and incremental costs

3.4.3 Uncertainty

Uncertainty is a factor in any number manipulation program. Cost variability and output variability can be incorporated into the IWR Plan program using sensitivity calculations. Sensitivity can be calculated by using either variable sensitivity or solution sensitivity. A uniform coefficient can be applied to all variables or selected variables.

Variable sensitivity calculates high and low variable values using a uniform coefficient. This creates results for a range for the variable value. Custom sensitivity can be applied.

The high and low values entered for solution sensitivity are uniform coefficients used for computing the high and low values for the selected solution combination. This creates a value range result for that solution.

3.5 Economic Impact Forecasting Systems (EIFS)

3.5.1 Program Overview

The Economic Impact Forecast Systems (EIFS) was originally developed by the U.S. Army Corps of Engineers Construction Engineering Research Laboratory (USACERL) in 1975 to efficiently identify and address the regional economic effects of proposed military actions. EIFS is a web-based program and information system that provides regional economic analyses to planners and analysts. The program was developed to provide socioeconomic impact assessment, necessitated by the passage of the National Environmental Policy Act (NEPA) in 1969, which requires federal agencies to consider the impacts of an action on the "human environment" before decisions are made or an action is taken. This process is intended to help public officials make better decisions that are based on an understanding of environmental consequences and take actions that protect, restore, and enhance the human environment.

The EIFS program draws information from a tailored socioeconomic database for any county (or multi-county area) in the United States, estimating the changes associated with any project proposal, as defined by the user. EIFS database consists of data gathered from economic analyses, including Census of Agriculture, the Bureau of Economic Analysis, and County Business Patterns. The EIFS program requires basic input data regarding the action being studied: the dollar amounts of associated construction, number of military and civilian employees and their average salaries. Once these inputs are ascertained, the local multi-county region of influence (ROI) can be defined. Given the inputs for a particular project proposal, EIFS through a series of algorithm that are based on regional economic theory will assess potential impacts on four elements of a local economy: business volume, employment, personal income, and population. In short the program provides flexibility for the evaluation of measure scenarios and "what if" games at minimal expense.

3.5.2 Extent of Use

The EIFS program was used to evaluate the Regional Economic Development (RED) of proposed measures and plans. The conclusion that EIFS makes is that it predicts resultant changes in total personal income, total employment, and total sales by local businesses, and total population. Once these aggregate changes are predicted, EIFS provides analyses of historical trends in the defined ROI, and uses the Rational Threshold Level (RTV) and Forecast Significance of Impacts (FSI) profiles to develop significance criteria. Comparisons of projected change are then easily compared to the significance thresholds to produce conclusions. If insignificant impacts result, the analysis is complete. If significant impacts are indicated, a more detailed analysis will likely be required. In other words, because a projected change indicates that it would not be within the historic RTV range, it does not necessarily mean that it has a significant impact. It only means that a more detailed analysis is likely required to resolve this issue. The EIFS program, in combination with the RTV, has proven successful in determining socioeconomic impacts. The system meets the criteria for a good assessment program; theoretically sound and defensible, available for public review and scrutiny, and pragmatic in its application.

3.5.3 Uncertainty

The EIFS model incorporates uncertainty by using a Rational Threshold Value (RTV). Once model projections are obtained, the Rational Threshold Value profile allows the user to evaluate the significance of the impacts. This analytical tool reviews the historical trends for the defined region and develops measures of local historical fluctuations in sales volume, income, employment, and population. These evaluations identify the positive and negative changes within which a project can affect the local economy without creating a significant impact. The greatest historical changes define the boundaries that provide a basis for comparing an action's impact on the historical fluctuation in a particular area. Specifically, EIFS sets the boundaries by multiplying the maximum historical deviation of the following variables:

	Increase	**Decrease**
Sales Volume	x%	x%
Income	x%	x%
Employment	x%	x%
Population	x%	x%

The major strengths of the RTV are its specificity to the region under analysis and its basis on actual historical data for the region. The EIFS impact model, in combination with the RTV, has proven successful in addressing perceived socioeconomic impacts. The EIFS model and the RTV technique for measuring the intensity of impacts have been reviewed by economic experts and have been deemed theoretically sound.

CHAPTER IV. DATA COLLECTION METHODOLOGY

This section describes in detail the methodology implemented for the collection of data for the evaluation of National Economic Development (NED) benefits, Regional Economic Development (RED) benefits, Environmental Quality (EQ) benefits, and Other Social Effects (OSE). Data collection is a central element in the overall inventory and evaluation process. Hurricane Katrina hit the Mississippi Gulf Coast on August 29th, 2005 and caused significant damage to the environmental, human, and economic landscape of the area. The effects of this devastating event form the existing conditions for the MsCIP Comprehensive Plan and the basis to which the analysis of potential solutions were conducted and outlined in this appendix.

Due to limited time and the magnitude of the number of structures in the 40-foot NAVD88 surge inundation footprint, a hybrid field verification/sampling technique was developed for purposes of collecting structure data. Structure characteristics are crucial in the evaluation of risk and potential damage from surge events. The main structure data collected for this analysis was 1/ damage category, 2/ structure occupancy type, 3/ first floor elevation, 4/ structure value, 5/ content value, and 6/ whether or not the structure was significantly damaged by Hurricane Katrina. The ability to confidently obtain values for these data variables were the driving force in the development of the field verification methodology.

The first step in the field verification process was to obtain existing data from Local, State, and Federal government agencies as well as credible academic sources. For economic structure data, pre-Hurricane Katrina (2005) tax data for each of the planning units was obtained from Hancock, Harrison, and Jackson Counties, Mississippi. Next, utilizing GIS software, all of the tax parcels that fell within the 40-foot (NAVD-88) surge inundation footprint were identified, creating the maximum extent of parcels that would be identified that would be impacted by a surge analysis. This area is approximately 1,361 square miles or 100 square miles larger than the state of Rhode Island.

Next, a cluster sampling methodology was created and inventoried by driving every street within the inundation area. The sampling methodology was based upon the fact that construction along the Gulf Coast is very similar and that blocks, streets, and or subdivisions could be grouped together. While driving the area, the PDT members determined the grouping sizes based on observations in the field, and then defined typical structure characteristics for the grouping. For example, "A subdivision may be four streets and include approximately fifty structures. The subdivision may have two basic construction types, 1/ residential one-story and 2/ residential two-story, split approximately seventy-percent and thirty-percent respectively. Within the subdivision, the first floor elevation above ground of structures may range from four to six feet. The homes were built in the 1990's so the construction is generally good in quality. Water was a factor in this area and approximately sixty percent of the homes in this area sustained significant inundation damage (50% or more damaged)." These observations were noted and input into the structure database for this area as the economic characteristics. The process was repeated over the course of six months from June through November, 2006. The end result was a database with economic data for over 200,000 tax parcels within the 40-foot NAVD88 inundation area.

Other sources of existing data were also identified for purposes of evaluating Environmental Quality, Regional Economic Development, and Other Social Effects. Data from Local, State, and Federal government agencies as well as reputable academic sources were utilized for data collection in these areas. The methodology used for the collection of data in this analysis is outline in Figure 4-1.

NED

- Get Pre-Katrina Tax Data
- Verify Asset Characteristics
    - o Damage Category and Occupancy Type
    - o First Floor Elevation
    - o Structure and Content Value
- Determine Assets Destroyed by Hurricane Katrina
- Develop a Structure Database

EQ

- Identify Pre-Katrina Habitat
    - o Barrier Islands
    - o MS Sound
    - o Tidal Marsh
    - o Upland Habitat
- Determine extent of Habitat Damage
- Identify Sites that could not recover on their own

RED

- Employment
- Income
- Regional Output
- Tourism
- Etc.

OSE

- Population
- Population Threatened
- Racial Distribution
- Etc.

Figure 4-1. Overview of Economic Data Collection Methodology

4.1 Damage Categories

Damage categories are a means of initially categorizing the structures within the study area. This basic category is dictated primarily by general use of the structure. For this report, all structures fall within the categories of residential, commercial, municipal, and mobile home. A combination of tax data and field verification were used to determine the damage category for each structure.

4.2 Occupancy Types

Structures in each damage category were further subcategorized into structure occupancy types. The structure occupancy type allows for the combining of structures that have very similar characteristics such as construction material and depth-damage relationships. The residential damage category includes one-story and two-story single family residences. The commercial category includes: 1/ eating and recreation, 2/ groceries and gas stations, 3/ multi-family residences, 4/ repair and home use, 5/ retail and personal services, 6/ professional business, and 7/ warehouse and contractor services. The municipal category includes those structures which are generally non-taxable structures including federal, state, and local structures as well as churches. The Mobile Home category includes pre-manufactured single family residential housing that is not on a permanently fixed foundation (can be moved with relative ease). Table 4-1 provides a list of structures that fall into the various categories and occupancy types. Figures 4.2-1 through 4.2-14.

Table 4-1.
Structure Damage Categories and Occupancy Types

Damage Category	Occupancy Type	Structure Examples
COMMERCIAL	EAT	Restaurants, bars, and lounges
COMMERCIAL	MULT	Apartments, condos, multi-family
COMMERCIAL	REPA	Auto repair shops
COMMERCIAL	RETA	Retail, Laundromat, barber shop
COMMERCIAL	GROC	Grocery stores and gas stations
COMMERCIAL	WARE	Warehouses, light industry
COMMERCIAL	PROF	Hospitals, medical clinics, lawyer and professional offices
RESIDENTIAL	1-STORY	Single family dwellings with one story construction
RESIDENTIAL	2-STORY	Single family dwellings with two story construction
Mobile Homes	MOBHOME	Mobile Homes and other small metal structures
Municipal	PUBL	Municipal buildings, schools, police and fire stations

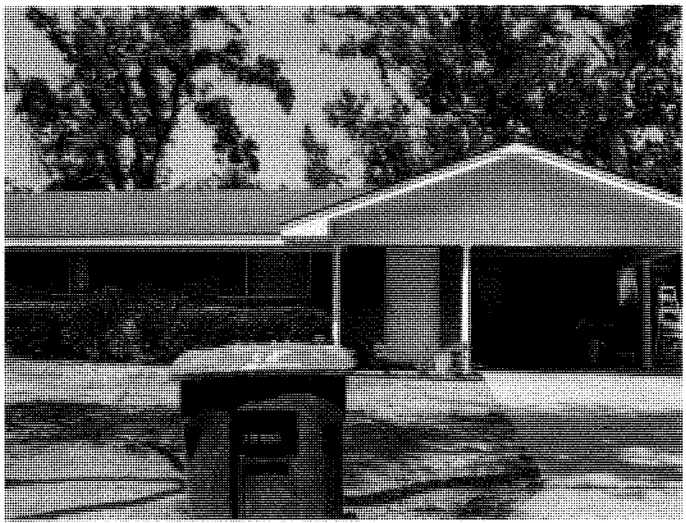


Figure 4.2-1. Example of a residential brick - slab on grade structure

Figure 4.2-2. Example of a residential masonry - slab on grade structure

Figure 4.2-3. Example of a residential wood – slab on grade structure

Figure 4.2-4. Example of a Wood Frame on Slab Residential Structure

Figure 4.2-5. Example of a mobile home residence

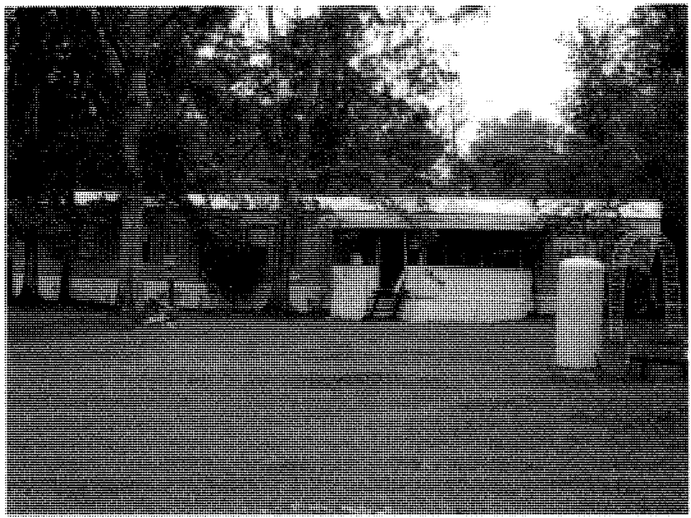


Figure 4.2-6. Example of a Mobile Home Residence

Figure 4.2-7. Example of Mobile Home Residence

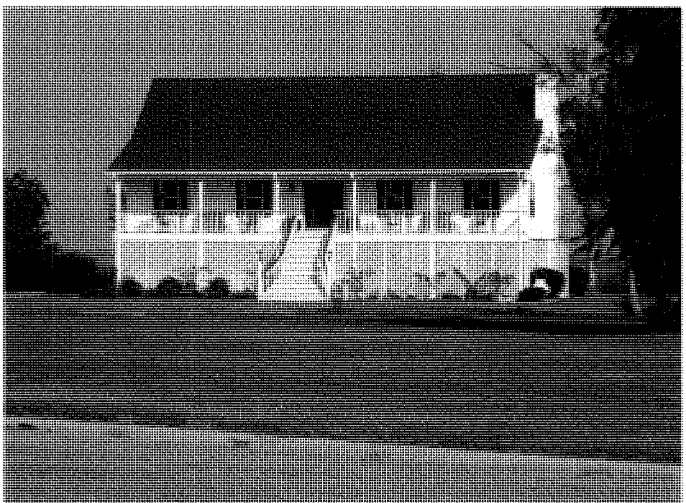


Figure 4.2-9. Example of residential wood on piles structure

Figure 4.2-10. Example of Masonry on Piles Residential Structure

Figure 4.2-11. Example of two-story masonry on slab

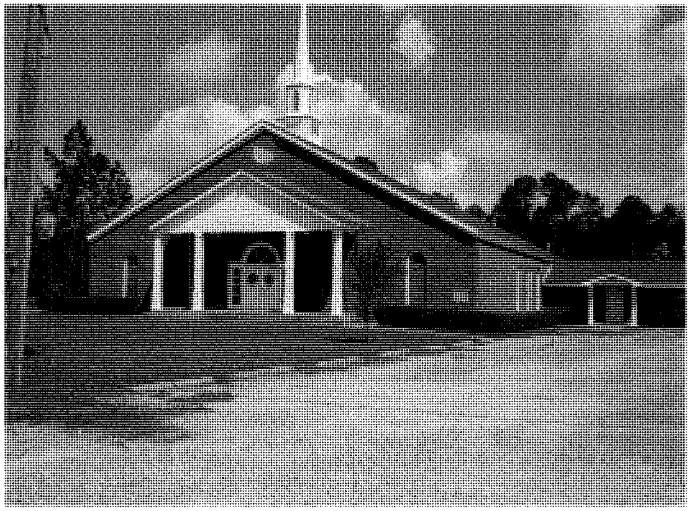


Figure 4.2-12. Example of a Church (Municipal Category)

Figure 4.2-13. Example of a Commercial Services Building

Figure 4.2-14. Example of a Municipal Fire Station

4.3 First Floor Elevations

First floor elevations were estimated using a two part approach. The first step was to estimate the ground elevation NAVD88 at the center point of each parcel using LIDAR data and a GIS program. The second part of the process was to estimate the finished floor elevation above the ground for each structure. The entire study area driven and estimates were made of the height above ground for each structure within a group or cluster. For example, "In neighborhood A, all on the structures were slab on grade and therefore the finished floor above ground for all the structures in that neighborhood were assigned a zero value. Thus, all structures in neighborhood A had a first floor elevation equal to the ground elevation." The sum of the ground elevation plus the finished floor height above ground (ground + finished floor above ground = first floor elevation) was the first floor elevation NAVD88 for a given structure. Those first floor elevations were then attributed to the appropriate structure in the structure database.

Uncertainty pertaining to first floor elevation estimates exist for reasons ranging from human error to software rounding and uncertainty with regards to the precision of LIDAR data collection. Both the HEC-FDA and Beach-FX programs allow for the inclusion of uncertainty with regards to first floor elevation estimates. For this analysis, the field observed uncertainty pertaining to first floor elevations is 3.52-feet at one standard deviation.

Uncertainty was calculated by comparing surveyed first floor elevations to LIDAR plus field estimating technique. This was accomplished by the comparison of 3,000 structures (1,000 in each planning unit), or approximately a two-percent sample. Contractors working for the MOBILE DISTRICT shot accurate first floor elevations for those 3,000 structures and the PDT members compared the contractor values with the LIDAR plus field estimated values to calculate the one-standard deviation uncertainty. This uncertainty was then used as an input into HEC-FDA and Beach-FX for the calculation of equivalent annual damages.

The 3.52-feet of uncertainty at one standard deviation are a significant uncertainty, and are commensurate of the time and scoping limitations placed on the MsCIP Comprehensive Effort. At approximately $25 per structure to acquire field shot first floor elevations, a cost of approximately $3,250,000 and an estimated time of two-and-a-half years would be needed to acquire the first floor elevation with the traditional confidence level of a feasibility level effort. A complete traditional survey of all of the first floor elevations within the MPI footprint is neither cost effective nor feasible with respect to timing constraints.

Even though the data shows a 3.52-foot uncertainty, it is believed that the first floor elevation data is more accurate than the distribution based on the two-percent sample suggests. Therefore a sensitivity analysis was conducted based on uncertainty used in previously conducted feasibility studies where costs and timing allowed for a complete traditional survey. This sensitivity analysis can be found below in Chapter VII of this appendix.

4.4 Structure Values

This section describes the estimation of structure values used as inputs for the calculation of equivalent annual damages. Typical Corps economic policy is to use an estimate of depreciated replacement cost for the value of a structure. Depreciated replacement cost was used for structures that were not destroyed by Hurricane Katrina, and full depreciated replacement cost was used for those structures that were expected to be rebuilt. The process for estimating depreciated replacement cost of structures was unique for the residential, commercial and industrial, and municipal categories. Where applicable, field observed and tax data was incorporated into the processes described in the following subsections. Where field and tax data gaps existed, Marshall and Swift proprietary software were used to estimate the value of structures.

4.4.1 Residential Structure Values

1) Tax data for all residential structures in the maximum probable intensity (MPI) inundation footprint area was collected from each county tax assessor. A sample for each residential category was provided to Savannah District (SAS) Real Estate Division.

2) Residential categories include:

a. Single family residences (SFR) - were categorized based on construction type (wood/slab, brick/pile, etc.) and floors (1, 2, or 3).

b. Multi-family residences (MFR)[1] - were categorized as town homes, duplexes, or triplexes and apartments were either 1 or 2 stories.

3) SAS Real Estate used Marshall and Swift software to determine the depreciated replacement cost of each residential structure within the sample and provided the estimates to the SAM Economic team.

[1] Multi-family residences (Duplexes, Triplexes, and Town homes) are given the commercial category name for depth damage purposes only, since they damage in a different way from single family residences even though they are still residential for discussion purposes.

Depreciated replacement cost estimates produced by the Marshall and Swift program were calculated using a number of inputs including:

- Square footage
- Number of stories
- Exterior wall materials e.g. masonry or wood
- Foundation
- Quality
- Age of structure

The most important input in determining the depreciated replacement cost of a structure is its age.

4) The Mobile District (SAM) Economic team compared the Marshall and Swift estimates to the pre-Hurricane Katrina tax assessed value of the sample and determined a depreciated replacement cost 'factor' by each category. Table 4-2 describes the depreciated replacement cost factors for the different types of residential structures.

Table 4-2.
Depreciated Replacement Factors by Occupancy Type Used for Residential Structures that Suffered Moderate to No Damage (Less than 50%) from Hurricane Katrina

Category Name	Type	Construction Type	Depreciated Replacement Factor (%)
Residential	Single Family Residence	Wood on Slab	81%
Residential	Single Family Residence	Masonry on Slab	88%
Residential	Single Family Residence	Wood on Piles	84%
Residential	Single Family Residence	Masonry on Piles	98%
Commercial[1]	Duplex	N/A	70%
Commercial[1]	Triplex	N/A	87%
Commercial[1]	Town Homes	N/A	70%
Commercial[1]	Apartments	N/A	100%

1 Multi-family residences (Duplexes, Triplexes, and Town homes) are given the commercial category name for depth damage purposes only, since they damage in a different way from single family residences even though they are still residential for discussion purposes.

5) The depreciated replacement cost factors described in table 4-2 were then applied to all the residential structures in the corresponding category by multiplying that percentage times the tax assessed value for the structure. For example, if the tax value for a single family wood on slab residence was $100,000, then the depreciated replacement value for the structure was $81,000 ($100,0000 x 81% = $81,000).

6) If the structure was sustained significant damage from Hurricane Katrina (50% or more destroyed), full depreciated replacement costs were given to that structure. The CEFIT program was used to determine the depreciated replacement cost of residential structures. The CEFIT model estimates depreciated replacement cost value based on the parameters mentioned above, such as square footage and age of structure. The estimation of depreciated replacement cost values was conducted by taking an average of values produced from a range of values in each parameter. For example, a range of 1,000, 1,250, 1,500, 1,750, 2,000, and 2,500 square feet was used when defining the size; a range of fair-to-good, good, good-to-very good, very good, very-good to excellent

and excellent were used for quality and condition; etc. Table 4-3 shows the averages from the sample range by residential category.

Table 4-3.
Depreciated Replacement Cost Values for Residential Structures Used for Residential Structures that Suffered Significant Damage (50% or more) from Hurricane Katrina

Category Name	Construction Type	Number of Floors	Depreciated Replacement Cost ($)
Residential	Wood	1	$119,400
Residential	Wood	2	$148,702
Residential	Masonry	1	$193,475
Residential	Masonry	2	$176,079

1/ Based on estimates obtained from the CEFIT program.

B. Commercial/Industrial:

1) Commercial structures were categorized by business type (fast food, grocery, restaurant, gas station, motel/hotel, etc).

2) SAS Real Estate used Marshall and Swift Estimator to determine the depreciated replacement cost of a typical structure in each category and provided the estimates to the SAM Economic team which was then applied to all structures in that category. This was compared with the Pre-Katrina tax records and a depreciated replacement cost factor was then found for each business category. The factor percentages for commercial structures were high in comparison with the norm of depreciated replacement costs. This is a result of deflated structure values before Hurricane Katrina and less recent tax data. Table 4-4 shows the depreciated replacement cost factors for various types of commercial structures. They were applied in the same way as the residential factors previously described.

Table 4-4.
Depreciated Replacement Factors by Occupancy Type Used for Residential Structures that Suffered Moderate to No Damage (Less than 50%) from Hurricane Katrina

Category Name	Type	Depreciated Replacement Factor (%)
Commercial	Airline Hanger	79%
Commercial	Bank	79%
Commercial	Casino (Small)	60%
Commercial	Casino (Medium)	88%
Commercial	Casino (Large)	100%
Commercial	Factory (Small)	80%
Commercial	Factory (Medium to Large)	100%
Commercial	Fast Food	92%
Commercial	Gas Station (Small)	83%
Commercial	Gas Station (Medium to Large)	95%
Commercial	Grocery (Small)	54%
Commercial	Grocery (Medium)	78%
Commercial	Grocery (Large)	100%

Table 4-4.
Depreciated Replacement Factors by Occupancy Type
Used for Residential Structures that Suffered Moderate to No Damage
(Less than 50%) from Hurricane Katrina (continued)

Category Name	Type	Depreciated Replacement Factor (%)
Commercial	Small Retail (Sore)	80%
Commercial	Large Retail	95%
Commercial	Hospital (Small)	71%
Commercial	Hospital (Medium to Large)	75%
Commercial	Laundromat	72%
Commercial	Lodge	70%
Commercial	Medical Clinic	80%
Commercial	Meeting Hall	55%
Commercial	Mini-Storage	88%
Commercial	Motel	100%
Commercial	Nursing Home	82%
Commercial	Office (Medical)	90%
Commercial	Quick Lube	94%
Commercial	Restaurant (Local)	80%
Commercial	Restaurant (National Chain)	96%
Commercial	Seafood Factory	100%
Commercial	Strip Mall (Small)	69%
Commercial	Strip Mall (Medium-Large)	100%
Commercial	Theater	100%
Commercial	Warehouse	69%
Commercial	Warehouse	100%

3) If the structure sustained significant damage from Hurricane Katrina (50% or more destroyed), full depreciated replacement costs were given to that structure. SAS Real Estate division estimated full depreciated replacement cost for the same business categories previously mentioned. Those depreciated replacement cost values were applied to the structures that were destroyed by Hurricane Katrina. Table 4-5 shows the depreciated replacement cost for the various commercial structure types.

Table 4-5.
Depreciated Replacement Cost Values for Residential Structures
Used for Residential Structures that Suffered Significant Damage
(50% or more) from Hurricane Katrina

Category Name	Type	Depreciated Replacement ($)
Commercial	Airline Hanger	$23,488
Commercial	Bank	$146,855
Commercial	Casino (Small)	$15,100,912
Commercial	Casino (Medium)	$63,289,595
Commercial	Casino (Large)	$176,994,638
Commercial	Factory (Small)	$454,045

Table 4-5.
Depreciated Replacement Cost Values for Residential Structures Used for Residential Structures that Suffered Significant Damage (50% or more) from Hurricane Katrina (continued)

Category Name	Type	Depreciated Replacement ($)
Commercial	Factory (Medium to Large)	$874,997
Commercial	Fast Food	$225,626
Commercial	Gas Station (Small)	$112,040
Commercial	Gas Station (Medium to Large)	$261,828
Commercial	Grocery (Small)	$580,453
Commercial	Grocery (Medium)	$1,609,533
Commercial	Grocery (Large)	$2,103,448
Commercial	Small Retail (Sore)	$319,779
Commercial	Large Retail	$3,535,050
Commercial	Hospital (Small)	$5,977,498
Commercial	Hospital (Medium to Large)	$8,445,952
Commercial	Laundromat	$72,224
Commercial	Lodge	$129,923
Commercial	Medical Clinic	$1,046,930
Commercial	Meeting Hall	$211,446
Commercial	Mini-Storage	$110,651
Commercial	Motel	$7,482,273
Commercial	Nursing Home	$123,606
Commercial	Office (Medical)	$350,235
Commercial	Quick Lube	$114,692
Commercial	Restaurant (Local)	$80,947
Commercial	Restaurant (National Chain)	$400,306
Commercial	Seafood Factory	$300,608
Commercial	Strip Mall (Small)	$319,779
Commercial	Strip Mall (Medium-Large)	$8,985,291
Commercial	Theater	$2,050,454
Commercial	Warehouse (Small)	$39,474
Commercial	Warehouse (Medium-Large)	$92,224

C. Municipal and Churches (Tax exempt):

1) No tax data existed for Municipal structures/Churches since they are tax exempt, therefore a depreciated cost factor could not be estimated for structures that fell into this category. Marshall and Swift software was used to estimate depreciated replacement cost for these structures.

2) Municipal structures/Churches were categorized as low, medium, and high based on size, number of floors, and other structure characteristics.

3) SAS Real Estate used Marshall and Swift software to determine the depreciated replacement cost of a typical structure in each category and provided the estimates to the SAM Economic team which were then applied to all structures in that category.

Estimates were calculated using a number of inputs including:

- Square footage
- Number of stories
- Exterior wall materials e.g. masonry or wood
- Foundation
- Quality
- Age of structure

The most important input in determining the depreciated replacement cost of a structure was its age. Table 4-6 shows the depreciated replacement costs for the various types of municipal structures.

Table 4-6.
Depreciated Replacement Factors by Occupancy Type

Category Name	Type	Depreciated Replacement Cost ($)
Municipal	Church (Small)	$126,125
Municipal	Church (Medium)	$990,116
Municipal	Church (Large)	$5,612,686
Municipal	Government and School (Small)	$462,712
Municipal	Government and School (Medium)	$523,404
Municipal	Government and School (Large)	$1,537,263

Uncertainty pertaining to structure value was estimated and put into the HEC-FDA and Beach-FX models as part of the process to calculate equivalent annual damages. Previous MOBILE DISTRICT feasibility studies estimated uncertainty of structure values between 10 and 15-percent. Since the nature of the sampling used for the MsCIP study was less rigorous than normal feasibility level efforts, a 25-percent uncertainty was used for structure values.

4.5 Content Values

This section describes the process used to estimate content values for residential, commercial and industrial, and municipal and church structures. Were available, data collected from field interviews was collected and utilized. It was difficult to obtain information about content and inventory during the field inventory process, thus significant data gaps of 'real world' data existed. In order to fill those data gaps, existing data from previous studies, Corps of Engineers Economic Guidance Memorandums (Gem's), and the CEFIT model was used.

A. Residential Content Values:

1) SAM Economic Team uses the Corps of Engineers Flood Inventory Tool (CEFIT) Residential Estimator by Marshall & Swift (in close cooperation with the Institute for Water Resources) to develop an appropriate structure-to-content ratio based on the various categories mentioned for depreciated replacement costs. Since limited data was available for the damage to contents from Katrina and other surge events, the methodology outline in the Corps of Engineer's Civil Works – Planning Guidance, Economic Guidance Memorandum 01-03 dated 12/2004 was adopted for the estimation of residential content values. Table 4-7 shows the content-to-structure ratio by occupancy type for residentially occupied dwellings.

Table 4-7.
Depreciated Replacement Factors by Occupancy Type

Category Name	Type	Construction Type	Content-to-Structure Ratio (%)
Residential[1]	Single Family Residence	Wood on Slab	100%
Residential[1]	Single Family Residence	Masonry on Slab	100%
Residential[1]	Single Family Residence	Wood on Piles	100%
Residential[1]	Single Family Residence	Masonry on Piles	100%
Commercial[2]	Duplex	N/A	23%
Commercial[2]	Triplex	N/A	23%
Commercial[2]	Town Homes	N/A	23%
Commercial[2]	Apartments	N/A	23%

1 Defined by Corps of Engineers EGM 01-03.
2 Multi-family residences (Duplexes, Triplexes, and Town homes) are given the commercial category name for depth damage purposes only, since they damage in a different way from single family residences even though they are still residential for discussion purposes.

B. Commercial/Industrial Inventory and Equipment Values:

1) SAM Economic Team interviewed businesses for inventory and equipment values based on categories of business types (fast food, grocery, restaurant, gas station, motel/hotel, etc.)

2) Where data gaps arose the team used previous studies, the FEMA Hazus MH program, and the Corps of Engineers Flood Inventory Tool (CEFIT) Residential Estimator by Marshall & Swift. The Commercial Contents Inventory Estimator was used to generate theses estimates. The team calculated estimates for a small, medium, and large business in each business category. Business such as large discount retailers e.g. Wal-Mart or home improvement stores like Home Depot had only one estimate each.

Each output generated consists of 4 inputs:

- The Standard Industrial Classification Code (sic code)
- Annual Revenue
- Square Footage
- Number of Employees

The inputs were altered to give realistic estimates for small, medium, and large businesses. The most important determinants in calculating an accurate output were the annual revenue and number of employees in a sample business.

3) The data was used to identify a typical inventory and equipment value by business type that will be applied to that category. Table 4-8 shows the commercial inventory and equipment values by category named and occupancy type.

Table 4-8.
Depreciated Replacement Factors by Occupancy Type

Category Name	Business Type	Annual Revenue ($)	Business Size	Total Estimated Employees	Depreciated Content Value ($)
Commercial	AIRLINE HANGER	$400,000	SMALL	7	**$44,404**
Commercial	AIRLINE HANGER	$1,500,000	MEDIUM	21	**$297,423**
Commercial	AIRLINE HANGER	$4,000,000	LARGE	35	**$722,361**
Commercial	AUTO AUDIO STORE	$600,000	SMALL	12	**$217,741**
Commercial	AUTO MART	$600,000	MEDIUM	7	**$129,626**
Commercial	AUTO REPAIR	$500,000	MEDIUM	9	**$52,223**
Commercial	BANK	$655,860	SMALL	10	**$380,262**
Commercial	BANK	$6,403,250	MEDIUM	50	**$4,021,226**
Commercial	BANK	$15,169,000	LARGE	100	**$15,083,976**
Commercial	BARBER SHOP	$100,000	SMALL	6	**$7,744**
Commercial	BEAUTY SHOP	$200,000	SMALL	10	**$27,744**
Commercial	BOAT REPAIR	$250,000	SMALL	5	**$26,200**
Commercial	BOAT STORAGE	$600,000	MEDIUM	9	**$124,370**
Commercial	BOOK STORE	$300,000	SMALL	6	**$60,080**
Commercial	CABINET MANUFACTURER	$700,000	MEDIUM	11	**$110,100**
Commercial	CARWASH	$750,000	LARGE	15	**$129,720**
Commercial	CHURCH	$209,010	SMALL	6	**$7,360**
Commercial	CHURCH	$639,072	MEDIUM	21	**$97,539**
Commercial	CHURCH	$7,500,000	LARGE	160	**$2,139,728**
Commercial	ELECTRICAL SUPPLY	$800,000	MEDIUM	10	**$169,600**
Commercial	FACTORY	$1,000,000	MEDIUM	13	**$188,100**
Commercial	FACTORY	$13,000,000	LARGE	50	**$6,054,700**
Commercial	FACTORY*	$257,000	SMALL	3	**$80,000**
Commercial	FAST FOOD	$1,600,000	MEDIUM	50	**$206,300**
Commercial	FAST FOOD	$765,840	SMALL	40	**$134,000**
Commercial	FIBERGLASS	$600,000	MEDIUM	7	**$80,000**
Commercial	FLORIST	$300,000	SMALL	7	**$57,861**
Commercial	FUNERAL HOME	$1,500,000	LARGE	24	**$293,113**
Commercial	GARDEN NURSERY	$600,000	MEDIUM	7	**$160,088**
Commercial	GAS STATION	$2,000,000	SMALL	16	**$234,357**
Commercial	GAS STATION	$5,000,000	LARGE	36	**$568,484**
Commercial	GENERAL CONTRACTING	$1,200,000	MEDIUM	6	**$340,548**
Commercial	GROCERY	$750,000	SMALL	15	**$86,600**
Commercial	GROCERY	$2,000,000	MEDIUM	50	**$292,150**
Commercial	GROCERY	$5,000,000	LARGE	90	**$1,397,268**
Commercial	HARDWARE STORE	$600,000	MEDIUM	8	**$168,566**
Commercial	HEALTH CLUB/ GYM	$500,000	MEDIUM	20	**$104,851**
Commercial	HOME DEPOT	$34,473,615	LARGE	220	**$30,925,597**
Commercial	HOSPITAL	$5,000,000	SMALL	125	**$419,680.00**
Commercial	HOSPITAL	$70,000,000	MEDIUM	1,000	**$7,266,392**
Commercial	HOSPITAL	$134,430,900	LARGE	1,700	**$11,820,155**
Commercial	INDUSTRIAL MACHINERY	$1,000,000	MEDIUM	8	**$193,450**
Commercial	INSURANCE/OFFICE	$800,000	MEDIUM	9	**$131,247**
Commercial	JUNIOR COLLEGE	$15,000,000	MEDIUM	321	**$1,817,232**
Commercial	LANDSCAPING	$300,000	SMALL	6	**$60,540**
Commercial	LAUNDROMAT	$200,000	SMALL	7	**$17,811**
Commercial	LAUNDROMAT	$400,000	MEDIUM	15	**$116,577**

Table 4-8.
Depreciated Replacement Factors by Occupancy Type (continued)

Category Name	Business Type	Annual Revenue ($)	Business Size	Total Estimated Employees	Depreciated Content Value ($)
Commercial	LAUNDROMAT	$700,000	LARGE	18	**$231,209**
Commercial	LIQUOR STORE	$600,000	MEDIUM	7	**$110,128**
Commercial	LODGE	$889,000	SMALL	25	**$178,925**
Commercial	LOUNGE	$254,110	SMALL	10	**$93,595**
Commercial	MACHINE FABRICATION	$1,000,000	MEDIUM	17	**$108,400**
Commercial	MARINE CARGO	$1,000,000	SMALL	15	**$268,151**
Commercial	MEDICAL CLINIC	$600,000	SMALL	8	**$47,415**
Commercial	MEDICAL CLINIC	$2,000,000	MEDIUM	27	**$218,292**
Commercial	MEDICAL CLINIC	$4,000,000	LARGE	40	**$329,675**
Commercial	MOTEL	$2,000,000	MEDIUM	45	**$567,267**
Commercial	MOVIE THEATER	$1,500,000	LARGE	50	**$400,000**
Commercial	NURSERY SCHOOL	$300,000	SMALL	17	**$12,795**
Commercial	NURSING HOME	$3,000,000	SMALL	120	**$466,992**
Commercial	NURSING HOME	$7,896,400	MEDIUM	270	**$1,403,893**
Commercial	PAPER MILL	$800,000	MEDIUM	10	**$152,100**
Commercial	PETFOOD MANUFACTURING	$700,000	MEDIUM	11	**$93,900**
Commercial	QUICK LUBE	$1,000,000	LARGE	15	**$325,469**
Commercial	RADIO STATION	$433,815	SMALL	15	**$77,300**
Commercial	RESTAURANT[1]		SMALL		**$250,000**
Commercial	RESTAURANT	$1,370,000	LARGE	70	**$219,141**
Commercial	SCHOOL	$300,000	SMALL	15	**$47,132**
Commercial	SCHOOL	$1,500,000	MEDIUM	35	**$216,118**
Commercial	SCHOOL	$5,000,000	LARGE	155	**$866,136**
Commercial	TIMBER COMPANY	$600,000	SMALL	12	**$256,809**
Commercial	WALMART	$100,000,000	LARGE	350	**$17,904,400**
Commercial	WAREHOUSE	$2,000,000	MEDIUM	20	**$287,708**
Commercial	WAREHOUSE	$4,000,000	LARGE	40	**$729,199**
Commercial	WAREHOUSE	$8,000,000	X-LARGE	80	**$2,546,637**
Commercial	WAREHOUSE/MINI STORAGE	$750,000	SMALL	8	**$69,631**
Commercial	AUTO DEALERSHIP[1]	N/A	N/A	N/A	**$27,375,190**
Commercial	MINI STORAGE[1]	N/A	N/A	N/A	**$8,000**
Commercial	HVAC INSTALL/REPAIR[1]	N/A	N/A	N/A	**$60,000**
Commercial	WOMEN'S APPAREL	$2,000,000	MEDIUM	18	**$580,458**
Commercial	FAST FOOD	$1,600,000	MEDIUM	50	**$206,300**
Commercial	FAST FOOD	$765,840	SMALL	40	**$134,000**
Commercial	DEPARTMENT STORE	$7,000,000	MEDIUM	100	**$969,471**
Commercial	RESTAURANT	$1,370,000	LARGE	70	**$219,141**
Commercial	VIDEO RENTAL	$700,000	MEDIUM	18	**$302,736**
Commercial	BEAUTY SHOP	$300,000	SMALL	18	**$193,247**
Commercial	DRY CLEANERS	$400,000	SMALL	13	**$65,566**
Commercial	DRUG STORE	$2,000,000	MEDIUM	20	**$441,860**
Commercial	STRIP MALL[2]	$16,135,840	MEDIUM	347	**$3,112,779**

1 Denotes real world identified values.
2 Strip Mall includes the rows from women's apparel through drug store.
3 All other values were derived from the Corps of Engineers Flood Inventory Tool (CEFIT) Residential Estimator Program.

C. Municipal/Churches:

1) Existing data from other Corps studies or the FEMA Hazus MH Program was used for municipal and church structures along with the Corps of Engineers Flood Inventory Tool (CEFIT) Residential Estimator by Marshall & Swift. The Commercial Contents Inventory Estimator was used to generate these estimates. Estimates were calculated for small, medium, and large churches and schools.

Each output generated consisted of 4 inputs:

- The Standard Industrial Classification Code (sic code)
- Annual Revenue
- Square Footage
- Number of Employees

The inputs were altered to give realistic estimates for small, medium, and large government buildings, schools, and churches. The most important determinants in calculating an accurate output were the annual revenue and number of employees in a sample school or church. The amount of annual funding was used as a substitute for annual revenue for schools. Both schools and churches have specific sic codes. Table 4-9 shows the content values for the different types of municipal structures.

Table 4-9.
Depreciated Replacement Factors by Occupancy Type

Category Name	Business Type	Annual Revenue ($)	Business Size	Total Estimated Employees	Depreciated Content Value ($)
Municipal	Church (Small)	$209,010	SMALL	6	**$7,360**
Municipal	Church (Medium)	$639,072	MEDIUM	21	**$97,539**
Municipal	Church (Large)	$7,500,000	LARGE	160	**$2,139,728**
Municipal	Government and School (Small)	$300,000	SMALL	15	**$47,132**
Municipal	Government and School (Medium)	$1,500,000	MEDIUM	35	**$216,118**
Municipal	Government and School (Large)	$5,000,000	LARGE	155	**$866,136**

Uncertainty pertaining to content value was estimated and put into the HEC-FDA and Beach-FX models as part of the process to calculate equivalent annual damages. Previous MOBILE DISTRICT feasibility studies estimated uncertainty of structure values between 5 and 15-percent. Since the nature of the sampling used for the MsCIP study was less rigorous than normal feasibility level efforts, a 25-percent uncertainty was used for content values.

CHAPTER V. INVENTORY AND FORECASTING CONDITIONS

This chapter describes the pre-Hurricane Katrina (historic) conditions, post-Hurricane Katrina (existing) conditions and the future without-project conditions for the fifty-four planning sub-units that define the surge inundation footprint up to the 40-foot NAVD88 contour (see figure 1.4.3. above).

5.1 Historic Conditions

5.1.1 Impacts of Hurricane Camille

The Mississippi Gulf Coast is no stranger to large storm surge events. On August 17, 1969, Hurricane Camille impacted the area in a similar fashion to Hurricane Katrina. Hurricane Camille made landfall at Bay St. Louis, Mississippi only miles way from Hurricane Katrina's landfall path. The total surge area ranged from lower Plaquemines Parish in Louisiana to Perdido Pass, Alabama. Maximum surge from Hurricane Camille on the Mississippi coast ranged from 21.7-feet above m.s.l. in planning unit one, to 24.2-feet above m.s.l. in planning unit two, and 15.8-feet above m.s.l. in planning unit 3.

Damage to the Mississippi Coast from Hurricane Camille was extensive. Federal relief expenditures topped 100 million dollars at 1970 prices, over 600 million dollars when accounted for inflation. The magnitude of this number is astounding considering that many of the relief programs that exist today did not exist for Hurricane Camille. Table 5-1 shows selected Hurricane Camille damage statistics. Tables 5-2 and 5-3 show damage to residential and commercial structures caused by Hurricane Camille surge.

Table 5-1.
Select Hurricane Camille Statistics.

Camille Statistics	Mississippi	Louisiana	Alabama
Persons Dead	135	9	Unknown
Persons Missing	27	0	Unknown
Families Suffering Loss	63,665	9,442	750
Dwellings Destroyed	3,881	1,771	10
Dwellings with major damage	12,112	1,753	50
Dwellings with minor damage	29,736	3,697	500
Trailers destroyed	406	664	12
Trailers with major damage	325	290	6
Farm buildings destroyed	645	114	5
Farm buildings with major damage	2,002	97	5
Small businesses destroyed or with major damage	569	110	14
Damage to public property	$200,000,000	$10,000,000	$500,000
Damage to private property	$750,000,000	$312,000,000	$7,500,000

1 Source: Report on Hurricane Camille U.S. Army Corps of Engineers – MOBILE DISTRICT
2 These dollars reflect a 1970 price level.

Table 5-2.
Damage to Residential Structures Caused by Hurricane Camille Surge.

County	Homes Destroyed	Homes Damaged	Total Homes Impacted
Hancock	936	4,067	**5,003**
Harrison	2,347	8,603	**10,950**
Jackson	276	1,232	**1,508**
Total	3,559	13,902	**17,461**

1 Source: Report on Hurricane Camille U.S. Army Corps of Engineers – MOBILE DISTRICT

Table 5-3.
Damage to Commercial Structures Caused by Hurricane Camille Surge.

County	Homes Destroyed	Homes Damaged	Total Homes Impacted
Hancock	52	150	**202**
Harrison	261	380	**641**
Jackson	4	57	**61**
Total	317	587	**904**

1 Source: Report on Hurricane Camille U.S. Army Corps of Engineers – MOBILE DISTRICT

Other damage statistics from Hurricane Camille include (1970 price levels):

- $23.5 million in industrial damages in Mississippi in flooded areas
- $7.8 million in damages to schools in Mississippi in flooded areas
- $3.5 million in damages to Mobile District navigation projects
- $10.1 million in damages to the two VA hospitals in Harrison County and $593,300 aggregate damage to other hospitals in Mississippi in flooded areas
- $5.2 million in damages to highways in Mississippi in flooded areas
- $2.1 million in damages to bridges in Mississippi
- $10.5 million in damages to vehicle in Mississippi in flooded areas
- $4.8 million in damages to Keesler Air Force Base
- Roughly $50 million in damages to Federal Government facilities
- $1.7 million in damages to Non-Federal Government facilities in Mississippi
- $14.7 million in marine damages in Mississippi
- $14.8 million cost of debris removal in flooded areas in Mississippi

5.1.2 Historic (Pre-Hurricane) Population Trends

The 1950-2000 population levels and growth for the U.S., Mississippi, the three-county study area, and each county are presented in Table 5-4. During this fifty year period, the population of the three-county study area grew by 186.6 percent. This is 5.6 times the Mississippi percentage population growth of 33.2 percent and 2.2 times the U.S. percentage population growth of 86.0 percent for the same timeframe. The three-county area accounted for 32.7 percent of the nominal population growth for Mississippi from 1950 to 2000.

Table 5-4.
1950-2000 Population Levels and Growth (in thousands)

	United States	Mississippi	Three-County Study Area	Hancock County	Harrison County	Jackson County
1950	151,326	2,179	127	12	84	31
1960	179,323	2,178	189	14	119	56
1970	203,212	2,217	239	17	134	88
1980	226,546	2,521	301	25	158	118
1990	248,710	2,573	312	32	165	115
2000	281,421	2,903	364	43	190	131
50 Year Nominal Change	130,095	724	237	31	106	100
50 Year Percentage Change	86.0%	33.2%	186.6%	258.3%	126.2%	322.5%

Source: U.S. Census Bureau, 2000 Census

5.1.3 Historic (Pre-Hurricane Katrina) Environmental Setting

The study area consists of the three coastal counties within the State of Mississippi: Hancock, Harrison, and Jackson counties; and the coastal (offshore) ecosystem including its barrier islands. This area ranges in elevation from sea level to about 30-feet NAVD88. The essentially flat to gently undulating, locally swampy Coastal Lowlands are underlain by alluvial, deltaic, estuarine, and coastal deposits and merge with the fluvial-deltaic plains of the streams of the area. According to the Cowardin et. al., *Classification of Wetlands and Deepwater Habitat of the United States*, there are five major wetland and deepwater systems, four of which are found within Coastal Mississippi. They include marine, estuarine, riverine, and palustrine wetland systems.

Within Coastal Mississippi, the marine system is the area along the Gulf of Mexico front south of the barrier islands. It is comprised of the intertidal beachfront of the barrier islands along the Gulf of Mexico, and subtidal which consists of the unconsolidated sandy water bottoms. The string of barrier islands are comprised of dynamic and diverse habitats and are part of a complex integrated system of beaches, dunes, marshes, bays, tidal flats, and inlets. These barrier islands are located along a littoral drift zone that moves sand westward creating three elongated islands and then to the westward most island (i.e. Cat) where littoral currents are not as well defined. From east to west, the islands are Petit Bois, Horn, Ship, and Cat. Ship Island was breached by prior hurricanes and now is actually two small islands, West Ship Island and East Ship Island, with a shallow sand bar between the two. Since Hurricane Camille in 1969, this breach has existed with varying amounts of natural rebuilding between later storms.

Under current conditions, the islands provide a natural boundary between the water's salinity [~33 parts per thousand (ppt)] of the open Gulf of Mexico and the brackish water found in Mississippi Sound. Salinity in the Sound during low flow periods range from 10 to 30 ppt. Highest salinities occur just south of Pascagoula and Gulfport and the lowest salinities in the Lake Borgne-Pearl River area. Mississippi Sound is a shallow coastal lagoon along northern Gulf of Mexico from Mobile Bay, Alabama, in the east to Lake Borgne, Louisiana, in the west. Circulation is driven by tides modified slightly with the wind. Gulf waters enter the Sound through the deep passes between the barrier islands with the help of tidal forces. This mixing of freshwater runoff and saline waters has created a dynamic estuarine environment. Mississippi Sound receives its major freshwater flow from the

Pascagoula and Pearl Rivers and is critical to the survival of numerous birds, mammals, fish, and other marine organisms of national importance.

Many different habitat types are found in and around the estuarine environment, including shallow open-waters, salt marshes, sandy beaches, mud and sand flats, oyster reefs, river deltas, tidal pools, and submerged aquatic vegetation (SAVs). These diverse ecosystems serve a variety of critical functions necessary to sustain a vital thriving commercial fishing industry of national economic significance. Prior to the hurricane season of 2005, sea grasses were restricted to the northern shores of the barrier islands and small patches throughout the immediate shorelines. These areas are characterized by *Diplanthera Wright* (Shoal grass), *Cymodocea manatorum* (Manatee grass), *Thalassia testudinum* (Turtle grass), and *Ruppia maritime* (Widgeon grass). Approximately 20,000 acres of SAVs were present in Mississippi Sound prior to 1969; however, in late 1969, Hurricane Camille caused the destruction of the majority of these areas. In 1969, an estimated 13,000 acres of SAVs were documented and as of 1998, only 2,000 acres were documented (Moncrieff 1998).

Prior to the 2005 hurricane season, the majority of the shoreline in Coastal Mississippi consisted of manmade beaches beyond concrete seawalls. A few remaining areas along the shoreline consist of more natural areas, such as expanses of marsh along the western and eastern borders of the state. A natural beach and dune system, located along Belle Fontaine in the central portion of Coastal Mississippi, is the only natural beach remaining and has experienced severe erosion to a point that it is virtually non-existent. The beach of Coastal Mississippi provides a unique habitet for a variety of plants and animals. For example, 75% of migratory waterfowl live in or depend on coastal beaches during their lifespan. Dune vegetation provides nesting areas for several kinds of birds, such as least terns, and animals, such as mole crabs and rodents.

Wet Pine Savannah wetlands found in Coastal Mississippi provide for diverse habitat for a number of plants and animals including many threatened and endangered species found only in these unique habitats. Pine Savannah wetlands are commonly referred to as sponges that provide floodwater retention, groundwater recharge, and water purification. Development stresses were impinging upon these wetland habitats.

Coastal Mississippi supports an array of reptiles, amphibians, birds, and mammals. Reptiles and amphibians found in the area include snakes, turtles, lizards, toads, frogs, salamanders, and crocodilians. Coastal Alabama and Mississippi have a great diversity of reptiles including 23 species of turtles, 10 species of lizards, 39 species of snakes, and the alligator. Eighteen species of salamanders and 22 species of frogs and toads are indigenous to the coastal region.

Overall, the environmental conditions of Coastal Mississippi were already stressed prior to the hurricane season of 2005 and with its onset, many habitats were adversely impacted. However, these stressed conditions in Coastal Mississippi are irreversible with adequate planning and management.

5.2 Existing (Post-Hurricane Katrina) Conditions

5.2.1 Impacts from Hurricane Katrina

On August 29, 2005, Hurricane Katrina made land fall in Hancock County, Mississippi just east of the Pearl River. By virtually all accounts, it was the single largest disaster in U.S. history. Storm surge from Hurricane Katrina was the largest that has ever hit the continental United States. The surge inundated approximately 484 square miles of southern Mississippi. The relief expenditures in

Mississippi alone have totaled in the billions of dollars. Figure 5.2-1 shows the inundation footprint of Hurricane Katrina.

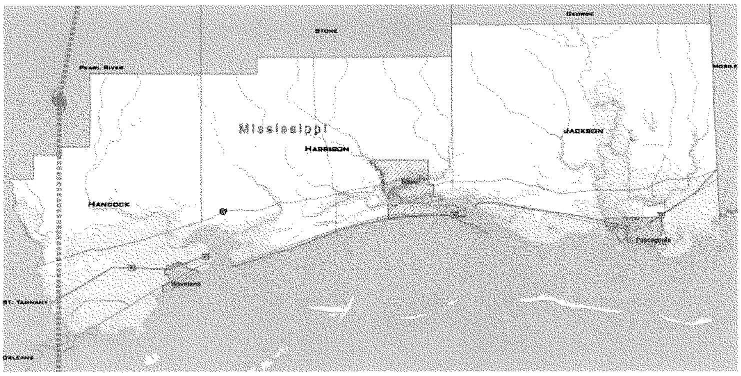


Figure 5.2-1. Hurricane Katrina Path and Extent of Hurricane Katrina Surge in Planning Units One, Two, and Three

5.2.2 Existing Structure Conditions

Data collected as part of the field inventory process was used to create a structure database. The structure database is the compilation of the data collection effort previously described. It includes each of the structure characteristics mentioned above, damage categories, structure occupancy types, first floor elevations, structure value, content value collected. These characteristics were put into the database along with the data collected from the tax assessor to create a structure database. This structure database represents the existing condition of the structures residing within the study area and the basis for the calculation of equivalent annual damages for the existing, future without-project and future with-project conditions using the HEC-FDA and Beach-FX programs. The structure database is intended to be a snap-shot in time of the structures within the study area. The use of this database was essential for the analysis conducted throughout the course of the MsCIP Comprehensive Plan.

The three planning units suffered tremendous devastation from Hurricane Katrina's surge. It is estimated that 32,446 structures were significantly destroyed (at least fifty-percent or more), with another 15,000 to 25,000 suffering moderate to minimal inundation damage. Of the structures sustaining significant destruction, 9,555 were in planning unit one, 16,528, in planning unit two, and 6,363 in planning unit three. Of those significant loss structures, approximately 19,000 claims were paid out by the Federal Emergency Management Agency's (FEMA's) National Flood Insurance Program (NFIP) totally over $2.3 Billion dollars, with the average claim around $137,000. Currently, no accurate data exists for uninsured losses, but estimates range in the billions of dollars. Table 5-5 displays the significantly damaged structures by planning unit and by structure category. Figures 5.2-2 through 5.2-14 show examples of the destruction caused by Hurricane Katrina in the three planning units.

Table 5-5.
Structures Damaged 50% or More by Planning Unit and by Category

	Planning Unit One	Planning Unit Two	Planning Unit Three	Total
Commercial	1,267	1,794	378	**3,439**
Residential	8,099	14,500	5,780	**28,379**
Municipal	127	89	136	**352**
Mobile Home	62	145	69	**276**
Total	**9,555**	**16,528**	**6,363**	**32,446**

Source: Estimated from field inventory cluster sampling.

Figure 5.2-2. Example of Structure Damage in Planning Unit One

Figure 5.2-3. Structure Damage in Planning Unit One

Figure 5.2-4. Katrina Surge Damage in Planning Unit One

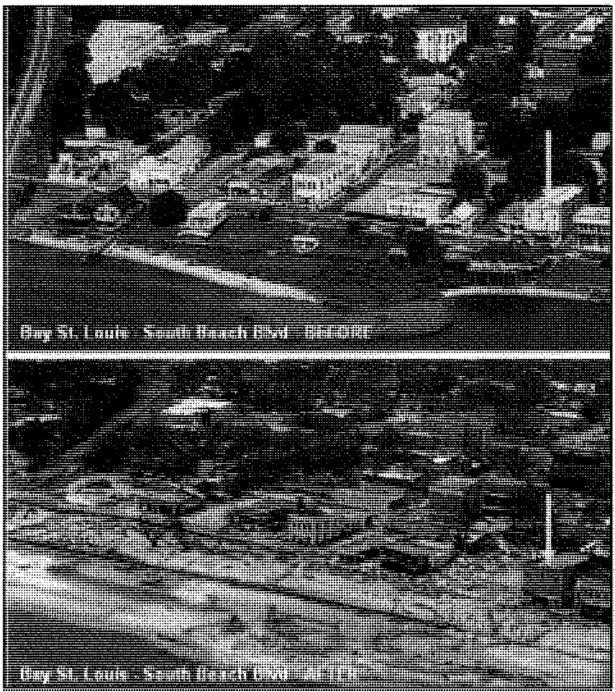


Figure 5.2-5. Surge Damage in Bay St. Louis – Planning Unit One

Figure 5.2-6. Surge Damage in Biloxi Area – Planning Unit Two

Figure 5.2-7. Surge Damage in Biloxi Area – Planning Unit Two

Figure 5.2-8. Surge Damage in Planning Unit Two

Figure 5.2-9. Pascagoula Beach Boulevard Pre-Hurricane Katrina – Planning Unit Three

Figure 5.2-10. Pascagoula Beach Boulevard Post-Hurricane Katrina – Planning Unit Three

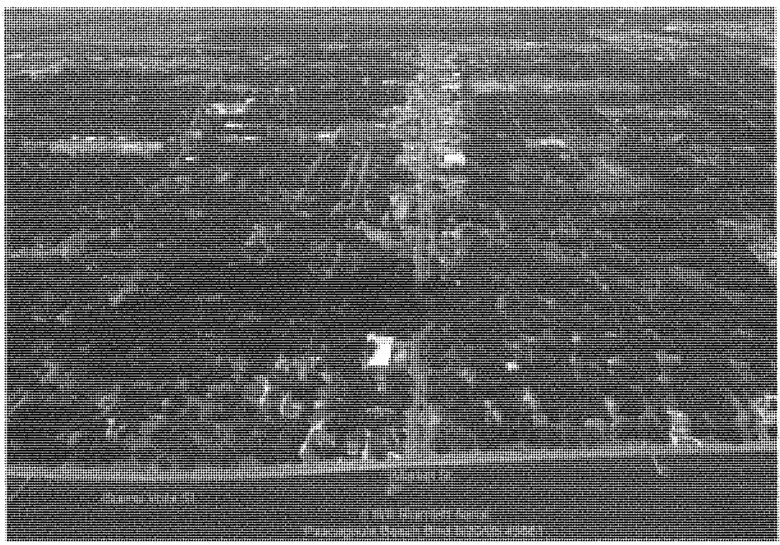


Figure 5.2-11. Pascagoula Beach Boulevard Pre-Hurricane Katrina – Planning Unit Three

Figure 5.2-12. Pascagoula Yacht Club Post-Hurricane Katrina – Planning Unit Three

Figure 5.2-13. Pascagoula Yacht Club Pre-Hurricane Katrina – Planning Unit Three

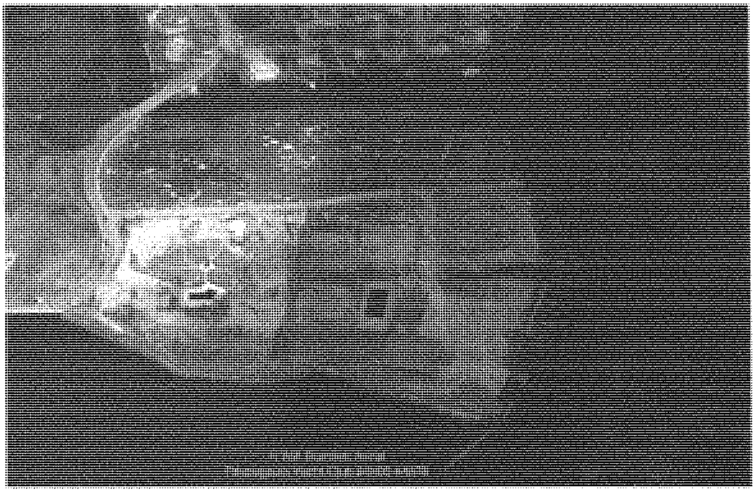


Figure 5.2-14. Pascagoula Yacht Club Post-Hurricane Katrina – Planning Unit Three

5.2.3 Existing (Post-Hurricane Katrina) Socio-economic Conditions

This section contains a description of the existing conditions (post-Hurricane Katrina) demographic and economic characteristics of the study area. It also provides analysis of the interrelation of those characteristics. The people who live in the study area and the economic activities in which they are engaged are vital components of the study area. This information provides insight into the study area's socioeconomic characteristics and provides part of the basis for certain facets of the economic impact evaluation study.

5.2.3.1 Demographics (Population)

5.2.3.1.1 Recent Population Trends

The 2000-2005 population level and growth estimates for the U.S., Mississippi, the three-county study area, and each county are displayed in Table 5-6. The July 1, 2000 to July 1, 2005 timeframe is the most recent before Hurricane Katrina made landfall in late August of 2005. During this five year period, the population of the three-county study area grew by 2.86 percent. This is 1.4 times the Mississippi percentage population growth of 2.10 percent and 0.6 times the U.S. percentage population growth of 5.06 percent. The three-county study area accounted for 17.4 percent of the nominal population growth for Mississippi from 2000-2005.

Table 5-6.
2000-2005 Estimates of Population Levels and Growth

	United States	Mississippi	Three-County Study Area	Hancock County	Harrison County	Jackson County
July 1, 2000	282,216,952	2,848,634	364,863	43,283	189,699	131,881
July 1, 2001	285,226,284	2,856,108	366,362	43,944	189,512	132,906
July 1, 2002	288,125,973	2,863,091	367,498	44,607	189,996	132,895
July 1, 2003	290,796,023	2,874,171	367,790	45,166	189,189	133,435
July 1, 2004	293,638,158	2,892,668	372,885	45,821	192,129	134,935
July 1, 2005	296,507,061	2,908,496	375,304	46,546	193,187	135,571
5 Year Nominal Change	14,290,109	59,862	10,441	3,263	3,488	3,690
5 Year Percentage Change	5.06%	2.10%	2.86%	7.54%	1.84%	2.80%

Source: U.S. Census Bureau, Population Division

5.2.3.1.2 Existing Condition (Post-Katrina) Population

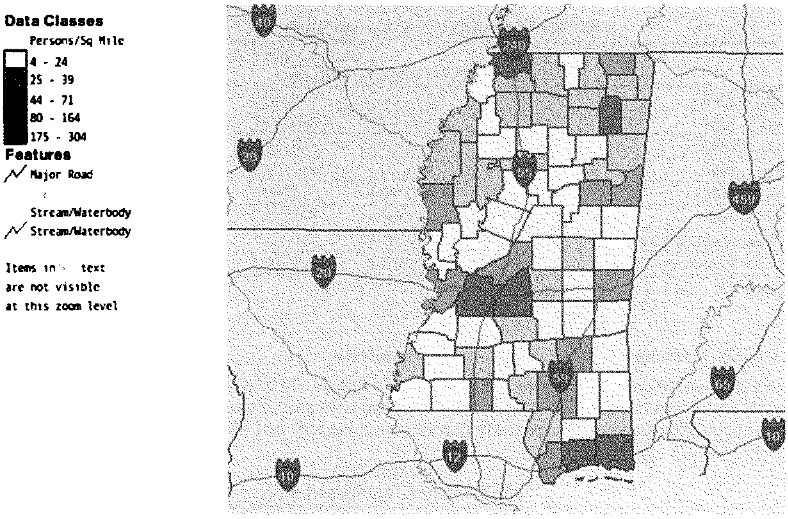
The 2006 population level estimates for the U.S., Mississippi, the three-county study area, and each county are shown in Table 5-7. The table also displays each county's population and the study area's population as a percentage of the populations of the U.S. and Mississippi.

Table 5-7.
2006 Estimated Population Levels

	United States	Mississippi	Three-County Study Area	Hancock County	Harrison County	Jackson County
July 1, 2006 Population Estimate	299,398,484	2,910,540	342,873	40,421	171,875	130,577
Percentage of U.S. Population	100.0%	0.972%	0.115%	0.014%	0.057%	0.040%
Percentage of Mississippi Population		100.0%	11.8%	1.4%	5.9%	4.5%

Source: U.S. Census Bureau, Population Division

Figure 5.2-15 is a map displaying the population densities of counties in Mississippi. As can be seen from the map, the three-county study area is one of the more densely populated areas in Mississippi. It can also be seen that Hancock County has a lower population density than Harrison County or Jackson County.



Source: U.S. Census Bureau

Figure 5.2-15. 2006 Mississippi Population Density

5.2.3.1.3 Urban Growth and Distribution

The 2000-2004 population changes for the U.S., Mississippi, the three-county study area, each county, and major cities within each county are displayed in Table 5-8. The city with the greatest nominal or percentage population growth in the study area from 2000 to 2004 is Gautier with population growth of 5,172 persons or 44.28 percent.

Table 5-8.
2000-2004 Urban Growth and Distribution

	2000	2004	2000-2004 Nominal Change	2000-2004 Percentage Change
United States	281,421,906	293,655,404	12,233,498	4.35%
Mississippi	2,844,658	2,902,966	58,308	2.05%
Three-County Area	363,988	373,762	9,774	2.69%
Hancock County	42,967	45,933	2,966	6.90%
Bay Saint Louis	8,209	8,293	84	1.02%
Waveland	6,674	7,120	446	6.68%
Harrison County	189,601	192,393	2,792	1.47%
Biloxi	50,644	50,115	-529	-1.04%
D'Iberville	7,608	7,757	149	1.96%
Gulfport	71,127	71,850	723	1.02%

Table 5-8.
2000-2004 Urban Growth and Distribution (continued)

	2000	2004	2000-2004 Nominal Change	2000-2004 Percentage Change
Long Beach	17,320	17,258	-62	-0.36%
Pass Christian	6,579	6,758	179	2.72%
Jackson County	131,420	135,436	4,016	3.06%
Gautier	11,681	16,853	5,172	44.28%
Ocean Springs	17,225	17,698	473	2.75%
Pascagoula	26,200	25,865	-335	-1.28%

Source: U.S. Census Bureau, Population Division

5.2.3.1.4 Racial Distribution

Table 5-9 shows the racial distribution for the U.S., Mississippi, each county in the study area, and also includes the racial distribution for the major cities in each county as of 2000.

Table 5-9.
2000 Population Racial Distribution

Table Header	White	Black	Hispanic	Asian	American Indian	Other	Multiple Races
United States	75.1%	12.3%	12.5%	3.6%	0.9%	5.5%	2.4%
Mississippi	61.4%	36.3%	1.4%	0.7%	0.4%	0.5%	0.7%
Hancock County	90.2%	6.8%	1.8%	0.9%	0.6%	0.3%	1.1%
Bay Saint Louis	80.2%	16.6%	1.7%	1.1%	0.4%	0.2%	1.4%
Diamondhead	95.3%	1.8%	2.9%	0.9%	0.4%	0.5%	1.1%
Pearlington	77.6%	20.4%	1.4%	0.1%	0.4%	0.1%	1.4%
Shoreline Park	94.6%	2.0%	1.9%	0.3%	1.0%	0.3%	1.7%
Waveland	85.4%	11.2%	2.0%	1.5%	0.5%	0.5%	0.9%
Harrison County	73.1%	21.1%	2.6%	2.6%	0.5%	0.9%	1.7%
Biloxi	71.4%	19.0%	3.6%	5.1%	0.5%	1.4%	2.4%
D'Iberville	78.2%	11.4%	2.6%	7.0%	0.4%	0.9%	2.1%
Gulfport	62.2%	33.5%	2.6%	1.3%	0.4%	0.5%	1.6%
Long Beach	87.5%	7.4%	2.3%	2.6%	0.4%	0.7%	1.4%
Pass Christian	65.9%	28.2%	1.7%%	3.5%	0.6%	0.6%	1.2%
Jackson County	75.4%	20.9%	2.1%	1.6%	0.3%	0.7%	1.1%
Escatawpa	80.5%	17.6%	0.6%	0.7%	0.3%	0.1%	0.7%
Gautier	68.2%	27.7%	3.2%	1.3%	0.5%	0.9%	1.4%
Moss Point	28.0%	70.6%	1.0%	0.2%	0.2%	0.4%	0.6%
Ocean Springs	87.7%	7.0%	2.5%	2.6%	0.4%	0.7%	1.5%
Pascagoula	67.2%	29.0%	3.9%	1.0%	0.2%	1.7%	1.0%

Source: U.S. Census Bureau, 2000 Census

5.2.3.2 Economy

5.2.3.2.1 Employment Distribution

The 2002 distribution of employment by major sectors for Mississippi, the three-county study area, and each county is shown in Table 5-10. Approximately 5.4% of Mississippi's Professional and Technical employment could be found in Hancock County in 2002. Hancock County is home to the John C. Stennis Space Center. The Stennis Space Center, with over 4,600 employees is NASA's primary center for rocket propulsion testing. Harrison County is a popular vacation destination for its beaches and casinos. Harrison County accounts for 26.9 percent of Mississippi's employment in the arts and 20.0 percent of Mississippi's employment in food and accommodation services. Jackson County features Pascagoula Harbor. In 2004, 66.7 percent of Mississippi's waterborne commerce volume and 1.3 percent of U.S. volume moved through Pascagoula Harbor. Pascagoula Harbor's annual volume increased 44% from 1986 to 2004. Northrop Grumman Ship Systems' Ingalls Operations, with over 10,000 employees, can also be found in Jackson County. Jackson County accounted for 8.8 percent of Mississippi's employment in manufacturing.

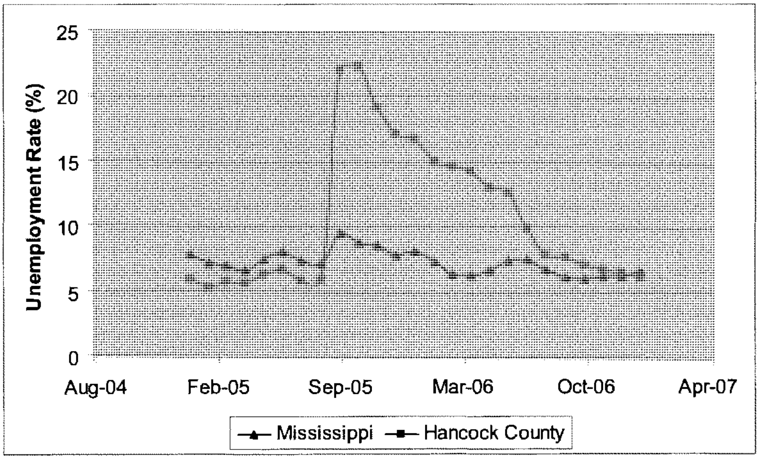
Table 5-10.
2002 Employment Distribution by Major Sector

	Mississippi	Three-County Study Area	Hancock County	Harrison County	Jackson County
Manufacturing	182,822	21,500	1,000	4,500	16,000
Wholesale	35,316	2,963	251	2,112	600
Retail	135,838	18,698	1,586	11,548	5,564
Real Estate	9,665	1,585	131	1,084	370
Professional & Technical	29,023	5,205	1,555	2,050	1,600
Administration	46,115	5,821	1,280	3,211	1,330
Education	1,678	204	20	100	84
Health & Social Care	131,976	17,549	500	12,429	4,620
Arts	9,292	2,700	100	2,500	100
Food & Accommodation	109,405	27,523	2,114	21,822	3,587
Other Services	22,180	3,558	176	2,067	1,315

Source: U.S. Census Bureau, 2002 Economic Census

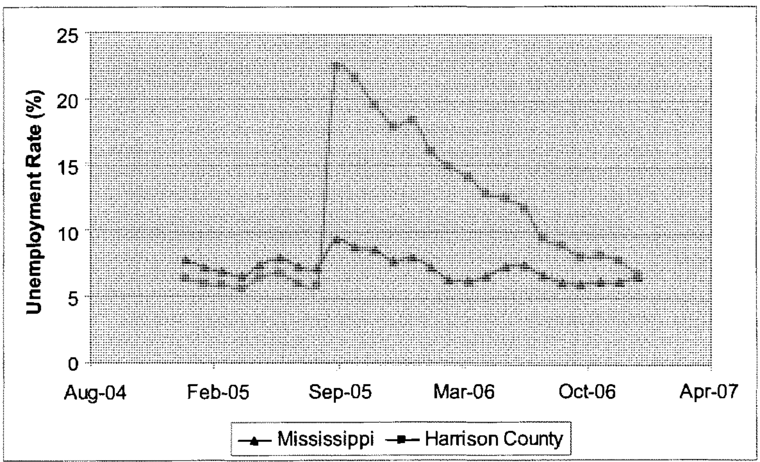
5.2.3.2.2 Unemployment

The non-seasonally adjusted unemployment rates for Mississippi and each county in the study area from January 2005 to January 2007 are displayed graphically in Figures 5.2-16, 5.2-17 and 5.2-18. These same numbers are also displayed in Table 5-11. Unemployment rates within the study area increased dramatically following Hurricane Katrina, but have since recovered to roughly pre-Katrina levels.



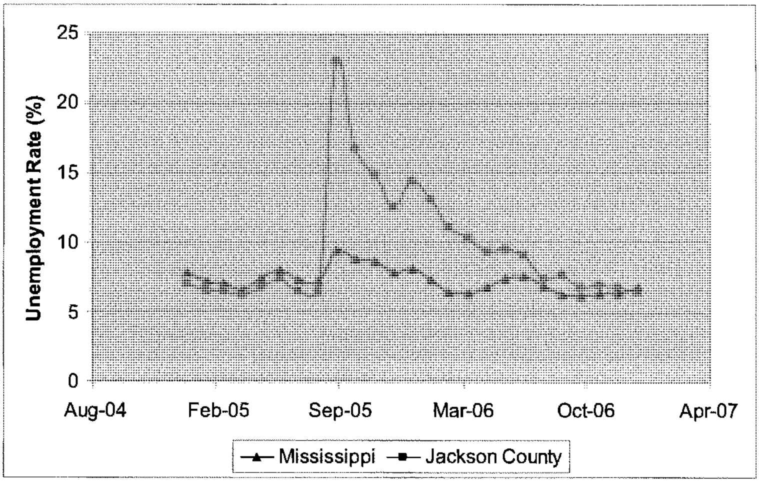
Source: Bureau of Labor Statistics

Figure 5.2-16. Non-Seasonally Adjusted Unemployment Rates for Mississippi and Hancock County



Source: Bureau of Labor Statistics

Figure 5.2-17. Non-Seasonally Adjusted Unemployment Rates for Mississippi and Harrison County



Source: Bureau of Labor Statistics

Figure 5.2-18. Non-Seasonally Adjusted Unemployment Rates for Mississippi and Jackson County

Table 5-11.
January 2005 – January 2007 Unemployment Rates (%)

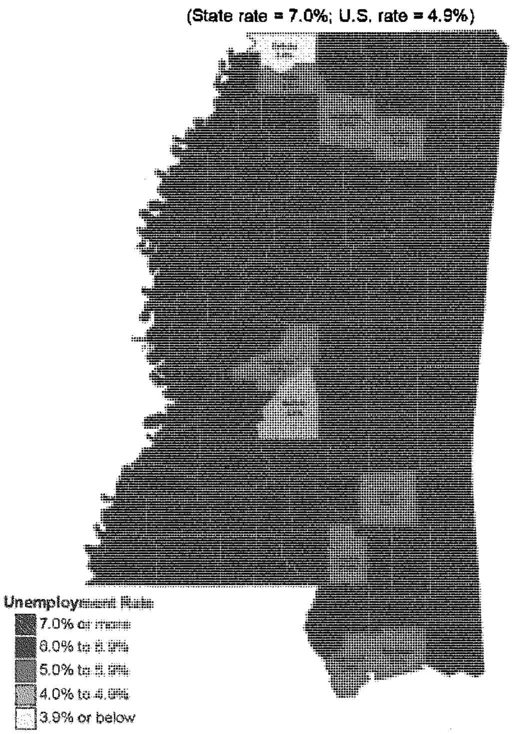
	Mississippi	Hancock County	Harrison County	Jackson County
Jan-05	7.8	5.9	6.4	7.0
Feb-05	7.2	5.3	6.0	6.5
Mar-05	7.0	5.7	5.9	6.5
Apr-05	6.6	5.6	5.6	6.2
May-05	7.4	6.3	6.5	6.7
Jun-05	8.0	6.7	6.9	7.4
Jul-05	7.3	5.8	6.0	6.5
Aug-05	7.2	5.9	5.9	6.4
Sep-05	9.4	22.0	22.6	23.0
Oct-05	8.8	22.3	21.7	16.7
Nov-05	8.6	19.2	19.6	14.8
Dec-05	7.8	17.2	18.0	12.5
Jan-06	8.1	16.8	18.5	14.4
Feb-06	7.3	15.1	16.2	13.0
Mar-06	6.4	14.7	15.0	11.1
Apr-06	6.3	14.3	14.2	10.3
May-06	6.7	13.1	13.0	9.3
Jun-06	7.4	12.7	12.6	9.5
Jul-06	7.5	9.9	11.8	9.0
Aug-06	6.8	7.9	9.6	7.4

Table 5-11.
January 2005 – January 2007 Unemployment Rates (%) (continued)

	Mississippi	Hancock County	Harrison County	Jackson County
Sep-06	6.2	7.7	9.0	7.6
Oct-06	6.1	7.2	8.2	6.7
Nov-06	6.3	6.8	8.3	6.9
Dec-06	6.3	6.6	7.9	6.7
Jan-07	6.7	6.2	6.9	6.4

Source: Bureau of Labor Statistics

Figure 5.2-19 is a map displaying the unemployment rates for Mississippi by county for August, 2005. Before Hurricane Katrina the counties in the study area had unemployment rates lower than the Mississippi unemployment rate.



Source: Bureau of Labor Statistics

Figure 5.2-19. Non-Seasonally Adjusted Unemployment Rates by County for Mississippi

5.2.3.2.3 *Income and Poverty*

Median income and poverty levels for the U.S., Mississippi and each county in the study area for 2004 are displayed in Table 5-12. Each of the three counties in the study area had a higher median income and a lower poverty rate than that of Mississippi in 2004.

Table 5-12.
2004 Median Income and Poverty Levels

	Median Income	Nominal Poverty	Poverty Rate
United States	$44,334	37,039,804	12.7%
Mississippi	$34,278	549,224	19.3%
Hancock County	$36,285	7,737	16.6%
Harrison County	$35,576	31,809	16.9%
Jackson County	$40,418	20,256	15.0%

Source: U.S. Census Bureau, Small Area Income & Poverty Estimates

5.2.4 *Existing (Post-Hurricane Katrina) Environmental Setting*

Prior to the storms, Coastal Mississippi had already experienced large population growth over the last few decades. Loss and/or alteration of various habitats types (i.e. barrier islands, submerged aquatic vegetation (SAVs), marsh habitat – freshwater and estuarine, wet pine savannah, etc.) had adverse impacts on both fish and wildlife and also on those habitats upon which they depend. Erosion to the barrier islands could possibly increase salinity; thus, greatly changing ecological habitats that exist, which could lead to saltwater intrusion, increased wave action, and destroying coastal wetlands. Increased salinity within Mississippi Sound would impact shellfish and many other forms of marine life. At the Chandeleur Islands in Louisiana, loss of those island masses allows us to anticipate potential environmental changes. Initial assessments are showing SAVs diminishing, marsh erosion ongoing/accelerating, and wave energy having no natural barrier.

Following Hurricane Katrina, the Commerce Secretary declared a complete fisheries failure due to the extensive devastation to the processing facilities, docks, loss of boats, degradation of habitat, deposition of marine debris, and degraded water quality. Losses to many commercially important fisheries stock, foraging areas, nurseries, and etc. have been felt economically in the region. Increased salinity due to continued degradation of the barrier islands will result in detrimental impacts to the vital economic fisheries industry that the estuarine environment sustains.

Oyster reefs have been seriously impacted by Hurricane Katrina and all reefs in Coastal Mississippi were closed immediately following the storm, with some of them still remaining closed almost 2 years later. There are signs the reefs are beginning some of the healing processes on their own; however, much work will be needed to restore the oyster reefs to their former prime condition. Extensive sampling of the reefs is currently being conducted by the MDMR to provide information needed to plan extensive long-term recovery activities. Initial assessments of the reef conditions are underway but at present, are incomplete. Conditions of the reefs are highly variable. Generally, offshore areas were heavily scoured. Recent very heavy oyster spat set (less than one inch in length) was found in some of these areas with no spat set in other areas. Some light SAVs, marsh grass and drift wood were found. Inshore reefs generally had moderate to very low numbers of live oysters in some areas with other areas revealing no live oysters.

The coastal maritime forests on the barrier islands and also the mainland were almost entirely lost as a result of the storm. Almost 2 years following those events, approximately 90% of this habitat is still lost. Even prior to the storms, but especially after, wet pine savannah wetland habitat has been under increased developmental pressures due to the extreme and urgent housing need faced by Mississippians as they are trying to rebuild. This habitat is becoming fragmented and with the increased development, fire maintenance is increasingly harder to perform. Due to the nature of the flat coastal plains with little relief, these lands are some of the first to be considered for housing development. These habitats are becoming fragmented causing a loss of wildlife corridors and contiguous expanses of habitat necessary for continued species existence. Coastal Mississippi has lost over half of its wet pine savannahs due to the urbanization throughout the area; thus, creating a threatened ecosystem that in turn is home to many threatened and endangered species. Because of the loss of these habitats, the species dependent upon them are increasingly becoming diminished. As a result of Hurricane Katrina and other storms of 2005, estuarine and freshwater marsh habitats were severely impacted by the debris that landed within its footprints; thus, clogging natural tidal and/or runoff flow. Furthermore, many historical marsh habitats (i.e. Shoreline Park) were noted to have detrimental damage due to its historical filling and development. Following those events, many historical habitats were identified that would benefit Coastal Mississippi upon its conversion back to its natural habitat. In conclusion, the hurricane season of 2005 greatly impacted the environmental setting of Coastal Mississippi.

5.3 Future Without-Project Conditions

5.3.1 Period of Analysis

For sensitivity purposes, the period of analysis used for the MsCIP Comprehensive Plan is a 100-year period, which was then converted to a 50-year period of analysis for those plan elements that would be recommended for construction. The base year used for the MsCIP Comprehensive Plan is the first year of the period of analysis. Typically, the base year is considered to be the first year that full project benefits come online and it is always the year to which benefits and costs of measures are discounted (present-worthed) back to in order to make an even ("apple-to-apples") comparison. The base year for the analysis used for the MsCIP Comprehensive Plan is the year 2012. Figure 5.3-1 depicts the methodology that was used for the 100-year period of analysis. This methodology was also used for the 50-year period of analysis, with the exception of the most likely future being 2061 (50 years), instead of 2111 (100 years).

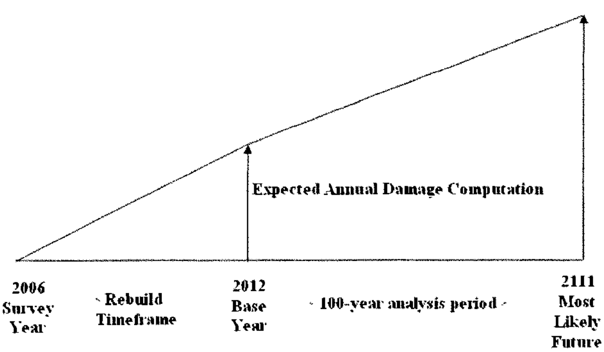


Figure 5.3-1. Period of Analysis used for Flood Damage Reduction and Hurricane and Storm Damage Prevention

5.3.2 Assumptions

The following assumptions were designed to construct the forecast estimate of the of the three county study area. The assumptions were based on discussions with state and local interests, various experts, and past experiences following devastating hurricanes along the northern Gulf Coast such as Hurricanes Camille and Fredrick. Further, these assumptions were based on an existing condition identified by using tax parcel data from the tax assessors of the three coastal counties and by conducting the field inventory to assess the extent of damages and where they occurred. These assumptions drive the future without-project structure inventory that was forecast and evaluated in HEC-FDA along with the hydrodynamic forecast conditions, which can be found in detail in the engineering appendix, to estimate future without-project inundation damages and damages reduced as result of potential measures.

- The base year for which costs and benefits are discounted is 2012.
- The discount rate used for this analysis is the FY-08 discount rate of 4-7/8-percent.
- The period of analysis for screening and sensitivity purposes is 100-years (2012 to 2111), however all measures recommended for construction will be converted back to a 50-year period of analysis (2012 to 2111). A more detailed discussion of this assumption can be found as a sensitivity analysis in chapter VII of this appendix.
- The demands for waterfront and near water living will not decrease in the future as a result of hurricanes (i.e. people will always want to live by the water).
- Only destruction of property occupied prior to Hurricane Katrina will be accounted for in forecasting (i.e. there will be no projection of previously undeveloped land).
- Destruction categories include significant (damaged 50-percent or more and must be completely rebuilt) and moderate to minimal (less than 50-percent rebuilt and can be either repaired or rehabilitated).
- Previously occupied structures that were destroyed as a result of Hurricane Katrina will be redeveloped and the population will return to at least pre-Katrina levels. Redevelopment is defined as the building back of structures that existed before Hurricane Katrina, not development that occurs on land that was undeveloped.
- Full redevelopment of previously occupied structures will occur by the base year 2012.
- Redevelopment of the study area could take the form of residential redevelopment (exactly the way it was pre-Hurricane Katrina) or a mixture of commercial/condominium and residential redevelopment. In addition to redevelopment, it is assumed that relative sea level rise could take the form of base, moderate or high relative sea level rise. The six future scenarios are outlined in the following section.
- Economic cycles such as recessionary and expansionary periods could, and probably will, have an impact on the timing and magnitude of the redevelopment of the coast over the period of analysis, but are not able to be predicted and are not accounted for in the forecast.
- An increase in relative sea level rise will probably occur over the period of analysis.
- Relative sea level rise is not a linear function, meaning that some years may experience more or less than other years. Since the amount of relative sea level rise in any given year is impossible to predict, a linear relationship is used to model relative sea level rise for purposes of forecasting.

- Given the majority of the coast is fronted by man-made seawalls and roadways and the majority of structures are not immediately located by the water like other Gulf Coast and Eastern Seaboard communities, effects of future erosion on human development behavior will be none to minimal.
- Effects of future inundation caused by relative sea level rise could have any where from a minimal to a moderate effect on human development behavior, but those effects are currently difficult or impossible to measure and are not account for in this forecasting effort.
- Communities will adopt and adhere to FEMA guidelines under the National Flood Insurance Program (NFIP).
- FEMA guidelines require minimum heights that the first floor elevation must be built to in order to be included in the National Flood Insurance Program (NFIP). For the purposes of the redevelopment projected in this report, houses that will be rebuilt before the start of 2009 are assumed to be rebuilt to the Pre-Hurricane Katrina Base Flood Elevation (BFE) and those that are rebuilt between 2009 and 2011 will be rebuilt to the Advisory Base Flood Elevation (ABFE) as existed May 2007. The BFE and ABFE estimates vary in range of elevation depending on the planning sub-unit in question. Table 5-13 shows these heights by reach.
- Redevelopment is estimated to occur as follows:

Table 5-13.
Assumptions of Structure Redevelopment by Year

Year	Percent Redeveloped	Elevation of Redevelopment
2005	N/A	Hurricane Katrina Landfall (August 29th)
2006	10%	Pre-Hurricane Katrina Base Flood Elevations
2007	25%	Pre-Hurricane Katrina Base Flood Elevations
2008	40%	Pre-Hurricane Katrina Base Flood Elevations
2009	60%	Advisory Base Flood Elevations
2010	80%	Advisory Base Flood Elevations
2011	100%	Advisory Base Flood Elevations
2012	Full Redevelopment	Base Year

- Depth damage characteristics of structures (the percent of structure damage at various levels of inundation) are assumed and used to define economic damage as a result of inundation.
- The depth damage characteristics of structures vary by construction type and are similar to those in other parts for the Gulf Coast, particularly the New Orleans area. It is also assumed that the duration of surge inundation is approximately 24 hours, which is considered short-term duration. The depth-damage relationships are explained in more detail in Addendums A and B.
- Depreciated replacement cost of structures was used unless a structure was destroyed fifty-percent or more due to surge from Hurricane Katrina. For those structures damaged fifty-percent or more and must be rebuilt, full depreciated replacement cost was used to denote the value in the structure inventory.

5.3.3 Scenario Testing

5.3.3.1 Methodology

Forecasting future scenarios is an important part of the Corps planning process. In order to evaluate the true economic value of potential measures over the project life, a forecast is created based on the historic and existing information, as well as quantitative and qualitative assumptions about what may happen within the study area in the future. One method is to identify the 'most likely' future, or the best guess about what may happen based on observed variables and assumptions of both natural and human behaviors. Another method is to conduct scenario planning, where multiple future scenarios are created in order to evaluate what would happen if observed variables or assumptions do not happen as projected. The purpose of scenario planning is to attempt to answer 'what if' questions that arise when making forecasting assumptions and predictions.

For the Mississippi Coastal Improvements Project, the former method was chosen due to the size, scope, and complexity of the overall analysis. The six future without-project scenarios are displayed in table 5-14 summarizes the six future scenarios.

These six future without-project scenarios were based on existing condition characteristics, patterns of rebuilding following historical hurricanes within the specific area such as Hurricane Camille, patterns of rebuilding in other similar parts of the northern Gulf Coastal area such as Gulf Shores and Orange Beach, AL following Hurricane Fredrick, and potential impacts of relative sea level rise over the period of analysis. Following Hurricane Camille, the Mississippi Gulf Coast not only rebuilt the structures and infrastructure it lost to the devastating storm surge, but saw substantial growth in both residential and commercial infrastructure. However, it did not see a major shift in their proportion, i.e., the ratio of residential and commercial infrastructure did not immediately change as a result of a shift in behavior immediately following the storm. In contrast, the effects of Hurricane Fredrick to the Alabama Gulf Coast Communities of Gulf Shores and Orange Beach saw a fundamental shift of infrastructure from typically residential, to condominium and business structures. These two scenarios form the two rebuilding components of the future without-project scenarios; residential (a rebuild of the coastal area based on what existed prior to Hurricane Katrina) and residential and commercial (a rebuild of what type existed prior to Hurricane Katrina with a shift from residential to commercial along the coast.

The other component of the future without-project scenarios is relative sea level rise, or an estimate of the affect of eustatic sea level rise combined with subsidence. In order to evaluate the effects of this component, a range of relative sea level rise was identified and modeled and the details can be found in the engineering appendix. Three potential relative sea level rise settings were identified; base (historical relative sea level rise with no future projection), moderate (historical relative sea level rise and a future projection of up to 2.4-feet depending on location), and high (historical relative sea level rise and a future projection of up to 3.4-feet depending on location). These three components, coupled with the two redevelopment components, form the six future without-project scenarios used in the evaluation of this study.

As with any attempt to project the future, accuracy is limited by a host of factors such as timing (what if a recession hits), reality not fully matching the assumptions used (what if the redevelopment effort doesn't happen as fast as predicted or what if human behavior shifts in a way that was unforeseen), and on. In other words, any attempt to project the future will include some risk and uncertainty and therefore the intent of making these forecasts is to provide an estimate of what the future could be in order to evaluate the impacts of potential actions, not to say this is exactly what is going to happen.

Table 5-14.
Overview of Future Scenarios

Future Scenario	Redevelopment Type	Relative Sea Level Rise	Description
Future Scenario 1	Residential	Historical Only	Rebuild structures as existed pre-Hurricane Katrina with no relative sea level rise over the period of analysis. This future scenario applies to all three planning units.
Future Scenario 2	Mixed Residential & Commercial	Historical Only	Rebuild structures as existed pre-Hurricane Katrina except at water front where condo/casino rebuild will occur. Also, no relative sea level rise over the period of analysis. This future scenario applies only to planning units one and two. Planning unit three would not allow commercial type redevelopment based on local ordinances.
Future Scenario 3	Residential	Expected (up to 2.4-Feet depending on location)	Rebuild structures as existed pre-Hurricane Katrina with up to 2.4-feet relative sea level rise over the This future scenario applies to all three planning units.
Future Scenario 4	Mixed Residential & Commercial	Expected (up to 2.4-Feet depending on location)	Rebuild structures as existed pre-Hurricane Katrina except at water front where condo/casino rebuild will occur. Also, a up to 2.4-feet relative sea level rise over the period of analysis. This future scenario applies only to planning units one and two. Planning unit three would not allow commercial type redevelopment based on local ordinances.
Future Scenario 5	Residential	High Rate (up to 3.4-feet depending on location)	Rebuild structures as existed pre-Hurricane Katrina with up to 3.4-feet of relative sea level rise over the period of analysis. This future scenario applies to all three planning units.
Future Scenario 6	Mixed Residential & Commercial	High Rate (Up to 3.4-feet depending on location)	Rebuild structures as existed pre-Hurricane Katrina except at water front where condo/casino rebuild will occur. Also, up to3.4-feet of relative sea level rise over the period of analysis. This future scenario applies only to planning units one and two. Planning unit three would not allow commercial type redevelopment based on local ordinances.

Future Scenarios One and Two are included only to evaluate the effects of relative sea level rise. These Future scenarios will not be used in the evaluation of potential measures. Futures Three, Four, Five, and Six will be the future scenarios by which potential measures will be evaluated depending on the planning unit.

5.3.3.2 Future Scenario 1

Scenario one is the full redevelopment of structures within the study area by the year 2012. Under this scenario, structures will be rebuilt as they were pre-Katrina. For example, if the structure was a residential structure pre-Katrina it will be rebuilt as a residential structure; commercial back to commercial; etc. It includes 220,776 tax parcels as defined by Hancock (planning unit one), Harrison (planning unit two), and Jackson (planning unit three) Counties, Mississippi. Of those parcels, 138,170 are structures including 22,313 are in planning unit one, 57,587 in planning unit two, and 58,270 in planning unit three. In addition to the redevelopment of structures, this scenario accounts for no relative sea level rise over the 100-year period of analysis (2012–2111). Table 5-15 displays the parcels by planning unit, category of structure, and by one-foot elevation contour. Table 5-16 displays the parcels for all three planning units by structure category and by one-foot elevation contour. Table 5-17 displays the value of structures and their contents by category and planning unit. **Note:** This scenario will not be used to evaluate potential measures in Chapter IV of this appendix because it does not adequately account for the effect of relative sea level rise. However, it will be used as a sensitivity analysis to evaluate the effects of the increment between a no relative sea level rise scenario and the expected relative sea level rise scenario.

Table 5-15.
Futures Without-Project Scenarios One, Three, and Five Inventory Parcels by Planning Unit and by Structure Category

Structure Categories	Planning Unit One	Planning Unit Two	Planning Unit Three	Total
Residential	17,907	49,121	49,688	**116,716**
Mobile Homes	498	2,497	3,553	**6,548**
Commercial	3,255	5,618	4,266	**13,139**
Municipal	653	351	763	**1,767**
Vacant Land	22,843	29,984	29,779	**82,606**
Total	**45,156**	**87,571**	**88,049**	**220,776**

Table 5-16.
Futures Without Project Scenarios One, Three, and Five Inventory Cumulative Structures for All Three Planning Units by Structure Category and One-foot Elevation

Estimated First Floor Elevation Elevation (NAVD88)	Residential	Mobile Homes	Commercial	Municipal	Total
1-foot	19	1	2	1	**23**
2-foot	115	1	16	4	**136**
3-foot	411	2	42	18	**473**
4-foot	1,015	2	88	34	**1139**
5-foot	2,566	20	143	52	**2,781**
6-foot	3,117	77	196	68	**3,458**
7-foot	3,975	129	270	87	**4,461**
8-foot	5,111	183	350	108	**5,752**
9-foot	6,475	226	463	130	**7,294**
10-foot	8,012	270	576	163	**9,021**
11-foot	10,381	321	730	194	**11,626**
12-foot	14,068	396	1,064	256	**15,784**
13-foot	18,411	507	1,537	352	**20,807**
14-foot	22,416	617	2,128	465	**25,626**
15-foot	31,139	779	3,424	629	**35,971**
16-foot	34,210	878	3,829	692	**39,609**
17-foot	37,925	1,006	4,125	774	**43,830**
18-foot	42,793	1,144	4,771	865	**49,573**
19-foot	47,914	1,368	5,650	942	**55,874**
20-foot	56,895	1,606	7,244	1,089	**66,834**
21-foot	60,673	1,784	7,809	1,154	**71,420**
22-foot	64,417	1,960	8,158	1,221	**75,756**
23-foot	71,143	2,174	8,893	1,293	**83,503**
24-foot	75,711	2,331	9,295	1,345	**88,682**
25-foot	79,957	2,473	9,633	1,392	**93,455**
26-foot	83,944	2,648	9,901	1,428	**97,921**

Table 5-16.
Futures Without Project Scenarios One, Three, and Five Inventory Cumulative Structures for All Three Planning Units by Structure Category and One-foot Elevation (continued)

Estimated First Floor Elevation Elevation (NAVD88)	Residential	Mobile Homes	Commercial	Municipal	Total
27-foot	86,948	2,788	10,144	1,463	**101,343**
28-foot	89,743	2,887	10,405	1,487	**104,522**
29-foot	92,130	2,986	10,634	1,502	**107,252**
30-foot	94,042	3,057	10,873	1,521	**109,493**
31-foot	95,586	3,158	11,114	1,535	**111,393**
32-foot	96,621	3,242	11,324	1,545	**112,732**
33-foot	97,531	3,300	11,450	1,555	**113,836**
34-foot	98,165	3,364	11,559	1,572	**114,660**
35-foot	98,669	3,429	11,623	1,584	**115,305**
36-foot	99,075	3,481	11,651	1,590	**115,797**
37-foot	99,498	3,532	11,682	1,598	**116,310**
38-foot	99,952	3,589	11,711	1,600	**116,852**
39-foot	100,478	3,644	11,747	1,605	**117,474**
40-foot	116,716	6,548	13,139	1,767	**138,170**

Table 5-17.
Futures Without-Project Scenarios One, Three, and Five Inventory Structure and Content Values by Category and Planning Unit

	Planning Unit One	Planning Unit Two	Planning Unit Three	Total
		Structure Values		
Residential	$2,415,885,807	$4,449,184,443	$3,200,940,955	**$10,066,011,205**
Mobile Homes	$8,518,174	$48,312,941	$52,053,731	**$108,884,846**
Commercial	$611,355,705	$4,526,104,161	$2,048,940,654	**$7,186,400,520**
Municipal	$335,220,287	$261,009,884	$303,986,556	**$900,216,727**
Structure Value Subtotal	**$3,370,979,973**	**$9,284,611,429**	**$5,605,921,896**	**$18,261,513,298**
		Content Values		
Residential	$2,415,885,807	$4,449,184,443	$3,200,940,955	**$10,066,011,205**
Mobile Homes	$12,606,898	71503152.68	77039521.88	**$161,149,573**
		Content Values		
Commercial	$1,213,472.28	$2,388,618,644	$428,362,111	**$2,818,194,227**
Municipal	$135,597,922	$102,609,763	$102,022,049	**$340,229,734**
Content Value Subtotal	**$2,565,304,099**	**$7,011,916,003**	**$3,808,364,637**	**$13,385,584,739**
Total	**$5,936,284,072**	**$16,296,527,432**	**$9,414,286,533**	**$31,647,098,037**

5.3.3.3 Future Scenario 2

Scenario two is the full redevelopment of structures within the study area by the year 2012. Under this scenario, structures away from the water front in Planning Units one and two and all of planning unit three will be rebuilt as they were pre-Katrina. For example, if the structure was a residential structure pre-Katrina it will be rebuilt as a residential structure; commercial structures will be rebuilt back to commercial structures; etc. In addition, structures in planning units one and two, structures along the Mississippi Sound and Back Bay water fronts will be rebuilt as condominiums and casinos. It includes 220,776 tax parcels as defined by Hancock (planning unit one), Harrison (planning unit two), and Jackson (planning unit three) Counties, Mississippi. Of those parcels, 138,199 are structures including 22,314 are in planning unit one, 57,615 in planning unit two, and 58,270 in planning unit three. In addition to the redevelopment of structures, this scenario accounts for no relative sea level rise over the 100-year period of analysis (2012–2111). Table 5-18 displays the parcels by planning unit, category of structure, and by one-foot elevation contour. Table 5-19 displays the parcels for all three planning units by structure category and by one-foot elevation contour. Table 5-20 displays the value of structures and their contents by category and planning unit. **Note:** This scenario will not be used to evaluate potential measures in Chapter IV of this appendix because it does not adequately account for the effect of relative sea level rise. However, it will be used as a sensitivity analysis to evaluate the effects of the increment between a no relative sea level rise scenario and the expected relative sea level rise scenario.

Table 5-18.
Futures Without-Project Scenarios Two, Four, and Six Inventory Parcels by Planning Unit and by Structure Category

Structure Categories	Planning Unit One	Planning Unit Two	Planning Unit Three	Total
Residential	17,757	48,636	49,688	**69,942**
Mobile Homes	498	2,497	3,553	**52,687**
Commercial	3,408	6,101	4,266	**13,775**
Municipal	651	381	763	**1,795**
Vacant Land	22,842	29,956	29,779	**82,577**
Total	**45,156**	**87,571**	**88,049**	**220,776**

Table 5-19.
Futures Without-Project Scenarios Two, Four, and Six Inventory Cumulative Structures for All Three Planning Units by Structure Category and One-foot Elevation

Elevation (NAVD88)	Residential	Mobile Homes	Commercial	Municipal	Total
1-foot	19	1	3	1	**24**
2-foot	111	1	17	4	**133**
3-foot	403	2	43	18	**466**
4-foot	1,003	2	89	34	**1,128**
5-foot	2,543	20	144	52	**2,759**
6-foot	3,080	77	197	68	**3,422**
7-foot	3,932	129	271	87	**4,419**
8-foot	5,055	183	351	108	**5,697**
9-foot	6,408	226	464	130	**7,228**
10-foot	7,934	270	577	163	**8,944**
11-foot	10,291	321	730	194	**11,536**
12-foot	13,954	396	1,069	256	**15,675**
13-foot	18,266	507	1,546	352	**20,671**
14-foot	22,220	617	2,147	465	**25,449**
15-foot	30,880	779	3,468	630	**35,757**
16-foot	33,923	878	3,930	692	**39,423**
17-foot	37,611	1,006	4,272	775	**43,664**
18-foot	42,439	1,144	4,949	866	**49,398**

Table 5-19.
Futures Without-Project Scenarios Two, Four, and Six Inventory Cumulative Structures for All Three Planning Units by Structure Category and One-foot Elevation (continued)

Elevation (NAVD88)	Residential	Mobile Homes	Commercial	Municipal	Total
19-foot	47,513	1,368	5,840	943	**55,664**
20-foot	56,412	1,606	7,398	1,089	**66,505**
21-foot	60,178	1,784	7,975	1,153	**71,090**
22-foot	63,910	1,960	8,365	1,220	**75,455**
23-foot	70,535	2,174	9,137	1,292	**83,138**
24-foot	75,091	2,331	9,590	1,344	**88,356**
25-foot	79,328	2,473	9,986	1,391	**93,178**
26-foot	83,308	2,648	10,301	1,427	**97,684**
27-foot	86,314	2,788	10,584	1,462	**101,148**
28-foot	89,112	2,887	10,878	1,486	**104,363**
29-foot	91,498	2,986	11,147	1,501	**107,132**
30-foot	93,409	3,057	11,406	1,520	**109,392**
31-foot	94,952	3,158	11,677	1,534	**111,321**
32-foot	95,986	3,242	11,902	1,544	**112,674**
33-foot	96,897	3,300	12,053	1,554	**113,804**
34-foot	97,531	3,364	12,178	1,571	**114,644**
35-foot	98,035	3,429	12,247	1,583	**115,294**
36-foot	98,441	3,481	12,278	1,589	**115,789**
37-foot	98,864	3,532	12,315	1,597	**116,308**
38-foot	99,318	3,589	12,345	1,599	**116,851**
39-foot	99,844	3,644	12,381	1,604	**117,473**
40-foot	116,081	6,548	13,775	1,795	**138,199**

Table 5-20.
Futures Two, Four, and Six Inventory Structure and Content Values by Category and Planning Unit

	Planning Unit One	Planning Unit Two	Planning Unit Three	Total
Structure Values				
Residential	$2,390,977,748	$4,402,477,082	$3,200,940,955	**$9,994,395,785**
Mobile Homes	$8,518,168	$48,312,740	$52,053,731	**$108,884,639**
Commercial	$1,500,399,292	$4,233,140,761	$2,048,940,654	**$7,782,480,707**
Municipal	$334,734,608	$261,025,195	$303,986,556	**$899,746,359**
Structure Value Subtotal	**$4,234,629,816**	**$8,944,955,778**	**$5,605,921,896**	**$18,785,507,490**
Content Values				
Residential	$2,390,977,748	$4,402,477,082	$3,200,940,955	**$9,994,395,785**
Mobile Homes	$12,606,888.64	$71,502,855.20	$77,039,521.88	**$161,149,266**
Commercial	$1,473,899,310	$2,498,045,931	$428,362,111	**$4,400,307,352**
Municipal	$135,240,760	$102,280,080	$102,022,049	**$339,542,889**
Content Value Subtotal	$4,012,724,707	$7,074,305,948	$3,808,364,637	**$14,895,395,292**
Total	**$8,247,354,523**	**$16,019,261,726**	**$9,414,286,533**	**$33,680,902,782**

5.3.3.4 Future Scenario 3

Scenario three is the full redevelopment of structures within the study area by the year 2012. Under this scenario, structures will be rebuilt as they were pre-Katrina. For example, if the structure was a residential structure pre-Katrina it will be rebuilt as a residential structure; commercial structures will be rebuilt back to commercial structures; etc. Scenario three is the same structure inventory as scenario one with the addition of a relative sea level rise of 2.4-feet over the 100-year period of analysis (2012–2111). The structure inventory, structure values, and content values for future scenario three are described in detail in above section 5.3.3.2. This scenario will be used to evaluate potential measures in Chapter IV of this appendix.

5.3.3.5 Future Scenario 4

Scenario four is the full redevelopment of structures within the study area by the year 2012. Under this scenario, structures away from the water front in Planning Units one and two and all of planning unit three will be rebuilt as they were pre-Katrina. For example, if the structure was a residential structure pre-Katrina it will be rebuilt as a residential structure; commercial back to commercial; etc. In planning units one and two, structures along the Mississippi Sound and Back Bay water fronts will be rebuilt as condominiums and casinos. Basically, Scenario three is the same structure inventory as scenario one with the addition of a relative sea level rise of up to 2.4-feet over the 100-year period of analysis (2012–2111). The structure inventory, structure values, and content values for future scenario three are described in detail in above section 5.3.3.3. This scenario will be used to evaluate potential measures in Chapter IV of this appendix.

5.3.3.6 Future Scenario 5

Scenario five is the same structure inventory as scenario one with the addition of a relative sea level rise of up to 3.4-feet depending over the 100-year period of analysis (2012–2111). The structure inventory, structure values, and content values for future scenario three are described in detail in above section 5.3.3.2. This scenario will be used to evaluate potential measures in Chapter IV of this appendix.

5.3.3.7 Future Scenario 6

Scenario six is the same structure inventory as scenario two with the addition of a relative sea level rise of up to 3.4-feet over the 100-year period of analysis (2012–2111). The structure inventory, structure values, and content values for future scenario three are described in detail in above section 5.3.3.3. This scenario will be used to evaluate potential measures in Chapter IV of this appendix.

5.3.4 Future Without-Project Surge Risk

5.3.4.1 *Maximum Probable Intensity (MPI) Event*

Computer simulations have predicted[2] how far inland storm surge will extend if the worse-case hurricane or maximum possible intensity (MPI) event hits the Mississippi coast. The extent of the surge from the MPI event is shown in Figure 5.3-2. The maximum water level of the MPI event along the Mississippi coastline was determined to be approximately 30 feet along the entire western half of the state and east of Pascagoula. The landward extent of the inundation indicates the storm surge reaches Interstate 10 for much of the western portion of the state. Lower peaks near Biloxi and Mobile Bay (24-27 feet) may be attributed to the protection afforded by the barrier islands. The line of defense accordingly approximates the 24 to 30 feet. (NAVD '88 datum) contours.

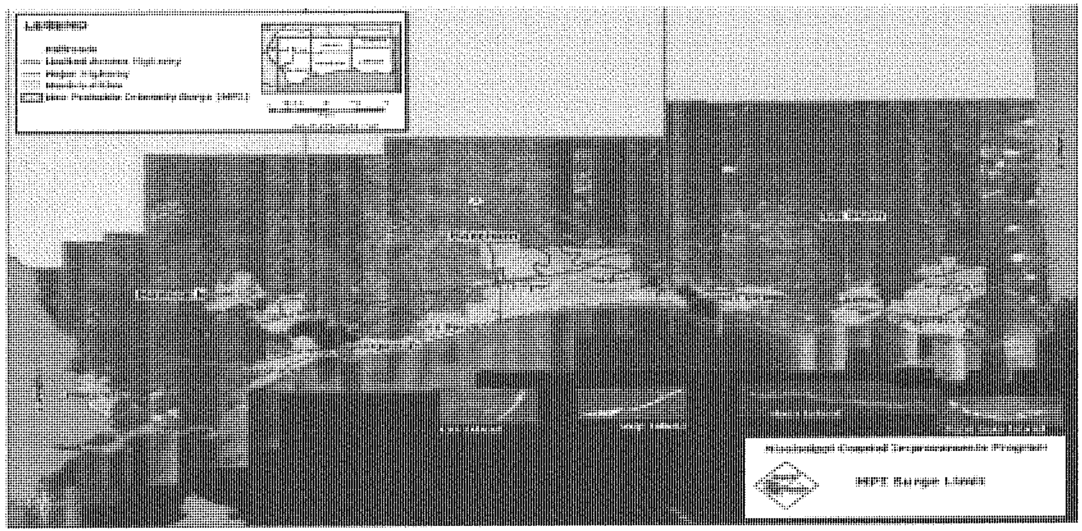


Figure 5.3-2. Maximum Probable Intensity Footprint for the Without Project Condition

[2] Storm surge modeling is described in the MsCIP Comprehensive Plan Engineering Appendix.

Figure 5.3-3 shows the population density of the three planning units within the MPI event footprint.

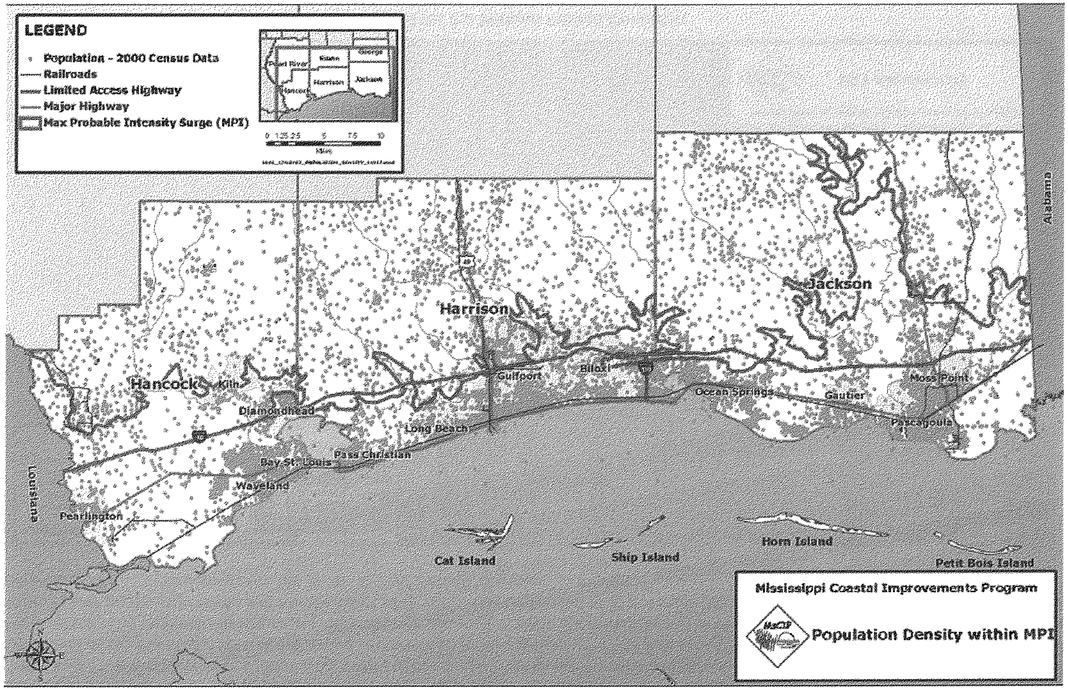


Figure 5.3-3. Population within the Future Without-Project Maximum Probable Intensity Surge Footprint

Figure 5.3-4 shows the various risk zones within the extent of the MPI event.

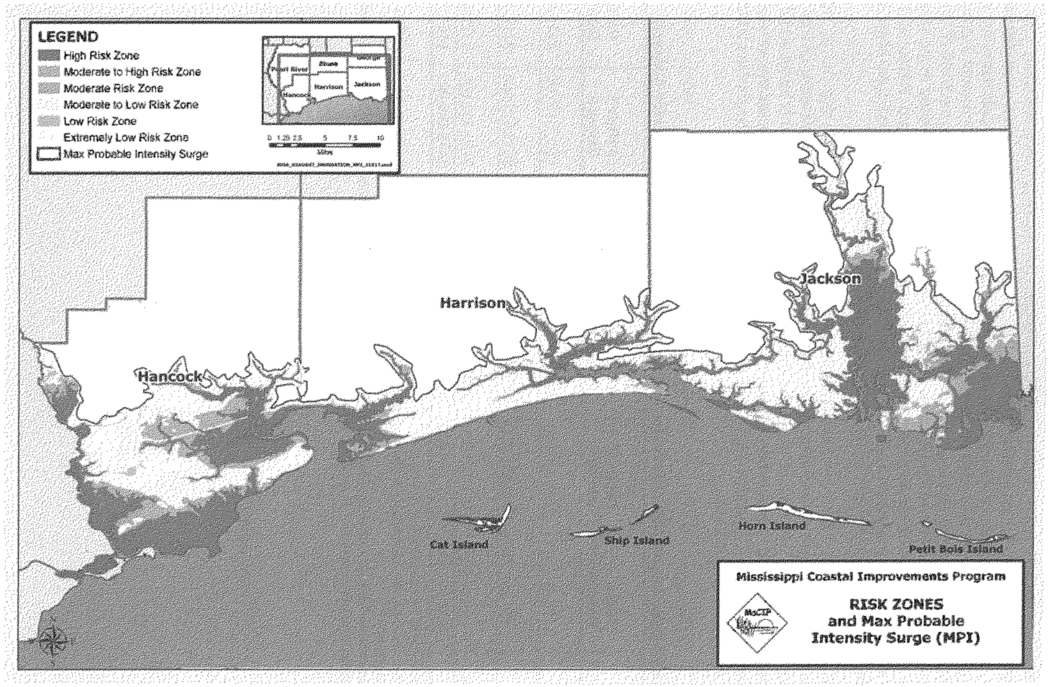


Figure 5.3-4. Risk Zones within the Maximum Probable Intensity Area

5.3.5 *Summary of Future Without-Project Damages*

This section describes the equivalent annual without-project damages for the entire study area to the 40-foot NAVD88 contour. Future without-project damages for the entire study area were calculated using the HEC-FDA program. Equivalent annual without-project damages were calculated for each of the 54 planning sub-units and each of the six future scenarios. The equivalent annual damages for specific areas, or planning sub-units, will be described in detail in the various sections of Chapter IV of this appendix. Note: The equivalent annual without-project damages calculated at the beach and dune sites will be evaluated on a localized scale using the Beach-FX program. Section 6.2 will describe in detail the equivalent annual without-project damages at the beach and dune sites. The remainder of this section will depict the outputs of the HEC-FDA modeling only.

The results of the without project conditions for all fifty-four planning sub-units in depicted in Table 5-21. The table shows the total equivalent annual without-project damages by planning unit for each of the future scenarios. These values represent the annual damages if no action is taken and if the study area is redeveloped to the levels described in Table 5-14. Figure 5.3-5 shows the without-project damages by future scenario. Table 5-22 shows the expected annual without-project damages by reach and by future scenario.

Table 5-21.
Equivalent Annual Without-Project Damages by Planning Unit and Future Scenario

Without-Project Damages	Future 1[2] Damages	Future 2[2] Damages	Future 3 Damages	Future 4 Damages	Future 5 Damages	Future 6 Damages
Planning Unit One	$198,960,000	$202,060,000	$218,050,000	$222,220,000	$237,310,000	$241,520,000
Planning Unit Two	$91,260,000	$94,680,000	$103,280,000	$107,120,000	$115,470,000	$119,760,000
Planning Unit Three	$88,670,000	$88,670,000	$104,700,000	$104,700,000	$122,420,000	$122,420,000
Total	**$378,890,000**	**$385,410,000**	**$426,030,000**	**$434,040,000**	**$475,200,000**	**$483,700,000**

Damages are rounded to the nearest ten thousand.
1 Futures Two, Four, and Six do not apply to planning unit three, therefore total damages are the same as future scenarios one, three, and five.
2 Future Scenarios one and two will be used to evaluate the impacts of relative sea level rise only, and will not be discussed in the direct evaluation of potential measures detailed in Chapter IV of this appendix.

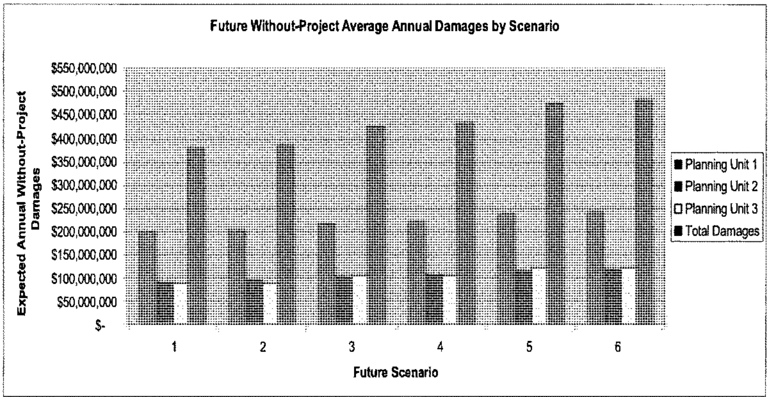


Figure 5.3-5. Without-Project Equivalent Damages by Future Scenario

Table 5-22.
Equivalent Annual Without-Project Damages by Planning Sub-Unit and Future Scenario[1]

Planning Unit and Sub-Unit	Future 1[2] Damages	Future 2[2] Damages	Future 3 Damages	Future 4 Damages	Future 5 Damages	Future 6 Damages
Unit One-Sub-Unit 1	$7,862,850	$7,863,020	$8,526,510	$8,571,980	$9,274,710	$9,275,260
Unit One-Sub-Unit 2	$137,947,140	$139,624,330	$150,862,640	$153,217,360	$163,864,720	$166,246,250
Unit One-Sub-Unit 3	$4,870,480	$5,842,300	$5,364,560	$6,513,000	$6,057,830	$7,287,670
Unit One-Sub-Unit 4	$2,739,650	$3,194,780	$3,014,870	$3,539,920	$3,308,930	$3,890,880
Unit One-Sub-Unit 5	$14,675,170	$14,677,680	$15,937,700	$16,015,090	$17,296,090	$17,300,110
Unit One-Sub-Unit 6	$11,568,960	$11,569,130	$12,885,400	$12,889,540	$14,205,370	$14,206,350
Unit One-Sub-Unit 7	$5,500,120	$5,500,120	$6,409,900	$6,460,160	$6,963,040	$6,963,380
Unit Two Sub-Unit-8	$14,860,070	$15,736,500	$16,671,180	$17,664,090	$18,732,000	$19,881,850
Unit Two Sub-Unit-9	$197,220	$197,220	$222,210	$222,220	$248,550	$248,550
Unit Two Sub-Unit-10	$5,884,170	$6,415,660	$6,616,080	$7,167,230	$7,464,200	$8,032,430
Unit Two Sub-Unit-11	$634,970	$634,990	$713,540	$713,560	$806,760	$806,790
Unit Two Sub-Unit-12	$14,831,530	$14,832,960	$16,886,630	$16,888,210	$19,298,510	$19,300,230

Table 5-22.
Equivalent Annual Without-Project Damages by Planning Sub-Unit and Future Scenario[1]
(continued)

Planning Unit and Sub-Unit	Future 12 Damages	Future 22 Damages	Future 3 Damages	Future 4 Damages	Future 5 Damages	Future 6 Damages
Unit Two Sub-Unit-13	$6,342,540	$6,436,620	$6,995,520	$7,104,440	$7,697,760	$7,821,230
Unit Two Sub-Unit-14	$149,990	$150,010	$174,120	$174,150	$206,540	$206,570
Unit Two Sub-Unit-15	$1,238,660	$1,234,760	$1,395,320	$1,391,460	$1,534,500	$1,532,550
Unit Two Sub-Unit-16	$1,241,620	$1,264,200	$1,417,560	$1,443,940	$1,580,110	$1,611,010
Unit Two Sub-Unit-17	$70	$70	$80	$80	$110	$110
Unit Two Sub-Unit-18	$17,649,830	$18,112,300	$20,105,420	$20,632,810	$22,318,530	$22,907,340
Unit Two Sub-Unit-19	$12,176,200	$12,176,200	$13,540,060	$13,540,060	$14,498,660	$14,498,660
Unit Two Sub-Unit-20	$9,104,980	$10,541,140	$10,619,760	$12,251,380	$12,244,150	$14,073,590
Unit Three Sub-Unit-21	$17,569,340	$17,569,340	$20,025,530	$20,025,530	$22,577,840	$22,577,840
Unit Three Sub-Unit-22	$1,719,390	$1,719,390	$1,958,170	$1,958,170	$2,190,200	$2,190,200
Unit Three Sub-Unit-23	$273,410	$ 273,410	$320,000	$320,000	$374,150	$374,150
Unit Three Sub-Unit-24	$3,819,150	$3,819,150	$4,298,090	$4,298,090	$4,705,940	$4,705,940
Unit Three Sub-Unit-25	$3,280	$3,280	$4,360	$4,360	$7,330	$7,330
Unit Three Sub-Unit-26	$5,416,740	$5,416,740	$6,273,270	$6,273,270	$7,010,490	$7,010,490
Unit Three Sub-Unit-27	$2,146,230	$2,146,230	$2,505,530	$2,505,530	$2,949,790	$2,949,790
Unit Three Sub-Unit-28	$5,233,540	$5,233,540	$5,756,790	$5,756,790	$6,165,720	$6,165,720
Unit Three Sub-Unit-29	$1,137,600	$1,137,600	$1,343,400	$1,343,400	$1,535,650	$1,535,650
Unit Three Sub-Unit-30	$4,920,250	$4,920,250	$5,831,120	$5,831,120	$6,701,750	$6,701,750
Unit Three Sub-Unit-31	$5,307,020	$5,307,020	$6,204,150	$6,204,150	$6,954,320	$6,954,320
Unit Three Sub-Unit-32	$2,548,650	$2,548,650	$3,100,610	$3,100,610	$3,660,240	$3,660,240
Unit Three Sub-Unit-33	$310	$310	$420	$420	$710	$710
Unit Three Sub-Unit-34	$11,550	$11,550	$13,440	$13,440	$17,680	$17,680

Table 5-22.
Equivalent Annual Without-Project Damages by Planning Sub-Unit and Future Scenario[1]
(continued)

Planning Unit and Sub-Unit	Future 12 Damages	Future 22 Damages	Future 3 Damages	Future 4 Damages	Future 5 Damages	Future 6 Damages
Unit Three Sub-Unit-35	$5,400,880	$5,400,880	$6,904,910	$6,904,910	$8,903,510	$8,903,510
Unit One-Sub-Unit 36	$8,908,670	$8,908,670	$9,763,750	$9,663,330	$10,537,160	$10,537,220
Unit One-Sub-Unit 37	$616,980	$616,980	$671,210	$675,150	$731,660	$731,680
Unit One-Sub-Unit 38	$4,267,130	$4,267,280	$4,617,740	$4,677,850	$5,069,830	$5,081,490
Unit Two Sub-Unit-39	$74,950	$74,950	$84,800	$84,800	$96,320	$96,330
Unit Two Sub-Unit-40	$3,780	$3,780	$4,650	$4,650	$5,940	$5,940
Unit Three Sub-Unit-41	$50	$50	$50	$50	$100	$100
Unit Three Sub-Unit-42	$1,040	$1,040	$1,350	$1,350	$2,220	$2,220
Unit Three Sub-Unit-43	$27,680	$27,680	$34,210	$34,210	$44,840	$44,840
Unit Three Sub-Unit-44	$91,160	$91,160	$108,070	$108,070	$132,280	$132,280
Unit Three Sub-Unit-45	$780	$780	$900	$900	$1,300	$1,300
Unit Three Sub-Unit-46	$39,750	$39,750	$44,590	$44,590	$52,110	$52,110
Unit Two Sub-Unit-47	$4,420	$4,420	$5,450	$5,450	$6,530	$6,530
Unit Two Sub-Unit-48	$56,210	$56,310	$65,730	$65,840	$74,870	$74,990
Unit Three Sub-Unit-49	$11,730	$11,730	$13,310	$13,310	$16,180	$16,180
Unit Two Sub-Unit-50	$6,804,480	$6,805,210	$7,764,770	$7,765,580	$8,656,060	$8,656,940
Unit Three Sub-Unit-51	$3,983,600	$3,983,600	$4,878,490	$4,878,490	$5,785,400	$5,785,400
Unit Three Sub-Unit-52	$17,464,120	$17,464,120	$21,199,790	$21,199,790	$27,027,040	$7,027,040
Unit Three Sub-Unit-53	$6,010,820	$6,010,820	$7,133,170	$7,133,170	$7,812,130	$7,812,130
Unit Three Sub-Unit-54	$5,532,370	$5,532,370	$6,744,800	$6,744,800	$7,790,870	$7,790,870
Total	**$378,883,280**	**$385,412,030**	**$426,035,680**	**$434,041,850**	**$475,199,230**	**$483,701,720**

1 Given the magnitude of the future-without project damages depicted in this table, a sensitivity analysis was conducted with regard to multiple criteria including period of analysis and first floor elevation uncertainty. The results of the sensitivity analysis can be found in Chapter VII of this appendix.
2 Future Scenarios one and two will be used to evaluate the impacts of relative sea level rise only, and will not be discussed in the

Table 5-22.
Equivalent Annual Without-Project Damages by Planning Sub-Unit and Future Sceuario[1] (continued)

Planning Unit and Sub-Unit	Future 12 Damages	Future 22 Damages	Future 3 Damages	Future 4 Damages	Future 5 Damages	Future 6 Damages

direct evaluation of potential measures detailed in Chapter IV of this appendix.

5.3.5.1 Future Without-Project Stage-Damage for Selected Reaches

As shown in the previous table, the magnitude of the equivalent annual damages is very large for the six future without-project scenario conditions. Planning sub-units two, five, six, eight, twelve, eighteen, nineteen, twenty-one, and fifty-two each have equivalent annual damages in the tens of millions of dollars. In order to communicate the effects that are being modeled, comparisons of the total present worth of damages by frequency event to the total economic value in the planning sub-units shows the nature of the damages that are being expressed by the HEC-FDA modeling.

This section is intended to dissect those nine planning sub-units for future without-project scenario one. This future scenario was chosen because it is the baseline case upon which the other Future Scenarios were built. It does not include the effects of a different type of redevelopment than what actually existed pre-Hurricane Katrina and it does not include the effects of relative sea level rise. Table 5-23 shows the total economic value input into HEC-FDA for each of these nine reaches.

Table 5-23.
Total Structure and Content Value for Selected Planning Sub-Units

Planning Sub-Unit	Structure Value Thousand $'s	Content Value Thousand $'s	Total Economic Value Thousand $'s
2	$1,359,527.34	$1,969,251.33	$3,328,778.67
5	$313,687.82	$256,492.02	$570,179.84
6	$168,756.85	$154,811.46	$323,568.31
8	$2,995,946.35	$987,316.91	$3,983,263.25
12	$1,174,270.25	$1,594,487.74	$2,768,757.99
18	$706,994.07	$365,494.03	$1,072,488.09
19	$95,273.76	$23,225.26	$118,499.03
21	$1,268,159.01	$761,125.18	$2,029,284.19
52	$909,227.20	$1,641,424.90	$2,550,652.10

Tables 5-24 through 5-32 display the total present worth of the stage damages for the 0.9990 to 0.0010 exceedance probability events. These damages are what the HEC-FDA model uses to calculate equivalent annual damages. Those stage damages are then compared to the total economic value for the reach to show what percentage of damage is expected. In each of the reaches, the 0.0100 to the 0.0010 probability events dominate the damage curve.

Probability and stage expressed in these tables was defined by the MOBILE DISTRICT Engineering Division working in concert with the Engineer Research and Development Center (ERDC). Stage mentioned in the tables is the mean stage for the event; however the HEC-FDA model incorporates uncertainty to two standard deviations, or approximately the 95% confidence level. For more detail about the exceedance probability functions, see the engineering appendix.

Table 5-24.
Stage Damage by Event for Future Scenario One, Planning Unit One, Planning Sub-Unit Two

Total Present Worth Stage Damages							
Exceedance Probability	**Mean Stage[1] (Feet)**	**Residential (Thnds $'s)**	**Commercial (Thnds $'s)**	**Mobile Home (Thnds $'s)**	**Municipal (Thnds $'s)**	**Total (Thnds $'s)**	**Percent Stage Damage to Total Structure and Content Value**
0.9990	2.71	$43,752.65	$6,816.17	$165.43	$913.49	$51,650.45	1.55%
0.2000	6.12	$117,474.39	$30,251.34	$794.75	3,$120.67	$151,647.27	4.56%
0.1000	7.28	$144,237.52	$42,772.81	$1,066.45	$4,059.85	$192,143.91	5.77%
0.0400	10.60	$247,259.36	$113,942.01	$2,158.47	$8,698.01	$372,068.45	11.18%
0.0200	14.50	$382,169.71	$247,948.38	$3,271.80	$16,782.18	$650,186.57	19.53%
0.0100	17.50	$516,672.42	$386,292.25	$4,052.87	$25,211.05	$932,246.09	28.01%
0.0040	20.39	$658,732.22	$531,087.42	$4,762.79	$34,179.58	$1,228,782.40	36.91%
0.0020	22.40	$781,660.37	$655,195.97	$5,278.95	$41,791.58	$1,483,949.27	44.58%
0.0010	24.00	$897,503.25	$766,823.05	$5,680.46	$48,926.85	$1,718,957.61	51.64%

1/ Exceedance probability functions go to two standard deviations over the mean stage in the HEC-FDA model.
2/ Explanation of the exceedance probability function can be found in the engineering appendix.

Table 5-25.
Stage Damage by Event for Future Scenario One, Planning Unit One, Planning Sub-Unit Five

Total Present Worth Stage Damages							
Exceedance Probability	**Mean Stage[1] (Feet)**	**Residential (Thnds $'s)**	**Commercial (Thnds $'s)**	**Mobile Home (Thnds $'s)**	**Municipal (Thnds $'s)**	**Total (Thnds $'s)**	**Percent Stage Damage to Total Structure and Content Value**
0.9990	2.71	$2,831.63	$159.23	$0.37	$3,252.07	$6,246.01	1.10%
0.2000	6.12	$8,546.12	$560.27	$2.54	$6,998.57	$16,113.62	2.83%
0.1000	7.09	$11,167.39	$626.61	$4.12	$8,004.18	$19,809.39	3.47%
0.0400	9.60	$20,645.22	$990.55	$11.89	$10,300.30	$31,957.56	5.60%
0.0200	13.50	$49,121.31	$1,806.15	$103.87	$13,938.97	$64,983.80	11.40%
0.0100	16.00	$77,080.05	$2,724.47	$307.90	$17,026.23	$97,154.65	17.04%
0.0040	18.42	$104,263.11	$3,947.35	$647.18	$20,769.96	$129,646.02	22.74%
0.0020	20.10	$134,148.90	$5,993.35	$1,251.67	$26,311.70	$167,725.72	29.42%
0.0010	21.40	$157,207.12	$7,381.61	$1,651.89	$29,674.20	$195,936.22	34.36%

1/ Exceedance probability functions go to two standard deviations over the mean stage in the HEC-FDA model
2/ Explanation of the exceedance probability function can be found in the engineering appendix.

Table 5-26.
Stage Damage by Event for Future Scenario One, Planning Unit One, Planning Sub-Unit Six

Total Present Worth Stage Damages

Exceedance Probability	Mean Stage[1] (Feet)	Residential (Thnds $'s)	Commercial (Thnds $'s)	Mobile Home (Thnds $'s)	Municipal (Thnds $'s)	Total (Thnds $'s)	Percent Stage Damage to Total Structure and Content Value
0.9990	2.71	$4,155.33	$0	$0	$0	$4,158.04	1.29%
0.2000	6.12	$13,762.69	$0	$0	$0	$13,768.81	4.26%
0.1000	7.09	$18,088.33	$0	$0	$0	$18,095.42	5.59%
0.0400	9.60	$31,662.57	$7.83	$0.94	$8.61	$31,689.55	9.79%
0.0200	13.50	$56,978.26	$139.11	$14.36	$146.16	$57,291.39	17.71%
0.0100	16.00	$73,714.92	$453.88	$44.47	$449.30	$74,678.57	23.08%
0.0040	18.42	$88,892.40	$1,035.06	$98.80	$1,007.65	$91,052.33	28.14%
0.0020	20.10	$106,163.34	$2,065.55	$190.31	$1,964.42	$110,403.72	34.12%
0.0010	21.40	$115,324.45	$3,683.34	$239.23	$2,475.17	$121,743.59	37.63%

1/ Exceedance probability functions go to two standard deviations over the mean stage in the HEC-FDA model.
2/ Explanation of the exceedance probability function can be found in the engineering appendix

Table 5-27.
Stage Damage by Event for Future Scenario One, Planning Unit Two, Planning Sub-Unit Eight

Total Present Worth Stage Damages

Exceedance Probability	Mean Stage[1] (Feet)	Residential (Thnds $'s)	Commercial (Thnds $'s)	Mobile Home (Thnds $'s)	Municipal (Thnds $'s)	Total (Thnds $'s)	Percent Stage Damage to Total Structure and Content Value
0.9990	2.71	$2,141.84	$54.64	$44.53	$202.54	$2,446.26	0.06%
0.2000	6.12	$9,323.46	$214.76	$129.53	$707.99	$10,381.86	0.26%
0.1000	7.22	$13,281.91	$289.37	$170.76	$923.10	$14,672.36	0.37%
0.0400	10.30	$33,548.77	$581.58	$319.65	$1,790.40	$36,250.70	0.91%
0.0200	14.10	$88,836.15	$5,206.34	$585.72	$3,347.80	$97,990.11	2.46%
0.0100	17.10	$155,514.48	$26,941.23	$973.69	$4,353.88	$187,800.38	4.71%
0.0040	20.11	$247,538.39	$103,117.93	$1,785.00	$5,143.68	$357,605.11	8.98%
0.0020	22.20	$325,623.37	$216,476.56	$2,744.81	$5,560.92	$550,427.86	13.82%
0.0010	23.80	$392,965.09	$337,060.26	$3,681.36	$5,811.47	$739,541.98	18.57%

1/ Exceedance probability functions go to two standard deviations over the mean stage in the HEC-FDA model.
2/ Explanation of the exceedance probability function can be found in the engineering appendix.

Table 5-28.
Stage Damage by Event for Future Scenario One, Planning Unit Two, Planning Sub-Unit Twelve

Total Present Worth Stage Damages

Exceedance Probability	Mean Stage[1] (Feet)	Residential (Thnds $'s)	Commercial (Thnds $'s)	Mobile Home (Thnds $'s)	Municipal (Thnds $'s)	Total (Thnds $'s)	Percent Stage Damage to Total Structure and Content Value
0.9990	2.71	$1,988.77	$47.46	$3.30	$2,084.47	$4,126.71	0.15%
0.2000	6.12	$8,560.61	$987.48	$27.34	$4,825.86	$14,407.41	0.52%
0.1000	7.06	$12,432.19	$1,831.97	$45.28	$5,619.54	$19,936.04	0.72%
0.0400	8.80	$20,819.74	$4,389.53	$92.88	$6,777.05	$32,088.00	1.16%
0.0200	11.60	$52,597.25	$17,540.91	$306.00	$9,567.96	$80,023.72	2.89%
0.0100	13.70	$88,637.76	$38,709.85	$602.27	$12,242.46	$140,206.04	5.06%
0.0040	15.77	$137,378.09	$74,366.99	$1,064.98	$15,937.42	$228,763.25	8.26%
0.0020	17.20	$180,500.95	$110,520.89	$1,533.91	$19,497.52	$312,070.47	11.27%
0.0010	18.30	$211,794.19	$139,076.04	$1,901.68	$22,109.50	$374,899.71	13.54%

1/ Exceedance probability functions go to two standard deviations over the mean stage in the HEC-FDA model.
2/ Explanation of the exceedance probability function can be found in the engineering appendix.

Table 5-29.
Stage Damage by Event for Future Scenario One, Planning Unit Two, Planning Sub-Unit Eighteen

Total Present Worth Stage Damages

Exceedance Probability	Mean Stage[1] (Feet)	Residential (Thnds $'s)	Commercial (Thnds $'s)	Mobile Home (Thnds $'s)	Municipal (Thnds $'s)	Total (Thnds $'s)	Percent Stage Damage to Total Structure and Content Value
0.9990	1.89	$1,196.85	$814.40	$0.45	$0	$2,013.59	0.19%
0.2000	4.52	$4,134.09	$4,428.21	$2.21	$0.03	$8,566.85	0.80%
0.1000	5.67	$5,769.70	$7,318.97	$3.31	$0.05	$13,097.70	1.22%
0.0400	9.10	$14,765.74	$29,763.69	$12.16	$12.75	$44,563.44	4.16%
0.0200	12.80	$30,337.62	$78,692.33	$25.27	$99.03	$109,167.05	10.18%
0.0100	15.70	$52,765.43	$137,070.85	$36.73	$338.35	$190,227.06	17.74%
0.0040	18.53	$85,274.97	$223,677.63	$49.13	$858.62	$224,603.91	20.94%
0.0020	20.50	$110,187.46	$294,474.00	$56.52	$1,289.90	$406,028.38	37.86%
0.0010	22.30	$128,969.02	$346,487.93	$60.90	$1,649.46	$477,189.61	44.49%

1/ Exceedance probability functions go to two standard deviations over the mean stage in the HEC-FDA model.
2/ Explanation of the exceedance probability function can be found in the engineering appendix.

Table 5-30.
Stage Damage by Event for Future Scenario One, Planning Unit Two, Planning Sub-Unit Nineteen

Total Present Worth Stage Damages							
Exceedance Probability	Mean Stage[1] (Feet)	Residential (Thnds $'s)	Commercial (Thnds $'s)	Mobile Home (Thnds $'s)	Municipal (Thnds $'s)	Total (Thnds $'s)	Percent Stage Damage to Total Structure and Content Value
0.9990	1.89	$417.12	$3,064.00	$0	$0	$3,483.01	2.94%
0.2000	4.52	$1,400.28	$9,518.44	$0	$0	$10,923.24	9.22%
0.1000	5.67	$1,913.34	$12,702.56	$0	$0	$14,621.57	12.34%
0.0400	9.00	$4,202.27	$24,542.56	$0	$0	$28,753.83	24.27%
0.0200	12.50	$6,385.52	$32,868.82	$0	$0	$39,266.84	33.14%
0.0100	15.50	$7,651.28	$38,032.17	$0	$0	$45,698.95	38.56%
0.0040	18.33	$8,282.91	$42,794.02	$0	$0	$51,095.26	43.12%
0.0020	20.30	$8,574.57	$48,380.46	$0	$0	$56,975.33	48.08%
0.0010	22.10	$8,733.57	$55,938.36	$0	$0	$64,694.03	54.59%

1/ Exceedance probability functions go to two standard deviations over the mean stage in the HEC-FDA model.
2/ Explanation of the exceedance probability function can be found in the engineering appendix.

Table 5-31.
Stage Damage by Event for Planning Unit Three, Planning Sub-Unit Twenty-One

Total Present Worth Stage Damages							
Exceedance Probability	Mean Stage[1] (Feet)	Residential (Thnds $'s)	Commercial (Thnds $'s)	Mobile Home (Thnds $'s)	Municipal (Thnds $'s)	Total (Thnds $'s)	Percent Stage Damage to Total Structure and Content Value
0.9990	1.89	$1,489.63	$1,351.47	$0.02	$69.50	$2,912.51	0.14%
0.2000	4.52	$5,105.26	$5,413.10	$0.20	$297.05	$10,820.13	0.53%
0.1000	5.67	$7,357.69	$8,197.76	$0.35	$440.67	$16,002.14	0.79%
0.0400	9.20	$22,551.01	$27,942.77	$2.85	$1,363.10	$51,868.93	2.56%
0.0200	12.90	$53,793.29	$78,582.18	$19.28	$2,728.38	$135,136.03	6.66%
0.0100	16.00	$104,083.69	$153,498.33	$88.03	$4,735.96	$262,422.01	12.93%
0.0040	18.95	$155,294.94	$211,865.24	$217.60	$7,192.37	$374,589.10	18.46%
0.0020	21.00	$225,520.81	$282,660.42	$457.75	$11,494.07	$520,154.05	25.63%
0.0010	22.90	$278,089.23	$333,611.61	$642.16	$15,032.83	$627,398.73	30.92%

1/ Exceedance probability functions go to two standard deviations over the mean stage in the HEC-FDA model.
2/ Explanation of the exceedance probability function can be found in the engineering appendix

Table 5-32.
Stage Damage by Event for Future Without-Project Scenario One, Planning Unit Three, Planning Sub-Unit Fifty-Two

Total Present Worth Stage Damages							
Exceedance Probability	Mean Stage[1] (Feet)	Residential (Thnds $'s)	Commercial (Thnds $'s)	Mobile Home (Thnds $'s)	Municipal (Thnds $'s)	Total (Thnds $'s)	Percent Stage Damage to Total Structure and Content Value
0.9990	2.06	$3,899.74	$14.64	$0.10	$4.29	$3,920.83	0.15%
0.2000	4.08	$9,646.99	$154.08	$1.32	$38.91	$9,845.38	0.39%
0.1000	6.04	$22,131.53	$973.43	$5.41	$189.83	$23,306.24	0.91%
0.0400	7.70	$38,867.81	$2,450.39	$12.89	$443.27	$41,782.06	1.64%
0.0200	11.20	$116,418.24	$15,160.58	$62.18	$2,329.48	$133,981.68	5.25%
0.0100	13.90	$211,730.44	$40,212.52	$148.06	$5,866.14	$257,971.06	10.11%
0.0040	16.44	$329,875.80	$85,879.90	$264.00	$11,561.68	$427,597.82	16.76%
0.0020	18.20	$425,218.57	$129,392.54	$350.77	$16,688.20	$571,668.28	22.41%
0.0010	19.80	$489,727.78	$159,839.78	$402.18	$20,420.62	$670,410.16	26.28%

1/ Exceedance probability functions go to two standard deviations over the mean stage in the HEC-FDA model.
2/ Explanation of the exceedance probability function can be found in the engineering appendix.

5.3.6 Impacts of Redevelopment Scenarios on Equivalent Annual Without-Project Damages

The two redevelopment scenarios, as previous discussed, are the redevelopment of the area back to the same way it was pre-Hurricane Katrina (residential redevelopment) and a redevelopment of the way the area was pre-Hurricane Katrina with commercial/condominium redevelopment (mixed redevelopment) along the water fronts of planning units one and two. The impacts of different redevelopment and the corresponding relationship to damages is a combination of different structure and content values that would could occupy the same space (five single family residences versus and condominium) and the depth-damage relationship of those different structures. The measurement of impacts from various redevelopment scenarios can be expressed by comparing the residential redevelopment to the mixed redevelopment for a given relative sea level rise scenario, or future scenario one versus future scenario two, future scenario three versus future scenario four, and future scenario five versus future scenario six. Tables 5-33 and figure 5.3-6 show the comparison of future scenario one to future scenario two, table 5-34 and figure 5.3-7 show the comparison of future scenario three to future scenario four, and table 5-35 and figure 5.3-8 compare future scenario five to future scenario six.

Table 5-33.
Comparison of Residential Redevelopment vs. Mixed Redevelopment for Expected Relative Sea Level Rise

Without-Project Damages	Future 1[1] Damages	Future 2[1] Damages	% Change from Future One
Planning Unit One	$198,960,000	$202,060,000	1.56%
Planning Unit Two	$91,260,000	$94,680,000	3.75%
Planning Unit Three	$88,670,000	$88,670,000	0.00%
Total	**$378,890,000**	**$385,410,000**	**1.72%**

Damages are rounded to the nearest ten thousand.
1 Future Scenarios one and two are used here to evaluate the impacts redevelopment only, and will not be discussed in the direct evaluation of potential measures detailed in Chapter IV of this appendix.

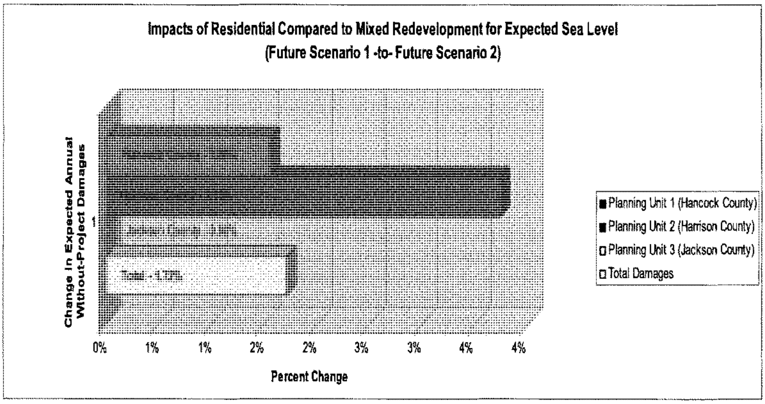


Figure 5.3-6. Impacts of Residential Compared to Mixed Redevelopment for Expected Relative Sea Level

Table 5-34.
Comparison of Residential Redevelopment vs. Mixed Redevelopment for Expected Relative Sea Level Rise

Without-Project Damages	Future 3 Damages	Future 4 Damages	% Change from Future One
Planning Unit One	$ 218,050,000	$ 222,220,000	1.91%
Planning Unit Two	$ 103,280,000	$ 107,120,000	3.72%
Planning Unit Three	$ 104,700,000	$ 104,700,000	0.00%
Total	**$ 426,030,000**	**$ 434,040,000**	**1.88%**

Damages are rounded to the nearest ten thousand.

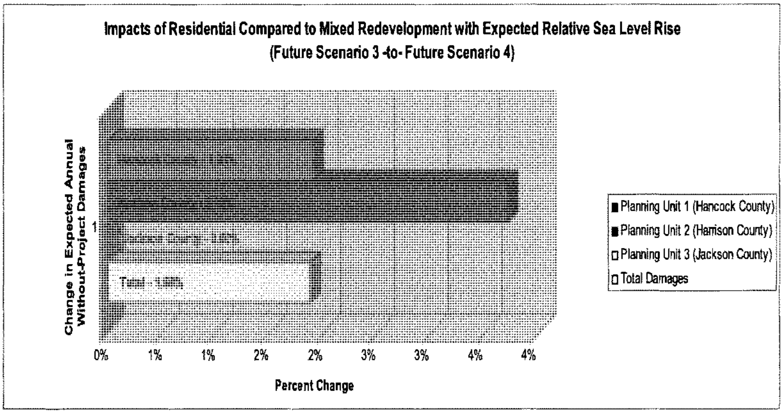


Figure 5.3-7. Impacts of Residential Compared to Mixed Redevelopment for Expected Relative Sea Level Rise

Table 5-35
Comparison of Residential Redevelopment vs. Mixed Redevelopment for Expected Relative Sea Level Rise

Without-Project Damages	Future 4 Damages	Future 6 Damages	% Change from Future One
Planning Unit One	$222,220,000	$241,520,000	1.77%
Planning Unit Two	$107,120,000	$119,760,000	3.72%
Planning Unit Three	$104,700,000	$122,420,000	0.00%
Total	**$434,040,000**	**$483,700,000**	**1.79%**

Damages are rounded to the nearest ten thousand.

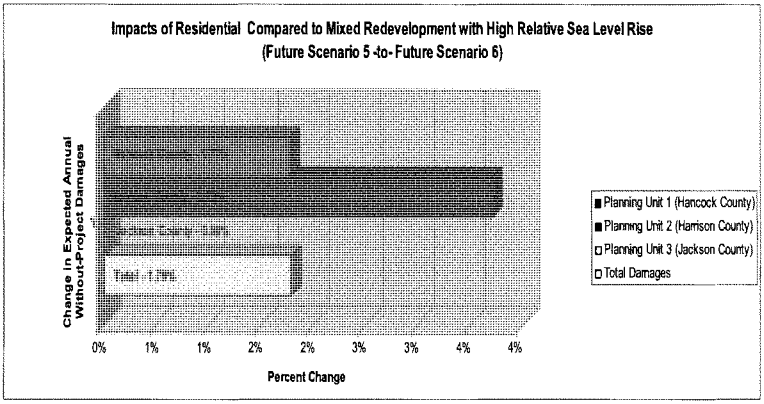


Figure 5.3-8. Impacts of Residential Compared to Commercial Redevelopment for High Relative Sea Level Rise

5.3.7 Impacts of Relative Sea Level Rise on Equivalent Annual Without-Project Damages

The impact of relative sea level rise over the period of analysis is the increase in damages when everything but relative sea level rise remains constant. This can be evaluated by comparing futures one, three and five against each other and futures two, four, and six against each other. The impact of relative sea level rise when compared to futures one, three, and five shows the effects that could be expected if the study area rebuilds exactly the way it was pre-Hurricane Katrina. The impact of relative sea level rise as compared to futures two, four, and six represent what could be expected given the rebuilding of the study area to a mixture of its pre-Hurricane Katrina setting with the shift from a residential coastline in planning units one and two to a commercial and condominium setting.

The increased equivalent annual damages are the direct effect of several phenomenon's' that result from the increased inundation. First, the higher water levels attributed to the expected relative sea level rise (Futures three and four - 2.0-feet) and high sea level rise (Futures five and six - 3.4-feet) would cause more damage to structures and their contents that would already be expected to be impacted under the existing relative sea level scenarios (Futures one and two). The second effect of increased relative sea level rise is that there would be damages to structures and their contents that would not be expected under the existing relative sea level rise scenarios, or completely new damage specifically attributable to the increased relative sea level rise. Table 5-36, figure 5.3-9, and figure 5.3-10 compares the effects of relative sea level rise on futures one, three, and five. Table 5-37, figure 5.3-11, and figure 5.3-12 compares its effects on futures two, four, and six.

Table 5-36.
Impacts of Relative Sea Level Rise on Futures One, Three, and Five

Without-Project Damages	Future 1[2] Damages	Future 3 Damages	% Change from Future One	Future 5 Damages	% Change from Future One
Planning Unit One	$198,960,000	$218,050,000	9.59%	$237,310,000	19.28%
Planning Unit Two	$91,260,000	$103,280,000	13.17%	$115,470,000	26.53%
Planning Unit Three	$88,670,000	$104,700,000	18.08%	$122,420,000	38.06%
Total	**$378,890,000**	**$426,030,000**	**12.44%**	**$475,200,000**	**25.42%**

Damages are rounded to the nearest ten thousand.
1 Future Scenario one is used here to evaluate the impacts of relative sea level rise only, and will not be discussed in the direct evaluation of potential measures detailed in Chapter IV of this appendix.

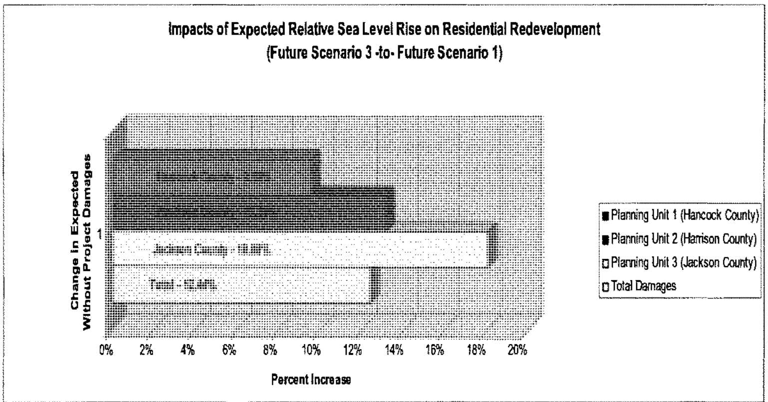


Figure 5.3-9. Impacts of 2.0-feet of relative sea level rise on a residential redevelopment

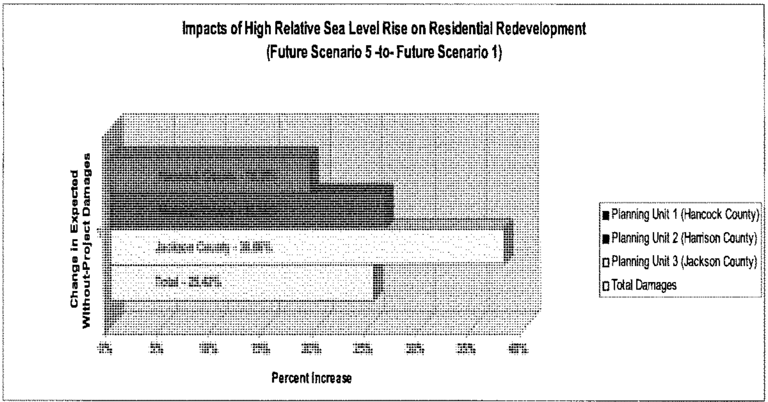


Figure 5.3-10. Impacts of 3.4-feet of relative sea level rise on a residential redevelopment

Table 5-37.
Equivalent Annual Without-Project Damages by Planning Unit and Future Scenario

Without-Project Damages	Future 2[2] Damages	Future 4 Damages	% Change from Future Two	Future 6 Damages	% Change from Future Two
Planning Unit One	$202,060,000	$222,220,000	9.98%	$ 241,520,000	19.53%
Planning Unit Two	$94,680,000	$107,120,000	13.14%	$ 119,760,000	26.49%
Planning Unit Three	$88,670,000	$104,700,000	18.08%	$ 122,420,000	38.06%
Total	**$385,410,000**	**$434,040,000**	**12.62%**	**$ 483,700,000**	**25.50%**

Damages are rounded to the nearest ten thousand.
1 Futures Two, Four, and Six do not apply to planning unit three, therefore total damages are the same as future scenarios one, three, and five for planning unit three.
2 Future Scenario two is used here to evaluate the impacts of relative sea level rise only, and will not be discussed in the direct evaluation of potential measures detailed in Chapter IV of this appendix.

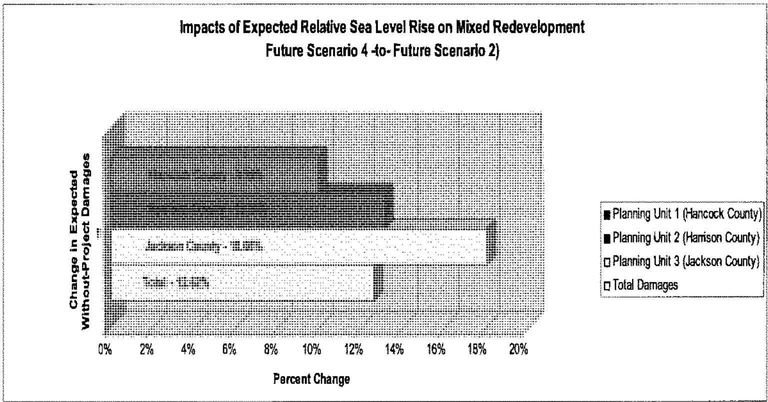


Figure 5.3-11. Impacts of 2.0-feet of relative sea level rise on a mixed redevelopment

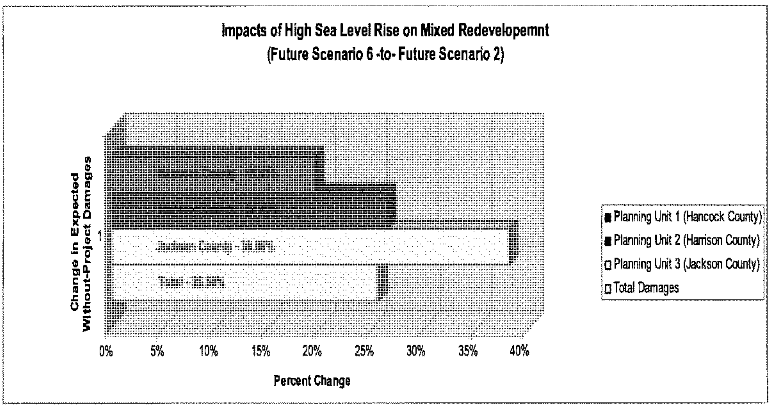


Figure 5.3-12. Impacts of 2.0-feet of relative sea level rise on a mixed redevelopment

CHAPTER VI. DEVELOPMENT AND EVALUATION OF MEASURES

This section describes steps three and four of the Corps six step planning process. These steps are the development of potential measures and the evaluation of those measures as compared to the without project conditions. Initial analysis yielded an extensive list of potential measures that were appropriate to a given site or problem area. The sites/problem areas are illustrated in the Main Report. The development of preliminary measures for structural and non-structural damage reduction is discussed in detail in the Engineering Appendix. The development of preliminary measures for ecosystem restoration and saltwater intrusion remediation is discussed in detail in the Environmental Appendix.

Many measures were initially evaluated and screened, based on technical or environmental criteria, and are not discussed here. Those measures that were found to be technically sound for a particular application, and environmentally sound, in regards to potential impacts to environmental resources, were forwarded for consideration, into the next phase of analysis. Measures forwarded into Round 2 of the evaluation and screening process were developed to a greater level of detail, to allow more detailed comparison, and potential modification for further study. The development of more detail included preliminary design and cost estimation, coastal, hydrologic and/or hydraulic analysis and design, environmental analysis, and determination of potential damages prevented, residual damages, and other factors. This latter process is discussed in more detail in the main report.

6.1 Overview of Benefits and Cost Evaluation

This section describes an overview of the methodology and steps taken in the calculation of benefits and costs. The principles for the overall process are the same no matter the area in question. Since the scope and scale of the comprehensive plan is so extensive, the methodologies utilized will be described here, and then summary tables and paragraphs will be used in the following sections that describe the evaluation of the various measures.

6.1.1 Calculation of National Economic Development Benefits

Except for the Beach and Dune placement measures described in detail in section 6.3, all of the surge inundation reduction benefits for the various measures were evaluated using the Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA) program. For the analyses in this comprehensive plan, National Economic Development (NED) benefits are the reduced inundation damages of assets and their contents when one of the potential measures is in place. Typically, NED benefits are annualized over the period of the analysis (average annual benefits) and then compared to annualized costs over the period of analysis (average annual costs). This comparison is commonly known as the benefit-to-cost ratio (BCR). For purposes of this analysis, no benefit-to-cost ratios will be calculated as per the Congressional language authorizing this study. The Coastal Mississippi Comprehensive Plan Report was authorized by the Department of Defense Appropriations Act, 2006 (P.L. 109-148) 30 December 2005, which states: "...***that the Secretary shall recommend a cost-effective project, but shall not perform an incremental benefit-cost analysis to identify the recommended project, and shall not make project plan features based upon maximizing net national economic development benefits...***" More detail on the authorizing language can be found in the MsCIP Comprehensive Plan Main Report.

Equivalent annual flood damages for the various measures and alternatives at each area were evaluated and compared to the applicable future without project scenarios previously described in Chapter V. As previously noted, the six future without project scenarios combine various types of relative sea level rise with two types of redevelopment (see section 5.3 for more detail). The HEC-FDA model calculates damages reduced for a base year and a most likely future year and interpolates damages between the two points to determine equivalent annual damages. The model was set up so the exceedance probability function for the base year does not incorporate relative sea level and the function for the most likely future year does include the relative sea level rise adjustment. This allows the model to determine the damages between the two points.

Equivalent annual damages are calculated as:

Equivalent annual damages (EAD) = Present Worth of Total Damages x Capital Recovery Factor

Capital Recovery Factor (CRF) = $i / (1-(1+i)^{-n})$

Where:

i = interest rate

n = period of analysis

Figure 6.1-1 shows the linear interpretation used by HEC-FDA to calculate equivalent annual damages. The same methodology was used when converting projects recommended for construction to a 50-year period of analysis.

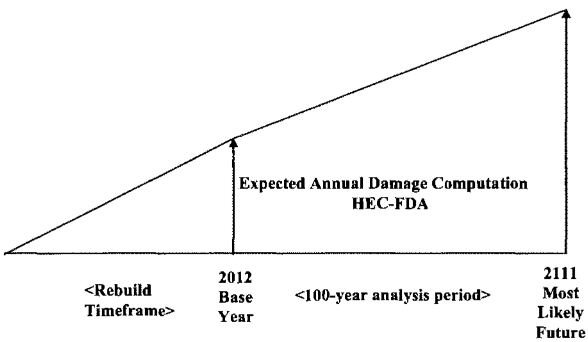


Figure 6.1-1. Linear Interpretation of Equivalent annual damages

6.1.2 Calculation of Costs

This section describes the use of cost estimates in the evaluation of the measures and alternatives. The methodology and application will be described here, and the sections describing the specific measures and alternatives at each site will show summaries of the costs. Detailed line item cost estimates can be found in the MsCIP Comprehensive Plan Cost Appendix.

6.1.2.1 Implementation Costs

Rough Order Magnitude (ROM) implementation costs were developed for each of the different measures and alternatives evaluated at each of the areas. The MOBILE DISTRICT Engineering Division developed the costs for structural measures and the Corps of Engineers Nonstructural Flood proofing Committee (NSFPC) developed the costs for the nonstructural measures. Savannah District Real Estate Division provided the real estate portions of each of the plans. All costs shown are in October 2007 price levels unless otherwise stated. Detailed cost estimates can be found in the cost estimating appendix to the MsCIP Comprehensive Plan Report.

6.1.2.2 Average Annual Implementation Costs

Average annual implementation costs were calculated for each of the measures and alternatives are calculated as:

Average Annual Implementation Cost = (Total Present Worth of Implementation Costs + IDC) x Capital Recovery Factor

Typically, costs are associated to the years they would be expended in should the project be constructed. Those expenditures are then brought back to the same fiscal year (FY) as the benefits in order for a direct and accurate comparison. This methodology was used for all measures and alternatives that will be recommended for construction. For those measures and alternatives that will be recommended for further study, the timing of expenditures have not yet been identified; therefore the total implementation cost act as the total present worth of the implementation costs and will be multiplied by the capital recovery factor to get the average annual implementation cost values.

Interest during construction is an added economic cost because it is the opportunity cost of having construction monies tied up until the measure becomes fully operational. Interest during construction was calculated based on the following formula:

IDC[3] = $\sum$ (Monthly Expenditure x Interest Rate Factor)

Monthly Expenditure = Implementation Cost / D

Interest Rate Factor = $(1+ I_M)$ ^ (D – M)) - 1

Where:

I_M = Interest Rate Factor = (Discount Rate / 12)

D = Total Construction Duration

M = Elapsed Time (Months) of Construction

Interest during construction was calculated for all measures and alternatives that will be recommended for construction. Due to the size and scope of the comprehensive effort, at this point in the analysis, the length of construction for many of the measures and alternatives has not been identified; interest during construction was not calculated for all of measures. Further study would be required in order to calculate interest during construction for those measures and alternatives not ready for construction recommendation. The main report details the measures and alternatives and their respective plan features.

[3] IDC was calculated based on Corps of Engineers National Economic Development Procedures Manual--Urban Flood Damage.

6.1.2.3 Operation and Maintenance Costs

Operation and Maintenance (O&M) costs were identified for each of the potential measures and alternatives. O&M costs for the structural solutions are described in the engineering appendix and the cost estimating appendix and are generally two-percent of the contract cost of the structure. O&M costs for the nonstructural measures and alternatives are described in the nonstructural appendix and are mostly based on the up keep of remaining lands associated with acquisition measures. All O&M costs shown for are annual costs and are typically borne by the local sponsor.

6.1.2.4 Total Average Annual Costs

Total average annual costs were calculated for each of the measures and alternative plans. Total average annual costs are the sum of the average annual implementation cost plus annual operation and maintenance cost.

6.1.3 Calculation of Regional Economic Development Benefits

This section describes the methodology and steps used to evaluate the regional economic development impacts attributable to each of the various measures and plans. The Economic Impact Forecasting System (EIFS) model was used in this analysis. Chapter III describes the background EIFS model. The methodology and application will be described here, and the sections describing the specific measures and alternatives at each site will show summaries of the costs.

6.1.3.1 Methodology

Impacts on business, employment, income, and population were evaluated using the Economic Impact Forecast System (EIFS), an economic analysis tool that, given the inputs for a particular project proposal, will asses potential impacts on four indicators of a local economy. EIFS is based on regional economic theory and provides regional economic analyses to planners and analysts. It draws information from a tailored socioeconomic database for any county in the United States. The database items are extracted from: Economic Censuses (wholesale, retail, services, and manufacturers), Census of Agriculture, the Bureau of Economic Analysis (BEA) employment and income time series, the BEA labor time series, and the County Business Patterns (CBP). The entire system-models, tools, and database-is then available to assess potential impacts on four indicators of a local economy: business volume, employment, personal income, and population.

6.1.3.2 EIFS Model Assumptions

EIFS assumes that the infrastructure pre-Katrina is intact, in-place, and functioning as a wholesome economic unit in the region of influence. The fact is that under existing conditions many of the established economic infrastructure is not present but transient. In some cases, rebuilt economic units have moved into fill that deficit to provide the goods and services. The assumption of this analysis assumes that the last or destroyed infrastructure will be rebuilt or replaced in the near-term and will not significantly reduce the impacts and outputs forecasted in this investigation.

6.1.3.3 Summary Explanation of the EIFS Model Inputs and Outputs

6.1.3.3.1 EIFS Model Inputs

The two data sources used as inputs for the EIFS model were the implementation cost and O&M cost for each of the measures and alternatives. Each of the cost inputs used was in present worth dollars, not average annual. Present worth costs were used because it is the actual estimated amount that will be spent to implement, operate, and maintain the measure or alternative and that is what will drive the regional impacts.

6.1.3.3.2 EIFS Model Outputs

- Change in Sales Volume

Changes in local business activity include direct sales volume and induced volume. Direct sales volume is the change in the dollar value of sales in the retail and wholesale trade sector and receipts in the service sector resulting from local purchases by people as well as construction and procurement expenditures. Induced sales volume is the additional sales activity generated as a result of the direct change in sales.

- Income

Changes in income represent the wage and salary payments made to construction workers and to the resident workforce.

- Employment

Employment changes include both direct and indirect changes, as well as short and long term changes. The direct long-term change in local employment is the increase in employment associated with construction. Subsequent indirect increases in employment are produced by the multiplier effect resulting from increased spending by the additional staff and construction employees.

6.2 Evaluation of Barrier Island Measures

6.2.1 General Description

The coastline of mainland Mississippi is bordered on the south by the Mississippi Sound, a shallow body of water that separates the coast from four barrier islands that lie several miles to the south. These barrier islands are located along a littoral drift zone that moves sand westward creating three elongated islands and then westward toward Cat Island, where littoral currents are not as well defined. Cat Island has a different origin than the other islands and is a remnant of a lobe of the St. Bernard Delta that was created by the Mississippi River. Wave action has created a beach on the eastern side of the island forming a distinctive T-shape. From west to east, the islands are Cat, Ship (now actually two islands, West and East Ship Island), Horn and Petit Bois. The western ends of both Petit Bois and Ship Islands have migrated to maintained navigation channels and the continuing littoral drift of the sand into the channels is causing an artificial termination of the migration. A new island has emerged on the west side of the channel from Petit Bois Island, created from the dredged sand coming from island that is disposed of on the west side of the channel.

6.2.1.1 Location

The barrier islands of Mississippi are located 10 to 15 miles south of the mainland. Currently, there are five islands in the chain that extends for 45 miles west from a point south of the Alabama – Mississippi state line along the coast. Currently, Ship Island exists as two islands separated by a shallow sand bar. It was breached during Hurricane Camille in 1969 and remains today as West and East Ship Island. Two maintained navigation channels pass through the chain of islands. The Gulfport channel passes near the west end of West Ship Island and the Pascagoula channel passes near the end of Petit Bois Island. The present day location of the channels prevents any further westward migration of either island.

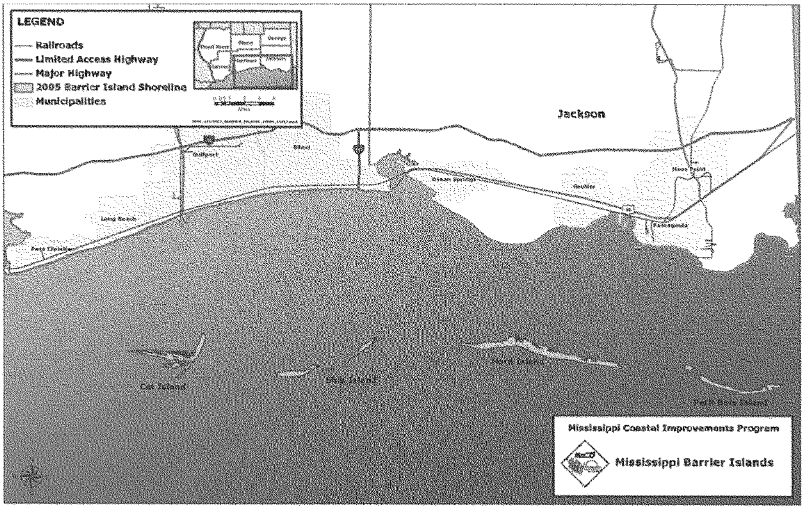


Figure 6.2.1-1. Location of the Mississippi Barrier Island

6.2.1.2 Historic Conditions (Pre-Hurricane Katrina)

6.2.1.2.1 Historic Fisheries

The value of the fisheries that are harvested from the Mississippi Sound has been an integral aspect of the local economy for decades. The industry has seen a significant rise in value since the 1970's, as is shown in table 6.2-1. The table and figure also show the effects of increased salinity on the system.

Table 6.2-1.
Historic Landings and Value of All Fisheries from Mississippi Sound

Year	Metric Tons	Pounds	% Change Pounds Since 1975	Value ($)	% Change Value ($) Since 1975
1975	138,690.7	305,757,600	N/A	$14,347,114	N/A
1976	130,708.7	288,160,500	-3%	$21,008,332	89%
1977	141,972.6	312,992,800	5%	$25,516,974	130%
1978	142,684.9	314,563,068	6%	$25,461,768	129%
1979	151,465.0	333,919,773	12%	$32,199,124	190%
1980	126,493.7	278,868,057	-6%	$24,866,290	124%
1981	95,263.2	210,017,239	-29%	$22,696,940	104%
1982	151,472.3	333,935,723	12%	$34,431,141	210%
1983	174,631.7	384,993,091	29%	$43,993,751	296%

Table 6.2-1.
Historic Landings and Value of All Fisheries from Mississippi Sound (continued)

Year	Metric Tons	Pounds	% Change Pounds Since 1975	Value ($)	% Change Value ($) Since 1975
1984	196,038.3	432,186,113	45%	$43,516,262	292%
1985	199,368.2	439,527,147	48%	$37,992,383	242%
1986	169,477.6	373,630,286	25%	$42,114,062	279%
1987	180,987.9	399,006,020	34%	$44,856,157	304%
1988	133,662.3	294,671,899	-1%	$43,744,133	294%
1989	122,979.5	271,120,626	-9%	$43,488,151	292%
1990	131,213.2	289,272,701	-3%	$39,748,280	258%
1991	97,280.4	214,464,348	-28%	$32,222,731	190%
1992	76,880.8	169,491,372	-43%	$29,986,817	170%
1993	83,485.4	184,051,940	-38%	$30,638,289	176%
1994	99,875.3	220,185,111	-26%	$36,930,906	233%
1995	65,725.1	144,897,569	-51%	$41,704,923	276%
1996	73,703.7	162,487,111	-45%	$35,120,373	216%
1997	81,842.8	180,430,714	-39%	$47,742,072	330%
1998	95,585.2	210,727,081	-29%	$48,402,305	336%
1999	121,378.6	267,591,178	-10%	$48,608,616	338%
2000	98,777.0	217,763,858	-27%	$58,751,487	429%
2001	97,034.6	213,922,401	-28%	$50,632,920	356%
2002	98,869.5	217,967,609	-27%	$47,565,219	328%
2003	96,828.8	213,468,811	-28%	$46,148,637	316%
2004	83,261.5	183,558,261	-38%	$43,618,143	293%

Source: Values were collected from the National Marine Fisheries website - http://www.st.nmfs.gov/st1/commercial/index.html

6.2.1.3 Existing Condition (Post-Hurricane Katrina)

6.2.1.3.1 Damage to Structures

The three coastal Mississippi counties suffered tremendous devastation from Hurricane Katrina's surge. It is estimated that 32,446 structures were significantly destroyed (at least fifty-percent or more), with another 15,000 to 25,000 suffering moderate to minimal inundation damage. Of the structures sustaining significant destruction, 9,555 were in planning unit one, 16,528, in planning unit two, and 6,363 in planning unit three. Of those significant loss structures, approximately 19,000 claims were paid out by the Federal Emergency Management Agency's (FEMA's) National Flood Insurance Program (NFIP) totally over $2.3 Billion dollars, with the average claim around $137,000. Currently, no accurate data exists for uninsured losses, but estimates range in the billions of dollars. Table 1 displays the significantly damaged structures by planning unit and by structure category. Table 6.2-2 shows the severely damaged structure by planning unit.

Table 6.2-2.
Structures Damaged 50% or More by Planning Unit and by Category

	Planning Unit One	Planning Unit Two	Planning Unit Three	Total
Commercial	1,267	1,794	378	3,439
Residential	8,099	14,500	5,780	28,379
Municipal	127	89	136	352
Mobile Home	62	145	69	276
Total	**9,555**	**16,528**	**6,363**	**32,446**

Source: Estimated from field inventory cluster sampling.

6.2.1.3.2 Damage to Barrier Islands

Immediately following Hurricane Katrina, most of the effort was spent protecting human life and securing structures throughout the impacted areas on the mainland; therefore, few assessments of the vegetation impacts exist, especially on the barrier islands. For the barrier island system, most all of the marsh vegetation recovered several months following Hurricane Katrina. The predominant vegetation that has long-term impacts consists of those pines found in the maritime forests. It is estimated that about 75% of these pine species were killed following the hurricane season of 2005, with most that attributable to Hurricane Katrina. The emergent marsh habitat is thriving so well it actually looks as though hurricanes never past through the barrier island system. The sea oats are still found in small patches due to the reduced dune system. Any measure that includes the planting of marsh vegetation will have to consider the current population of nutria that inhabits the islands. These exotic animals from South America can destroy attempts to establish marsh planting and any program should include the control of these rodents.

As is typical of most barrier island systems, the Mississippi islands are an ever-changing and dynamic landscape. Data shows that the islands have lost approximately 20 to 25 percent of their land mass since pre-Camille times. The islands have been heavily influenced by the various hurricanes including even the lower intensity ones. Hurricane George, in 1998, even though a small hurricane, proved to be devastating to the islands due heavy erosion from waves. Many of the higher dunes systems on the islands were destroyed and much of the elevation the islands once had is gone. Most of the islands are now very susceptible to over-wash during storms. Another result of being submerged during Hurricane Katrina was the loss of much of the maritime pine forest that existed on the islands. The trees, mostly now dead from the salt water submergence, played a major role in preventing erosion both from wind and any surges against the islands.

Figure 6.2.1-2. Photo of the south beach at Horn Island. Pre-existing dunes have been destroyed by numerous hurricanes over the last several years

6.2.1.2 Without-Project Condition

6.2.1.2.3 Equivalent annual damages

As previously described in Chapter V, six future without-project scenarios were developed, based on the existing condition characteristics, for the evaluation of future without-project conditions. The six scenarios were evaluated over a 100-year period of analysis from the base year 2012 (2012–2111) and using the FY08 federal discount rate of four-and-seven-eighths (4.875) percent. The six future scenarios include two redevelopment scenarios (residential and mixed-residential and commercial) and three relative sea level rise scenarios (base sea level, expected relative sea level rise, and high relative sea level rise) for a total of six different future scenarios. Scenario one is a residential redevelopment with no relative sea level rise over the 100-year period of analysis, scenario two is a mixed residential and commercial redevelopment with no relative sea level rise, scenario three is a residential redevelopment with an expected relative sea level rise, scenario four is a mixed residential and commercial redevelopment and an expected relative sea level rise, scenario five is a residential redevelopment with a high relative sea level rise, and scenario six is a mixed residential and commercial redevelopment with a high relative sea level rise. Table 6.2-3 shows the equivalent annual damages for the six future without-project scenarios.

Table 6.2-3.
Equivalent Annual Without-Project Damages by Planning Unit and Future Scenario

Without-Project Damages	Future 1[2] Damages	Future 2[2] Damages	Future 3 Damages	Future 4 Damages	Future 5 Damages	Future 6 Damages
Planning Unit One	$198,960,000	$202,060,000	$218,050,000	$222,220,000	$237,310,000	$241,520,000
Planning Unit Two	$91,260,000	$94,680,000	$103,280,000	$107,120,000	$115,470,000	$119,760,000
Planning Unit Three	$88,670,000	$88,670,000	$104,700,000	$104,700,000	$122,420,000	$122,420,000
Total	**$378,890,000**	**$385,410,000**	**$426,030,000**	**$434,040,000**	**$475,200,000**	**$483,700,000**

Damages are rounded to the nearest ten thousand.
1 Futures Two, Four, and Six do not apply to planning unit three, therefore total damages are the same as future scenarios one, three, and five.
2 Future Scenarios one and two will be used to evaluate the impacts of relative sea level rise only, and will not be discussed in the direct evaluation of potential measures detailed in Chapter IV of this appendix.

These equivalent annual without-project damages are those that would be expected to occur over the period of analysis should the barrier islands remain in their existing state, however, recent data collected by the USGS, and analysis of historical data by the Corps and others, suggests that this may not be the case. The long-term trends exhibited by the Barrier Islands and wetlands of Louisiana, and the coastal areas of Alabama and the panhandle of Florida, suggest that the regional sediment budget of the Northern Gulf of Mexico is not sufficient to restore and/or maintain these areas in their existing condition. Although no one study or investigator has suggested a time frame for the demise of these features, it is increasingly evident that their effectiveness at reducing storm surge and wave energies has been reduced significantly in the last 50 years. This has been exhibited most dramatically after Katrina in reduction of Barrier Island extent [note – look at Bob Morten's report].

Unfortunately, due to severe timing and funding constraints pertaining to the MsCIP Comprehensive Plan and the complexity of modeling various states of the barrier islands, only a sensitivity analysis was conducted to roughly capture the increased inundation risk of the further degradation of the islands. The data from that sensitivity analysis indicates that further loss of the barrier islands could result in as much as ten-feet of additional wave damage to structures and their contents. This loss of surge protection could actually increase the total equivalent annual damages over the project life by as much as an additional eight to nine-percent. Table 6.2-4 displays the anticipated effects of increased damages due to further loss of the barrier islands.

Table 6.2-4.
Increase in Equivalent Annual Without-Project Damages by Planning Unit and Future Scenario due to Further Degradation of the Barrier Islands

Without-Project Damages	Future 1[2] Damages	Future 2[2] Damages	Future 3 Damages	Future 4 Damages	Future 5 Damages	Future 6 Damages
Planning Unit One with Islands	$198,960,000	$202,060,000	$218,050,000	$222,220,000	$237,310,000	$241,520,000
% Increase without Islands	0%	0%	0%	0%	0%	0%
$ Increase without Islands	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Planning Unit Two with Islands	$91,260,000	$94,680,000	$103,280,000	$107,120,000	$115,470,000	$119,760,000
% Increase without Islands	7%	7%	7%	7%	7%	7%
$ Increase without Islands	**$6,388,200**	**$6,627,600**	**$7,229,600**	**$7,498,400**	**$8,082,900**	**$8,383,200**
Planning Unit Three with Islands	$88,670,000	$88,670,000	$104,700,000	$104,700,000	$122,420,000	$122,420,000
% Increase without Islands	10%	10%	10%	10%	10%	10%
$ Increase without Islands	**$8,670,000**	**$8,670,000**	**$10,470,000**	**$10,470,000**	**$12,242,000**	**$12,242,000**
Total $ Increase without Islands	**$15,058,200**	**$15,297,600**	**$17,699,600**	**$17,968,400**	**$20,324,900**	**$20,625,200**

Damages are rounded to the nearest ten thousand.
1/ Futures Two, Four, and Six do not apply to planning unit three, therefore total damages are the same as future scenarios one, three, and five.
2/ Future Scenarios one and two will be used to evaluate the impacts of relative sea level rise only, and will not be discussed in the direct evaluation of potential measures detailed in Chapter IV of this appendix.

6.2.1.2.3 Loss of Fisheries

Marine resources harvested from the Mississippi Sound are crucial to the economy of the three coastal counties and the state of Mississippi. It is estimated that in 2004, approximately 4,800 jobs and $300 million in gross annual revenue were dependent on fisheries from the sound. Various species harvested include oysters, bluefish, drum sea trout, sea catfish, white and brown shrimp, mullet, and snapper. According to National Marine Fisheries, total landings in 2004, the most accurate pre-Katrina data available, included 83,262 metric tons (183,558,261 pounds) for an estimated landing value of $43,618,143. In 2004, oyster production from the Mississippi Sound accounted for 8-percent of national oyster production and 11-percent of eastern oyster production. Comparison of pre-Katrina and post-Katrina landings provides a sharp comparison of what Mississippi Sound provided the State of Mississippi in terms of economic benefits, and what was lost as a result of the hurricane.

Comparison of the nearest full year (use of 2005 is problematic due to the fact that the hurricanes occurred mid-year) of monetary benefits due to commercial fish and shellfish landings, on either side of the hurricanes of 2005, provides the following insight into losses caused by those hurricanes. Table 6.2-5 shows an example of the devastating impacts of increased salinity in the Mississippi Sound due to Hurricane Katrina. If the islands continue to degrade, a point will be reached where the salinity would kill the entire oyster and shrimp harvesting and the majority of all other existing fisheries as well. More detail about the devastating impacts of island degradation can be found in the environmental appendix.

Table 6.2-5.
Loss of Shrimp, Oysters, and other Species Due to Hurricane Katrina

Species	2004	2006	Loss
Shrimp	$26,353,576	$11,854,449	$14,499,127
Oysters	$6,073,242	$1,447,132*	$4,626,110
All Species Listed Above	$43,618,143	$21,741,108	$21,877,035

6.2.1.2.4 Loss of Recreation

This section describes the without-project recreation conditions for the barrier islands, which are the continued degradation of the islands and loss of all recreational use as a result of the continued degradation. Typically, recreational uses on the islands include general recreation such as boating, sightseeing, picnicking, swimming, and fishing from banks and boats. Additionally, the western portion of Ship Island, known as West Ship Island, is the home to two historic sites; Fort Massachusetts and the French Warehouse. Ship Island, the second island from the west in figure 6.2.1-1 above, was split into two islands by Hurricane Camille.

Visitors attend West Ship Island by using a commercial company called Ship Island Excursions or privately owned recreation boats. The island and facilities are run by the National Park Service. Table 6.2-6 below shows annual statistics estimated by the Park Service from 1989 through 2006.

Table 6.2-6.
Annual Ship Island Visitation

Year	Annual Visitation	Change from Previous Year (%)
1989	45,386	N/A
1990	54,661	20.436%
1991	49,301	-9.806%
1992	51,623	4.710%
1993	49,432	-4.244%
1994	51,059	3.291%
1995	53,793	5.355%
1996	59,724	11.026%
1997	58,969	-1.264%
1998	59,917	1.608%
1999	65,657	9.580%
2000	66,609	1.450%
2001	63,059	-5.330%
2002	62,720	-0.538%
2003	65,327	4.157%
2004	62,135	-4.886%
2005	41,453	-33.286%
2006	20,340	-50.932%

As the table shows, annual attendance to West Ship Island was relatively stable until the Island was impacted by Hurricane Katrina. Attendance in 2006 plummeted by more than 67-percent from its 2004 pre-Katrina level. The average yearly attendance for the five year period pre-Hurricane Katrina (2000-2004) was 63,970 visitors. Since there is little other data available on the recreational use of the barrier islands, and due to the timing constraints of this study, this number was used to estimate the annual recreational use.

Based on 63,970 annual user days, a unit day value (UDV) analysis was conducted to determine the monetary recreational value of use of the barrier islands. The UDV method relies on expert or informed opinion and judgment to estimate the average willingness to pay of recreational users. Interviews conducted pertaining to the without-project condition relied on expert or informed opinion and judgment to approximate the average willingness to pay of users of West Ship Island.

The guidelines for assigning points to general recreation include five categories:

- The quality of the recreational experience as affected by congestion,
- Availability of substitute areas in terms of travel time,
- Carrying capacity determined by level of facility development,
- Accessibility as affected by road and parking conditions, and
- Environmental quality based on aesthetics.

A resource is then rated on a 100-point scale. The total possible points that can be assigned to each criterion are as follows:

- Recreational Experience – 30,
- Availability of Opportunity – 18,
- Carrying Capacity – 14,
- Accessibility – 18, and
- Environmental - 20.

The conversion of points to dollar values for general recreation is expressed in two activity categories: general recreation and general fishing and hunting. Hence, points are expressed in the same manner. Therefore, for this project, general recreation includes boating, sightseeing, picnicking, swimming, and the visitation of the historical Fort Massachusetts and the French Warehouse. General fishing and hunting includes fishing from banks and boats. Table 6.2-7 summarizes the point value system as defined by EGM 08-02.

Table 6.2-7.
Guidelines for Assigning Points for General Recreation

Criteria	Judgment Factors				
Recreation experience[1] **Total Points: 30**	Two general activities[2]	Several general activities	Several general activities; one high quality value activity[3]	Several general activities; more than one high quality value activity	Numerous high quality value activities, some general activities
Point Value:	0-4	5-10	11-16	17-23	24-30
Availability of opportunity[4] **Total Points: 18**	Several within 1 hr. travel time; a few within 30 min. travel time	Several within 1 hr. travel time; none within 30 min. travel time	One or two within 1 hr. travel time; none within 45 min. travel time	None within 1 hr. travel time	None within 2 hr. travel time
Point Value:	0-3	4-6	7-10	11-14	15-18
Carrying Capacity[5] **Total Points: 14**	Minimum facility for development for public health and safety	Basic facility to conduct activity(ies)	Adequate facilities to conduct without deterioration of the resource or activity experience	Optimum facilities to conduct activity at site potential	Ultimate facilities to achieve intent of selected alternative
Point Value:	0-2	3-5	6-8	9-11	12-14
Accessibility **Total Points: 18**	Limited access by any means to site or within site	Fair access, poor quality roads to site; limited access within site	Fair access, fair road to site; fair access, good roads within site	Good access, good roads to site; fair access, good roads within site	Good access, high standard road to site; good access within site
Point Value:	0-3	4-6	7-10	11-14	15-18
Environmental **Total Points: 20**	Low aesthetic factors6 that significantly lower quality[7]	Average aesthetic quality; factors exist that lower quality to minor degree	Above average aesthetic quality; any limiting factors can be reasonably rectified	High aesthetic quality; no factors exist that lower quality	Outstanding aesthetic quality; no factors exist that lower quality
Point Value:	0-2	3-6	7-10	11-15	16-20

Table 6.2-8 shows the average respondent values for the value of recreational use of the barrier islands. Notes from those interviews include overwhelming high aesthetic value, general uses except for the ability to visit the historical Fort Massachusetts and French Warehouse, fair to good accessibility, and adequate to optimum facilities at the site.

Table 6.2-8.
Point Value of Recreational Use

	Recreational Experience	Availability of Opportunity	Carrying Capacity	Accessibility	Environmental	Totals
Average Respondent	10.00	3.00	8.00	10.00	20.00	**51.00**

Table 6.2-9 shows the conversion of points to FY 2008 dollar based on EGM 08-02.

Table 6.2-9.
Point Value of Recreational Use

Point Values	General Recreation Values	General Fishing and Hunting Values	Specialized Fishing and Hunting Values	Specialized Recreation Values other than Fishing and Hunting
0	$3.40	$4.89	$23.81	$13.82
10	$4.04	$5.53	$24.44	$14.67
20	$4.46	$5.95	$24.87	$15.73
30	$5.10	$6.59	$25.51	$17.00
40	$6.38	$7.23	$26.14	$18.07
50	$7.23	$7.86	$28.69	$20.40
60	$7.86	$8.71	$31.24	$22.53
70	$8.29	$9.14	$33.16	$27.21
80	$9.14	$9.78	$35.71	$31.67
90	$9.78	$9.99	$38.26	$36.13
100	$10.20	$10.20	$40.38	$40.38

Table is from EGM 08-02 "Unit Day Values for Recreation, Fiscal Year 2008"

The general recreation score of 51 translates to unit day value of $7.29. The average annual benefits were calculated by multiplying the UDV by the annual visitor occasions. Using the estimated 63,970 annual users and the interpolated $7.29 unit day value, the average annual recreation loss of continuing to allow the islands to degrade is $466,341

6.2.2 List of Measures

Measure A – Restore Island Footprint

The pre-Camille footprint of the islands was obtained from historical records and the amount of area that has been lost to coastal erosion since that time was computed. Without accurate topography of the islands and an assumption was made that some dunes had a top of elevation of 20 feet NAVD88. It should be noted that some of the islands have migrated and any reconstruction would be to increase their footprint at their present location and not move them back to historical locations.

Several approaches to restoration of the islands were considered. This measure will only include new land mass that is being added to the islands by using sand dredged and transported from an off-shore location. The shaping of the sand into beaches, dunes and marsh areas will not affect the existing islands other than that narrow strip of land that will form the boundary between the existing island and the new land mass. This measure can be used in combination with other measures under this line of defense should it be desired to restore habitat on the existing islands.

Restoration of Ship Island to a pre-Camille configuration includes closing the post-Katrina, 3-mile long breach to a 2000-foot width and with elevation 20.0-foot NAVD88 dunes, along with some rebuilding of the other islands to a larger land area. The land mass of each of the islands was estimated in a pre-Hurricane Camille condition using historical aerial photography.

Measure B – Replenish Sand in Littoral Zone, Inland Source

Another consideration to help restore the islands is to supplement the sand in the littoral system. This could be accomplished by adding sand in specific locations based on sediment transport modeling. This would allow the littoral currents to move the sand onto the islands where the natural process of island building could take place. This would not directly affect the present-day islands and would help mitigate any effects of dredging the ship channels that pass through the chain of islands where sand may have been lost from the system.

The construction of inland waterways in Alabama and Mississippi has resulted in continuing maintenance dredging to maintain the channel depths and alignments. Dredging of some of the areas along the river has produced large quantities of sand that have potential use for replenishment of littoral zones such as are found along the Mississippi Barrier Islands. This dredged material, approximately 30 million cubic yards, is now accumulated in disposal areas along the banks of the rivers.

Measure C – Replenish Sand in Select Littoral Zones, Offshore and Inland River Sources

Another consideration to help restore the islands is to supplement the sand into specific areas of the littoral system with sand obtained from both Inland and offshore borrow areas. Like Measure B, this could be accomplished by adding sand in specific locations based on sediment transport modeling. The general locations for this measure were based on islands that have migrated westward to alignments of maintained navigation channels causing an artificial termination of further migration. Placing sand into these locations would allow the littoral currents to move the sand onto the islands where the natural process of island building could take place. While this process would not directly affect the present-day islands, it would help mitigate any effects of dredging the ship channels that pass through the chain of islands where sand may have been lost from the system. The sand that could be used in this measure may come from the same offshore borrow area as Measure A, the St. Bernard Shoals located about 45 miles south of the barrier islands as well as the inland river systems as described in Measure B.

Measure D – Environmental Restoration w/ 2-foot Dune

This measure would involve environmental restoration of the islands consisting of shaping existing sand into low dunes on the beaches with planted vegetation and planting of maritime forests on the existing islands where they were mostly destroyed by Hurricane Katrina.

Despite continual changes that occur, the barrier islands remain to buffer the mainland from storms and provide habitat for the rich, diverse wildlife residing within the area. On the southern portion of the islands, sea oats primarily, which are tolerant of high salt levels, thrive on the dune system which is located behind the beach area. Behind the primary dunes, trees and shrubs, such as short-leaf and long-leaf pines, can be found in the maritime forest. In the island interiors, emergent marshes collect fresh rainwater to help support its inhabitants

A restoration measure with the least impact on the existing post-Katrina islands would be to re-establish the vegetation that was destroyed. This measure could involve restoration of the existing islands through adding sand dunes on the beaches along with planted vegetation (i.e. *Uniola paniculata*), planting of marshes (i.e. *Spartina alterniflora*, *Juncus roemerianus*, and *Spartina patens*) and maritime forests (i.e. *Pinus elliottii Engelm*, *Serenoa repens*, *Sabal minor*, etc.), and planting sea grasses (i.e. *Diplanthera wrightii*, *Cymodocea manatorum*, *Thalassia testudinum*, and *Ruppia maritime*) in the near-shore areas of the islands. Foremost, the vegetation would restore the island's natural setting, which allows for the diverse array of flora and fauna to persist. This plan would not involve adding any land mass to the islands other than the possibility of adding to the dune system. Vegetation would aid in reducing erosion from wind; thus helping in maintaining the stability of the islands. The vegetation would also aid in preventing erosion in the event that the islands gets overtopped by storm surge in a large hurricane.

Measure E – Environmental Restoration w/ 6-foot Dune

This measure would involve environmental restoration of the islands consisting of adding sand onto the existing beaches in sufficient quantities to construct a dune approximately 6 feet high. The dunes on the beaches would be planted with vegetation along with the planting of maritime forests on the existing islands where they were mostly destroyed by Hurricane Katrina. The sand required to construct a dune of this size would be more than could be removed from the existing beach berm and would come from the same offshore borrow area as the sand used in Measure A. Placement of the sand would require moving the sand from a hopper dredge to a staging area on the beach, then moving the sand to the area of placement along the beach.

Measure F – Environmental Restoration of Sea Grass Beds

This measure would involve environmental restoration of the sea grass beds that have historically existed on the north side of the islands in the Mississippi Sound. Knowledge of submerged aquatic vegetation (SAVs) is limited to reports by Humm (1956) and Humm and Caylor (1957) before the Gulf of Mexico Estuarine Inventory (GMEI) Study (1973). They reported the occurrence of five flowering species known as "seagrasses" and 77 algal species all along the Mississippi barrier islands. Studies carried out by the GMEI personnel revealed that there were about 17,000 acres of SAVs in Mississippi Sound prior to Hurricane Katrina. Information obtained from MDMR indicated that since Hurricane Camille in 1969, 8,800 acres of SAVs have been lost. Using maps from MDMR, fifty percent of the total lost acreage would be replaced throughout the previous range to help restore this valuable habitat under this measure.

Measure G – Restore Ship Island Breach

The most predominate affect of Hurricane Katrina on the Mississippi Barrier Islands was the large increase in size of the breach in Ship Island commonly known as the Camille Cut. The pre-Camille footprint of Ship Island was obtained from historical records. This data showed the area that was breached during Hurricane Camille forming two separate islands. West and East Ship Island has two major historic sites that are in danger from the continuing erosion of the barrier islands. Current studies by the Corps indicate that restoring the two islands to a single island, pre-Camille condition may prevent the rapid erosion of the beaches that is now occurring as well as helping to provide wave erosion on the mainland. Estimates indicated that the total restoration of Ship Island to a single land mass off the Mississippi coast will involve approximately 8 million cubic yards of sand. As happened during Hurricane Camille, the breach was opened during Hurricane Katrina leaving two islands with approximately three miles of open water between the remaining portions. This portion of the island has also been breached during other prior hurricanes and while most of the island has reformed to a low bar over time, it never gained enough sand to form dunes and establish vegetation along this center portion.

Fort Massachusetts is located on the northern shore of West Ship and the French Warehouse is located on the northern shore of East Ship Island. Both of these sites are endangered by on-going erosion of the shoreline with Mississippi Sound. Another site, known as the Quarantine Station, has already been lost to erosion.

Measure H – Comprehensive Measure

This plan is a physical implementation combination of measures C and G.

6.2.3 With-Project Conditions

The benefits attributable to the proposed barrier island measures are those avoided future losses should no action be taken. Implementation of the measures would result in the avoidance of increased surge damages due to amplified wave attack, the preservation of the Mississippi Sound habitat that is vital to both local fisheries and economies, but also a large source of national oyster production, and the continued use of the barrier islands as a recreational resource. Table 6.2-10 shows the estimated NED benefits for each of the barrier island measures and table 6.2-11 shows the EQ benefits by measure. Benefits were quantified where possible and are based on expert elicitation from six interviews conducted with project delivery team members and knowledgeable federal and state agency contacts.

Table 6.2-10.
NED Benefits by Measures

Measures	Future 3 Avoidance of Increased Surge Damage (Annual $)	Future 4 Avoidance of Increased Surge Damage (Annual $)	Future 5 Avoidance of Increased Surge Damage (Annual $)	Future 6 Avoidance of Increased Surge Damage (Annual $)	Avoidance of Recreation Loss (Annual $)
	NED Benefits				
(No Action)	$0	$0	$0	$0	$0
Measure A	$17,699,600	$17,699,600	$17,699,600	$17,699,600	$466,341
Measure B	$10,831,480	$10,844,920	$12,646,145	$12,661,160	$116,585
Measure C	$9,748,332	$9,760,428	$11,381,531	$11,395,044	$116,585
Measure D	$9,206,758	$8,296,364	$9,674,301	$9,685,787	$116,585
Measure E	$9,206,758	$8,296,364	$9,674,301	$9,685,787	$116,585
Measure F	$7,365,406	$6,637,091	$7,739,441	$7,748,630	$116,585
Measure G	$7,229,600	$7,498,400	$8,082,900	$8,383,200	$233,171
Measure H	$17,699,600	$17,699,600	$17,699,600	$17,699,600	$466,341

1/ Estimates are based on expert or informed opinion and judgment to estimate the extent of the losses avoided in each category.

Table 6.2-11.
EQ Benefits by Measures

Measures	Avoidance Fisheries Landings Lost (Annual Pounds)	Avoidance Fisheries Landings Lost (Annual $)
(No Action)	0	$0
Measure A	183,558,261	$43,618,143
Measure B	36711652	$8,723,629
Measure C	27533739	$6,542,721
Measure D	18355826	$4,361,814
Measure E	18355826	$4,361,814
Measure F	9177913	$2,180,907
Measure G	91779131	$21,809,072
Measure H	183,558,261	$43,618,143

1/ Estimates are based on expert or informed opinion and judgment
to estimate the extent of the losses
avoided in each category.

6.2.4 Summary of Costs

Table 6.2-12 summarizes the rough order magnitude (ROM) costs for potential barrier island measures. IDC was calculated based on a five-year (60 month) construction duration and the FY08 discount rate of 4-7/8-percent. Average annual costs are based on the 4-7/8-percent discount rate and a 100-year period of analysis. There are no estimated direct costs for annual operation and maintenance; however, a maintenance plan does exist and is detailed in the barrier island appendix.

Table 6.2-12.
Total Average Annual Costs by Measure

Measures	Total Implementation Cost ($)[1]	IDC ($)	Total First Cost ($)	Average Annual First Cost ($)	Average Annual O&M Cost ($)	Total Average Annual Costs ($)
(No Action)	$0	$0	$0	$0	$0	$0
Measure A	$942,200,000	$119,317,000	$1,061,517,000	$53,431,000	$0	$53,431,000
Measure B	$1,013,800,000	$128,383,000	$1,142,183,000	$57,491,000	$0	$57,491,000
Measure C	$147,400,000	$18,667,000	$166,067,000	$8,359,000	$0	$8,359,000
Measure D	$14,200,000	$1,798,000	$15,998,000	$805,000	$0	$805,000
Measure E	$39,200,000	$4,965,000	$44,165,000	$2,223,000	$0	$2,223,000
Measure F	$264,500,000	$33,495,000	$297,995,000	$14,999,000	$0	$14,999,000
Measure G	$181,400,000	$22,972,000	$204,372,000	$10,287,000	$0	$10,287,000
Measure H	$328,800,000	$41,639,000	$370,439,000	$18,646,000	$0	$18,646,000

1/ Numbers are rounded to the nearest thousand and are based on ROM costs at an FY-08 price level. The cost estimating appendix shows these in more detail, as well as MCACES costs for the tentatively-recommended plan.

6.2.5 Regional Economic Development (EIFS Model)

The purpose of this analysis is to determine the economic impact of the proposed project measures on business (sale volumes), income, employment, and population of the local area. Each of the measures would affect the local areas of Jackson County, Harrison County and Hancock County Mississippi. The expenditures for the measures are estimated to be $942,200,000 for Measure A, Restore Island Footprint measure, $1,013,800,000 for Measure B, Replenish Littoral Zone (river sand) measure, $147,700,000 for Measure C, Replenish Littoral Zone (offshore sand) measure, $14,200,000 for Measure D, 2-foot Dune with beach sand measure, $39,200,000 for Measure E, 6-foot Dune with plantings measure, $264,500,000 for the Measure F measure and $181,400,000 for Measure G, Restore Ship Island measure. Tables 6.2-10 and 6.2-11 summarize the EIFS model inputs and outputs for the Barrier Island Measures.

Table 6.2-13.
EIFS Model Inputs for Barrier Island Measures

	Measure A	Measure B	Measure C	Measure D	Measure E	Measure F	Measure G	Measure H
Region of Influence (ROI)	Three Counties	Three Counties	Three Counties	Three Counties	Three Counties	Three Counties	Three Counties	Three Counties
Change in Local Expenditures	$942,200,000	$1,013,800,000	$147,400,000	$14,200,000	$39,200,000	$264,500,000	$181,400,000	$328,800,000

Based of the given inputs the outputs are as followed:

Table 6.2-14.
EIFS Model Outputs for Barrier Island Measures

	Measure A	Measure B	Measure C	Measure D	Measure E	Measure F	Measure G	Measure H
Direct Sales Volume	$942,200,000	$1,013,800,000	$147,400,000	$14,200,000	$39,200,000	$264,500,000	$181,400,000	$328,800,000
Induced Sales Volume	$1,347,346,000	$1,449,734,000	$210,782,000	$20,306,000	$56,056,000	$378,235,000	$259,402,000	$470,184,000
Total Sales Volume	$2,289,546,000	$2,463,534,000	$358,182,000	$34,506,000	$95,256,000	$642,735,000	$440,802,000	$798,984,000
Direct Income	$197,936,200	$212,977,800	$30,965,600	$2,983,118	$8,235,085	$55,565,820	$38,108,280	$69,073,880
Induced Income	$283,048,700	$304,558,200	$44,280,810	$4,265,858	$11,776,170	$79,459,120	$54,494,840	$98,775,650
Total Income	$480,984,900	$517,536,000	$75,246,410	$7,248,976	$20,011,255	$135,024,940	$92,603,120	$167,849,530
Direct Employment	5,802	6,243	908	87	241	1,629	1,117	2,025
Induced Employment	8,297	8,928	1,298	125	345	2,329	1,597	2,895
Total Employment	14,099	15,171	2,206	212	586	3,958	2,714	4,920
Local Population	0	0	0	0	0	0	0	0

6.2.6 Summary of Costs and Benefits

Table 6.2-15 summarizes the costs and benefits for the various Barrier Island measures.

Table 6.2-15.
Summary Benefits and Costs by Measures

	Measure A	Measure B	Measure C	Measure D	Measure E	Measure F	Measure G	Measure H
National Economic Development Benefits								
Future 3 Damages Avoided (Annual $)	$17,699,600	$10,831,480	$9,748,332	$9,206,758	$9,206,758	$7,365,406	$7,229,600	$17,699,600
Future 4 Damages Avoided (Annual $)	$17,699,600	$10,844,920	$9,760,428	$8,296,364	$8,296,364	$6,637,091	$7,498,400	$17,699,600
Future 5 Damages Avoided (Annual $)	$17,699,600	$12,646,145	$11,381,531	$9,674,301	$9,674,301	$7,739,441	$8,082,900	$17,699,600
Future 6 Damages Avoided (Annual $)	$17,699,600	$12,661,160	$11,395,044	$9,685,787	$9,685,787	$7,748,630	$8,383,200	$17,699,600
Recreation Losses Avoided (Annual $)	$466,341	$116,585	$116,585	$116,585	$116,585	$116,585	$233,171	$466,341
Environmental Quality Benefits								
Fishery Losses Avoided ($)	$43,618,143	$8,723,629	$6,542,721	$4,361,814	$4,361,814	$2,180,907	$21,809,072	$43,618,143

Table 6.2-15.
Summary Benefits and Costs by Measures (continued)

	Measure A	Measure B	Measure C	Measure D	Measure E	Measure F	Measure G	Measure H
Regional Economic Development Benefits								
Change in Sales Volume	$2,289,546,000	$2,463,534,000	$358,182,000	$34,506,000	$95,256,000	$642,735,000	$440,802,000	$798,984,000
Change in Income	$480,984,900	$517,536,000	$75,246,410	$7,248,976	$20,011,255	$135,024,940	$92,603,120	$167,849,530
Change in Employment	14,099	15,171	2,206	212	586	3,958	2,714	4,920
Average Annual Costs including IDC								
Average Annual Cost	$53,431,000	$57,491,000	$8,359,000	$805,000	$2,223,000	$14,999,000	$10,287,000	$18,646,000

6.3 Evaluation of Beach and Dune Construction Measures

6.3.1 Planning Unit One

6.3.1.1 Background

The beaches of Hancock County are approximately 9 miles in length, and host one of the Gulf Coast's largest populations of Least Tern, a Federally-listed endangered species, plus a significant number of Piping Plover. The beaches possessed a vegetated dune system (pre-Katrina) that was maintained by local interests and supported a significant ecosystem, in addition to passive recreation usage outside the dune system. This dune system provided not only ecosystem benefits, but some measure of hurricane or storm damage reduction due to its ability to absorb some of the surge and wave energy during those types of events. During Hurricane Katrina, this dune system was almost entirely destroyed by surge and wave action. Almost all ecosystem functions and values were eliminated during this single event. Much of the sand removed is believed to be close off shore in the near shore zone. The MsCIP Interim Chiefs Report recommended that a beach and dune placement project be constructed in planning unit one. The interim project consists of the following: (1) replacing approximately 43,800 cubic yards of lost sand dune material, (2) placing 37,000 linear feet of stabilizing sand fence, and (3) planting 19.3 acres of dune vegetation. Figures 6.3-1 and 6.3-2 show the project location and extent for planning unit one.

6.3.1.1.1 Opportunities

The following opportunities were identified for this area:

- Hurricane storm damage reduction or remediation
- Preservation of Fish & Wildlife and restoration of their habitats
- Prevention or remediation of erosion
- Other related water resource purposes, such as ecosystem restoration or barrier island restoration

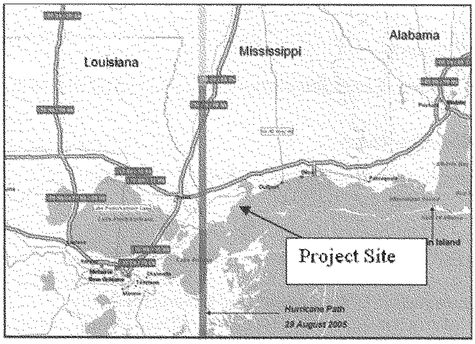


Figure 6.3-1. Project Sites for LOD2 in Planning Unit One

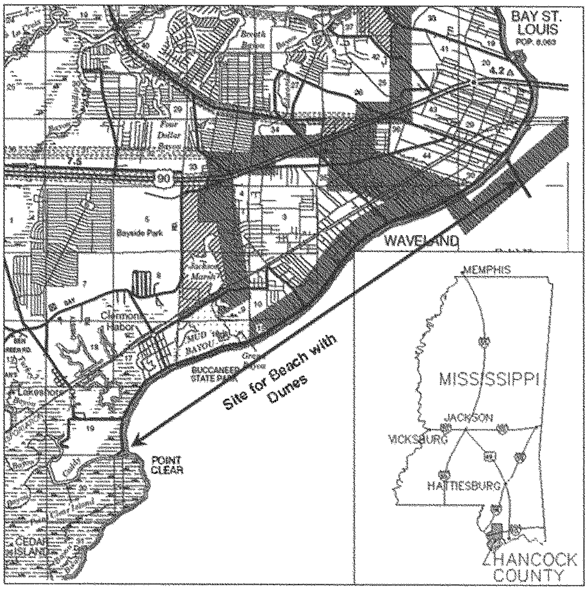


Figure 6.3-2. Project Limits for Line of Defense 2 in Planning Unit One

6.3.1.2 General Assumptions

The following assumptions were used in this analysis.

- The FY 2008 discount rate of 4-7/8 percent was used in estimating average annual benefits and costs,
- Price levels are October, 2007 unless otherwise stated,
- A 50-year period of analysis was used to calculate average annual benefits and costs.

6.3.1.3 Measures

Eleven measures were evaluated for enhanced beach protection at the study site. All involve providing a dune and berm to the location. Some of the measures, Measures A through H described below, can not be constructed without the construction of the Seawall and Elevated roadway measure, which is evaluated in great detail later in this appendix. The measures for Line of Defense 2 in planning unit one are as follows:

- Measure A consists of a 10.0 feet NAVD88 dune elevation, 40.0 feet dune crest width, with a dune slope of 1:3, and a berm with an 80.0 feet width, an upper berm elevation of 5.5 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10. This measure is dependent on the elevated roadway and seawall and could not be implemented as a stand alone measure.
- Measure B consists of an 8.0 feet NAVD88 dune elevation, 50.0 feet dune crest width, with a dune slope of 1:3, and a berm with an 80.0 feet width, an upper berm elevation of 5.5 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10. This measure is dependent on the elevated roadway and seawall and could not be implemented as a stand alone measure.
- Measure C consists of a 10.0 feet NAVD88 dune elevation, 20.0 feet dune crest width, with a dune slope of 1:3, and a berm with a 100.0 feet width, an upper berm elevation of 5.5 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10. This measure is dependent on the elevated roadway and seawall and could not be implemented as a stand alone measure.
- Measure D consists of an 8.0 feet NAVD88 dune elevation, 30.0 feet dune crest width, with a dune slope of 1:3, and a berm with a 100.0 feet width, an upper berm elevation of 5.5 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10. This measure is dependent on the elevated roadway and seawall and could not be implemented as a stand alone measure.
- Measure E consists of a 10.0 feet NAVD88 dune elevation, 40.0 feet dune crest width, with a dune slope of 1:3, and a berm with an 80.0 feet width, an upper berm elevation of 5.5 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10. In addition, sea oats would be planted on the seaward dune face in an 18 by 18 inch grid pattern, with a total of three rows starting at the seaward toe of the dune. This measure is dependent on the elevated roadway and seawall and could not be implemented as a stand alone measure.
- Measure F consists of an 8.0 feet NAVD88 dune elevation, 50.0 feet dune crest width, with a dune slope of 1:3, and a berm with an 80.0 feet width, an upper berm elevation of 5.5 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10. In addition, sea oats would be planted on the seaward dune face in an 18 by 18 inch grid pattern, with a total of three rows starting at the seaward toe of the dune. This measure is dependent on the elevated roadway and seawall and could not be implemented as a stand alone measure.

- Measure G consists of a 10.0 feet NAVD88 dune elevation, 20.0 feet dune crest width, with a dune slope of 1:3, and a berm with a 100.0 feet width, an upper berm elevation of 5.5 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10. In addition, sea oats would be planted on the seaward dune face in an 18 by 18 inch grid pattern, with a total of three rows starting at the seaward toe of the dune. This measure is dependent on the elevated roadway and seawall and could not be implemented as a stand alone measure.
- Measure H consists of an 8.0 feet NAVD88 dune elevation, 30.0 feet dune crest width, with a dune slope of 1:3, and a berm with a 100.0 feet width, an upper berm elevation of 5.5 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10. In addition, sea oats would be planted on the seaward dune face in an 18 by 18 inch grid pattern, with a total of three rows of starting at the seaward toe of the dune. This measure is dependent on the elevated roadway and seawall and could not be implemented as a stand alone measure. Figure 6.3-3 shows a typical cross section for Measures A though H.

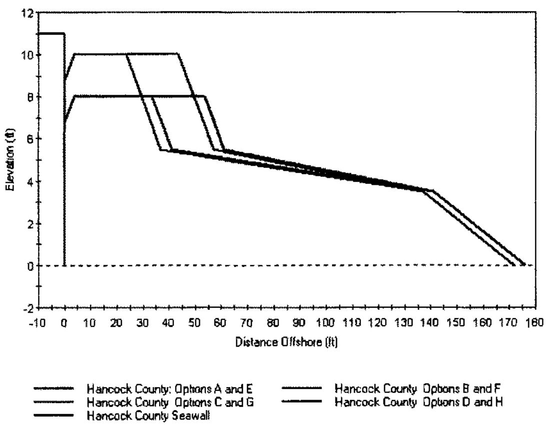


Figure 6.3-3. Typical Cross Section for Measures A through H

- Measures I and J are comparative with-project measures, for future evaluation, consisting of a design cross-section which includes a dune and berm constructed as a stand alone project which does not incorporate the Line of Defense 3 seawall. Measure I consists of a dune feature constructed approximately 50.0 feet seaward of the seawall at an elevation of 10.0 feet NAVD 88, with a crest width of 55.0 feet, and a dune slope of 1:3. The berm width would be extended to accommodate the placement of the dune feature. Sand fencing would be placed on the dunes to reduce sand transport due to the strong winds which frequently occur during storms. The cross section for Measure J is the same as Measure I; however the dune would be planted to provide for additional environmental habitat. For Measure J, sea oats would be planted on both the landward and seaward dune face in an 18 by 18 inch grid pattern, with a total of three rows of planted starting at the landward and seaward toes of the dune. The dunes will require initial and continued maintenance of vegetation and sand fencing. These measures are intended to be stand alone and are not dependent on the elevated roadway and seawall that is described in section 6.4.

- Measure K is also a measure for future evaluation which consists of an elevated berm section constructed primarily for the creation of environmental habitat. Measure K would be constructed as a stand alone measure which does not incorporate the Line of Defense 3 seawall. The elevated berm section would be constructed approximately 50.0 feet seaward of the existing seawall to an elevation 2.0 feet NAVD88 above the existing berm with a width of approximately 60.0 feet. The berm width would not be extended to accommodate the placement of the elevated berm feature. The new feature would be vegetated and sand fencing would be placed to create environmental habitat and to reduce sand transport due to the strong winds which frequently occur during storms. For Measure K, sea oats would be planted in a 30 by 30 inch grid pattern over the entire elevated berm area. The new feature will require initial and continued maintenance of vegetation and sand fencing. This measure is intended to be a stand alone and is not dependent on the elevated roadway and seawall that is described in section 6.4.

6.3.1.4 National Economic Development (NED)

This section describes the National Economic Development benefits for the various beach and dune placement measures in planning unit one that are attributable to hurricane and storm damage reduction. National economic development benefits are damages to structures and their contents that are reduced when a measure or alternative is implemented, or the difference between the with-project and without-project conditions.

There are two types of beach and dune placement measures for planning unit one; those that are dependent on the seawall and elevated roadway and those that can be implemented as stand alone measures. Those measures dependent on the seawall and elevated roadway, measures A through H, would be implemented to abut the seawall and elevated roadway and would be constructed to a maximum elevation of 1.0 foot lower than the seawall and elevated roadway, or to elevation 10.0 feet NAVD88, thus acting as a system. For these measures, equivalent annual damage reduction would be limited to structures that are physically located south of Beach Boulevard, since seawall and elevation of that roadway would be higher than the dune system itself. A visual description of this system can be seen above in figure 6.3-3. The remaining measures I, J, and K are stand alone, and would be implemented in lieu of the seawall and elevated roadway with dune system. The equivalent annual damage reduction attributable to the stand alone measures would impact structures located south of Beach Boulevard in planning unit one and some footprint of structures north of beach boulevard. Also, all beach and dune placement measures would provide some level of protection to the seawall and roadways that they abut, but those benefits are difficult to quantify and were not conducted in this analysis.

The Beach-FX program was selected to quantify the damage reduction benefits of all of the beach and dune placement measures. Beach-FX is a Monte Carlo based model that combines coastal processes economic conditions to evaluate damages from storm events and the level of damage reduction that would be attributable to a given measure. Chapter III of this appendix depicts the overall process of the Beach-FX evaluation. For this study, the exploration of the costal processes and economic inventorying was conducted. Further study would be required to combine the observed data and to evaluate the eleven alternatives previously mentioned. More detail on the further study can be found in the MsCIP Comprehensive Plan Main Report. Table 6.3-1 summarizes the costs by measure.

Summary of Costs

Table 6.3-1 summarizes the ROM costs at an FY-08 price level for the beach and dune placement measures for planning unit one.

Table 6.3-1.
Summary of Beach and Dune Costs by Measure for Planning Unit One

Measures	Implementation Cost ($)	IDC ($)	Total Implementation Cost ($)	Average Annual Implementation Cost ($)	Average Annual O&M ($)	Total Average Annual Costs ($)
(No Action)	$0	$0	$0	$0	$0	$0
Measure A[1] (10FT by 40FT Dune no plantings)	$8,070,000	$178,700	$8,248,700	$443,139	$2,167,694	$2,610,833
Measure B[1] (8FT by 50FT Dune no plantings)	$6,100,000	$134,900	$6,234,900	$334,953	$1,638,530	$1,973,483
Measure C[1] (10FT by 20ft Dune no plantings)	$4,960,000	$109,600	$5,069,600	$272,350	$1,332,313	$1,604,663
Measure D[1] (8FT by 30FT Dune no plantings)	$4,030,000	$89,200	$4,119,200	$221,293	$1,082,504	$1,303,797
Measure E[1] (10FT by 40FT Dune with plantings)	$8,400,000	$185,900	$8,585,900	$461,254	$2,256,336	$2,717,590
Measure F[1] (8FT by 50FT Dune with plantings)	$6,440,000	$142,500	$6,582,500	$353,627	$1,729,857	$2,083,484
Measure G[1] (10FT by 20ft Dune with plantings)	$5,300,000	$117,300	$5,417,300	$291,030	$1,423,640	$1,714,670
Measure H[1] (8FT by 30FT Dune with plantings)	$4,360,000	$96,400	$4,456,400	$239,408	$1,171,146	$1,410,554
Measure I (10FT by 50FT Dune without plantings)	$19,100,000	$422,600	$19,522,600	$1,048,799	$5,130,478	$6,179,277
Measure J (10FT by 50FT Dune with plantings)	$19,450,000	$430,300	$19,880,300	$1,068,015	$5,224,492	$6,292,507
Measure K (2FT by 60FT Dune with plantings)	$4,640,000	$102,600	$4,742,600	$254,783	$0	$254,783

1/ Denotes measures that could not be implemented without the construction of the seawall, which is discussed in section 6.4.
2/ Cost include Construction Management, Supervision & Administration, and Contingencies. More detail on the costs can be found in the Cost Estimating Appendix.

6.3.1.6 National Ecosystem Restoration (NER)

The P&G defines the environmental quality account as, "displays of non-monetary effects on ecological, cultural, and aesthetic resources…" The EQ account is typically associated with ecosystem restoration projects, although it does address the following:

Cost Effective Analysis

The justification for the proposed section is evaluated on a cost effective and incremental cost basis in accordance with guidelines contained in ER 1105-2-100, *Planning – Planning Guidance Notebook*. The Corps' ecosystem restoration policy is described in more detail in ER 1165-2-501, *Water Resources Policies and Authorities – Civil Works Ecosystem Restoration Policy;* and EP 1165-2-501, *Water Resources Policies and Authorities – Ecosystem Restoration – Supporting Policy Information*. As cited in the *Planning Guidance Notebook*, Cost Effectiveness and Incremental Cost Analyses procedures are detailed in IWR Report 94-PS-2, Cost Effectiveness Analysis for Environmental Planning: Nine EASY steps; IWR Report 95-R-1, *Evaluation of Environmental Investments Procedures Manual Interim: Cost Effectiveness and Incremental Cost Analyses; and IWR Report 98-R-1, Making More Informed Decisions in Your Watershed When Dollars aren't Enough*. The analysis compares the cost effectiveness of the five measures based on their environmental outputs to determine the selected measure. Note: this section is intended to identify the cost effective environmental measures that can be constructed with the elevated roadway and seawall. Since measures I, J, and K are concept measures at the time of this report, and they were formulated based on reducing flood damages to be stand alone measures, they will automatically be carried forward for further consideration.

6.3.1.6.1 Cost Effective Analysis Assumptions

This analysis assumes a 50-year project life. Costs were amortized using the FY 2008 federal discount rate of 4.875-percent and are presented at October 2008 price levels. The outputs quantified in this cost effective analysis are defined as the quantification of expected improvements in target functions as related to project objectives (functional habitat index, FHI). FHI scores were based on an assessment protocol, which provide a basic level of stream health evaluation that is based on physical conditions within the assessment area. The assessment is used to record the scores for up to 15 assessment elements (i.e., channel condition, hydrologic alteration, riparian zone, bank stability, water appearance, nutrient enrichment, barriers to fish movement, instream fish cover, pools, insect/invertebrate habitat, canopy cover [warm water fishery], manure presence, salinity, riffle embeddedness, and macroinvertebrates observed). However, all assessment elements were not applicable to the assessment area and were not included.

The first step in cost-effective analysis is to display the environmental outputs (effects on habitat expressed in Functional Habitat Index, FHI) and the cost estimates of the management measure increments. Outputs and costs are displayed as average annual outputs and average annual costs. Both are acceptable so long as they are comparable. Average annual outputs and average annual costs were used for this analysis.

Table 6.3-2 displays the project measures and their associated average annual outputs and average annual costs. Project outputs for each measure are displayed in terms of functional habitat index (FHI) that can be supported for each measure considered.

Table 6.3-2.
Outputs and Costs by Measure

Measures	Annualized Implementation Cost ($)	Annual O&M ($)	Total Annual Cost ($)	Total Annual Output (FHI)
Measure AA (No Action)	$0	$0	$0	0
Measure A	$443,139	$2,167,694	$2,610,833	142
Measure B	$334,953	$1,638,530	$1,973,483	172
Measure C	$272,350	$1,332,313	$1,604,663	142
Measure D	$221,293	$1,082,504	$1,303,797	154
Measure E	$461,254	$2,256,336	$2,717,590	304
Measure F	$353,627	$1,729,857	$2,083,484	330
Measure G	$291,030	$1,423,640	$1,714,670	250
Measure H	$239,408	$1,171,146	$1,410,554	276

The second step in incremental analysis is to identify combinable management measures. This involves the analysis of the management measures to determine those that can be implemented together from those that cannot be implemented together. Each of the measures in this analysis is independent of the others. After the selection of one of the measures, the other measures are not needed; therefore the measures are not combinable.

The next step is to calculate outputs and costs of combinations. The combinations of the management measures are defined and analyzed incrementally. In this step, each combination of output (FHI) and cost ($) is calculated. However, since the measures cannot be combined, this step is not necessary in this case.

Eliminating economically inefficient solutions is the fourth step in incremental analysis. In order to do this, the list of solutions is reordered so that they are listed in ascending order of their outputs. Where two or more solutions produce the same output, the solutions are ranked in ascending order of their costs. The result is a ranking of measures AA, A, C, D, B, G, H, E, and F as displayed below in table 6.3-3. At each level of output the least cost measure is determined. Measure A was identified as an inefficient measure because it provides the same output as measure C for a greater cost. Measure A will not be carried forward in this analysis.

Table 6.3-3.
List of Efficient Measures

Measures	Total Annual Cost ($)	Total Annual Output (FHI)
Measure AA (No Action)	$0	0
Measure A	$2,610,833	142
Measure C	$1,604,663	142
Measure D	$1,303,797	154
Measure B	$1,973,483	172
Measure G	$1,714,670	250
Measure H	$1,410,554	276
Measure E	$2,717,590	304
Measure F	$2,083,484	330

The fifth step in incremental analysis is to eliminate economically ineffective solutions. The outputs and costs undergo a pair-wise comparison. The results of the comparison are analyzed to determine which solutions will produce less output at equal or greater cost than subsequently ranked solutions. Those solutions that will produce less output at equal or greater cost than subsequently ranked solutions are deleted. Measures C, B, G, and E were eliminated because they were found to be ineffective solutions. Measure C was eliminated because measure D produces more output for less cost than measure C, measures B and G were eliminated because measure H produces more output for less cost, and measure E was eliminated because measure F produces more output for less cost. Table 6.3-4 summarizes the results of step five.

Table 6.3-4.
List of Effective Measures

Measures	Total Annual Cost ($)	Total Annual Output (FHI)
Measure AA (No Action)	$0	0
Measure C	$1,604,663	142
Measure D	$1,303,797	154
Measure B	$1,973,483	172
Measure G	$1,714,670	250
Measure H	$1,410,554	276
Measure E	$2,717,590	304
Measure F	$2,083,484	330

Step six calculates the average cost of each of the cost effective solutions and eliminates those measures that yield less output at a higher cost than the measure with the lowest average cost per functional habitat index (FHI). Step seven repeats step six to further screen measures. Steps eight and nine perform an incremental cost analysis on the measures that were moved forward after going through steps six and seven.

Traditionally, these steps are part of the incremental analysis portion of the "Nine Easy Steps" and are performed on the remaining measures. However, since the Congressional Authority that was given to do the MsCIP Comprehensive study specifically directs the Corps of Engineers not to conduct Incremental Cost Analysis, this analysis will conclude at step six, with measures D, H and F moving forward for further consideration. Table 6.3-5 shows the environmentally cost effective measures for beach and dune placement for planning unit one that will be carried forward for further comparison.

Table 6.3-5.
List of Cost Effective Measures for Planning Unit One

Measures	Total Annual Cost ($)	Total Annual Output (FHI)
Measure AA (No Action)	$0	0
Measure D	$1,303,797	154
Measure H	$1,410,554	276
Measure F	$2,083,484	330
Measure I	$6,179,277	136
Measure J	$6,292,507	216
Measure K	$254,783	248

6.3.1.7 Regional Economic Development (RED)

The purpose of this section is to show the regional economic impact of the cost effective measures on business (sale volumes), income, employment, and population of the local area. Each of the measures would affect the local area of Hancock County, Mississippi. The expenditures for the measures are estimated to be $4,030,000 for the Measure D measure, $6,440,000 for the Measure F measure, $4,360,000 for the Measure H measure, $19,100,000 for the Measure I measure, $19,450,000 for the Measure J measure and $4,640,000 for the Measure K measure. Moreover, the total present worth of the operation and maintenance (O&M) expenditures are estimated to be $20,150,000 for the measure D, $32,200,000 for the measure F, $21,800,000 for the measure H, $95,500,000 for the measure I, $97,520,000 for the Measure J measure and $0 for the Measure K measure (assuming a 50-year period of analysis and an interest rate of 4.875 percent). Tables 6.3-6 through 6.3-9 summarize the EIFS model inputs and outputs for the beach and dune placement measures at for Planning Unit One.

Table 6.3-6.
EIFS Model Implementation Inputs for LOD2

	Measure D	Measure F	Measure H	Measure I	Measure J	Measure K
Region of Influence (ROI)	Hancock County	Hancock County	Hancock County	Hancock County	Hancock County	Hancock County
Change in Local Expenditures	$4,030,000	$6,440,000	$4,360,000	$19,100,000	$19,450,000	$4,640,000

Based of the given inputs the outputs are as follows:

Table 6.3-7.
EIFS Model Implementation Outputs for LOD2

	Measure D	Measure F	Measure H	Measure I	Measure J	Measure K
Direct Sales Volume	$4,030,000	$6,440,000	$4,360,000	$19,100,000	$19,450,000	$4,640,000
Induced Sales Volume	$4,030,000	$6,440,000	$4,360,000	$19,100,000	$19,450,000	$4,640,000
Total Sales Volume	$8,060,000	$12,880,000	$8,720,000	$38,200,000	$38,900,000	$9,280,000
Direct Income	$971,774	$1,552,910	$1,051,349	$4,605,680	$4,690,077	$1,118,867
Induced Income	$971,774	$1,552,910	$1,051,349	$4,605,680	$4,690,077	$1,118,867
Total Income	$1,943,549	$3,105,820	$2,102,698	$9,211,359	$9,380,154	$2,237,733
Direct Employment	24	39	26	116	118	28
Induced Employment	24	39	26	116	118	28
Total Employment	49	78	53	231	235	56
Local Population	0	0	0	0	0	0

Table 6.3-8.
EIFS Model Operation and Maintenance Cost Inputs for LOD2

	Measure D	Measure F	Measure H	Measure I	Measure J	Measure K
Region of Influence (ROI)	Hancock County	Hancock County	Hancock County	Hancock County	Hancock County	Hancock County
Change in Local Expenditures	$20,150,000	$32,200,000	$21,800,000	$95,500,000	$97,250,000	$0

Based of the given inputs the outputs are as follows:

Table 6.3-9.
EIFS Model Operation and Maintenance Cost Outputs for LOD2

	Measure D	Measure F	Measure H	Measure I	Measure J	Measure K
Direct Sales Volume	$20,150,000	$32,200,000	$21,800,000	$95,500,000	$97,250,000	$0
Induced Sales Volume	$20,150,000	$32,200,000	$21,800,000	$95,500,000	$97,250,000	$0
Total Sales Volume	$40,300,000	$64,400,000	$43,600,000	$191,000,000	$194,500,000	$0
Direct Income	$4,858,871	$7,764,549	$5,256,744	$23,028,398	$23,450,385	$0
Induced Income	$4,858,871	$7,764,549	$5,256,744	$23,028,398	$23,450,385	$0
Total Income	$9,717,743	$15,529,098	$10,513,489	$46,056,796	$46,900,769	$0
Direct Employment	122	195	132	578	588	0
Induced Employment	122	195	132	578	588	0
Total Employment	244	390	264	1156	1177	0
Local Population	0	0	0	0	0	0

6.3.1.8 Summary of Cost Effective Measures and their Benefits

Table 6.3-10 shows the potential measures that are being carried forward for further consideration. Measures D, H, and F are beach and dune placement measures that depend on the construction of the seawall in order to be implemented. Measures I, J, and K are stand alone measures that do not depend on the seawall and elevated roadway for implementation.

Table 6.3-10.
List of Cost Effective Measures Carried Forward for Further Consideration
Planning Unit One

Measures	Total Annual Cost ($)	Environmental Output (FHI)	Change in Sales Volume	Change in Income	Change in Employment
Measure AA (No Action)	$0	0	$0	$0	0
Measure D	$1,303,797	154	$48,360,000	$11,661,292	293
Measure H	$1,410,554	276	$52,320,000	$12,616,186	317
Measure F	$2,083,484	330	$77,280,000	$18,634,917	468
Measure I	$6,179,277	136	$229,200,000	$55,268,156	1,387
Measure J	$6,292,507	216	$233,400,000	$56,280,923	1,412
Measure K	$254,783	248	$9,280,000	$2,237,733	56

6.3.1.9 Public Access and Parking

An analysis of public access and parking was conducted on the sections where beach and dune construction would take place. It was determined that planning unit one has sufficient access and parking to satisfy the requirements established in Engineering Regulation (ER) 1165-2-100. Planning unit one has access along the entire stretch of beach with 592 parking spaces that are available to everyone for no cost. Addendum C describes the result of the access and parking analysis in greater detail.

6.3.2 Panning Unit Two

6.3.2.1 Background

The beaches of Hancock County are approximately 9 miles in length, and host one of the Gulf Coast's largest populations of Least Tern, a Federally-listed endangered species, plus a significant number of Piping Plover. The beaches possessed a dune system (pre-Katrina) that was maintained by local interests, that was vegetated and supported a significant ecosystem, in addition to passive recreation usage outside the dune system. This dune system provided not only ecosystem benefits, but some measure of hurricane or storm damage reduction due to its ability to absorb some of the surge and wave energy during those types of events. During Hurricane Katrina, this dune system was almost entirely destroyed by surge and wave action. Almost all ecosystem functions and values were eliminated during this single event. Much of the sand removed is believed to be close off shore in the near shore zone. The MsCIP Interim Chief's Report recommended that a beach and dune placement project be constructed in Panning Unit 3. This interim project consists of restoring approximately 26 miles of dune systems that were destroyed by Hurricane Katrina. The proposed project area for planning unit two is shown in figures 6.3.2-1 through 6.3.2-3.

6.3.2.1.1 Opportunities

The following opportunities were identified for this area:

- Hurricane storm damage reduction or remediation
- Prevention or remediation of Saltwater Intrusion
- Preservation of Fish & Wildlife and restoration of their habitats
- Prevention or remediation of erosion
- Other related water resource purposes, such as ecosystem restoration or barrier island restoration

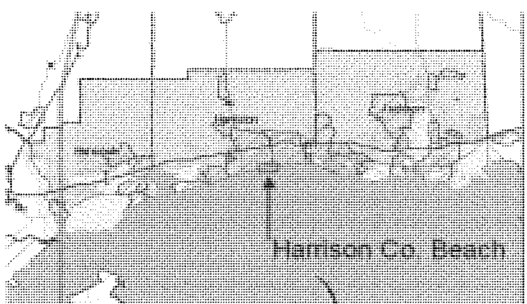


Figure 6.3.2-1. Project Sites for LOD2 in Panning Unit 2

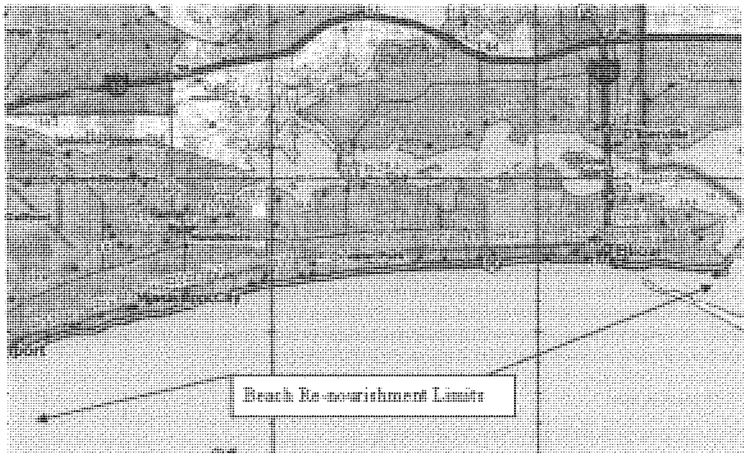


Figure 6.3.2-2. Eastern Project Limits for Line of Defense 2 in Panning Unit 2

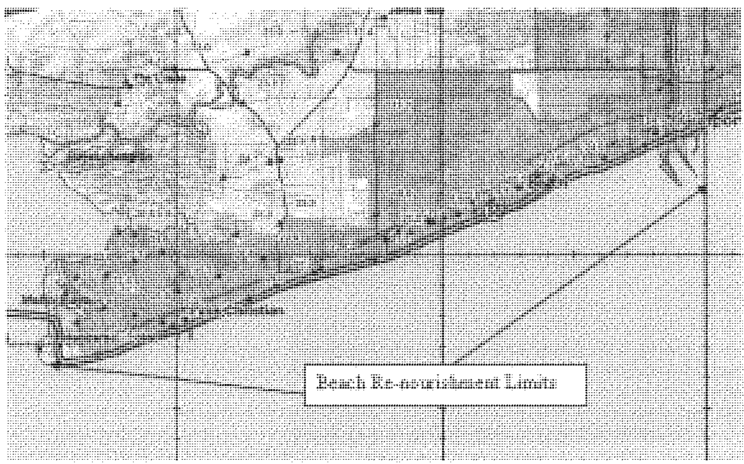


Figure 6.3.2-3. Western Project Limits for Line of Defense 2 in Panning Unit 2

6.3.2.2 General Assumptions

The following assumptions were used in this analysis.

- The FY 2008 discount rate of 4-7/8 percent was used in estimating average annual benefits and costs
- Price levels are October, 2007 unless otherwise stated.
- A 50-year period of analysis was used to calculate average annual benefits and costs.

6.3.2.3 Measures

Eleven plans were evaluated for enhanced beach protection at the study site. All involve providing a dune and berm to the location. Some of the alternatives, Measures A through H described below, can not be constructed without the construction of the Seawall and Elevated roadway measure, which is evaluated in great detail later in this appendix. The measures for Line of Defense 2 in Panning Unit 2 are as follows:

- Measure A consists of a 15.0 feet NAVD88 dune elevation, 35.0 feet dune crest width, with a dune slope of 1:3, and a berm with a 160.0 feet width, an upper berm elevation of 7.2 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10.
- Measure B consists of a 13.0 feet NAVD88 dune elevation, 45.0 feet NAVD88 dune crest width, with a dune slope of 1:3, and a berm with a 160.0 feet width, an upper berm elevation of 7.2 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10.
- Measure C consists of a 15.0 feet NAVD88 dune elevation, 25.0 feet dune crest width, with a dune slope of 1:3, and a berm with a 170.0 feet width, an upper berm elevation of 7.2 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10.
- Measure D consists of a 13.0 feet NAVD88 dune elevation, 15.0 feet dune crest width, with a dune slope of 1:3, and a berm with a 160.0 feet width, an upper berm elevation of 7.2 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10.
- Measure E consists of a 15.0 feet NAVD88 dune elevation, 35.0 feet dune crest width, with a dune slope of 1:3, and a berm with a 160.0 feet width, an upper berm elevation of 7.2 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10. In addition, sea oats would be planted on the seaward dune face in an 18 by 18 inch grid pattern, with a total of three rows of plants starting at the seaward toe of the dune.
- Measure F consists of a 13.0 feet NAVD88 dune elevation, 45.0 feet dune crest width, with a dune slope of 1:3, and a berm with a 160.0 feet width, an upper berm elevation of 7.2 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10. In addition, sea oats would be planted on the seaward dune face in an 18 by 18 inch grid pattern, with a total of three rows of plants starting at the seaward toe of the dune.
- Measure G consists of a 15.0 feet NAVD88 dune elevation, 25.0 feet dune crest width, with a dune slope of 1:3, and a berm with a 170.0 feet width, an upper berm elevation of 7.2 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10. In addition, sea oats would be planted on the seaward dune face in an 18 by 18 inch grid pattern, with a total of three rows of plants starting at the seaward toe of the dune.
- Measure H consists of a 13.0 feet NAVD88 dune elevation, 15.0 feet dune crest width, with a dune slope of 1:3, and a berm with a 160.0 feet width, an upper berm elevation of 7.2 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10. In addition, sea oats would be planted on the seaward dune face in an 18 by 18 inch grid pattern,

with a total of three rows of plants starting at the seaward toe of the dune. Figure 6.3.2-4 shows a typical cross section for Measures A though H.

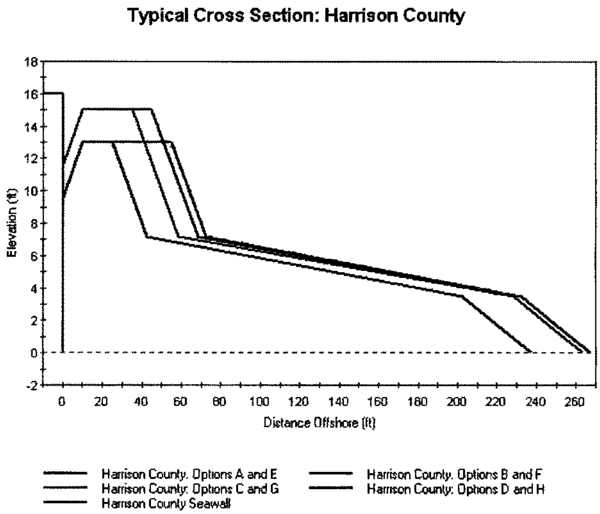


Figure 6.3.2-4. Typical Cross Section for Measures A through H

- Measures I and J are comparative with-project measures, for future evaluation, consisting of a design cross-section which includes a dune and berm constructed as a stand alone project which does not incorporate the Line of Defense 3 seawall. Measure I consists of a dune feature constructed approximately 50.0 feet seaward of the seawall at an elevation of 15.0 feet NAVD 88, with a crest width of 55.0 feet, and a dune slope of 1:3. The berm width would be extended to accommodate the placement of the dune feature. Sand fencing would be placed on the dunes to reduce sand transport due to the strong winds which frequently occur during storms. The cross section for Measure J is the same as Measure I; however the dune would be planted to provide for additional environmental habitat. For Measure J, sea oats would be planted on both the landward and seaward dune face in an 18 by 18 inch grid pattern, with a total of three rows of plants starting at the landward and seaward toes of the dune. The dunes will require initial and continued maintenance of vegetation and sand fencing. A typical cross section for Measures I and J is shown in Figure 6.3.2-5.

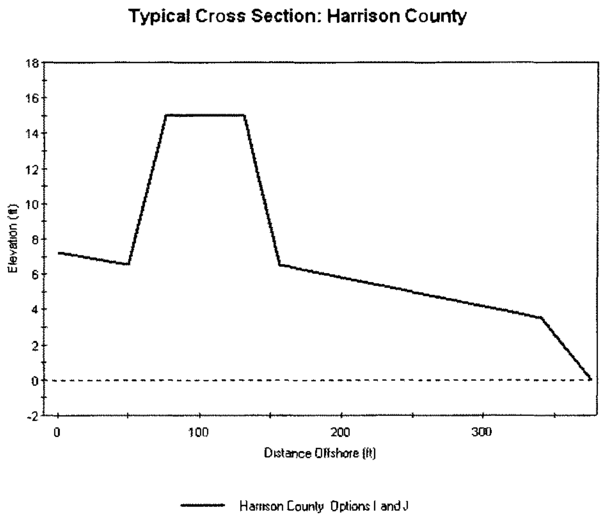


Figure 6.3.2-5. Typical Cross Section for Measures I and J

- Measure K is also a measure for future evaluation which consists of an elevated berm section constructed primarily for the creation of environmental habitat. Measure K would be constructed as a stand alone measure which does not incorporate the Line of Defense 3 seawall. The elevated berm section would be constructed approximately 50.0 feet seaward of the existing seawall to an elevation 2.0 feet above the existing berm with a width of approximately 60.0 feet. The berm width would not be extended to accommodate the placement of the elevated berm feature. The new feature would be vegetated and sand fencing would be placed to create environmental habitat and to reduce sand transport due to the strong winds which frequently occur during storms. For Measure K, sea oats would be planted in a 30 by 30 inch grid pattern over the entire elevated berm area. The new feature will require initial and continued maintenance of vegetation and sand fencing. A typical cross section for Measure K is shown in Figure 6.3.2-6.

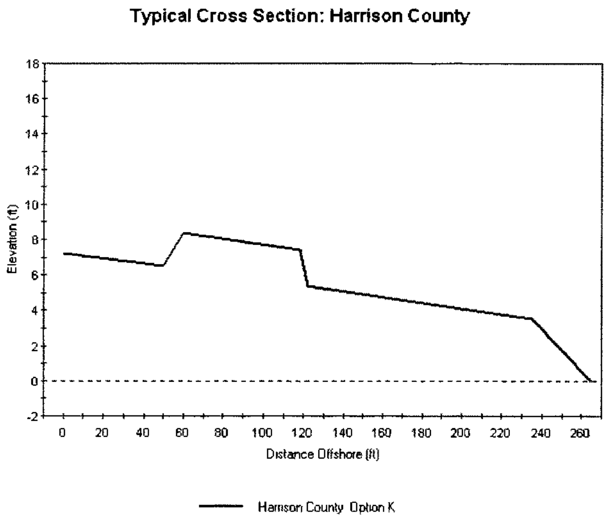


Figure 6.3.2-6. Typical Cross Section for Measure K

6.3.2.4 National Economic Development (NED)

This section describes the National Economic Development benefits for the various beach and dune placement measures in planning unit two that are attributable to hurricane and storm damage reduction. National economic development benefits are damages to structures and their contents that are reduced when a measure or alternative is implemented, or the difference between the with-project and without-project conditions.

There are two types of beach and dune placement measures for planning unit two; those that are dependent on the seawall and elevated roadway and those that can be implemented as stand alone measures. Those measures dependent on the seawall and elevated roadway, measures A through H, would be implemented to abut the seawall and elevated roadway and would be constructed to a maximum elevation of 1.0 foot lower than the seawall and elevated roadway, or to elevation 15.0 feet NAVD88, thus acting as a system. For these measures, equivalent annual damage reduction would be limited to structures that are physically located south of Beach Boulevard, since seawall and elevation of that roadway would be higher than the dune system itself. A visual description of this system can be seen above in figure 6.3-7. The remaining measures I, J, and K are stand alone, and would be implemented in lieu of the seawall and elevated roadway with dune system. The equivalent annual damage reduction attributable to the stand alone measures would impact structures located south of Beach Boulevard in planning unit two and some footprint of structures north of beach boulevard. Also, all beach and dune placement measures would provide some level of protection to the seawall and roadways that they abut, but those benefits are difficult to quantify and were not conducted in this analysis.

The Beach-FX program was selected to quantify the damage reduction benefits of all of the beach and dune placement measures. Beach-FX is a Monte Carlo based model that combines coastal processes economic conditions to evaluate damages from storm events and the level of damage reduction that would be attributable to a given measure. Chapter III of this appendix depicts the overall process of the Beach-FX evaluation. For this study, the exploration of the costal processes and economic inventorying was conducted. Further study would be required to combine the observed data and to evaluate the eleven alternatives previously mentioned. More detail on further study can be found in the MsCIP Comprehensive Plan Main Report. Table 6.3.2-1 summarizes the costs by measure for planning unit two.

6.3.2.6 National Ecosystem Restoration (NER)

The P&G defines the environmental quality account as, "displays of non-monetary effects on ecological, cultural, and aesthetic resources..." The EQ account is typically associated with ecosystem restoration projects, although it does address the following:

6.3.2.6.1 Cost Effective Analysis Assumptions

This analysis assumes a 50-year project life. Costs were amortized using the FY 2008 federal discount rate of 4.875-percent and are presented in October 2007 dollars. The outputs quantified in this cost effective analysis are defined as the quantification of expected improvements in target functions as related to project objectives (functional habitat index, FHI). FHI scores were based on an assessment protocol, which provide a basic level of stream health evaluation that is based on physical conditions within the assessment area. The assessment is used to record the scores for up to 15 assessment elements (i.e., channel condition, hydrologic alteration, riparian zone, bank stability, water appearance, nutrient enrichment, barriers to fish movement, instream fish cover, pools, insect/invertebrate habitat, canopy cover [warm water fishery], manure presence, salinity, riffle embeddedness, and macroinvertebrates observed). However, all assessment elements were not applicable to the assessment area and were not included.

The first step in cost-effective analysis is to display the environmental outputs (effects on habitat expressed in Functional Habitat Index, FHI) and the cost estimates of the management measure increments. Outputs and costs can be displayed as average annual outputs and average annual costs or total outputs and total costs. Both are acceptable so long as they are comparable. Average annual outputs and average annual costs were used for this analysis.

Table 6.3.2-2 displays the project alternatives and their associated average annual outputs and average annual costs. Project outputs for each alternative are displayed in terms of functional habitat index (FHI) that can be supported for each alternative considered.

Summary of Costs

Table 6.3.2-1 summarizes the ROM costs at an FY-08 price level for the beach and dune measures in planning unit two.

Table 6.3.2-1.
Summary of Beach and Dune Costs by Measure for Planning Unit Two

Measures	Implementation Cost (FY-08) ($)	IDC ($)	Total Implementation Cost ($)	Average Annual Implementation Cost ($)	Average Annual O&M ($)	Total Average Annual Costs ($)
(No Action)	$0	$0	$0	$0	$0	$0
Measure A[1] (15FT by 35FT Dune without plantings)	$21,840,000	$752,800	$22,592,800	$1,213,737	$5,866,473	$7,080,210
Measure B[1] (13FT by 45FT Dune without plantings)	$18,600,000	$641,200	$19,241,200	$1,033,681	$4,996,172	$6,029,853
Measure C[1] (15FT by 25FT Dune without plantings)	$18,100,000	$624,100	$18,724,100	$1,005,901	$4,861,867	$5,867,768
Measure D[1] (13FT by 15FT Dune without plantings)	$10,400,000	$358,500	$10,758,500	$577,971	$2,793,559	$3,371,530
Measure E[1] (15FT by 35FT Dune with plantings)	$22,970,000	$791,800	$23,761,800	$1,276,538	$6,170,004	$7,446,542
Measure F[1] (13FT by 45FT Dune with plantings)	$19,760,000	$681,200	$20,441,200	$1,098,148	$5,307,761	$6,405,909
Measure G[1] (15FT by 25FT Dune with plantings)	$19,210,000	$662,100	$19,872,100	$1,067,575	$5,160,025	$6,227,600
Measure H[1] (13FT by 15FT Dune with plantings)	$11,520,000	$397,100	$11,917,100	$640,214	$3,094,403	$3,734,617
Measure I (Standalone 15FT Dune without plantings)	$40,290,000	$1,389,000	$41,679,000	$2,239,091	$10,822,354	$13,061,445
Measure J (Standalone 15FT Dune with plantings)	$41,460,000	$1,429,000	$42,889,000	$2,304,095	$11,136,629	$13,440,724
Measure K (Standalone 2FT Dune with plantings)	$9,680,000	$333,600	$10,013,600	$537,953	$0	$537,953

1/ Denotes measures that could not be implemented without the construction of the seawall, which is discussed in section 6 4.
2/ Cost include Construction Management, Supervision & Administration, and Contingencies. More detail on the costs can be found in the Cost Estimating Appendix

Table 6.3.2-2.
Outputs and Costs by Measure

Measures	Annualized Implementation Cost ($)	Annual O&M ($)	Total Annual Cost ($)	Output (FHI)
Measure AA (No Action)	$0	$0	$0	0
Measure A	$1,213,737	$5,866,473	$7,080,210	142
Measure B	$1,033,681	$4,996,172	$6,029,853	172
Measure C	$1,005,901	$4,861,867	$5,867,768	154
Measure D	$577,971	$2,793,559	$3,371,530	130
Measure E	$1,276,538	$6,170,004	$7,446,542	304
Measure F	$1,098,148	$5,307,761	$6,405,909	330
Measure G	$1,067,575	$5,160,025	$6,227,600	276
Measure H	$640,214	$3,094,403	$3,734,617	250

The second step in cost effective analysis is to identify combinable management measures. This involves the analysis of the management measures to determine those that can be implemented together from those that cannot be implemented together. Each of the alternatives in this analysis is independent of the others. After the selection of one of the alternatives, the other alternatives are not needed; therefore the alternatives are not combinable.

The next step is to calculate outputs and costs of combinations. The combinations of the management measures are defined and analyzed incrementally. In this step, each combination of output (HU) and cost ($) is calculated. However, since the alternatives cannot be combined, this step is not necessary in this case.

Eliminating economically inefficient measures is the fourth step in cost effective analysis. In order to do this, the list of measures is reordered so that they are listed in ascending order of their outputs. Where two or more measures produce the same output, the measures are ranked in ascending order of their costs. The result is a ranking of measures AA, D, A, C, B, H, G, E, and F as displayed below in table 6.3.2-3. At each level of output the least cost measure is determined. No measures were identified as inefficient measures since all of the measures provide different levels of environmental lift; therefore all measures will be carried forward to the next step of this analysis.

Table 6.3.2-3.
List of Efficient Measures

Measures	Total Annual Cost ($)	Output (FHI)
Measure AA (No Action)	$0	0
Measure D	$3,371,530	130
Measure A	$7,080,210	142
Measure C	$5,867,768	154
Measure B	$6,029,853	172
Measure H	$3,734,617	250
Measure G	$6,227,600	276
Measure E	$7,446,542	304
Measure F	$6,405,909	330

The fifth step in cost effective analysis is to eliminate economically ineffective measures. The outputs and costs undergo a pair-wise comparison. The results of the comparison are analyzed to determine which measures will produce less output at equal or greater cost than subsequently ranked measures. Those measures that will produce less output at equal or greater cost than subsequently ranked measures are deleted. Measures A, C, and B were eliminated because they were found to be ineffective measures. Measure H produces more output for less cost than measures A, C, B. The results of this step are shown in table 6.3.2-4.

Table 6.3.2-4.
List of Effective Measures

Measures	Total Annual Cost ($)	Output (FHI)
Measure AA (No Action)	$0	0
Measure D	$3,371,530	130
Measure A	$7,080,210	142
Measure C	$5,867,768	154
Measure B	$6,029,853	172
Measure H	$3,734,617	250
Measure G	$6,227,600	276
Measure E	$7,446,542	304
Measure F	$6,405,909	330

Step six calculates the average cost of each of the cost effective measures and eliminates those measures that yield less output at a higher cost than the measure with the lowest average cost per functional habitat index (FHI). Step seven repeats step six to further screen alternatives. Steps eight and nine perform an incremental cost analysis on the measures that were moved forward after going through steps six and seven.

Traditionally, these steps are part of the cost effective analysis portion of the "Nine Easy Steps" and are performed on the remaining plans. However, since the Congressional Authority that was given to do the MsCIP Comprehensive study specifically directs the Corps of Engineers not to conduct Incremental Cost Analysis, this analysis will conclude at step five, with measures D, G, H and F moving forward for further consideration. Table 6.3.2-5 shows the environmentally cost effective plans for beach and dune placement for Panning Unit two that will be carried forward for further comparison.

Table 6.3.2-5.
List of Cost Effective Measures for Planning Unit Two

Measures	Total Annual Cost ($)	Output (FHI)
Measure AA (No Action)	$0	0
Measure D	$3,371,530	130
Measure H	$3,734,617	250
Measure G	$6,227,600	276
Measure F	$6,405,909	330
Measure I	$13,061,445	140
Measure J	$13,440,724	220
Measure K	$537,953	240

6.3.2.7 *Regional Economic Development (RED)*

The purpose of this section is to show the economic impact of the cost effective measures on business (sale volumes), income, employment, and population of the local area. Each of the measures would affect the local area of Harrison County, Mississippi. The expenditures for the measures are estimated to be $10,400,000 for the measure D, $19,760,000 for the measure F, $19,210,000 for measure G, $11,520,000 for the measure H, $40,290,000 for the measure I, $41,460,000 for the measure J, and $9,680,000 for the measure K. Moreover, the total present worth of the operation and maintenance (O&M) expenditures are estimated to be $52,000,000 for the measure D, $98,800,000 for the measure F, $$96,050,000 for measure G, $57,600,000 for the measure H, $201,450,000 for the measure I, $207,300,000 for the measure J, and $0 for the measure K (assuming a 50-year period of analysis and an interest rate of 4.875 percent). Tables 6.3.2-6 through 6.3.2-9 summarize the EIFS model inputs and outputs for the beach and dune placement measures at Planning Unit Two.

Table 6.3.2-6.
EIFS Model Implementation Cost Inputs for LOD2

	Measure D	Measure F	Measure G	Measure H	Measure I	Measure J	Measure
Region of Influence (ROI)	Harrison County	Harrison County	Harrison County	Harrison County	Harrison County	Harrison County	Harrison County
Change in Local Expenditures	$10,400,000	$19,760,000	$19,210,000	$11,520,000	$40,290,000	$41,460,000	$9,680,000

Based of the given inputs the outputs are as follows:

Table 6.3.2-7.
EIFS Model Implementation Cost Outputs for LOD2

	Measure D	Measure F	Measure G	Measure H	Measure I	Measure J	Measure K
Direct Sales Volume	$10,400,000	$19,760,000	$19,210,000	$11,520,000	$40,290,000	$41,460,000	$9,680,000
Induced Sales Volume	$13,000,000	$24,700,000	$24,012,500	$14,400,000	$50,362,500	$51,825,000	$12,100,000
Total Sales Volume	$23,400,000	$44,460,000	$43,222,500	$25,920,000	$90,652,500	$93,285,000	$21,780,000
Direct Income	$2,201,423	$4,182,705	$4,066,283	$2,438,500	$8,528,399	$8,776,059	$2,049,017
Induced Income	$2,751,780	$5,228,381	$5,082,855	$3,048,125	$10,660,500	$10,970,076	$2,561,272
Total Income	$4,953,203	$9,411,086	$9,149,138	$5,486,625	$19,188,899	$19,746,135	$4,610,289
Direct Employment	66	125	122	73	256	263	61
Induced Employment	83	157	153	91	320	329	77
Total Employment	149	282	275	165	576	592	138
Local Population	0	0	0	0	0	0	0

Table 6.3.2-8.
EIFS Model Operation and Maintenance Cost Inputs for LOD2

	Measure D	Measure F	Measure G	Measure H	Measure I	Measure J	Measure K
Region of Influence (ROI)	Harrison County	Harrison County	Harrison County	Harrison County	Harrison County	Harrison County	Harrison County
Change in Local Expenditures	$52.000,000	$98,800,000	$96,050,000	$57,600,000	$201,450,000	$207,300,000	$0

Based of the given inputs the outputs are as follows:

Table 6.3.2-9.
EIFS Model Operation and Maintenance Cost Outputs for LOD2

	Measure D	Measure F	Measure G	Measure H	Measure I	Measure J	Measure K
Direct Sales Volume	$52,000,000	$98,800,000	$96,050,000	$57,600,000	$201,450,000	$207,300,000	$0
Induced Sales Volume	$65,000,000	$123,500,000	$120,062,500	$72,000,000	$251,812,500	$259,125,000	$0
Total Sales Volume	$117,000,000	$222,300,000	$216112,500	$129,600,000	$453,262,500	$466,425,000	$0
Direct Income	$11,007,117	$20,913,523	$20,331,415	$12,192,499	$42,641,995	$43,880,296	$0
Induced Income	$13,758,898	$26,141,907	$25,414,273	$15,240,626	$53,302,502	$54,850,378	$0
Total Income	$24,766,016	$47,055,430	45,745,688	$27,433,125	$95,944,497	$98,730,674	$0
Direct Employment	330	627	610	366	1,279	1,316	0
Induced Employment	413	784	763	457	1,600	1,646	0
Total Employment	743	1,412	1,373	823	2,879	2,962	0
Local Population	0	0		0	0	0	0

6.3.2.8 Summary of Cost Effective Measures

Table 6.3.2-10 shows the potential measures that are being carried forward for further consideration. Measures D, H, G, and F are beach and dune placement measures that depend on the construction of the seawall in order to be implemented. Measures I, J, and K are stand alone measures that do not depend on the seawall for implementation.

Table 6.3.2-10.
List of Measures Carried Forward for Further Evaluation in Planning Unit Two
Planning Unit Two

Measures	Total Annual Cost ($)	Total Annual Output (FHI)	Change in Sales Volume	Change in Income	Change in Employment
Measure AA (No Action)	$0	0	$0	$0	0
Measure D[1]	$3,371,530	130	$140,400,000	$29,719,219	892
Measure H[1]	$3,734,617	250	$155,520,000	$32,919,750	988
Measure G[1]	$6,227,600	276	$259,335,000	$54,894,826	1,647
Measure F[1]	$6,405,909	330	$266,760,000	$56,466,515	1,694
Measure I	$13,061,445	140	$543,915,000	$115,133,396	3,454
Measure J	$13,440,724	220	$559,710,000	$118,476,808	3,555
Measure K	$537,953	240	$21,780,000	$4,610,289	138

6.3.2.9 Public Access and Parking

A parking and access analysis was conducted on the sections where beach and dune constriction would take place for planning unit two. It was determined that planning unit two has sufficient access and parking to satisfy the requirements established in Engineering Regulation (ER) 1165-2-100. Planning unit two also has access along the entire twenty-six mile length of beach and has 2,788 free parking spaces. Addendum C describes the result of the access and parking analysis in greater detail.

6.3.3 Planning Unit Three

6.3.3.1 Background

The beaches of Jackson County are host one of the Gulf Coast's largest populations of Least Tern, a Federally-listed endangered species, plus a significant number of Piping Plover. During Hurricane Katrina, this dune system was almost entirely destroyed by surge and wave action. Almost all ecosystem functions and values were eliminated during this single event. Much of the sand removed is believed to be close off shore in the near shore zone. The MsCIP Interim Chiefs Report did not recommend a beach and dune placement project be constructed in planning unit three; therefore the without-project condition for this planning unit is the post storm condition. Maintenance occurs on the Jackson County beaches if it is determined that significant erosion occurs following a significant event; with the beaches restored to the pre-storm condition. There is no scheduled periodic maintenance of the beaches. The future without-project conditions assume continuation of the present maintenance activities to restore the berm only feature in Jackson. The berm elevation varies from approximately 5.0 feet NAVD88 at the seawall to 3.5 feet NAVD88 at the slope break to the Mississippi Sound. Figure 6.3.3-1 shows the project location for planning unit three.

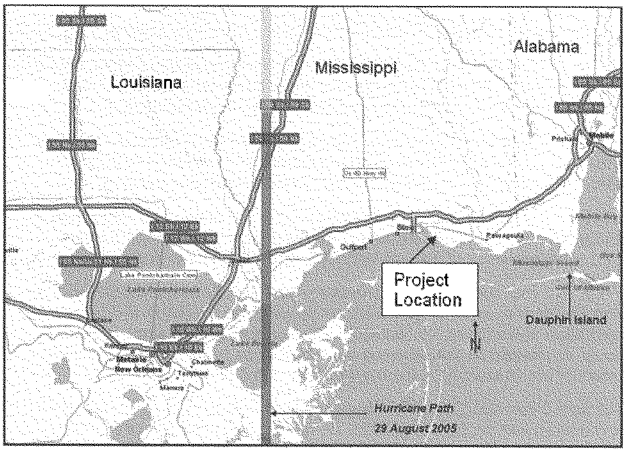


Figure 6.3.3-1. Project Sites for Beach and Dune Placement in Planning Unit Three

6.3.3.1.1 Opportunities

The following opportunities were identified for this area:

- Hurricane storm damage reduction or remediation
- Preservation of Fish & Wildlife and restoration of their habitats
- Prevention or remediation of erosion
- Other related water resource purposes, such as ecosystem restoration or barrier island restoration

6.3.3.2 General Assumptions

The following assumptions were used in this analysis.

- The FY 2008 discount rate of 4-7/8 percent was used in estimating average annual benefits and costs
- Price levels are October, 2007 unless otherwise stated.
- A 50-year period of analysis was used to calculate average annual benefits and costs.

6.3.3.3 Measures

Two plans were evaluated for enhanced beach protection at the study site. All involve providing a dune and berm to the location. Some of the alternatives, Measures A through H described below, can not be constructed without the construction of the Seawall and Elevated roadway measure, which is evaluated in great detail later in this appendix. The measures for Line of Defense 2 in planning unit three are as follows:

- Measure A consists of a 10.0 feet NAVD88 dune elevation, 40.0 feet dune crest width, with a dune slope of 1:3, and a berm with an 80.0 feet width, an upper berm elevation of 5.5 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10.
- Measure B consists of an 8.0 feet NAVD88 dune elevation, 50.0 feet dune crest width, with a dune slope of 1:3, and a berm with an 80.0 feet width, an upper berm elevation of 5.5 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10.
- Measure C consists of a 10.0 feet NAVD88 dune elevation, 20.0 feet dune crest width, with a dune slope of 1:3, and a berm with a 100.0 feet width, an upper berm elevation of 5.5 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10.
- Measure D consists of an 8.0 feet NAVD88 dune elevation, 30.0 feet dune crest width, with a dune slope of 1:3, and a berm with a 100.0 feet width, an upper berm elevation of 5.5 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10.
- Measure E consists of a 10.0 feet NAVD88 dune elevation, 40.0 feet dune crest width, with a dune slope of 1:3, and a berm with an 80.0 feet width, an upper berm elevation of 5.5 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10. In addition, sea oats would be planted on the seaward dune face in an 18 by 18 inch grid pattern, with a total of three rows of plants starting at the seaward toe of the dune.
- Measure F consists of an 8.0 feet NAVD88 dune elevation, 50.0 feet dune crest width, with a dune slope of 1:3, and a berm with an 80.0 feet width, an upper berm elevation of 5.5 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10. In addition, sea oats would be planted on the seaward dune face in an 18 by 18 inch grid pattern, with a total of three rows of plants starting at the seaward toe of the dune.
- Measure G consists of a 10.0 feet NAVD88 dune elevation, 20.0 feet dune crest width, with a dune slope of 1:3, and a berm with a 100.0 feet width, an upper berm elevation of 5.5 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10. In addition, sea oats would be planted on the seaward dune face in an 18 by 18 inch grid pattern, with a total of three rows of plants starting at the seaward toe of the dune.
- Measure H consists of an 8.0 feet NAVD88 dune elevation, 30.0 feet dune crest width, with a dune slope of 1:3, and a berm with a 100.0 feet width, an upper berm elevation of 5.5 feet NAVD88, and seaward berm elevation of 3.5 feet NAVD88, and a foreshore slope of 1:10. In addition, sea oats would be planted on the seaward dune face in an 18 by 18 inch grid pattern,

with a total of three rows of plants starting at the seaward toe of the dune. Figure 6.3.3-2 shows a typical cross section for Measures A though H.

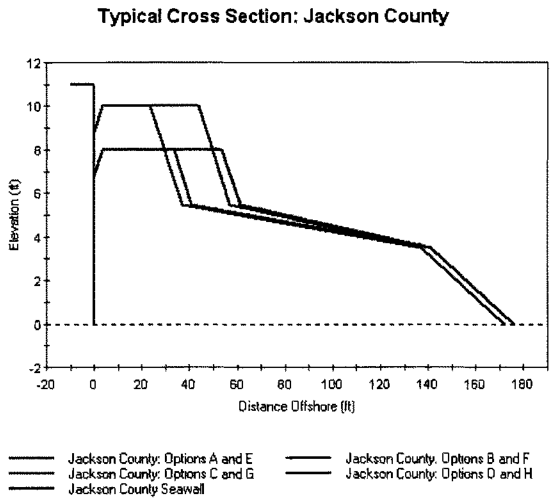


Figure 6.3.3-2. Typical Cross Section for Measures A through H

Measures I and J are comparative with-project measures, for future evaluation, consisting of a design cross-section which includes a dune and berm constructed as a stand alone project which does not incorporate the Line of Defense 3 seawall. Measure I consists of a dune feature constructed approximately 50.0 feet seaward of the seawall at an elevation of 10.0 feet NAVD 88, with a crest width of 55.0 feet, and a dune slope of 1:3. The berm width would be extended to accommodate the placement of the dune feature. Sand fencing would be placed on the dunes to reduce sand transport due to the strong winds which frequently occur during storms. The cross section for Measure J is the same as Measure I; however the dune would be planted to provide for additional environmental habitat. For Measure J, sea oats would be planted on both the landward and seaward dune face in an 18 by 18 inch grid pattern, with a total of three rows of plants starting at the landward and seaward toes of the dune. The dunes will require initial and continued maintenance of vegetation and sand fencing. Figure 6.3.3-3 shows the typical cross section for measures I and J.

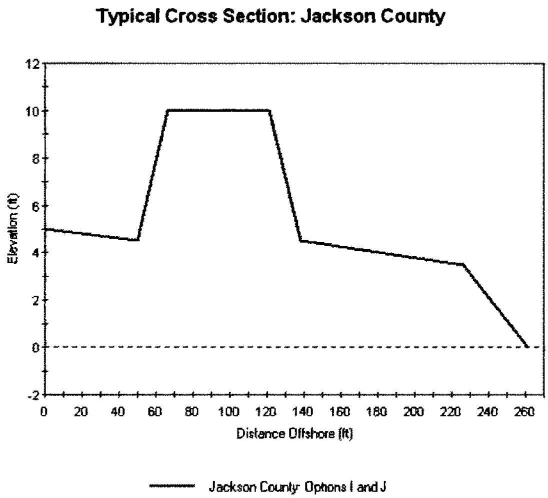


Figure 6.3.3-3. Typical cross section for Measures I and J

Measure K is also a measure for future evaluation which consists of an elevated berm section constructed primarily for the creation of environmental habitat. Measure K would be constructed as a stand alone measure which does not incorporate the Line of Defense 3 seawall. The elevated berm section would be constructed approximately 50.0 feet seaward of the existing seawall to an elevation 2.0 feet above the existing berm with a width of approximately 60.0 feet. The berm width would not be extended to accommodate the placement of the elevated berm feature. The new feature would be vegetated and sand fencing would be placed to create environmental habitat and to reduce sand transport due to the strong winds which frequently occur during storms. For Measure K, sea oats would be planted in a 30 by 30 inch grid pattern over the entire elevated berm area. The new feature will require initial and continued maintenance of vegetation and sand fencing. Figure 6.3.3-4 shows the typical cross section for measure K.

Typical Cross Section: Jackson County

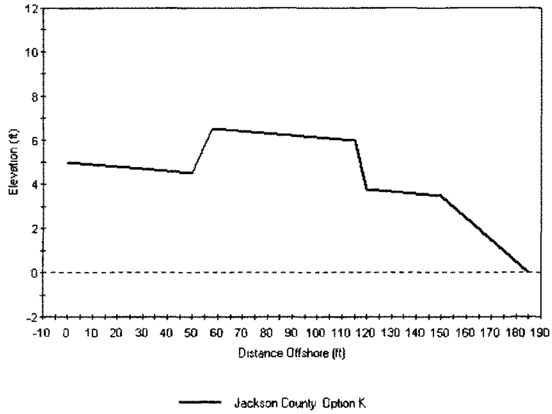


Figure 6.3.3-4. Typical cross section for measure K

6.3.3.4 National Economic Development (NED)

This section describes the National Economic Development benefits for the various beach and dune placement measures in planning unit three that are attributable to hurricane and storm damage reduction. National economic development benefits are damages to structures and their contents that are reduced when a measure or alternative is implemented, or the difference between the with-project and without-project conditions.

There are two types of beach and dune placement measures for planning unit three; those that are dependent on the seawall and elevated roadway and those that can be implemented as stand alone measures. Those measures dependent on the seawall and elevated roadway, measures A through H, would be implemented to abut the seawall and elevated roadway and would be constructed to a maximum elevation of 1.0 foot lower than the seawall and elevated roadway, or to elevation 10.0 feet NAVD88, thus acting as a system. For these measures, equivalent annual damage reduction would be limited to structures that are physically located south of Beach Boulevard, since seawall and elevation of that roadway would be higher than the dune system itself. A visual description of this system can be seen above in figure 6.3-11. The remaining measures I, J, and K are stand alone, and would be implemented in lieu of the seawall and elevated roadway with dune system. The equivalent annual damage reduction attributable to the stand alone measures would impact structures located south of Beach Boulevard in planning unit three and some footprint of structures north of Beach Boulevard. Also, all beach and dune placement measures would provide some level of protection to the seawall and roadways that they abut, but those benefits are difficult to quantify and were not conducted in this analysis.

The Beach-FX program was selected to quantify the damage reduction benefits of all of the beach and dune placement measures. Beach-FX is a Monte Carlo based model that combines coastal processes economic conditions to evaluate damages from storm events and the level of damage reduction that would be attributable to a given measure. Chapter III of this appendix depicts the overall process of the

Beach-FX evaluation. For this study, the exploration of the coastal processes and economic inventorying was conducted. Further study would be required to combine the observed data and to evaluate the eleven alternatives previously mentioned. More detail on the further study can be found in the MsCIP Comprehensive Plan Main Report. Table 6.3.3-1 summarizes the costs for the beach and dune construction measures for planning unit three. For this study, the exploration of the coastal processes and economic inventorying was conducted. Further study would be required to combine the observed data and to evaluate the eleven alternatives previously mentioned. More detail on the further study can be found in the MsCIP Comprehensive Plan Main Report. Table 6.3.3-1 summarizes the costs for the beach and dune construction measures for planning unit three.

6.3.3.5 Summary of Costs

Table 6.3.3-1 summarizes the ROM costs at an FY-08 price level for the beach and dune measures in planning unit three.

Table 6.3.3-1.
Summary of Beach and Dune Costs by Measure for Planning Unit Three

Measures	Implementation Cost ($)	IDC ($)	Total Implementation Cost ($)	Average Annual Implementation Cost ($)	Average Annual O&M ($)	Total Average Annual Costs ($)
(No Action)	$0	$0	$0	$0	$0	$0
Measure A[1] (10FT by 40FT Dune without plantings)	$1,910,000	$42,200	$1,952,200	$104,877	$513,048	$617,924
Measure B[1] (8FT by 50FT Dune without plantings)	$1,450,000	$32,100	$1,482,100	$79,622	$389,487	$469,108
Measure C[1] (10FT by 20FT Dune without plantings)	$1,180,000	$26,400	$1,206,400	$64,811	$316,961	$381,772
Measure D[1] (8FT by 30FT Dune without plantings)	$960,000	$21,200	$981,200	$52,712	$257,867	$310,579
Measure E[1] (10FT by 40FT Dune with plantings)	$1,990,000	$44,000	$2,034,000	$109,271	$534,537	$643,808
Measure F[1] (8FT by 50FT Dune with plantings)	$1,530,000	$33,900	$1,563,900	$84,016	$410,975	$494,992
Measure G[1] (10FT by 20ft Dune with plantings)	$1,260,000	$27,900	$1,287,900	$69,189	$338,450	$407,639
Measure H[1] (8FT by 30FT Dune with plantings)	$1,040,000	$22,900	$1,062,900	$57,101	$279,356	$336,457
Measure I (10FT by 50FT Dune without plantings)	$4,490,000	$99,400	$4,589,400	$246,553	$1,206,065	$1,452,618
Measure J (10FT by 50FT Dune with plantings)	$4,570,000	$101,200	$4,671,200	$250,948	$1,227,554	$1,478,502
Measure K (2FT by 60FT Dune with plantings)	$1,110,000	$24,600	$1,134,600	$60,953	$0	$60,953

1/ Denotes measures that could not be implemented without the construction of the seawall, which is discussed in section 6.4.
2/ Cost include Construction Management, Supervision & Administration, and Contingencies. More detail on the costs can be found in the Cost Estimating Appendix

6.3.3.6 National Ecosystem Restoration (NER)

The P&G defines the environmental quality account as, "displays of non-monetary effects on ecological, cultural, and aesthetic resources..." The EQ account is typically associated with ecosystem restoration projects, although it does address the following:

6.3.3.6.1 Cost Effective Analysis Assumptions

This analysis assumes a 50-year project life. Costs were amortized using the FY 2008 federal discount rate of 4.875-percent and are presented in October 2007 dollars. The outputs quantified in this cost effective analysis are defined as the quantification of expected improvements in target functions as related to project objectives (functional habitat index, FHI). FHI scores were based on an assessment protocol, which provide a basic level of stream health evaluation that is based on physical conditions within the assessment area. The assessment is used to record the scores for up to 15 assessment elements (i.e., channel condition, hydrologic alteration, riparian zone, bank stability, water appearance, nutrient enrichment, barriers to fish movement, instream fish cover, pools, insect/invertebrate habitat, canopy cover [warm water fishery], manure presence, salinity, riffle embeddedness, and macroinvertebrates observed). However, all assessment elements were not applicable to the assessment area and were not included.

The first step in cost-effective analysis is to display the environmental outputs (effects on habitat expressed in Functional Habitat Index, FHI) and the cost estimates of the management measure increments. Outputs and costs can be displayed as average annual outputs and average annual costs or total outputs and total costs. Both are acceptable so long as they are comparable. Average annual outputs and average annual costs were used for this analysis.

Table 6.3.3-2 displays the project alternatives and their associated average annual outputs and average annual costs. Project outputs for each alternative are displayed in terms of functional habitat index (FHI) that can be supported for each alternative considered.

Table 6.3.3-2.
Outputs and Costs by Increments by Measure

Measures	Annualized Implementation Cost ($)	Annual O&M ($)	Total Annual Cost ($)	Total Annual Output (FHI)
Measure AA (No Action)	$0	$0	$0	0
Measure A	$104,877	$513,048	$617,924	142
Measure B	$79,622	$389,487	$469,108	172
Measure C	$64,811	$316,961	$381,772	142
Measure D	$52,712	$257,867	$310,579	154
Measure E	$109,271	$534,537	$643,808	304
Measure F	$84,016	$410,975	$494,992	330
Measure G	$69,189	$338,450	$407,639	250
Measure H	$57,101	$279,356	$336,457	276

The second step in cost effective analysis is to identify combinable management measures. This involves the analysis of the management measures to determine those that can be implemented together from those that cannot be implemented together. Each of the alternatives in this analysis is independent of the others. After the selection of one of the alternatives, the other alternatives are not needed; therefore the alternatives are not combinable.

The next step is to calculate outputs and costs of combinations. The combinations of the management measures are defined and analyzed incrementally. In this step, each combination of output (FHI) and cost ($) is calculated. However, since the alternatives cannot be combined, this step is not necessary in this case.

Eliminating economically inefficient solutions is the fourth step in cost effective analysis. In order to do this, the list of solutions is reordered so that they are listed in ascending order of their outputs. Where two or more solutions produce the same output, the solutions are ranked in ascending order of their costs. The result is a ranking of measures AA, A, C, D, B, G, H, E, and F as displayed below in table 6.3.3-3. At each level of output the least cost measure is determined. Measure A was identified as an inefficient measure and will not be carried forward in this analysis.

Table 6.3.3-3.
List of Economically Efficient Measures for Planning Unit Three

Measures	Total Annual Cost ($)	Total Annual Output (FHI)
Measure AA (No Action)	$0	0
Measure A	$617,924	142
Measure C	$381,772	142
Measure D	$310,579	154
Measure B	$469,108	172
Measure G	$407,639	250
Measure H	$336,457	276
Measure E	$643,808	304
Measure F	$494,992	330

The fifth step in cost effective analysis is to eliminate economically ineffective solutions. The outputs and costs undergo a pair-wise comparison. The results of the comparison are analyzed to determine which solutions will produce less output at equal or greater cost than subsequently ranked solutions. Those solutions that will produce less output at equal or greater cost than subsequently ranked solutions are deleted. Measures C, B, G, and E were eliminated because they were found to be ineffective solutions. These measures were eliminated from further consideration because measure D produces more output for less cost than measure C, measure H produces more output for less cost than measures B and G, and measure F produces more output at less cost than measure E. The results of this step are summarized in table 6.3.3-4.

Step six calculates the average cost of each of the cost effective solutions and eliminates those measures that yield less output at a higher cost than the measure with the lowest average cost per functional habitat index (FHI). Step seven repeats step six to further screen alternatives. Steps eight and nine perform an incremental cost analysis on the measures that were moved forward after going through steps six and seven.

Table 6.3.3-4.
List of Economically Effective Measures for Planning Unit Three

Measures	Total Annual Cost ($)	Total Annual Output (FHI)
Measure AA (No Action)	$0	0
Measure C	$381,772	142
Measure D	$310,579	154
Measure B	$469,108	172
Measure G	$407,639	250
Measure H	$336,457	276
Measure E	$643,808	304
Measure F	$494,992	330

Traditionally, these steps are part of the cost effective analysis portion of the "Nine Easy Steps" and are performed on the remaining plans. However, since the Congressional Authority that was given to do the MsCIP Comprehensive study specifically directs the Corps of Engineers not to conduct Incremental Cost Analysis, this analysis will conclude at step six, with measures H and F moving forward for further consideration. Table 6.3.3-5 shows the environmentally cost effective plans for beach and dune placement for planning unit three that will be carried forward for further comparison.

Table 6.3.3-5.
List of Cost Effective Measures for Planning Unit Three

Measures	Total Annual Cost ($)	Total Annual Output (FHI)
Measure AA (No Action)	$0	0
Measure D	$310,579	154
Measure H	$336,45	276
Measure F	$494,992	330
Measure I	$1,452,618	136
Measure J	$1,478,502	216
Measure K	$60,953	248

6.3.3.7 Regional Economic Development (RED)

The purpose of this section is to show the economic impact of the cost effective project measures on business (sale volumes), income, employment, and population of the local area. Each of the measures would affect the local area of Jackson County, Mississippi. The expenditures for the measures are estimated to be $960,000 for the measure D, $1,530,000 for the measure F, $1,040,000 for the measure H, $4,490,000 for the measure I, $4,570,000 for the measure J, and $1,110,000 for the measure K. Moreover, the total present worth of the operation and maintenance (O&M) expenditures are estimated to be $4,800,000 for the measure D, $7,650,000 for the measure F, $5,200,000 for the measure H, $22,450,000 for the measure I, $22,850,000 for the Measure J measure, and $0 for the Measure K measure (assuming a 50-year period of analysis and an interest rate of 4.875 percent). Tables 6.3.3-6 through 6.3.3-9 show the EIFS model inputs and outputs for the measures ate planning unit three.

Table 6.3.3-6.
EIFS Model Implementation Inputs for LOD2

	Measure D	Measure F	Measure H	Measure I	Measure J	Measure K
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$960,000	$1,530,000	$1,040,000	$4,490,000	$4,570,000	$1,110,000

Based of the given inputs the outputs are as follows:

Table 6.3.3-7.
EIFS Model Implementation Outputs for LOD2

	Measure D	Measure F	Measure H	Measure I	Measure J	Measure K
Direct Sales Volume	$960,000	$1,530,000	$1,040,000	$4,490,000	$4,570,000	$1,110,000
Induced Sales Volume	$1,075,200	$1,713,600	$1,164,800	$5,028,800	$5,118,400	$1,243,200
Total Sales Volume	$2,035,200	$3,243,600	$2,204,800	$9,518,800	$9,688,400	$2,353,200
Direct Income	$187,225	$298,389	$202,827	$875,665	$891,267	$216,478
Induced Income	$209,691	$334,196	$227,166	$980,744	$998,219	$242,456
Total Income	$396,916	$632,585	$429,992	$1,856,409	$1,889,486	$458,934
Direct Employment	5	9	6	25	26	6
Induced Employment	6	10	7	28	29	7
Total Employment	12	18	12	54	55	13
Local Population	0	0	0	0	0	0

Table 6.3.3-8.
EIFS Model Operation and Maintenance Cost Inputs for LOD2

	Measure D	Measure F	Measure H	Measure I	Measure J	Measure K
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$4,800,000	$7,650,000	$5,200,000	$22,450,000	$22,850,000	$0

Based of the given inputs the outputs are as follows:

Table 6.3.3-9.
EIFS Model Operation and Maintenance Cost Outputs for LOD2

	Measure D	Measure F	Measure H	Measure I	Measure J	Measure K
Direct Sales Volume	$4,800,000	$7,650,000	$5,200,000	$22,450,000	$22,850,000	$0
Induced Sales Volume	$5,376,000	$8,568,000	$5,824,000	$25,144,000	$25,592,000	$0
Total Sales Volume	$10,176,000	$16,218,000	$11,024,000	$47,594,000	$48,442,000	$0
Direct Income	$936,123	$1,491,946	$1,014,133	$4,378,324	$4,456,334	$0
Induced Income	$1,048,457	$1,670,979	$1,135,829	$4,903,722	$4,991,094	$0
Total Income	$1,984,580	$3,162,924	$2,149,962	$9,282,046	$9,447,428	$0
Direct Employment	27	43	29	127	129	0
Induced Employment	30	49	33	142	145	0
Total Employment	58	92	62	269	274	0
Local Population	0	0	0	0	0	0

6.3.3.8 Summary of Cost Effective Measures and their Benefits for Planning Unit Three

Table 6.3.3-10 shows the potential measures that are being carried forward for further consideration. Measures D, H, and F are beach and dune placement measures that depend on the construction of the seawall in order to be implemented. Measures I, J, and K are stand alone measures that do not depend on the seawall for implementation.

Table 6.3.3-10.
List of Measures Carried Forward for Further Evaluation in Planning Unit Three

Measures	Total Annual Cost ($)	Total Annual Output (FHI)	Change in Sales Volume	Change in Income	Change in Employment
Measure AA (No Action)			$0	$0	0
Measure D[1]	$310,579	154	$12,211,200	$2,381,496	69
Measure F[1]	$494,992	330	$19,461,600	$3,795,509	110
Measure H[1]	$336,45	276	$13,228,800	$2,579,954	75
Measure I	$1,452,618	136	$57,112,800	$11,138,455	323
Measure J	$1,478,502	216	$58,130,400	$11,336,913	329
Measure K	$60,953	248	$2,353,200	$458,934	13

6.3.3.9 Public Access and Parking

A public access and parking analysis was conducted on the sections where beach and dune constriction would take place. It was determined that each of the three planning units has sufficient access and parking to satisfy the requirements established in Engineering Regulation (ER) 1165-2-100. Planning unit three has three access points for the Ocean Springs beach area that are all within the required half mile distance and have 300 free parking spaces all within a quarter mile of one of the access points. Addendum C describes the result of the access and parking analysis in greater detail.

6.4 Seawall and Elevated Roadway Area Measures

6.4.1 General

The Seawall and Elevated Roadway area is located in all three planning units just north of the roadways that run parallel to the beach. These areas are denoted by the coastal zone area. In planning unit one, the seawall area includes planning sub-units two, three and four, in planning unit two, planning sub-units eight, ten, thirteen, fifteen, eighteen, and twenty, and in planning unit three the planning sub-units are twenty-one and twenty-two. These areas are all highly populated and include several east/west evacuation routes.

6.4.2 Historic (Pre-Hurricane Katrina) Conditions

The pre-Hurricane Katrina conditions for planning sub-units three and four in planning unit one represented a mostly residential community. The areas in planning unit one included 27,310 tax parcels, of which 15,464 contained an asset with some economic value and 11,846 were vacant land. Of the 15,464 parcels that contain assets, 12,061 were residential one-story, 337 were residential two-story, 237 were mobile homes, 2,419 were commercial, and 410 were municipal. The areas in planning unit two included 34,028 tax parcels, of which 20,028 contained an asset with some economic value and 14,000 were vacant land. Of the 20,028 parcels that contain assets, 18,628 were residential one-story, 658 were residential two-story, 318 were mobile homes, 256 were commercial, and 168 were municipal. The areas in planning unit three included 17,360 tax parcels, of which 12,705 contained an asset with some economic value and 4,655 were vacant land. Of the 12,705 parcels that contain assets, 11,380 were residential one-story, 315 were residential two-story, 85 were mobile homes, 793 were commercial, and 132 were municipal. Table 6.4-1 summarizes the assets by planning unit for the seawall and elevated roadway area.

Table 6.4-1.
Pre-Hurricane Katrina Economic Asset Characteristics for the Impacted Seawall and Roadway Areas

	Planning Unit One	Planning Unit Two	Planning Unit Three	
Asset Categories	**Assets by Category**	**Assets by Category**	**Assets by Category**	**Total**
Residential	12,398	19,286	11,695	43,379
Mobile Homes	237	318	85	640
Commercial	2,419	256	793	3,468
Municipal	410	168	132	710
Vacant Land	11,846	14,000	4,655	30,501
Total	**27,310**	**34,028**	**17,360**	**78,698**

Figure 6.4-1 denotes the various zones and shows the coastal zone in beige. Figure 6.4-2 shows the planning sub-units of the area by planning unit.

6.4.2.1 Existing (Post-Hurricane Katrina) Conditions

Hurricane Katrina made its Mississippi landfall just west of planning sub-units three and four. It is estimated that the storm destroyed 21,228 structures at least fifty-percent or more in these areas. Of those, 7.903 were destroyed in planning unit one, 12,789 in planning unit two, and 536 were destroyed in planning unit three. Table 6.4-2 displays the destroyed structures by category and by planning unit for these areas.

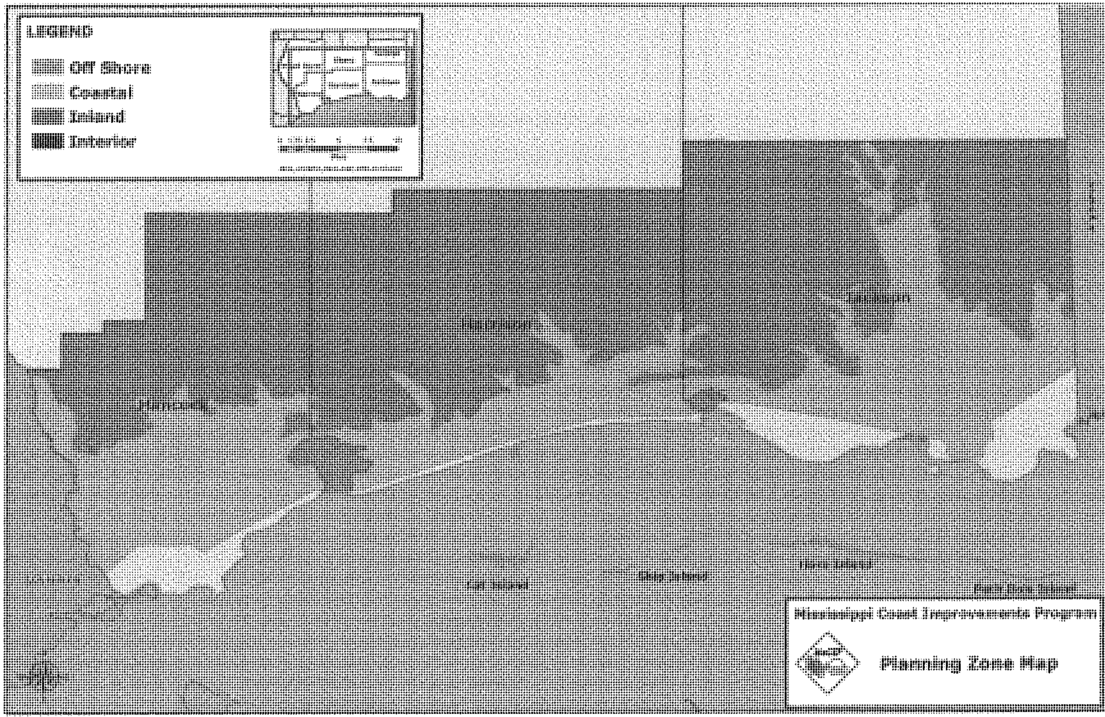


Figure 6.4-1. Planning Zones – Impacted area is the coastal zone

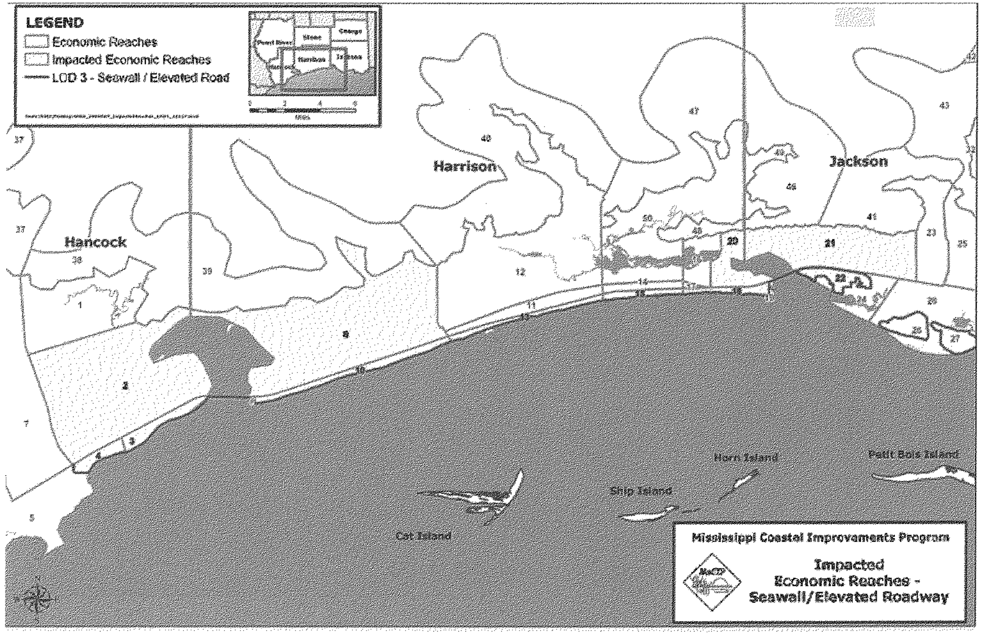


Figure 6.4-2. Planning sub-units in Coastal Area for Planning Unit One, Two, and Three

Table 6.4-2.
Destroyed Structures by Category and Planning Unit

	Planning Unit One	Planning Unit Two	Planning Unit Three	
Asset Categories	**Assets by Category**	**Assets by Category**	**Assets by Category**	**Total**
Residential	6,741	11,106	474	18,321
Mobile Homes	27	111	10	148
Commercial	1,054	1,492	44	2,590
Municipal	81	80	8	169
Total	**7,903**	**12,789**	**536**	**21,228**

6.4.3 Opportunities

The following opportunities were identified for this area:

- Hurricane storm damage reduction or remediation.

6.4.4 Assumptions

The following assumptions were used in this analysis.

- The FY 2008 discount rate of 4-7/8-percent was used in estimating average annual benefits and costs.
- Price levels are October, 2007 unless otherwise stated.
- A 100-year period of analysis (2012 to 2111) was used to calculate average annual benefits and costs.
- Full redevelopment of the area will take place by the base year 2012.

6.4.5 Measures

Initially, a comprehensive list of measures was identified for flood damage reduction purposes for planning unit one. This list was screened and vetted for engineering and environmental feasibility and for policy compliance. The MsCIP Comprehensive Main Report and the Engineering and Environmental Appendices contain a detailed description of the measures that were initially screened.

Several potential measures were carried forward for this area for the purpose of flood damage reduction. These measures include both structural features and nonstructural actions. The measures evaluated for economic benefits include:

- Measure A - LOD-3, Seawall and Elevated Roadway

This measure will elevate an existing 2-lane roadway up to an elevation of 11.0-feet NAVD88 in planning unit one, to an elevation of 16.0-feet NAVD88 in planning unit two, and up to an elevation of 11.0-feet NAVD88 in planning unit three. This will include raising an associated seawall, landward slope protection, interior drainage, and pumping stations as required. This measure also requires the installation of surge barriers across St. Louis Bay and Biloxi Bay to elevation 20.0-feet NAVD88. See the Engineering Appendix for more detail on this measure.

- Measure B – Nonstructural One

This measure includes the acquisition and flood proofing (elevate in place) of structures to an ABFE level of protection. See the Nonstructural Appendix for more detail on this measure.

- Measure C – Nonstructural Two

This measure includes the acquisition and flood proofing (elevate in place) of structures to approximately elevation 20.0-feet NAVD88. See the Nonstructural Appendix for more detail on this measure.

- Measure D – Nonstructural Three

This measure includes the acquisition and flood proofing (elevate in place) of structures to approximately elevation 30.0-feet NAVD88. See the Nonstructural Appendix for more detail on this measure. See the Nonstructural Appendix for more detail on this measure.

6.4.6 National Economic Development (NED)

The purpose of this section is to document investigations conducted to identify the National Economic Development (NED) benefits of each of the potential measures previously listed. For this analysis, NED benefits are the reduced inundation damages of assets and their contents when one of the potential measures is in place. Typically, NED benefits are annualized over the period of the analysis (average annual benefits) and then compared to annualized costs over the period of analysis (average annual costs). This comparison is commonly known as the benefit-to-cost ratio (BCR). For purposes of this analysis, no benefit-to-cost ratios will be calculated as per the legislative Congressional language authorizing this study. The Coastal Mississippi Comprehensive Plan Report was authorized by the Department of Defense Appropriations Act, 2006 (P.L. 109-148) 30 December 2005, which states: "...***that the Secretary shall recommend a cost-effective project, but shall not perform an incremental benefit-cost analysis to identify the recommended project, and shall not make project plan features based upon maximizing net national economic development benefits...***" More detail on the authorizing language can be found in the MsCIP Comprehensive Plan Main Report.

6.4.6.1 Future Without-Project Conditions

Equivalent annual flood damages for several future without-project scenarios were evaluated using the Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA) model. Each of the alternatives were evaluated and compared to the without project conditions for three of the six future without project scenarios. Future without-project scenarios one, two, three, four, five and six were used to evaluate the flood damage reduction benefits for this area. These future scenarios were chosen because the redevelopment projected for this area could take the form it was before Hurricane Katrina or it could be redeveloped back as condominiums and condos.

Future scenario one is the full redevelopment of structures within the study area by the year 2012 with no relative sea level rise over the 100-year period of analysis. Structures will be rebuilt to what they were pre-Hurricane Katrina; residential back to residential, commercial back to commercial, etc. This future scenario, as previously noted in section 5.3, is for sensitivity purposes only and will not be evaluated against all of the potential measures for the Inland Barrier area.

Future scenario two is the full redevelopment of structures within the study area by the year 2012 with no relative sea level rise over the 100-year period of analysis. Structures will be rebuilt to what they were pre-Hurricane Katrina; residential back to residential, commercial back to commercial, etc, with the exception of the water front areas for planning units one and two. In these planning units, the scenario will address what if commercial and casino redevelopment would occur along the water front and Back Bay areas. This future scenario, as previously noted in section 5.3, is for sensitivity purposes only and will not be evaluated against all of the potential measures for the Inland Barrier area.

Future scenario three has the same redevelopment as future scenario one with a maximum relative sea level rise of 2.0-feet depending on location. Equivalent annual damages that could occur under this scenario are $426,040,000 (rounded to the nearest thousand).

Future scenario four has the same redevelopment as future scenario two with a maximum relative sea level rise of 2.0-feet depending on location. Equivalent annual damages that could occur under this scenario are $434,040,000 (rounded to the nearest thousand).

Future scenario five has the same redevelopment as future scenario one with a maximum relative sea level rise of 3.4-feet depending on location. Equivalent annual damages that could occur under this scenario are $475,200,000 (rounded to the nearest thousand). These damages are an 11.54-percent increase over the 2.0-feet relative sea level rise accounted for in future scenario two.

Future scenario six has the same redevelopment as future scenario two with a maximum relative sea level rise of 3.4-feet depending on location. Equivalent annual damages that could occur under this scenario are $483,700,000 (rounded to the nearest thousand). These damages are an 11.44-percent increase over future scenario four with a maximum of 2.0-feet relative sea level rise.

6.4.6.2 Equivalent annual damages Reduced and Residual Damages

Equivalent annual damages reduced are calculated as the difference between the damages under the future without-project scenarios and the damages incurred with the measure in place. The HECFDA model was run for each measure to determine the damages reduced as compared to the without-project scenario.

In order to provide the HEC-FDA model with accurate information about the economic characteristics of each measure, separate inventories were created for each measure. The inventories are the same as the without-project inventory except that footprints of seawall and elevated roadway and the acquisitions were deleted from the inventory and flood proofed (structure to be raised in place) structures were given a specific first floor elevation. The structure inventories for each of the HEC-FDA with-measure runs are as follows:

- Measure A – Seawall and Elevated Roadway

This measure includes the without-project inventory less 1,543 parcels that were deleted out of the inventory. Of those, 411 parcels were estimated to be impacted in planning unit one, 1,004 in planning unit two, and 128 in planning unit three. These parcels represent the footprint of the seawall and elevated roadway across the three planning units and some portion of the total would have to be purchase for its construction. At this level of analysis, it is assumed that all of the structures identified to be touched in any way by the ring levee would be purchased; therefore all were deleted from the without-project structure inventory. Some of the parcels are wetland impacts and are discussed below in the Environmental Quality section.

- Measure B – ABFE Nonstructural

This measure includes the acquisition of 24,411 parcels some with structures and some vacant land, and the flood proofing (elevate structure in place) of 8,053 structures to an elevation ranging from 14.9-feet NAVD88 to 22.4-feet NAVD88 depending on the planning sub-unit the structures is assigned. This plan was formulated by the nonstructural flood proofing committee and details can be found in the Nonstructural Appendix. This elevation was determined to be approximately the ABFE level of protection is defined as still water elevation, plus wave run-up plus and estimate for waves (depth divided by two), and is the minimum implementation elevation that a nonstructural measure do to the requirements of the National Flood Insurance Program (NFIP).

The equivalent annual damage reduction by measure for the Seawall and Elevated Roadway is shown in table 6.4-3.

Table 6.4-3.
Equivalent Annual Damage Reduction by Future Scenario

Measures	Equivalent Annual Damage Reduction Future 3 ($)	Equivalent Annual Damage Reduction Future 4 ($)	Equivalent Annual Damage Reduction Future 5 ($)	Equivalent Annual Damage Reduction Future 6 ($)
(No Action)	$0	$0	$0	$0
Measure A Seawall/Elevated Roadway	$52,030,000	$54,260,000	$58,090,000	$59,920,000
Measure B ABFE Nonstructural	$200,860,000	$206,490,000	$220,160,000	$226,120,000

Equivalent annual damages reduced are rounded to the nearest thousand dollars.

6.4.6.3 Residual Damages

Residual damages are the equivalent annual damages that still remain even when a project is in place. Residual damages are calculated as the future without-project equivalent annual damages minus the damages reduced of the various measures. The purpose of residual damages is to calculate and communicate the portions of damages that will not be reduced by the implementation of a plan or "what damages are left on the table". Residual damage by measure is shown in table 6.4-4.

Table 6.4-4.
Residual Damages by Measure and by Future Scenario

Measures	Residual Damages Future 3 ($)	Residual Damages Future 4 ($)	Residual Damages Future 5 ($)	Residual Damages Future 6 ($)
(No Action)	$0	$0	$0	$0
Measure A Seawall/Elevated Roadway	$374,010,000	$379,780,000	$417,110,000	$423,780,000
Measure B ABFE Nonstructural	$225,180,000	$227,550,000	$255,040,000	$257,580,000

Equivalent annual damages reduced are rounded to the nearest thousand dollars.

6.4.7 Environmental Quality (EQ)

6.4.7.1 Impacts of Seawall Elevated Roadway Measure

The Engineering Research and Development Center Wetlands and Coastal Ecology Branch were asked to conduct an assessment of potential impacts to wetlands as a result of constructing various levees and seawalls along the Mississippi Gulf Coastal Plain. This report summarizes the results of the assessment. The analysis of impacts included two components:

1) A calculation of total acreage of all wetlands (by type and planning reach) that is directly under the levee footprints.

2) A modified Hydrogeomorphic (HGM) wetland rapid assessment of impacted Estuarine/Tidal Fringe wetlands, based on the Mississippi and Alabama Gulf Coast HGM guidebook (Shafer et al., 2007), with impacts reported as loss of functional units. Tables 6.4-5 and 6.4-6 show the impacts of the Jackson, Hancock, and Harrison Counties Seawall footprints respectively.

Table 6.4-5.
Wetland Acres Impacted by Jackson County Seawall

Reach ID	Estuarine and Marine Deepwater	Estuarine and Marine Wetland	Freshwater Emergent Wetland	Freshwater Forested/Shrub Wetland	Total
22	0.0	0.7	0.2	0.5	1.4
24	0.6	0.6	0.0	0.0	1.3
Total	**0.6**	**1.4**	**0.2**	**0.5**	**2.7**

Table 6.4-6.
Wetland Acres Impacted by Hancock and Harrison Seawall

Reach ID	Estuarine and Marine Deepwater	Estuarine and Marine Wetland	Freshwater Emergent Wetland	Freshwater Forested/Shrub Wetland	Total
2	0.0	0.0	0.6	3.8	4.4
3	0.0	0.1	0.0	0.0	0.1
4	0.6	0.7	0.8	0.0	2.1
5	0.0	0.4	0.0	5.3	5.6
7	0.0	0.0	0.0	1.9	1.9
10	0.0	4.7	0.0	0.0	4.7
13	0.0	6.4	0.0	0.0	6.4
18	0.0	0.1	0.1	0.0	0.3
Total	**0.6**	**12.4**	**1.5**	**10.9**	**25.4**

Nonstructural measures would have no construction activities other than demolition and disposal of building materials in an approved land fill occurs as a result of this measure. More detail on the impacts of the structural and nonstructural measures for the coast wide area can be found in the Environmental Appendix.

6.4.8 Summary of Costs

Table 6.4-7 summarizes the ROM costs at an FY-08 price level by measure for the seawall and elevated roadway impact area.

Table 6.4-7.
Summary of Costs by Measure for Seawall and Elevated Roadway Area

Measures	Implement Cost (FY-08) ($)	Average Annual Implementation Cost ($)	Average Annual O&M ($)	IDC ($)	Total Average Annual Costs ($)
(No Action)	$0	$0	$0	$0	$0
Measure A Seawall and Elevated Roadway	$5,002,500,000	$245,979,051	$60,148,000	N/A	$306,127,051
Measure C ABFE Nonstructural	$8,580,261,000	$421,902,000	$110,000	N/A	$422,012,000

6.4.9 Regional Economic Development (RED)

The purpose of this section is to describe the economic impact of the proposed measure on business (sale volumes), income, employment, and population of the local area. Each of the measures would affect the local area of Hancock, Jackson, and Harrison Counties, Mississippi. The expenditures for the measures are estimated to be $5,002,500,000 for the seawall and elevated roadway measure, $8,580,261,333 for the ABFE nonstructural measure. Moreover, the total present worth of the operation and maintenance (O&M) expenditures are estimated to be $1,223,235,756 for the seawall and elevated roadway measure, $2,237,081 for the ABFE nonstructural measure based on a 100-year period of analysis and an FY 08 discount rate of 4.875-percent. The EIFS model inputs and outputs for the seawall and elevated roadway area are summarized in tables 6.4-8 through 6.4-11.

Table 6.4-8.
EIFS Model Implementation Costs Inputs for the Seawall and Elevated Area

	Seawall & Elevated Roadway	ABFE Nonstructural
Region of Influence (ROI)	Hancock, Harrison & Jackson Counties	Hancock, Harrison & Jackson Counties
Change in Local Expenditures	$5,002,500,000	$8,580,261,333

Based of the given implementation cost inputs the outputs are as follows:

Table 6.4-9.
EIFS Model Implementation Costs Outputs for the Seawall and Elevated Area

	Seawall & Elevated Roadway	ABFE Nonstructural
Direct Sales Volume	$5,002,500,000	$8,580,261,333
Induced Sales Volume	$5,755,350,000	$9,336,803,805
Total Sales Volume	$10,757,850,000	$17,917,065,137
Direct Income	$1,115,405,211	$1,965,390,069
Induced Income	$1,274,630,230	$2,124,627,724
Total Income	$2,390,035,440	$4,090,017,793
Direct Employment	31,133	52,577
Induced Employment	35,915	57,351
Total Employment	67,048	109,928
Local Population	0	0

Table 6.4-10.
EIFS Model O&M Costs Inputs for the Seawall and Elevated Area

	Seawall & Elevated Roadway	ABFE Nonstructural
Region of Influence (ROI)	Hancock, Harrison & Jackson Counties	Hancock, Harrison & Jackson Counties
Change in Local Expenditures	$1,223,235,756	$2,237,081

Based of the given O&M cost inputs the outputs are as follows:

Table 6.4-11.
EIFS Model O&M Costs Outputs for the Seawall and Elevated Area

	Seawall & Elevated Roadway	ABFE Nonstructural
Direct Sales Volume	$1,223,235,756	$2,237,081
Induced Sales Volume	$1,393,527,224	$2,590,946
Total Sales Volume	$2,616,762,980	$4,828,027
Direct Income	$274,711,471	$484,736
Induced Income	$310,746,337	$558,828
Total Income	$585,457,808	$1,043,565
Direct Employment	7,602	14
Induced Employment	8,684	16
Total Employment	16,286	30
Local Population	0	0

6.5 Evaluation of Pearlington Area Measures

6.5.1 General

The Pearlington area, shown in figure 6.5-1, is located in the western area of planning unit one along the Pearl River. The area is denoted as planning sub-unit six and is depicted in the figure below. The pre-Hurricane Katrina conditions for this area represented a mostly residential community. As shown in Table 6.5-1, it was estimated from the field inventorying process that planning sub-unit six included 1,155 tax parcels, of which 1,152 contained a structure with some economic value and 3 ere vacant land. Of those 1,152 parcels that contain structures, 1,043 were residential one-story, 5 ere residential two-story, 17 were mobile homes, 64 were commercial, and 23 were municipal.

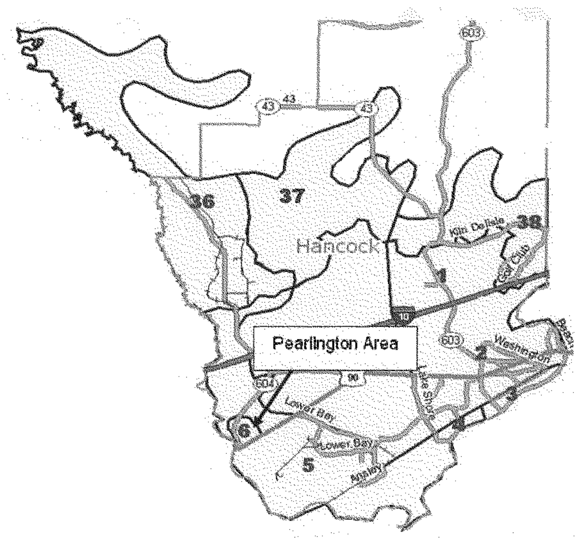


Figure 6.5-1. Pearlington Area – Planning Sub-unit Six

Table 6.5-1.
Pre-Hurricane Katrina Estimate of Structures for the Pearlington Area Planning Sub-unit Six

Asset Categories	Assets by Category
Residential	1,048
Mobile Homes	17
Commercial	64
Municipal	23
Vacant Land	3
Total Tax Parcels	**1,155**

6.5.2 Opportunities

The following opportunities were identified for this area:

- Hurricane storm damage reduction or remediation.

6.5.3 Assumptions

The following assumptions were used in this analysis:

- The FY 2008 discount rate of 4-7/8 percent was used in estimating average annual benefits and costs.
- Price levels are October, 2007 unless otherwise stated.
- A 100-year period of analysis (2012 to 2111) was used to calculate average annual benefits and costs.

6.5.4 Measures

Initially, a comprehensive list of measures was identified for flood damage reduction purposes for planning unit one. This list was screened and vetted for engineering and environmental feasibility and for policy compliance. The MsCIP Comprehensive Main Report and the Engineering and Environmental Appendices contain a detailed description of the measures that were initially screened.

Several potential measures were carried forward for this area for the purpose of flood damage reduction. These measures include both structural features and nonstructural actions. The measures evaluated for economic benefits include:

Measure A - Pearlington Ring Levee
This measure will provide a ring levee with interior drainage, pumping stations, and roadway access up to a crest elevation of 20.0-feet NAVD88.

Measure B - Pearlington Ring Levee
This measure will provide a ring levee with interior drainage, pumping stations, and roadway access up to a crest elevation of 30.0-feet NAVD88.

Measure C – Pearlington Nonstructural One
This measure includes the acquisition and flood proofing (elevate-in-place) of structures to the FEMA advisory base flood elevation (ABFE).

Measure D – Pearlington Nonstructural Two
This measure includes the acquisition and flood proofing of structures to approximately elevation 20.0-feet NAVD88.

Measure E – Pearlington Nonstructural Three
This measure includes the acquisition and flood proofing of structures to approximately elevation 30.0-feet NAVD88.

Figure 6.5-2 shows the measures for the Pearlington Area (planning sub-unit six); the red line represents the approximate footprint of the ring levees, the dark green within the ring levee footprint represents potential ABFE buyout areas and the light green area within the ring levee footprint represents potential flood proof (elevate-in-place) areas.

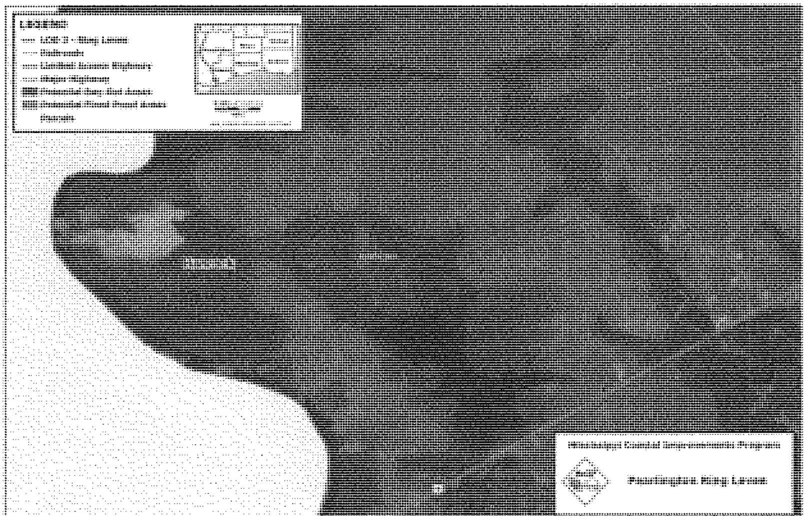


Figure 6.5-2. Display of Potential Measures for the Pearlington Area (Planning Sub-Unit Six)

6.5.5 National Economic Development (NED)

The purpose of this section is to document investigations conducted to identify the National Economic Development (NED) benefits of each of the potential measures previously listed. For this analysis, NED benefits are the reduced inundation damages of assets and their contents when one of the potential measures is in place. Typically, NED benefits are annualized over the period of the analysis (average annual benefits) and then compared to annualized costs over the period of analysis (average annual costs). This comparison is commonly known as the benefit-to-cost ratio (BCR). For purposes of this analysis, no benefit-to-cost ratios will be calculated as per the legislative Congressional language authorizing this study. The Coastal Mississippi Comprehensive Plan Report was authorized by the Department of Defense Appropriations Act, 2006 (P.L. 109-148) 30 December 2005, which states: "*...**that the Secretary shall recommend a cost-effective project, but shall not perform an incremental benefit-cost analysis to identify the recommended project, and shall not make project plan features based upon maximizing net national economic development benefits...***" More detail on the authorizing language can be found in the MsCIP Comprehensive Plan Main Report.

6.5.5.1 Existing Conditions Post-Hurricane Katrina)

The effects of Hurricane Katrina storm surge were devastating to the Pearlington Area. Peak water elevation in the area ranged from 16-to-19-feet NAVD88. It is estimated that between 95 and 99-percent of the structures in the area sustained significant inundation damage (fifty-percent or more). Destroyed residences and commercial structures have displaced the majority of the residences within the area. Expected redevelopment of the area is described in the following section.

6.5.5.2 *Future Without-Project Conditions*

Equivalent annual flood damages for several future without-project scenarios were evaluated using the Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA) model. Each of the measures were evaluated and compared to future without-project scenarios three, and five, as previously discussed in section 5.3. These future scenarios were chosen because the redevelopment projected for this area is anticipated to return to the pre-Katrina development. Futures scenarios two, four, and six were not used for evaluation purposes since this area is not accommodative for commercial and condominium redevelopment under those mixed redevelopment scenarios (see section 5.3 for more detail).

Future scenario one is the full redevelopment of structures within the study area by the year 2012 with no relative sea level rise over the 100-year period of analysis. Table 6.5-2 shows structures by category and by elevation. The number of structures per elevation is added to the previous number of structures per elevation in each category. For example, in the residential category there is one structure with an elevation of 1-foot or lower, there are ten structures with an elevation of 2-feet or less, etc. This future scenario, as previously noted in section 5.3, is for sensitivity purposes only and will not be evaluated against all of the potential measures for the Pearlington area.

Table 6.5-2.
Cumulative Structures by Category and by Estimated First Floor Elevation Future Scenarios One, Three, and Five Applicable for Base Year and Most Likely Future Years

Estimated First Floor Elevation (NAVD88)	Residential	Mobile Homes	Commercial	Municipal	Total
1-foot	1	0	0	0	1
2-foot	10	0	0	0	10
3-foot	22	0	0	0	22
4-foot	35	0	0	0	35
5-foot	51	0	0	0	51
6-foot	75	0	0	0	75
7-foot	125	0	0	0	125
8-foot	214	0	0	0	214
9-foot	351	0	0	0	351
10-foot	425	0	0	0	425
11-foot	452	0	0	0	452
12-foot	459	0	0	0	459
13-foot	460	0	0	0	460
14-foot	460	0	0	0	460
15-foot	460	0	0	0	460
16-foot	460	0	0	0	460
17-foot	460	0	0	0	460
18-foot	460	0	0	0	460
19-foot	460	0	0	0	460
20-foot	1,048	17	64	23	1,152
Total	**1,048**	**17**	**64**	**23**	**1,152**

Estimated first floor elevations can be compared to the exceedance probability functions or both future scenarios three and five.

Future scenario three is the full redevelopment of assets within the study area by the year 2012. Under this scenario, assets will be rebuilt as they were pre-Hurricane Katrina. For example, if the asset was a residential structure pre-Hurricane Katrina it will be rebuilt as a residential structure;

commercial structures will be built back to commercial structures; etc. Basically, future scenario three is the same structure inventory as future scenario one with the addition of an expected relative sea level rise over the 100-year period of analysis (2012–2111). Equivalent annual damages that could occur under this scenario are $12,885,000 (rounded to the nearest thousand). The total number of structures in this scenario are the same as in scenario one and can be seen above in table 6.5-2. Figures 6.5-3 and 6.5-4 depict the base year and most likely future year exceedance probability functions for the Pearlington area (planning sub-unit six). The exceedance probability functions are for still water elevation (SWEL's) and based on a combination of observed data from USACE gauges and from modeling efforts conducted by the Engineer Research and Development Center (ERDC). The most likely future year exceedance probability function depicted in figure 6.5-4 includes an adjustment for expected relative sea level rise over the 100-year period of analysis. **Note**: Due to uncertainty issues regarding the first floor elevations, a base of 100-feet was applied to the exceedance probability functions and the first floor elevations. For example, if the stage for a given event probability shows 102-feet, the stage is really 2-feet. For more detail on the estimation and use of the exceedance probability functions see the Engineering Appendix.

Future scenario five is the same as future scenario one with the addition of a high relative sea level rise 100-year period of analysis (2012–2111). Equivalent annual damages that could occur under this scenario are $14,205,000 (rounded to the nearest thousand). These damages represent approximately a ten-percent (10.24%) increase over the expected relative sea level rise accounted for in future scenario three. The total number of structures in this scenario is the same as in scenarios one and three and can be seen above in table 6.5.2. Figures 6.5-5 and 6.5-6 depict the base year and most likely future year exceedance probability functions for the Pearlington area (planning sub-unit six). The exceedance probability functions are for still water elevation (SWEL's) and based on a combination of observed data from USACE gauges and from modeling efforts conducted by the Engineer Research and Development Center (ERDC). The most likely future year exceedance probability function depicted in figure 6.5-5 includes an adjustment for expected relative sea level rise over the 100-year period of analysis. **Note**: Due to uncertainty issues regarding the first floor elevations, a base of 100-feet was applied to the exceedance probability functions and the first floor elevations. For example, if the stage for a given event probability shows 102-feet, the stage is really 2-feet. For more detail on the estimation and use of the exceedance probability functions see the Engineering Appendix.

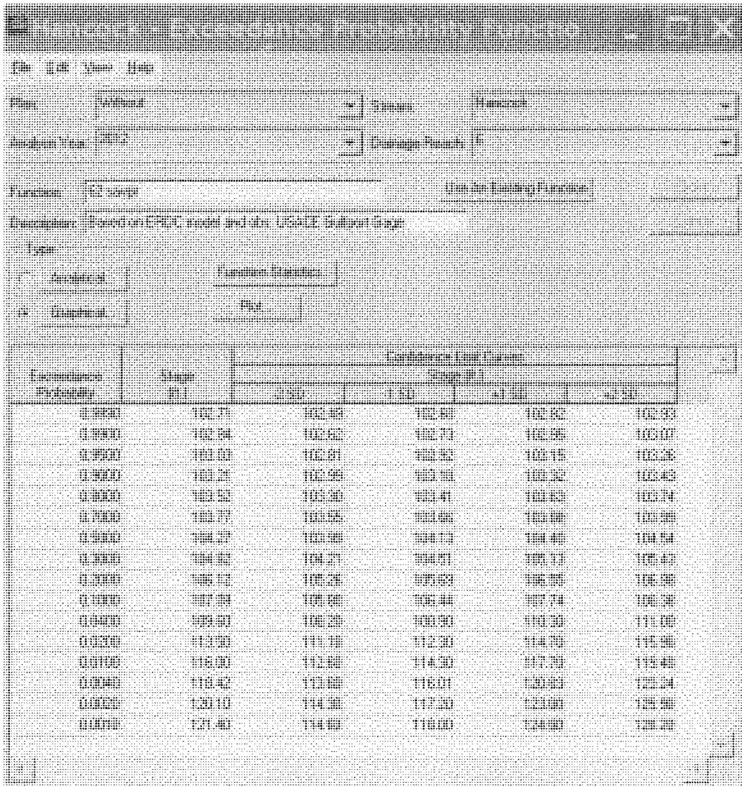
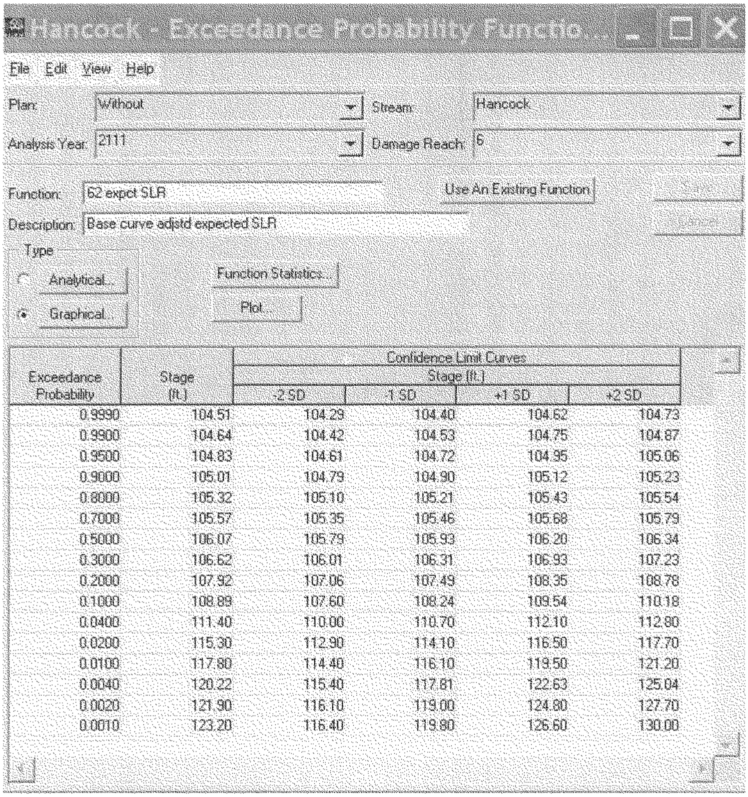


Figure 6.5-3 Future Scenario 3 Base Year (2012) Exceedance Probability Function for the Pearlington Area



Hancock - Exceedance Probability Functio...

File Edit View Help

Plan: Without | Stream: Hancock

Analysis Year: 2111 | Damage Reach: 6

Function: 62 expct SLR | Use An Existing Function

Description: Base curve adjstd expected SLR

Type: Analytical... / Graphical... | Function Statistics... | Plot...

Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.)			
		-2 SD	-1 SD	+1 SD	+2 SD
0.9990	104.51	104.29	104.40	104.62	104.73
0.9900	104.64	104.42	104.53	104.75	104.87
0.9500	104.83	104.61	104.72	104.95	105.06
0.9000	105.01	104.79	104.90	105.12	105.23
0.8000	105.32	105.10	105.21	105.43	105.54
0.7000	105.57	105.35	105.46	105.68	105.79
0.5000	106.07	105.79	105.93	106.20	106.34
0.3000	106.62	106.01	106.31	106.93	107.23
0.2000	107.92	107.06	107.49	108.35	108.78
0.1000	108.89	107.60	108.24	109.54	110.18
0.0400	111.40	110.00	110.70	112.10	112.80
0.0200	115.30	112.90	114.10	116.50	117.70
0.0100	117.80	114.40	116.10	119.50	121.20
0.0040	120.22	115.40	117.81	122.63	125.04
0.0020	121.90	116.10	119.00	124.80	127.70
0.0010	123.20	116.40	119.80	126.60	130.00

Figure 6.5-4 Future Scenario 3 Most Likely Future Year (2012) Exceedance Probability Function for the Pearlington Area – Includes an adjustment for relative sea level rise

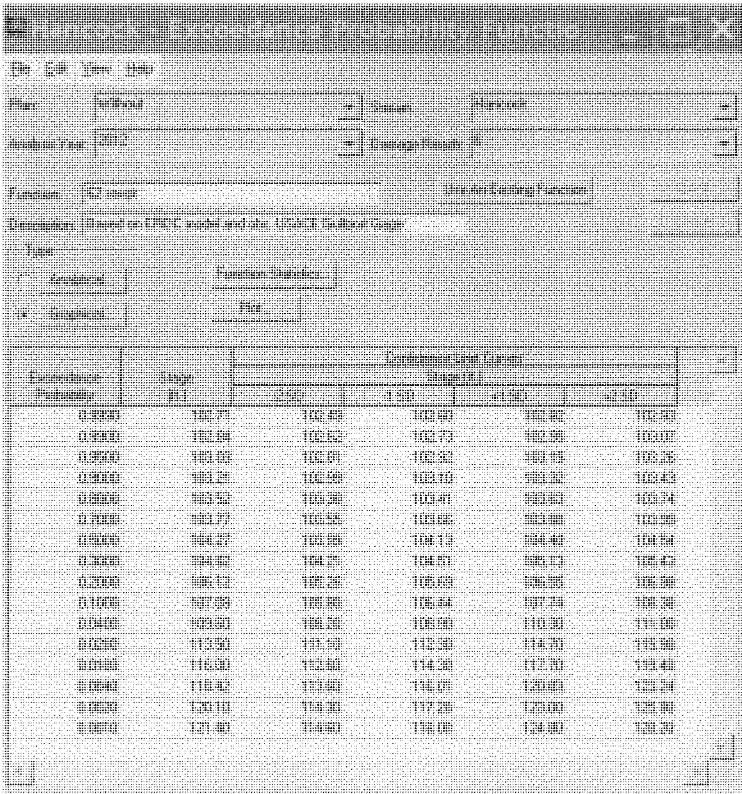
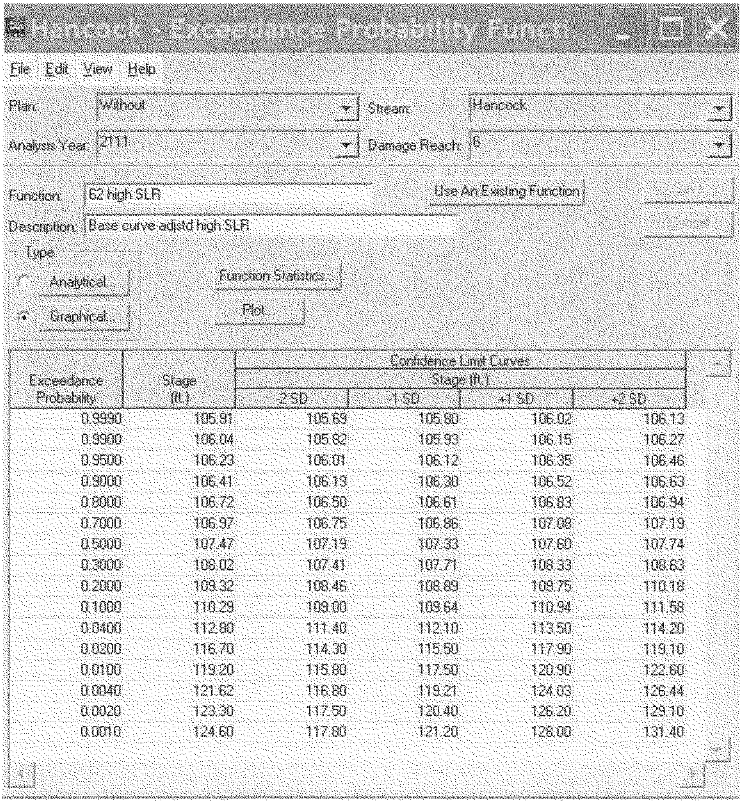


Figure 6.5-5 Future Scenario 5 Base Year (2012) Exceedance Probability Function for the Pearlington Area



Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	105.91	105.69	105.80	106.02	106.13
0.9900	106.04	105.82	105.93	106.15	106.27
0.9500	106.23	106.01	106.12	106.35	106.46
0.9000	106.41	106.19	106.30	106.52	106.63
0.8000	106.72	106.50	106.61	106.83	106.94
0.7000	106.97	106.75	106.86	107.08	107.19
0.5000	107.47	107.19	107.33	107.60	107.74
0.3000	108.02	107.41	107.71	108.33	108.63
0.2000	109.32	108.46	108.89	109.75	110.18
0.1000	110.29	109.00	109.64	110.94	111.58
0.0400	112.80	111.40	112.10	113.50	114.20
0.0200	116.70	114.30	115.50	117.90	119.10
0.0100	119.20	115.80	117.50	120.90	122.60
0.0040	121.62	116.80	119.21	124.03	126.44
0.0020	123.30	117.50	120.40	126.20	129.10
0.0010	124.60	117.80	121.20	128.00	131.40

Figure 6.5-6 Future Scenario 5 Most Likely Future Year (2012) Exceedance Probability Function for the Pearlington Area – Includes an adjustment for relative sea level rise

6.5.5.3 Equivalent annual damages Reduced and Equivalent Annual Residual Damages

Equivalent annual damages reduced are calculated as the difference between the damages under the future without-project scenarios three and five and the damages incurred with the measure in place. The HEC-FDA model was run for each measure to determine the damages reduced as compared to the without-project scenario. In order to provide the HEC-FDA model with accurate information about the economic characteristics of each measure, separate inventories were created for each measure. The inventories are the same as the without project inventory except that footprints of levees and acquisitions were deleted from the inventory and flood proofed structures

(structures to be raised in place) were given a higher elevation. The structure inventories for each of the HEC-FDA measure runs are as follows:

- Measure A – Pearlington Ring Levee at elevation 20.0-feet NAVD88

This measure includes the without-project inventory less 138 parcels that were deleted out of the inventory. These parcels represent the footprint of the 20.0-feet NAVD88 elevation ring levee and some portion of the total would have to be purchased for its construction. At this level of analysis, it is assumed that all of the structures identified to be touched in any way by the ring levee would be purchased; therefore all were deleted from the without-project structure inventory. Some of the parcels are wetland impacts and are discussed below in the Environmental Quality section.

- Measure B – Pearlington Ring Levee at elevation 30.0-feet NAVD88

This measure includes the without-project inventory less 138 parcels that were deleted out of the inventory. These parcels represent the footprint of the 30.0-feet NAVD88 elevation ring levee and some portion of the total would have to be purchased for its construction. At this level of analysis, it is assumed that all of the parcels identified to be touched in any way by the ring levee would be purchased; therefore all were deleted from the without-project structure inventory. Some of the parcels are wetland impacts and are discussed below in the Environmental Quality section.

- Measure C – Pearlington ABFE Nonstructural One

This measure includes the acquisition of 539 parcels that include a structure and the flood proofing (raise structure in place) of 588 structures to elevation of 19.35-feet NAVD88. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was determined to be approximately the ABFE level of protection and is defined as still water elevation, plus wave run-up, plus an estimate for waves (depth divided by two), and is the minimum implementation elevation that a nonstructural measure do to the requirements of the National Flood Insurance Program (NFIP).

- Measure D – Pearlington Nonstructural Two to elevation 20.0-feet NAVD88

This measure includes the acquisition of 950 parcels that include a structure and the flood proofing (raise structure in place) of 177 structures to an elevation of 20.0-feet NAVD88. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was chosen to show a direct comparison to the ring levee at elevation 20.0-feet NAVD88.

- Measure E – Pearlington Nonstructural Three to elevation 30.0-feet NAVD88

This measure includes the acquisition of 1,127 parcels that include a structure. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was chosen to show a direct comparison to the ring levee at elevation 30.0-feet NAVD88.

Residual damage is the equivalent annual damages that still remain even when a project is in place. Residual damage is calculated as the future without-project equivalent annual damages minus the damages reduced of the various measures. The purpose of residual damage is to calculate and communicate the portions of damages that will not be reduced by the implementation of a plan or "what damages are left on the table." Table 6.5-3 summarizes the without project damages, damages reduced, and the residual damage by measure and by future scenario.

Table 6.5-3.
Summary of Damages by Potential Measure and Applicable Future Scenario

Measures	Equivalent Annual Damages Future 3 ($)	Equivalent Annual Damage Reduction Future 3 ($)	Residual Damage Future 3 ($)	Equivalent annual damages Future 5 ($)	Equivalent Annual Damage Reduction Future 5 ($)	Residual Damage Future 5 ($)
(No Action)	$0	$0	$0	$0	$0	$0
Measure A 20Ft Ring Levee	$12,885,000	$11,894,000	$991,000	$14,205,000	$13,088,000	$1,117,000
Measure B 30FT Ring Levee	$12,885,000	$12,267,000	$618,000	$14,205,000	$13,228,000	$977,000
Measure C ABFE Nonstructural	$12,885,000	$12,260,000	$625,000	$14,205,000	$13,520,000	$685,000
Measure D 20FT Nonstructural	$12,885,000	$ 12,813,000	$ 72,000	$14,205,000	$ 14,123,000	$ 82,000
Measure E 30FT Nonstructural	$12,885,000	$12,885,000	$0	$14,205,000	$14,205,000	$0

Damages are rounded to the nearest thousand dollars.

6.5.6 Environmental Quality (EQ)

6.5.6.1 Impacts of Ring Levee Measures

The Engineering Research and Development Center Wetlands and Coastal Ecology Branch were asked to conduct an assessment of potential impacts to wetlands as a result of constructing various levees and seawalls along the Mississippi Gulf Coastal Plain. This report summarizes the results of the assessment. The analysis of impacts included two components:

1. A calculation of total acreage of all wetlands (by type and planning reach) that is directly under the levee footprints.
2. A modified Hydrogeomorphic (HGM) wetland rapid assessment of impacted Estuarine/Tidal Fringe wetlands, based on the Mississippi and Alabama Gulf Coast HGM guidebook (Shafer et al., 2007), with impacts reported as loss of functional units. Tables 6.5-4 and 6.5-5 show the impacts of the Pearlington ring levees at elevations 20.0-feet NAVD88, and 30.0-feet NAVD88 respectively.

Table 6.5-4.
Wetland acres impacted by elevation 20' Pearlington ring levee

Reach ID	Freshwater Emergent Wetland	Freshwater Forested/Shrub Wetland	Freshwater Pond	Total
5	1.1	0.6	0.1	1.9
6	2.7	0.7	0.0	3.4
Total	**3.8**	**1.3**	**0.1**	**5.3**

Table 6.5-5.
Wetland acres impacted by elevation 30' Pearlington ring levee

Reach ID	Freshwater Emergent Wetland	Freshwater Forested/Shrub Wetland	Freshwater Pond	Total
5	2.2	1.2	0.2	3.6
6	3.3	1.0	0.0	4.3
Total	**5.5**	**2.2**	**0.2**	**7.9**

Nonstructural measures would have no construction activities other than demolition and disposal of building materials in an approved land fill occurs as a result of this measure. More detail on the impacts of the structural and nonstructural measures for the Pearlington area can be found in the Environmental Appendix.

6.5.7 Summary of Costs

Table 6.5-6 summarizes the ROM costs at an FY-08 price level by measure for the Pearlington Area (planning sub-unit six).

Table 6.5-6.
Summary of Costs by Measure for the Pearlington Area

Measures	Implement Cost (FY-08) ($)	Capital Recovery Factor	Average Annual Implementation Cost ($)	Average Annual O&M ($)	IDC ($)	Total Average Annual Costs ($)
(No Action)	$0	0.049171225	$0	$0	$0	$0
Measure A 20FT Ring Levee	$104,800,000	0.049171225	$5,153,000	$1,320,000	N/A	$6,473,000
Measure B 30FT Ring Levee	$120,200,000	0.049171225	$5,910,000	$1,526,000	N/A	$7,436,000
Measure C ABFE Nonstructural	$274,808,000	0.049171225	$13,513,000	$10,000	N/A	$13,523,000
Measure D 20FT Nonstructural	$152,102,000	0.049171225	$7,479,000	$10,000	N/A	$7,489,000
Measure E 30FT Nonstructural	$152,102,000	0.049171225	$7,479,000	$10,000	N/A	$7,489,000

The implementation costs include 1/ supervision and administration (30 account), 2/ planning, engineering & design (31 account) and 3/ appropriate contingencies. See the Cost Appendix for more detail on the implementation cost breakdowns. Numbers are rounded to the nearest thousand.

6.5.8 Regional Economic Development (RED)

The purpose of this section is to describe the economic impact of the proposed measures on business (sale volumes), income, employment, and population of the local area. Each of the measures would affect the local area of Hancock County, Mississippi. The expenditures for the measures are estimated to be $104,800,000 for the 20.0-feet NAVD88 ring levee measure, $120,200,000for the 30.0-feet NAVD88 ring levee measure, $274,808,000 for the ABFE nonstructural measure, $152,102,000 for the 20.0-feet NAVD88 nonstructural measure, and $152,102,000 for the 30.0-feet NAVD88 nonstructural measure. Moreover, the total Operation and

Maintenance (O&M) expenditures, which are based on the total present worth of O&M costs over the period of analysis, are estimated to be $26,845,000 for the 20.0-feet NAVD88 ring levee measure, $31,034,000 for the 30.0-feet NAVD88 ring levee measure, $203,000 for the ABFE nonstructural measure, $203,000 for the 20.0-feet NAVD88 nonstructural measure, and $203,000 for the 30.0-feet NAVD88 nonstructural measure respectively (assuming a 100- year period of analysis and an interest rate of 4.875-percent). The following tables summarize the inputs and outputs of the EIFS model by measure.

Table 6.5-7.
EIFS Model Construction Costs Inputs for the Pearlington Area

	20-Foot Ring Levee	30-Foot Ring Levee	ABFE Nonstructural	20-Foot Nonstructural	30-Foot Nonstructural
Region of Influence (ROI)	Hancock County	Hancock County	Hancock County	Hancock County	Hancock County
Change in Local Expenditures	$104,800,000	$120,200,000	$387,900,000	$152,102,000	$152,102,000

Based of the given inputs the outputs are as follows:

Table 6.5-8.
EIFS Model Construction Costs Outputs for the Pearlington Area

	20-Foot Ring Levee	30-Foot Ring Levee	ABFE Nonstructural	20-Foot Nonstructural	30-Foot Nonstructural
Direct Sales Volume	$104,800,000	$120,200,000	$387,900,000	$152,102,000	$152,102,000
Induced Sales Volume	$104,800,000	$120,200,000	$387,900,000	$152,102,000	$152,102,000
Total Sales Volume	$209,600,000	$240,400,000	$775,800,000	$304,204,000	$304,204,000
Direct Income	$25,270,954	$28,984,434	$93,536,290	$36,677,125	$36,677,125
Induced Income	$25,270,954	$28,948,434	$93,536,290	$36,677,125	$36,677,125
Total Income	$50,541,909	$57,968,868	$187,072,580	$73,354,250	$73,354,250
Direct Employment	634	727	2,347	920	920
Induced Employment	634	727	2,347	920	920
Total Employment	1,268	1,454	4,694	1,840	1,840
Local Population	0	0	0	0	0

Table 6.5-9.
EIFS Model O&M Costs Inputs for the Pearlington Area

	20-Foot Ring Levee	30-Foot Ring Levee	ABFE Nonstructural	20-Foot Nonstructural	30-Foot Nonstructural
Region of Influence (ROI)	Hancock County	Hancock County	Hancock County	Hancock County	Hancock County
Change in Local Expenditures	$26,845,000	$31,034,000	$203,000	$203,000	$203,000

Based of the given inputs the outputs are as follows:

Table 6.5-10.
EIFS Model O&M Costs Outputs for the Pearlington Area

	20-Foot Ring Levee	30-Foot Ring Levee	ABFE Nonstructural	20-Foot Nonstructural	30-Foot Nonstructural
Direct Sales Volume	$26,845,000	$31,034,000	$203,000	$203,000	$203,000
Induced Sales Volume	$26,845,000	$31,034,000	$203,000	$203,000	$203,000
Total Sales Volume	$53,690,000	$62,068,000	$406,000	$406,000	$406,000
Direct Income	$6,473,271	$7,483,385	$48,950	$48,950	$48,950
Induced Income	$6,473,271	$7,483,385	$48,950	$48,950	$48,950
Total Income	$12,946,541	$14,966,771	$97,900	$97,900	$97,900
Direct Employment	162	188	1	1	1
Induced Employment	162	188	1	1	1
Total Employment	324	376	2	2	2
Local Population	0	0	0	0	0

6.6 Admiral Island Ecosystem Restoration Measures

This section describes the evaluation of ecosystem restoration measures at the Admiral Island area that is located within planning sub-unit two, which is part of planning unit one. The total area includes approximately 400 acres of state owned land. This area was selected for ecosystem restoration using the Decision Support System, a GIS based model created by the Corps' Engineer Research and Development Center (ERDC). For more details on the selection process for ecosystem restoration sites see the economic appendix. Figure 6.6-1 shows the location of the Admiral Island area.

6.6.1 Formulation of Alternatives

6.6.1.1 Assumption

In order for the Admiral Island site to undergo ecosystem restoration, it is assumed that there will be mandatory buy-outs of properties and removal of all existing structures within the footprint of the site. These buy-outs will be part of the flood damage reduction alternative and not this ecosystem restoration alternative.

6.6.1.2 Objectives

The following ecosystem restoration objectives were developed:

- Restore the natural hydrology
- Provide storm surge protection
- Restore native tidal wetland plant communities
- Provide fish and tidal wildlife habitat
- Prevent saltwater intrusion

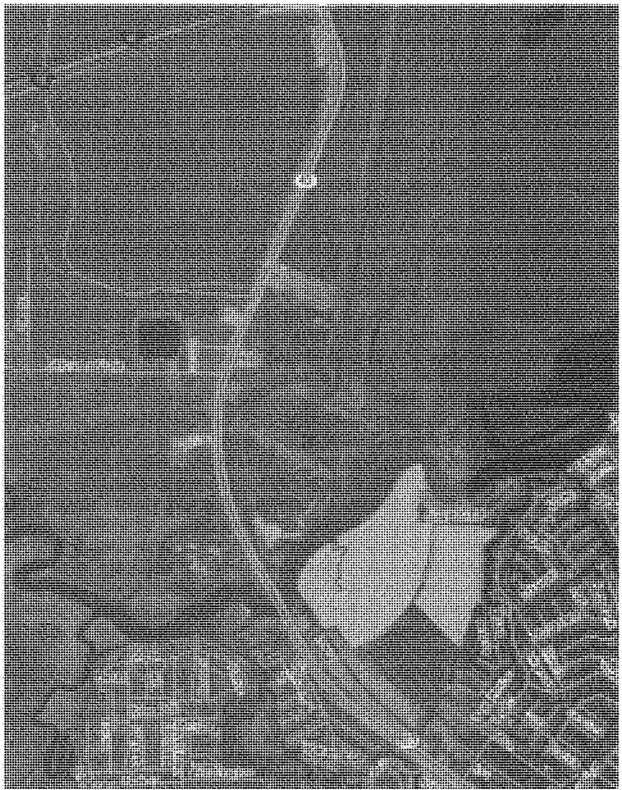


Figure 6.6-1. Location of the Admiral Island Restoration Area

6.6.1.3 Ecosystem Restoration Management Measures

Proposed restoration management measures are listed in Table 6.6-1. Narrative descriptions of each management measure follow this table.

Table 6.6-1.
Ecosystem Restoration Management Measures

Management Measure	Description
No Action	No Action
1	Excavate Old Fill Material
2	Remove Exotic Species
3	Fill Existing Artificial Ditches
4 *a* *b* *C*	Plant Native Vegetation - 0.5 meter spacing - 1.0 meter spacing - 2.0 meter spacing

6.6.1.4 Excavate Old Fill Material (1)

This management measure must be included in all alternatives for the restoration to be successful. It includes 90-95 percent removal of existing exotic species in the excavated areas. This measure positively affects the hydrologic regime.

6.6.1.5 Remove Exotic Species from Non-Excavated Areas and Maintenance of Exotics in All Areas over the Project Life (2)

This management measure must be included in all alternatives for the restoration to be successful. It includes 100 percent removal of exotic species from non-excavated areas over the life of the project. The exotic species include Chinese Tallow, Phragmites, and Cogon Grass. This measure positively affects the percentage of the area covered by exotic species.

6.6.1.6 Fill Existing Artificial Ditches and Channels (3)

This management measure does not need to be included in all alternatives for the restoration to be successful. It includes 100 percent removal of existing artificial ditches and channels. This measure provides additional positive affects to the hydrologic regime.

6.6.1.7 Plant Native Vegetation (4)

The types of native vegetation that will be planted include Spartina alterniflora (Smooth Cordgrass) at the seaward edge of marsh; Juncus roemerianus (Black Needle Rush) at a just slightly higher elevation; and Spartina patens (Saltmeadow Cordgrass) at the next slightly higher elevation.

This management measure must be included in all alternatives for the restoration to be successful. There are three different planting density options: (a) 0.5 meter spacing, (b) 1.0 meter spacing, and (c) 2.0 meters spacing. Planting emergent tidal marsh at varying densities will result in obtaining desired environmental output at varying years and costs. It is estimated that 2 re-planting efforts would be required for the two least dense plantings: 2.0 meters and 1.0 meter spacing. It is estimated that the 0.5 meter spacing will achieve full benefits in about 5 years while the 1.0 meter spacing and 2.0 meter spacing will achieve full benefits in about 7 and 10 years, respectively.

This measure affects the percent cover by woody plant species, wildlife habitat diversity, vegetation height, wetland indicator status and the mean percent cover emergent plant species.

6.6.1.8 Ecosystem Restoration Alternatives

These four management measures were combined to create six alternatives. Each alternative includes the mandatory management measures of excavating old fill material, removing exotic plant species from non-excavated areas, and planting native vegetation. Since there are three different planting densities, three alternatives are created with this combination of management measures. When the management measure of filling existing artificial ditches is added to this combination, this creates another three alternatives.

All alternatives will restore 123 acres. Alternative 1 consists of restoring the study area by excavating old fill material, removing exotic plant species from non-excavated areas, planting native vegetation at a density of 0.5 meters, and filling existing artificial ditches. Alternative 2 consists of restoring the study area by excavating old fill material, removing exotic plant species from non-excavated areas, planting native vegetation at a density of 1.0 meter, and filling existing artificial ditches. Alternative 3 consists of restoring the study area by excavating old fill material, removing exotic plant species from non-excavated areas, planting native vegetation at a density of 2.0 meter, and filling existing artificial ditches. Alternative 4 consists of restoring the study area by excavating old fill material, removing exotic plant species from non-excavated areas and planting native vegetation at a density of 0.5 meters. Alternative 5 consists of restoring the study area by excavating old fill material, removing exotic plant species from non-excavated areas and planting native vegetation at a density of 1.0 meter. Alternative 6 consists of restoring the study area by excavating old fill material, removing exotic plant species from non-excavated areas and planting native vegetation at a density of 2.0 meters. Figure 6.6-2 shows the location of the Admiral Island restoration site. Table 6.6-2 displays a description of each ecosystem restoration alternative.

Figure 6.6-2 Admiral Island restoration site

Table 6.6-2.
Ecosystem Restoration Alternatives

Alternative	Management Measure	Description
0	No Action	No Action
1	1 + 2 +3+ 4a	Excavate Fill Remove Exotics Plant at Density 0.5m Fill Ditches
2	1 + 2 + 3+4b	Excavate Fill Remove Exotics Plant at Density 1.0m Fill Ditches
3	1 + 2 + 3+4c	Excavate Fill Remove Exotics Plant at Density 2.0m Fill Ditches
4	1 + 2 + 4a	Excavate Fill Remove Exotics Plant at Density 0.5m
5	1 + 2 + 4b	Excavate Fill Remove Exotics Plant at Density 1.0m
6	1 + 2 + 4c	Excavate Fill Remove Exotics Plant at Density 2.0m

6.6.1.9 Benefits

Benefits are measured in terms of Average Annual Functional Units (AAFU). The Hydrogeomorphic (HGM) approach was used to assess wetland function. A HGM assessment was performed in 2000 using the Regional Guidebook for Applying the HGM Approach to Assessing Wetland Functions of Wet Pine Flats on Mineral Soils in the Atlantic and Gulf Coastal Plains. Results from this assessment were used to establish baseline (current) conditions and, ultimately, to measure the functional unit benefits resulting from different restoration alternatives. Table 6.6-3 displays the AAFU net benefits for each alternative. The AAFU net benefit was calculated as the difference between the total functional units for the ecosystem restoration alternative and the total functional units for the no action alternative.

Table 6.6-3.
Summary of Benefits

Alternative	Alternative Description	Net AAFU Net Benefits
No Action	No Action	0
Alternative 1	Excavate Fill Remove Exotics Plant at Density 0.5m Fill Ditches	61
Alternative 2	Excavate Fill Remove Exotics Plant at Density 1.0m Fill Ditches	60
Alternative 3	Excavate Fill Remove Exotics Plant at Density 2.0m Fill Ditches	59
Alternative 4	Excavate Fill Remove Exotics Plant at Density 0.5m	51
Alternative 5	Excavate Fill Remove Exotics Plant at Density 1.0m	50.5
Alternative 6	Excavate Fill Remove Exotics Plant at Density 2.0m	49

6.6.1.10 Costs

The rough order magnitude (ROM) first costs of construction, which do not include interest during construction, include excavating 916,483 cubic yards of old fill material for $10,998,000 and planting native vegetation at densities of 0.5m, 1m and 2.0m spacing for $3,571,000, $1,786,000 and $893,000, respectively. The cost of filling ditches with 7,000 cubic yards of material is estimated at approximately $35,000. Herbicide application by hand to 62 acres of land not excavated is estimated at approximately $893,000. Mobilization and demobilization are estimated at approximately $2,400,000, and miscellaneous site items are estimated at approximately $1,000,000. A contingency of 25 percent and lands and damages costs of $25,000 were added to the construction cost. This cost was increased by an 8 percent planning, Engineering and Design (PED) cost and a 6 percent Construction Management cost.

For each alternative, these first costs of construction are presented in Table 6.6-4 in OCTOBER 2007 dollars along with the Interest During Construction (IDC), investment cost (first cost plus the IDC), Average Annual Investment Cost (AAIC), Average Annual Operations and Maintenance (AAO&M) cost and, ultimately, the Average Annual Costs (AAC).

Table 6.6-4.
Summary of Costs by Measure for Admiral Island Area

Alternative	Alternative Description	Implement-ation Cost (FY-08)	IDC	Investment Cost	AAIC	AAO&M	AAC
0	No Action	$0	$0	$0	$0	$0	$0
1	Excavate Fill Remove Exotics Plant at Density 0.5m Fill Ditches	$26,340,000	$580,000	$26,920,000	$1,447,000	$2,000	$1,449,000
2	Excavate Fill Remove Exotics Plant at Density 1.0m Fill Ditches	$23,790,000	$530,000	$24,320,000	$1,306,000	$58,000	$1,364,000
3	Excavate Fill Remove Exotics Plant at Density 2.0m Fill Ditches	$22,490,000	$500,000	$22,990,000	$1,235,000	$58,000	$1,293,000
4	Excavate Fill Remove Exotics Plant at Density 0.5m	$26,280,000	$580,000	$26,860,000	$1,443,000	$2,000	$1,445,000
5	Excavate Fill Remove Exotics Plant at Density 1.0m	$23,720,000	$530,000	$24,250,000	$1,302,000	$58,000	$1,360,000
6	Excavate Fill Remove Exotics Plant at Density 2.0m	$22,440,000	$500,000	$22,900,000	$1,232,000	$58,000	$1,290,000

Note: Numbers are rounded to the nearest thousand.

First costs of construction are used along with the duration of 12 months of construction and a discount rate of 4.875 percent to calculate IDC. The sum of the first costs of construction and IDC cost equal the investment cost. This cost is amortized at the Fiscal Year (OCTOBER) 2007 Federal discount rate of 4.875 percent over a 50-year economic period of analysis to calculate the AAIC. AAO&M costs for monitoring in years 2 through 6 and re-planting in years 3 and 5 were present valued and amortized at an interest rate of 4.875 percent over a 50-year economic period of analysis. The sum of the AAIC and AAO&M cost equal the AAC.

6.6.2 Comparison of Alternatives

Table 6.6-5 displays all alternatives with their respective AAC and AAFU in increasing order of AAFU.

To determine if an alternative is cost effective, economically inefficient alternatives must first be identified and eliminated. An economically inefficient alternative is an alternative that cost more for the same level of benefit. No alternatives are eliminated for the reason of economic inefficiency because each alternative produces a different level of benefit.

Table 6.6-5.
All Alternatives: AAC and AAFU for Admiral Island

Alternative	AAC	AAFU
No Action	$0	0
6	$1,290,000	49
5	$1,360,000	50.5
4	$1,445,000	51
3	$1,293,000	59
2	$1,364,000	60
1	$1,449,000	61

Note: The AAC values are rounded to the nearest thousand.

Lastly, economically ineffective alternatives are identified and eliminated to determine which alternatives are cost effective. An economically ineffective alternative is an alternative that will produce less benefit at an equal or greater cost than a subsequent alternative. The AAFU benefits are place in ascending order and a pair-wise comparison of the benefits and costs is conducted to eliminate economically ineffective alternatives.

As shown in Table 6.6-6, the two shaded alternatives, 5 and 6, were eliminated because they produced less benefit at greater cost than a subsequent alternative. For example, Alternative 4 produces 51 AAFU at an AAC of $1,445,000 while Alternative 3 produces 59 AAFU at an AAC $1,293,000. Alternative 4 produces less AAFU at a greater cost than Alternative 3. Therefore, Alternative 4 is eliminated. As shown in Table 6.6-7 and plotted in Figure 6.6-3, the cost effective alternatives are Alternative 6, Alternative 3, Alternative 2, and Alternative 1.

Table 6.6-6.
Elimination of Economically Ineffective Alternatives

Alternative	Alternative Description	AAC	AAFUs	Cost Effective?
No Action	No Action	$0	0	Yes
6	Excavate Fill Remove Exotics Plant at Density 2.0m	$1,290,000	49	Yes
5	Excavate Fill Remove Exotics Plant at Density 1.0m	$1,360,000	50.5	No
4	Excavate Fill Remove Exotics Plant at Density 0.5m	$1,445,000	51	No
3	Excavate Fill Remove Exotics Plant at Density 2.0m Fill Ditches	$1,293,000	59	Yes
2	Excavate Fill Remove Exotics Plant at Density 1.0m Fill Ditches	$1,364,000	60	Yes
1	Excavate Fill Remove Exotics Plant at Density 0.5m Fill Ditches	$1,449,000	61	Yes

Note: The AAC values are rounded to the nearest thousand.

Table 6.6-7.
Cost Effective Alternatives

Alternative	Alternative Description	AAC	AAFUs	Cost Effective?
No Action	No Action	$0	0	Yes
6	Excavate Fill Remove Exotics Plant at Density 2.0m	$1,290,000	49	Yes
3	Excavate Fill Remove Exotics Plant at Density 2.0m Fill Ditches	$1,293,000	59	Yes
2	Excavate Fill Remove Exotics Plant at Density 1.0m Fill Ditches	$1,364,000	60	Yes
1	Excavate Fill Remove Exotics Plant at Density 0.5m Fill Ditches	$1,449,000	61	Yes

Note: The AAC values are rounded to the nearest thousand.

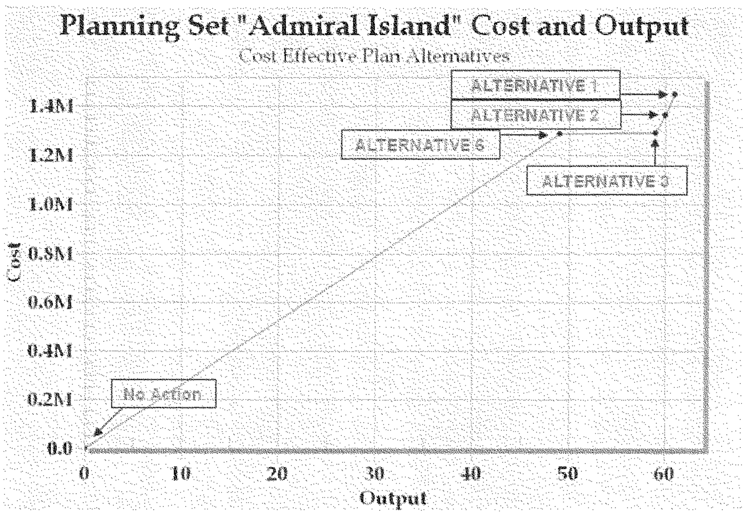


Figure 6.6-3 Display of Cost Effective Alternatives for the Admiral Island Area

6.6.3 Regional Economic Development (RED) Benefits

6.6.3.1 Socioeconomic Impacts using the Economic Impact Forecast System

The purpose of this analysis is to determine the economic impact of the proposed project alternatives on business (sales volumes), income, employment, and population of the local area. Each of the alternatives would affect the local area of Hancock County, Mississippi. The expenditures for the alternatives are estimated to be $26,300,000for Alternative 1, $23,800,000 for the Alternative 2, $22,500,000for Alternative 3, and $22,400,000 for Alternative 6. Moreover, the total present worth of the operation and maintenance (O&M) expenditures are estimated to be $43,000for Alternative 1, $1,075,000 for Alternative 2, $1,075,000 for Alternative 3, and $1,075,000 for Alternative 6, (assuming a 50 year period of analysis and an interest rate of 4.875 percent). Tables 6.6-8 through 6.6-11 summarize the EIFS model inputs and outputs for the cost effective measures at Admiral Island.

Table 6.6-8.
EIFS Model Implementation Inputs for Admiral Island Ecosystem

	No Action	Alternative 1	Alternative 2	Alternative 3	Alternative 6
Region of Influence (ROI)	Hancock County	Hancock County	Hancock County	Hancock County	Hancock County
Change in Local Expenditures	$0	$26,300,000	$23,800,000	$22,500,000	$22,400,000

Based of the given inputs the outputs are as follows:

Table 6.6-9.
EIFS Model Implementation Outputs for Admiral Island Ecosystem

	No Action	Alternative 1	Alternative 2	Alternative 3	Alternative 6
Direct Sales Volume	$0	$26,300,000	$23,800,000	$22,500,000	$22,400,000
Induced Sales Volume	$0	$26,300,000	$23,800,000	$22,500,000	$22,400,000
Total Sales Volume	$0	$52,600,000	$47,600,000	$45,000,000	$44,800,000
Direct Income	$0	$6,341,852	$5,739,014	$5,425,539	$5,401,425
Induced Income	$0	$6,341,852	$5,739,014	$5,425,539	$5,401,425
Total Income	$0	$12,683,704	$11,478,029	$10,851,078	$10,802,851
Direct Employment	0	159	144	136	136
Induced Employment	0	159	144	136	136
Total Employment	0	318	288	272	271
Local Population	0	0	0	0	0

Table 6.6-10.
EIFS Model O&M Inputs for Admiral Island Ecosystem

	No Action	Alternative 1	Alternative 2	Alternative 3	Alternative 6
Region of Influence (ROI)	Hancock County	Hancock County	Hancock County	Hancock County	Hancock County
Change in Local Expenditures	$0	$43,000	$1,075,000	$1,075,000	$1,075,000

Based of the given inputs the outputs are as followed:

Table 6.6-11.
EIFS Model O&M Outputs for Admiral Island Ecosystem

	No Action	Alternative 1	Alternative 2	Alternative 3	Alternative 6
Direct Sales Volume	$0	$43,000	$1,075,000	$1,075,000	$1,075,000
Induced Sales Volume	$0	$43,000	$1,075,000	$1,075,000	$1,075,000
Total Sales Volume	$0	$86,000	$2,150,000	$2,150,000	$2,150,000
Direct Income	$0	$10,369	$259,220	$259,220	$259,220
Induced Income	$0	$10,369	$259,220	$259,220	$259,220
Total Income	$0	$20,738	$518,440	$518,440	$518,440
Direct Employment	0	0	7	7	7
Induced Employment	0	0	7	7	7
Total Employment	0	0	14	14	14
Local Population	0	0	0	0	0

6.7 Evaluation of Turkey Creek Ecosystem Restoration Measures

This section describes the evaluation of ecosystem restoration measures at the Turkey Creek area that is located within planning sub-unit 12, which is part of planning unit two. The total area includes 879 acres. There are no structures within the area, and the acquisition of the parcels would have to occur before the implementation of any of the alternatives. This area was selected for ecosystem restoration using the Decision Support System, a GIS based model created by the Corps' Engineer Research and Development Center (ERDC). For more details on the selection process for ecosystem restoration sites see the Economic Appendix. Figure 6.7-1 shows the location of the Turkey Creek area.

6.7.1 Formulation of Alternatives

6.7.1.1 Assumption

In order for the Turkey Creek site to undergo ecosystem restoration, it is assumed that there will be mandatory buy-outs of required properties in the site footprint. The costs of these buy-outs are accounted for in the flood damage reduction alternative and not in this ecosystem restoration alternative. However, there are non-building structures that require removal and disposal. These costs result from and are included in this ecosystem restoration alternative.

6.7.1.2 Objectives

The following objectives were developed for this ecosystem restoration study:

- Restore native vegetation
- Restore natural hydrology
- Restore fish and wildlife habitat
- Provide storm water storage protection

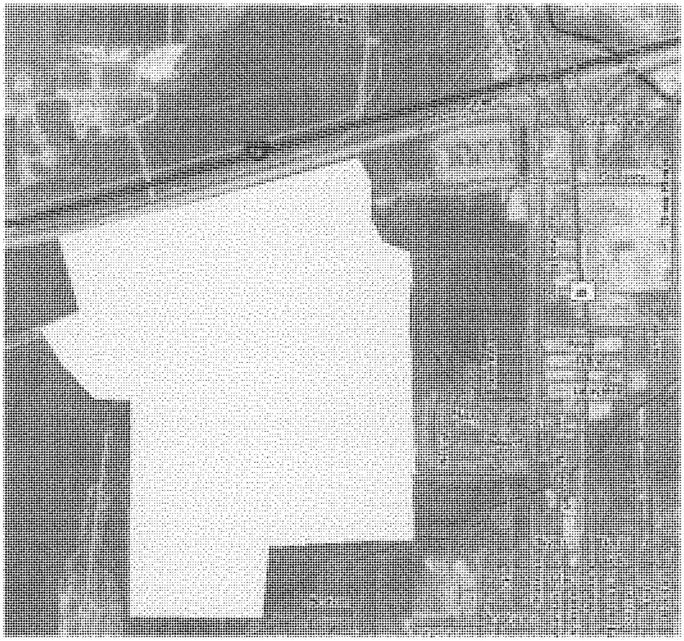


Figure 6.7-1. Location of Turkey Creek Restoration area in Planning Unit Two

6.7.1.3 Ecosystem Restoration Management Measures

Proposed restoration management measures are listed in table 6.7-1. Narrative descriptions of each management measure follow this table.

Table 6.7-1.
Ecosystem Restoration Management Measures

Management Measure	Description
No Action	No Action
1	Fill Ditches
2	Maintain Vegetation
a	By Burning
b	By Mowing
3	Excavate and Remove Existing Roadbeds and Any Additional Fill

6.7.1.3.1 Fill Ditches (1)

This management measure must be included in all alternatives for the restoration to be successful. This measure affects the outflow of water. It measures the removal of water by ditches or drains.

6.7.1.3.2 Maintain Vegetation (2)

This management measure must be included in all alternatives for the restoration to be successful. There are two methods that will be analyzed for maintaining vegetation: (a) burning and (b) mowing. Fire benefits this ecosystem in many different ways. It creates a bare seedbed for pine seedlings and other fire dependent plants, reduces fuel loads and recycles nutrients. Periodic burning promotes early successional plants that are important to many species of wildlife indigenous to this ecosystem. Many of the plant species found in this ecosystem are fire dependent; for example, the federally endangered American Chaff seed flowers almost exclusively after a fire. It has been reduced to a fraction of its original range due to fire suppression and habitat destruction. Fire suppression is mainly due to liability issues and fear of litigation.

Mowing is a mechanical alternative that many land managers use to maintain early successional habitats. Although it is successful to some extent, it fails to provide all the necessary components that come from prescribed fire. This method also has a negative effect. Mowing requires the use of heavy equipment in sensitive areas. Tractors can create ruts in saturated soils, creating hydrologic problems and micro site conditions. Mowing can also introduce non-native species through the use of contaminated equipment. Another disadvantage of mowing is that the duff or litter layer remains on the ground, preventing seeds from reaching the bare ground needed for germination. This thick litter layer can also provide heavy fuel loads increasing the risk of wildfires during dry periods. Although mowing provides some level of habitat management in pine savannahs, it is not a substitute for prescribed fire. Mowing can maintain succession, but may inhibit other functions of the system.

6.7.1.3.3 Excavate and Remove Existing Roadbeds and Any Additional Fill (3)

This management measure must be included in all alternatives for the restoration to be successful. This measure affects the surface water storage.

6.7.1.4 Ecosystem Restoration Alternatives

These management measures were combined to create six alternatives. Each alternative requires filling ditches, maintaining vegetation growth by burning and mowing the project area in the initial year of construction as well as maintaining it by either burning every three years or mowing every year over the life of the project, and excavating and removing existing roadbeds and any additional fill. The difference between each alternative includes the number of acres restored and the method of maintaining vegetation over the life of the project.

Alternatives 1 and 2 consist of restoring the project areas north and south of the railroad: 897 acres. Alternative 1 maintains vegetation by burning once every three years. Alternative 2 maintains vegetation by mowing every year. Alternatives 3 and 4 consist of restoring only the project area south of the railroad: 689 acres. Alternative 3 maintains vegetation by burning once every three years. Alternative 4 maintains vegetation by mowing every year. Alternatives 5 and 6 consist of restoring only the project area north of the railroad: 190 acres. Alternative 5 maintains vegetation by burning once every three years. Alternative 6 maintains vegetation by mowing every year. Figure 6.7-2 shows the Turkey Creek restoration site. Table 6.7-2 displays a description of each ecosystem restoration alternative.

Figure 6.7-2. Turkey Creek Restoration Site

Table 6.7-2.
Ecosystem Restoration Alternatives

Alternative	Management Measures	Alternative Description
0	No Action	No Action
1	1 + 2a +3	879 Acre Restoration Maintain by Burning
2	1 + 2b + 3	879 Acre Restoration Maintain by Mowing
3	1 + 2a +3	689 Acre Restoration Maintain by Burning
4	1 + 2b + 3	689 Acre Restoration Maintain by Mowing
5	1 + 2a +3	190 Acre Restoration Maintain by Burning
6	1 + 2b + 3	190 Acre Restoration Maintain by Mowing

6.7.1.5 Benefits

In order to restore this area to a Wet Pine Savannah habitat, the higher areas will be designated as Wet Pine Savannah. These areas have depression areas within them which will enable water to flow down to the depression areas; thus, holding water. The Wet Pine Savannah habitat will be restored with Wet Pine Flatwoods, such as Pinus elliotti, Morella cerifera, Ilex glabra, Spartina patens and Panicum virgatum.

Many species of wildlife are indigenous to the Wet Pine Savannah habitat. Understory plant communities may contain wiregrass, sedges, orchids, American Chaff seed and rough-leaved loosestrife. Insectivorous plants that may be found include pitcher plants, bladderworts, venus flytrap, and sundews. Rare, threatened or endangered birds that may occur in these areas include Henslowe's sparrow, Bachman's sparrow, red-cockaded woodpecker, and Mississippi Sandhill Crane. This ecosystem may also benefit the Mississippi Gopher frog and in drier areas along ridges, the black pine snake and the gopher tortoise.

Benefits are measured in terms of Average Annual Functional Units (AAFU). The Hydrogeomorphic (HGM) approach was used to assess wetland function. A HGM assessment was performed in 2000 using the Regional Guidebook for Applying the HGM Approach to Assessing Wetland Functions of Wet Pine Flats on Mineral Soils in the Atlantic and Gulf Coastal Plains. Results from this assessment were used to establish baseline (current) conditions and, ultimately, to measure the functional unit benefits resulting from different restoration alternatives. Table 6.7-3 shows the total functional units under each alternative and the AAFU net benefit. It is assumed that functional units will remain the same under existing conditions and the no action alternative. The AAFU net benefit was calculated as the difference between the total functional units for the ecosystem restoration alternative and the total functional units for the no action alternative.

Table 6.7-3.
Summary of Benefits

Alternative	Alternative Description	Total Functional Units	AAFU Net Benefit
Existing Condition (alternatives 1-2)	Existing Condition	1,222	-
Existing Condition (alternatives 3-4)	Existing Condition	1,012	-
Existing Condition (alternatives 5-6)	Existing Condition	210	-
No Action (alternatives 1-2)	No Action	1,222	0
No Action (alternatives 3-4)	No Action	1,012	0
No Action (alternatives 5-6)	No Action	210	0
Alternative 1	879 Acre Restoration Maintain by Burning	3,268	2,046
Alternative 2	879 Acre Restoration Maintain by Mowing	2,574	1,352
Alternative 3	689 Acre Restoration Maintain by Burning	2,577	1,565
Alternative 4	689 Acre Restoration Maintain by Mowing	2,037	815
Alternative 5	190 Acre Restoration Maintain by Burning	691	481
Alternative 6	190 Acre Restoration Maintain by Mowing	537	327

6.7.1.6 Costs

A rough order magnitude (ROM) cost estimate was developed for the 879, 190, and 689 acres of restoration. It included the cost of filling ditches with 130,200, 28,100, and 102,100 cubic yards of material for $1,562,420, $337,480, and $1,224,900, respectively; burning 879, 190, and 689 acres of vegetation for $131,850, 28,480, and 103,370, respectively; mowing 879, 190, and 689 acres for $74,720, 16,140, and 58,580, respectively; removing and disposing of structures, roads and utilities for $2,601,040, $560,530, and $2,040,510, respectively; mobilizing and demobilizing for $20,000; and miscellaneous site items for $45,000. These construction costs equaled $4,435,000, $1,008,000, and $3,492,000, respectively. A contingency cost of 25% and lands and damages costs of $1,126,000, $375,000, and 777,000 were added to the construction cost. Then, Planning, Engineering and Design (PED) costs of 8% and a Construction Management cost of 6% were added for a total first cost of construction. The first cost of 879 acres of restoration is estimated at $7,600,000. The first cost of 190 acres of restoration is estimated at $1,900,000. The first cost of 689 acres of restoration is estimated at $5,900,000.

The first cost plus Interest During Construction (IDC) equals the investment cost. IDC cost of 879, 190, and 689 acres of restoration is estimated at $168,900, $41,400, and $130,200, respectively. Investment cost of 897, 190, and 689 acres of restoration is estimated at $7,800,000, $1,910,000, and $6,020,000, respectively. O&M cost of burning every three years 879, 190, and 689 acres is estimated at $3,040,000, $2,384,000, and $656,000, respectively. O&M cost of mowing every year 879, 190, and 689 acres is estimated at $5,243,000, $4,116,000, and $1,127,000, respectively. Average Annual Investment Cost (AAIC) plus Average Annual Operations and Maintenance (AAO&M) cost equals Average Annual Costs (AAC).

- For Plan 1, AAIC of $419,000 plus AAO&M of $60,000.equals an AAC of $479,000.
- For Plan 2, AAIC of $419,000 plus AAO&M of $107,000.equals an AAC of $526,000.
- For Plan 3, AAIC of $101,000 plus AAO&M of $13,000.equals an AAC of $114,000.
- For Plan 4, AAIC of $101,000 plus AAO&M of $23,000.equals an AAC of $124,000.
- For Plan 5, AAIC of $323,000 plus AAO&M of $47,000.equals an AAC of $370,000.
- For Plan 6, AAIC of $323,000 plus AAO&M of $84,000.equals an AAC of $407,000.

For each alternative, the first costs of construction, IDC, investment cost, O&M cost, AAIC, AAO&M cost and AAC are presented in table 6.7-4 at October 2007 price levels.

First cost of construction is used along with the duration of 12 months of construction and a discount rate of 4.875 percent to calculate Interest During Construction (IDC). The sum of the first cost of construction and IDC cost equals the investment cost. This cost is amortized at the FY 2007 federal discount rate of 4.875 percent over a 50-year economic period of analysis to calculate the Average Annual Investment Cost (AAIC). Average Annual O&M (AAO&M) costs for burning once every three years or mowing every year were present valued and amortized at an interest rate of 4.875 percent over a 50-year economic period of analysis. The sum of the AAIC and AAO&M cost equals the Average Annual Costs (AAC).

Table 6.7-4.
Summary of Costs by Measure for Turkey Creek

Alternative	Alternative Description	Implementation Cost (FY-08)	IDC	Investment Cost	AAIC	AAO&M	AAC
0	No Action	$0	$0	$0	$0	$0	$0
1	879 Acre Restoration Maintain by Burning	$7,636,000	$169,000	$7,804,000	$419,000	$60,000	$479,000
2	879 Acre Restoration Maintain by Mowing	$7,636,000	$169,000	$7,804,000	$419,000	$107,000	$526,000
3	689 Acre Restoration Maintain by Burning	$5,887,000	$130,000	$6,017,000	$323,000	$47,000	$370,000
4	689 Acre Restoration Maintain by Mowing	$5,887,000	$130,000	$6,017,000	$323,000	$84,000	$407,000
5	190 Acre Restoration Maintain by Burning	$1,871,000	$41,000	$1,913,000	$101,000	$13,000	$114,000
6	190 Acre Restoration Maintain by Mowing	$1,871,000	$41,000	$1,913,000	$101,000	$23,000	$124,000

Note: Numbers are rounded to the nearest thousand dollars.

6.7.2 Comparison of Alternatives

Table 6.7-5 displays all alternatives with their respective AAC and AAFU.

Table 6.7-5.
All Alternatives: AAC and AAFU

Alternative	AAC	AAFU
No Action	$0	0
1	$479,000	2,046
2	$526,000	1,352
3	$370,000	1,565
4	$407,000	815
5	$114,000	481
6	$124,000	327

Note: The AAC values are rounded to the nearest thousand dollars.

In order to determine the cost effectiveness of each alternative, the list of alternatives is reordered so that they are listed in increasing order of their outputs (AAFU). This list is shown in table 6.7-6.

To determine if an alternative is cost effective, economically inefficient alternatives must first be identified and eliminated. An economically inefficient alternative is an alternative that cost more for the same level of benefit. No alternatives are eliminated for the reason of economic inefficiency because each alternative produces a different level of benefit.

Table 6.7-6.
All Alternatives Arrayed by Increasing Output

Alternative	AAC	AAFU
No Action	$0	0
6	$124,000	327
5	$114,000	481
4	$407,000	815
2	$526,000	1,352
3	$370,000	1,565
1	$479,000	2,046

Note: The AAC values are rounded to the nearest thousand dollars.

Lastly, economically ineffective alternatives are identified and eliminated to determine which alternatives are cost effective. An economically ineffective alternative is an alternative that cost more or the same as a subsequent alternative but produces less benefit than that subsequent alternative. As shown in table 6.7-7, the three shaded alternatives, 6, 4, and 2 were eliminated because they produced less benefit at greater cost than a subsequent alternative. For example, Alternative 6 produces 327 AAFU at an AAC of $124,000 while Alternative 5 produces 481 AAFU at an AAC $114,000. Alternative 6 produces less AAFU at a greater cost than Alternative 5. Therefore, Alternative 6 is eliminated. As shown in table 6.7-8 and plotted in figure 6.7-3, the cost effective alternatives are Alternative 5 (190 acres of restoration maintained by burning), Alternative 3 (689 acres of restoration maintained by burning) and Alternative 1 (879 acres of restoration maintained by burning).

Table 6.7-7.
Elimination of Economically Ineffective Alternatives

Alternative	Alternative Description	AAC	AAFUs	Cost Effective?
No Action	No Action	$0	0	Yes
6	190 Acre Restoration Maintain by Mowing	$124,000	327	No
5	190 Acre Restoration Maintain by Burning	$114,000	481	Yes
4	689 Acre Restoration Maintain by Mowing	$407,000	815	No
2	879 Acre Restoration Maintain by Mowing	$526,000	1,352	No
3	689 Acre Restoration Maintain by Burning	$370,000	1,565	Yes
1	879 Acre Restoration Maintain by Burning	$479,000	2,046	Yes

Note: The AAC values are rounded to the nearest thousand dollars.

Table 6.7-8.
Cost Effective Alternatives for the Turkey Creek Area

Alternative	Alternative Description	AAC	AAFUs	Cost Effective?
No Action	No Action	$0	0	Yes
5	190 Acre Restoration Maintain by Burning	$114,000	481	Yes
3	689 Acre Restoration Maintain by Burning	$370,000	1,565	Yes
1	879 Acre Restoration Maintain by Burning	$479,000	2,046	Yes

Note: The AAC values are rounded to the nearest thousand dollars.

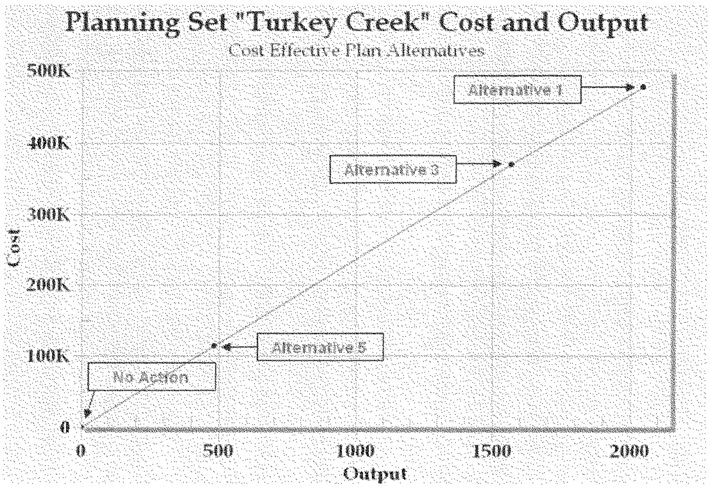


Figure 6.7-3. Display of Cost Effective Alternatives for the Turkey Creek Area

6.7.3 Regional Economic Development Benefits

6.7.3.1 Socioeconomic Impacts using the Economic Impact Forecast System

The purpose of this section is to show the economic impact of the proposed project alternatives on business (sale volumes), income, employment, and population of the local area. Each of the alternatives would affect the local area of Harrison County, Mississippi. The expenditures for the alternatives are estimated to be $7,600,000 for Alternative 1, $5,900,000 for Alternative 3, $1,900,000 for Alternative 5. Moreover, the total present worth of the operation and maintenance (O&M) expenditures are estimated to be $1,112,000 for Alternative 1, $872,000 for Alternative 3, and $240,000 for Alternative 5 (assuming a 50 year period of analysis and an interest rate of 4.875 percent). Tables 6.7-9 through 6.7-12 show the EIFS model inputs and outputs for the cost effect alternatives.

Table 6.7-9.
EIFS Model Implementation Inputs for Turkey Creek Ecosystem

	No Action	Alternative 1	Alternative 3	Alternative 5
Region of Influence (ROI)	Harrison County	Harrison County	Harrison County	Harrison County
Change in Local Expenditures	$0	$7,600,000	$5,900,000	$1,900,000

Based of the given inputs the outputs are as follows:

Table 6.7-10.
EIFS Model Implementation Outputs for Turkey Creek Ecosystem

	No Action	Alternative 1	Alternative 3	Alternative 5
Direct Sales Volume	$0	$7,600,000	$5,900,000	$1,900,000
Induced Sales Volume	$0	$9,500,000	$7,375,000	$2,375,000
Total Sales Volume	$0	$17,100,000	$13,275,000	$4,275,000
Direct Income	$0	$1,608,733	$1,248,884	$402,183
Induced Income	$0	$2,010,916	$1,561,106	$502,729
Total Income	$0	$3,619,648	$2,809,990	$904,912
Direct Employment	0	48	37	12
Induced Employment	0	60	47	15
Total Employment	0	109	84	27
Local Population	0	0	0	0

Table 6.7-11.
EIFS Model O&M Inputs for Turkey Creek Ecosystem

	No Action	Alternative 1	Alternative 3	Alternative 5
Region of Influence (ROI)	Harrison County	Harrison County	Harrison County	Harrison County
Change in Local Expenditures	$0	$1,112,000	$872,000	$240,000

Based of the given inputs the outputs are as follows:

Table 6.7-12.
EIFS Model O&M Outputs for Turkey Creek Ecosystem

	No Action	Alternative 1	Alternative 3	Alternative 5
Direct Sales Volume	$0	$1,112,000	$872,000	$240,000
Induced Sales Volume	$0	$1,390,000	$1,090,000	$300,000
Total Sales Volume	$0	$2,502,000	$1,962,000	$540,000
Direct Income	$0	$235,383	$184,581	$50,802
Induced Income	$0	$294,229	$230,726	$63,503
Total Income	$0	$529,612	$415,307	$114,305
Direct Employment	0	7	6	2
Induced Employment	0	9	7	2
Total Employment	0	16	13	4
Local Population	0	0	0	0

6.8 Evaluation of Ocean Springs Area Measures

6.8.1 General

The Ocean Springs area, shown in figure 6.8-1, is located in the southwestern extent of planning unit three along the eastern shore of the Biloxi Bay. The area is denoted as planning sub-unit 22 and is depicted in the figure below. The pre-Hurricane Katrina conditions for this area represented a mostly residential community. As shown in table 6.8-1, it was estimated from the field inventorying process that planning sub-unit 22 included 3,722 tax parcels, of which 3,371 contained a structure with some economic value and 351 were vacant land. Of those 3,371 parcels that contain structures, 2,995 were residential one-story, 85 were residential two-story, 5 were mobile homes, 220 were commercial, and 66 were municipal.

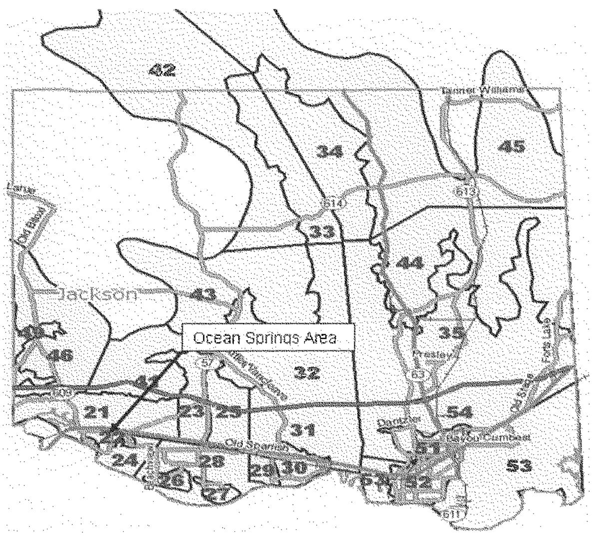


Figure 6.8-1. Ocean Springs Area – Planning Sub-unit 22

Table 6.8-1.
Pre-Hurricane Katrina Estimate of Structures for the Ocean Springs Area Planning Sub-unit 22

Asset Categories	Assets by Category
Residential	3,080
Mobile Homes	5
Commercial	220
Municipal	66
Vacant Land	351
Total Tax Parcels	**3,722**

6.8.2 Opportunities

The following opportunities were identified for this area:

- Hurricane storm damage reduction or remediation

6.8.3 Assumptions

The following assumptions were used in this analysis.

- The FY 2008 discount rate of 4.875 percent was used in estimating average annual benefits and costs
- Price levels are October, 2007 unless otherwise stated.
- A 100-year period of analysis (2012 to 2111) was used to calculate average annual benefits and costs.

6.8.4 Measures

Initially, a comprehensive list of measures was identified for flood damage reduction purposes for planning unit three. This list was screened and vetted for engineering and environmental feasibility and for policy compliance. The MsCIP Comprehensive Main Report and the Engineering and Environmental Appendices contain a detailed description of the measures that were initially screened.

Several potential measures were carried forward for this area for the purpose of flood damage reduction. These measures include both structural features and nonstructural actions. The measures evaluated for economic benefits include:

- Measure A – Ocean Springs 20-foot NAVD88 Ring Levee
  This measure will provide a ring levee with interior drainage, pumping stations, and roadway access up to a crest elevation of 20.0-feet NAVD88.
- Measure B – Ocean Springs 30-foot NAVD88 Ring Levee
  This measure will provide a ring levee with interior drainage, pumping stations, and roadway access up to a crest elevation of 30.0-feet NAVD88.
- Measure C – Ocean Springs Nonstructural One
  This measure includes the acquisition and flood proofing (elevate-in-place) of structures to the FEMA advisory base flood elevation (ABFE).

- Measure D – Ocean Springs Nonstructural Two
  This measure includes the acquisition and flood proofing of structures to approximately elevation 20.0-feet NAVD88.
- Measure E – Ocean Springs Nonstructural Three
  This measure includes the acquisition and flood proofing of structures to approximately elevation 30.0-feet NAVD88.

Figure 6.8-2 shows the measures for the Ocean Springs Area (planning sub-unit 22); the red line represents the approximate footprint of the ring levees, the dark green within the ring levee footprint represents potential ABFE buyout areas and the light green area within the ring levee footprint represents potential flood proof (elevate-in-place) areas.

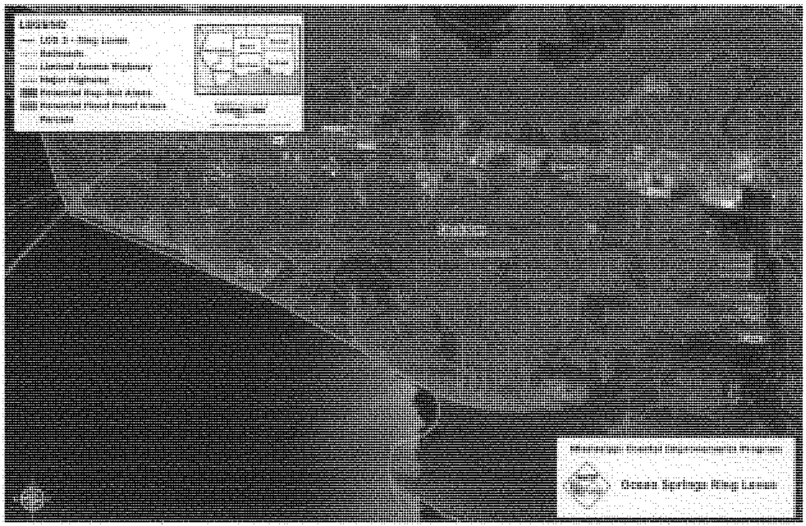


Figure 6.8-2. Display of Potential Measures for the Ocean Springs Area (Planning Sub-Unit 22)

6.8.5 National Economic Development (NED)

The purpose of this section is to document investigations conducted to identify the National Economic Development (NED) benefits of each of the potential measures previously listed. For this analysis, NED benefits are the reduced inundation damages of assets and their contents when one of the potential measures is in place. Typically, NED benefits are annualized over the period of the analysis (average annual benefits) and then compared to annualized costs over the period of analysis (average annual costs). This comparison is commonly known as the benefit-to-cost ratio (BCR). For purposes of this analysis, no benefit-to-cost ratios will be calculated as per the legislative Congressional language authorizing this study. The Coastal Mississippi Comprehensive Plan Report was authorized by the Department of Defense Appropriations Act, 2006 (P.L. 109-148) 30 December

2005, which states: "...*that the Secretary shall recommend a cost-effective project, but shall not perform an incremental benefit-cost analysis to identify the recommended project, and shall not make project plan features based upon maximizing net national economic development benefits...*" More detail on the authorizing language can be found in the MsCIP Comprehensive Plan Main Report.

6.8.5.1 Existing Conditions Post-Hurricane Katrina)

The effects of Hurricane Katrina storm surge were devastating to the Ocean Springs Area. Peak water elevation in the area ranged from 20-to-21-feet NAVD88. It is estimated that between 95 and 99-percent of the structures in the area sustained significant inundation damage (fifty-percent or more). Destroyed residences and commercial structures have displaced the majority of the residences within the area. Expected redevelopment of the area is described in the following section.

6.8.5.2 Future Without-Project Conditions

Equivalent annual flood damages for several future without-project scenarios were evaluated using the Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA) model. Each of the measures were evaluated and compared to future without-project scenarios three, and five, as previously discussed in section 5.3. These future scenarios were chosen because the redevelopment projected for this area is anticipated to return to the pre-Katrina development. Futures scenarios two, four, and six were not used for evaluation purposes since this area is not accommodative for commercial and condominium redevelopment under those mixed redevelopment scenarios (see section 5.3 for more detail).

Future scenario one is the full redevelopment of structures within the study area by the year 2012 with no relative sea level rise over the 100-year period of analysis. Table 6.8-2 shows structures by asset category and by elevation. The number of structures per elevation is added to the previous number of structures per elevation in each category. For example, in the residential category there are no structures with an elevation of 1-foot or lower, and there is one structure with an elevation of 2-feet or less, etc. This future scenario, as previously noted in section 5.3, is for sensitivity purposes only and will not be evaluated against all of the potential measures for the Ocean Springs area.

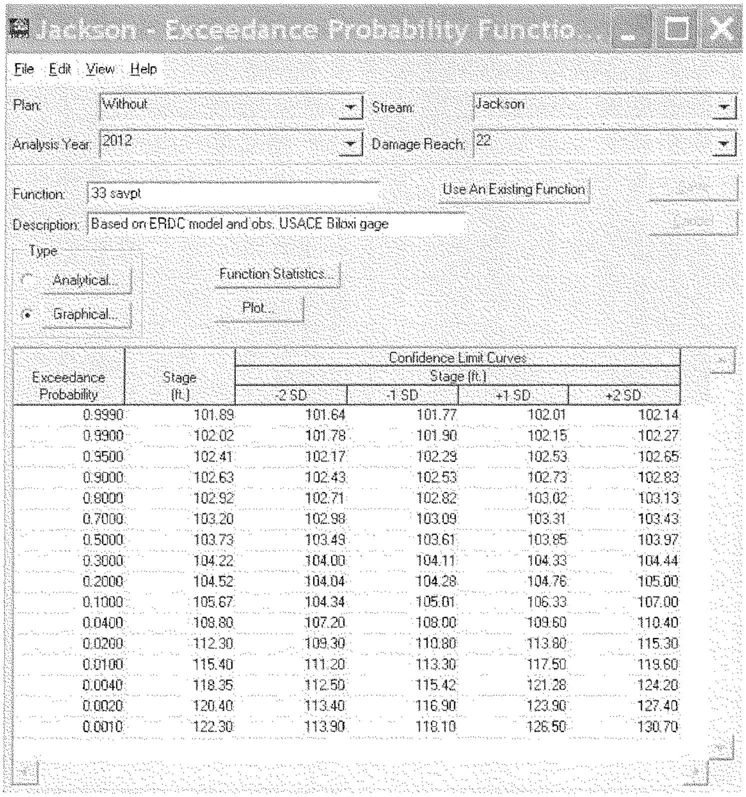
Table 6.8-2.
Cumulative Structures by Category and by Estimated First Floor Elevation Future Scenarios One, Three, and Five Applicable for Base Year and Most Likely Future Years

Estimated First Floor Elevation (NAVD88)	Residential	Mobile Homes	Commercial	Municipal	Total
1-foot	0	0	0	0	0
2-foot	1	0	0	0	1
3-foot	2	0	0	0	2
4-foot	4	0	0	0	4
5-foot	5	0	0	0	5
6-foot	9	0	0	0	9
7-foot	13	0	0	0	13
8-foot	22	0	0	0	22
9-foot	33	0	0	0	33
10-foot	48	0	0	0	48
11-foot	56	0	0	0	56

Table 6.8-2.
Cumulative Structures by Category and by Estimated First Floor Elevation Future Scenarios One, Three, and Five Applicable for Base Year and Most Likely Future Years (continued)

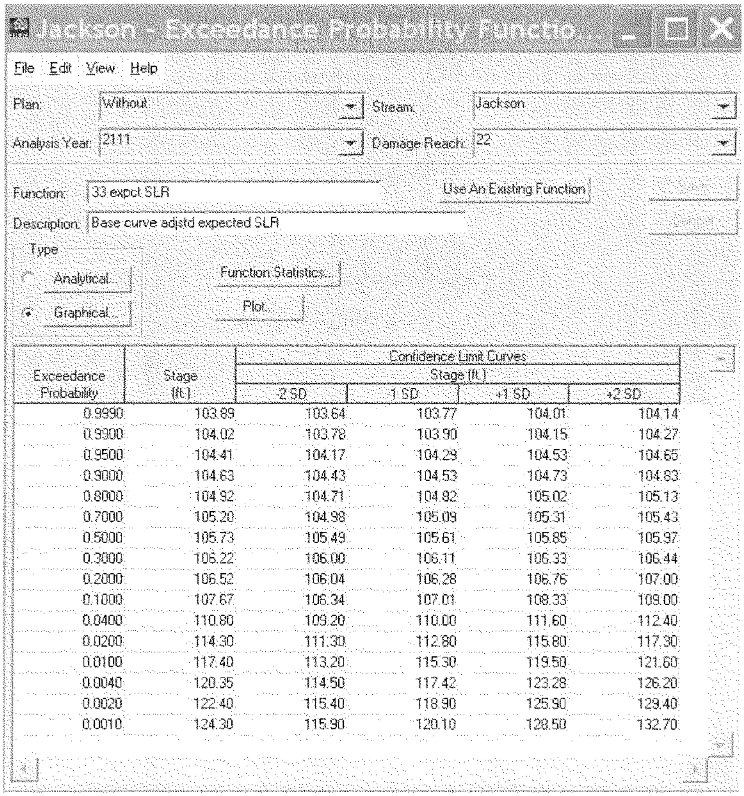
Estimated First Floor Elevation (NAVD88)	Residential	Mobile Homes	Commercial	Municipal	Total
12-foot	66	0	0	1	67
13-foot	78	0	0	1	79
14-foot	101	0	0	2	103
15-foot	122	0	0	2	124
16-foot	170	0	0	3	173
17-foot	296	1	9	13	319
18-foot	387	1	11	13	412
19-foot	577	1	17	14	609
20-foot	833	1	31	18	883
21-foot	1,150	1	46	20	1,217
22-foot	1,828	4	86	36	1,954
23-foot	2,687	5	169	52	2,913
24-foot	3,038	5	214	65	3,322
25-foot	3,075	5	220	66	3,366
26-foot	3,076	5	220	66	3,367
27-foot	3,077	5	220	66	3,368
28-foot	3,078	5	220	66	3,369
29-foot	3,079	5	220	66	3,370
30-foot	3,080	5	220	66	3,371
Total	**3,080**	**5**	**220**	**66**	**3,371**

Future scenario three is the full redevelopment of assets within the study area by the year 2012. Under this scenario, assets will be rebuilt as they were pre-Hurricane Katrina. For example, if the asset was a residential structure pre-Hurricane Katrina it will be rebuilt as a residential structure; commercial structures will be built back to commercial structures; etc. Basically, future scenario three is the same structure inventory as future scenario one with the addition of an expected relative sea level rise over the 100-year period of analysis (2012–2111). Equivalent annual damages that could occur under this scenario are $1,958,000 (rounded to the nearest thousand dollars). The total number of structures in this scenario are the same as in scenario one and can be seen above in table 6.8-2. Figures 6.8-3 and 6.8-4 depict the base year and most likely future year exceedance probability functions for the Ocean Springs area (planning sub-unit 22). The exceedance probability functions are for still water elevation (SWEL's) and based on a combination of observed data from USACE gauges and from modeling efforts conducted by the Engineer Research and Development Center (ERDC). The most likely future year exceedance probability function depicted in figure 6.8-4 includes an adjustment for expected relative sea level rise over the 100-year period of analysis. **Note**: Due to uncertainty issues regarding the first floor elevations, a base of 100-feet was applied to the exceedance probability functions and the first floor elevations. For example, if the stage for a given event probability shows 102-feet, the stage is really 2-feet. For more detail on the estimation and use of the exceedance probability functions see the Engineering Appendix.



Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	101.89	101.64	101.77	102.01	102.14
0.9900	102.02	101.78	101.90	102.15	102.27
0.9500	102.41	102.17	102.29	102.53	102.65
0.9000	102.63	102.43	102.53	102.73	102.83
0.8000	102.92	102.71	102.82	103.02	103.13
0.7000	103.20	102.98	103.09	103.31	103.43
0.5000	103.73	103.49	103.61	103.85	103.97
0.3000	104.22	104.00	104.11	104.33	104.44
0.2000	104.52	104.04	104.28	104.76	105.00
0.1000	105.67	104.34	105.01	106.33	107.00
0.0400	108.80	107.20	108.00	109.60	110.40
0.0200	112.30	109.30	110.80	113.80	115.30
0.0100	115.40	111.20	113.30	117.50	119.60
0.0040	118.35	112.50	115.42	121.28	124.20
0.0020	120.40	113.40	116.90	123.90	127.40
0.0010	122.30	113.90	118.10	126.50	130.70

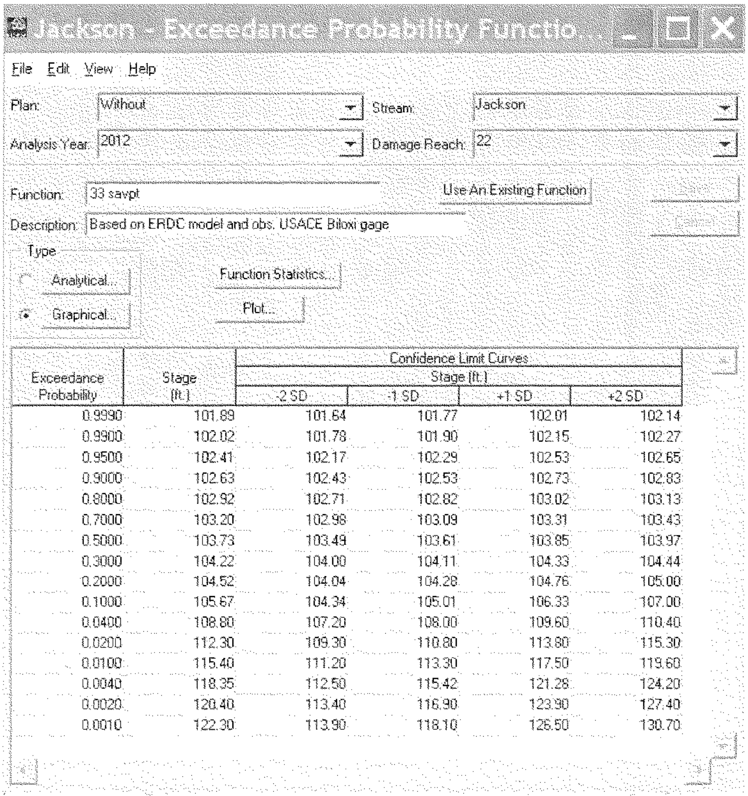
Figure 6.8-3. Future Scenario 3 Base Year (2012) Exceedance Probability Function for the Ocean Springs Area



Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	103.89	103.64	103.77	104.01	104.14
0.9900	104.02	103.78	103.90	104.15	104.27
0.9500	104.41	104.17	104.29	104.53	104.65
0.9000	104.63	104.43	104.53	104.73	104.83
0.8000	104.92	104.71	104.82	105.02	105.13
0.7000	105.20	104.98	105.09	105.31	105.43
0.5000	105.73	105.49	105.61	105.85	105.97
0.3000	106.22	106.00	106.11	106.33	106.44
0.2000	106.52	106.04	106.28	106.76	107.00
0.1000	107.67	106.34	107.01	108.33	109.00
0.0400	110.80	109.20	110.00	111.60	112.40
0.0200	114.30	111.30	112.80	115.80	117.30
0.0100	117.40	113.20	115.30	119.50	121.60
0.0040	120.35	114.50	117.42	123.28	126.20
0.0020	122.40	115.40	118.90	125.90	129.40
0.0010	124.30	115.90	120.10	128.50	132.70

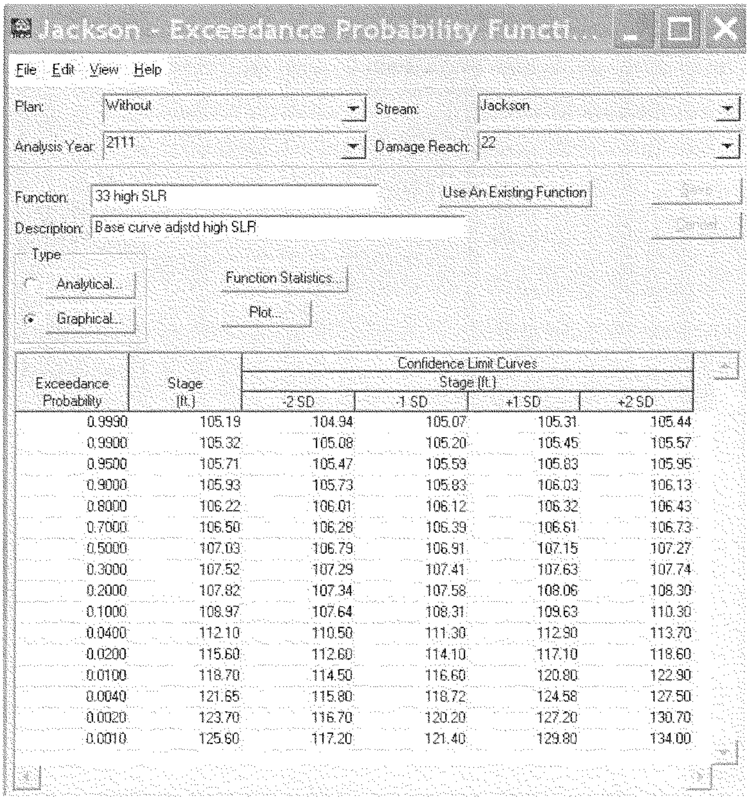
Figure 6.8-4. Future Scenario 3 Most Likely Future Year (2012) Exceedance Probability Function for the Ocean Springs Area – Includes an adjustment for relative sea level rise

Future scenario five is the same as future scenario one with the addition of a high relative sea level rise 100-year period of analysis (2012–2111). Equivalent annual damages that could occur under this scenario are $2,190,000 (rounded to the nearest thousand). These damages represent a approximately a ten-percent (10.2%) increase over the 2.0-feet of relative sea level rise accounted for in future scenario three. The total number of structures in this scenario is the same as in scenarios one and three and can be seen above in table 6.8-2. Figures 6.8-5 and 6.8-6 depict the base year and most likely future year exceedance probability functions for the Ocean Springs area (planning sub-unit 22). The exceedance probability functions are for still water elevation (SWEL's) and based on a combination of observed data from USACE gauges and from modeling efforts conducted by the Engineer Research and Development Center (ERDC). The most likely future year exceedance probability function depicted in figure 6.8-6 includes an adjustment for expected relative sea level rise over the 100-year period of analysis. **Note**: Due to uncertainty issues regarding the first floor elevations, a base of 100-feet was applied to the exceedance probability functions and the first floor elevations. For example, if the stage for a given event probability shows 102-feet, the stage is really 2-feet. For more detail on the estimation and use of the exceedance probability functions see the Engineering Appendix.



Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	101.89	101.64	101.77	102.01	102.14
0.9900	102.02	101.78	101.90	102.15	102.27
0.9500	102.41	102.17	102.29	102.53	102.65
0.9000	102.63	102.43	102.53	102.73	102.83
0.8000	102.92	102.71	102.82	103.02	103.13
0.7000	103.20	102.98	103.09	103.31	103.43
0.5000	103.73	103.49	103.61	103.85	103.97
0.3000	104.22	104.00	104.11	104.33	104.44
0.2000	104.52	104.04	104.28	104.76	105.00
0.1000	105.67	104.34	105.01	106.33	107.00
0.0400	108.80	107.20	108.00	109.60	110.40
0.0200	112.30	109.30	110.80	113.80	115.30
0.0100	115.40	111.20	113.30	117.50	119.60
0.0040	118.35	112.50	115.42	121.28	124.20
0.0020	120.40	113.40	116.90	123.90	127.40
0.0010	122.30	113.90	118.10	126.50	130.70

Figure 6.8-5 Future Scenario 5 Base Year (2012) Exceedance Probability Function for the Ocean Springs Area



Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	105.19	104.94	105.07	105.31	105.44
0.9900	105.32	105.08	105.20	105.45	105.57
0.9500	105.71	105.47	105.59	105.83	105.95
0.9000	105.93	105.73	105.83	106.03	106.13
0.8000	106.22	106.01	106.12	106.32	106.43
0.7000	106.50	106.28	106.39	106.61	106.73
0.5000	107.03	106.79	106.91	107.15	107.27
0.3000	107.52	107.29	107.41	107.63	107.74
0.2000	107.82	107.34	107.58	108.06	108.30
0.1000	108.97	107.64	108.31	109.63	110.30
0.0400	112.10	110.50	111.30	112.90	113.70
0.0200	115.60	112.60	114.10	117.10	118.60
0.0100	118.70	114.50	116.60	120.80	122.90
0.0040	121.65	115.80	118.72	124.58	127.50
0.0020	123.70	116.70	120.20	127.20	130.70
0.0010	125.60	117.20	121.40	129.80	134.00

Figure 6.8-6 Future Scenario 5 Most Likely Future Year (2012) Exceedance Probability Function for the Ocean Springs Area – Includes an adjustment for relative sea level rise

6.8.5.3 *Equivalent annual damages Reduced*

Equivalent annual damages reduced are calculated as the difference between the damages under the future without-project scenarios three and five and the damages incurred with the measure in place. The HECFDA model was run for each measure to determine the damages reduced as compared to the without-project scenario.

In order to provide the HEC-FDA model with accurate information about the economic characteristics of each measure, separate inventories were created for each measure. The inventories are the same as the without project inventory except that footprints of levees and acquisitions were deleted from the inventory and flood proofed structures (structures to be raised in place) were given a higher elevation. The structure inventories for each of the HEC-FDA measure runs are as follows:

- Measure A – Ocean Springs Ring Levee at elevation 20.0-feet NAVD88

This measure includes the without-project inventory less 150 parcels that were deleted out of the inventory. These parcels represent the footprint of the 20.0-feet NAVD88 elevation ring levee and some portion of the total would have to be purchased for its construction. At this level of analysis, it is assumed that all of the structures identified to be touched in any way by the ring levee would be purchased; therefore all were deleted from the without-project structure inventory. Some of the parcels are wetland impacts and are discussed below in the Environmental Quality section.

- Measure B – Ocean Springs Ring Levee at elevation 30.0-feet NAVD88

This measure includes the without-project inventory less 488 parcels that were deleted out of the inventory. These parcels represent the footprint of the 30.0-feet NAVD88 elevation ring levee and some portion of the total would have to be purchased for its construction. At this level of analysis, it is assumed that all of the structures identified to be touched in any way by the ring levee would be purchased; therefore all were deleted from the without-project structure inventory. Some of the parcels are wetland impacts and are discussed below in the Environmental Quality section.

- Measure C – Ocean Springs Nonstructural One

This measure includes the acquisition of 50 parcels that include a structure and the flood proofing (raise structure in place) of 92 structures to an elevation of 16.1-feet NAVD88. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was determined to be approximately the ABFE level of protection and is defined as still water elevation, plus wave run-up, plus an estimate for waves (depth divided by two), and is the minimum implementation elevation that a nonstructural measure do to the requirements of the National Flood Insurance Program (NFIP).

- Measure D – Ocean Springs Nonstructural Two to elevation 20.0-feet NAVD88

This measure includes the acquisition of 93 parcels that include a structure and the flood proofing (raise structure in place) of 49 structures to an elevation of 20.0-feet NAVD88. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was chosen to show a direct comparison to the ring levee at elevation 20.0-feet NAVD88.

- Measure E – Ocean Springs Nonstructural Three to elevation 30.0-feet NAVD88

This measure includes the acquisition of 142 parcels that include a structure. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing

Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was chosen to show a direct comparison to the ring levee at elevation 30.0-feet NAVD88.

Residual damage is the equivalent annual damages that still remain even when a project is in place. Residual damage is calculated as the future without-project equivalent annual damages minus the damages reduced of the various measures. The purpose of residual damages is to calculate and communicate the portions of damages that will not be reduced by the implementation of a plan or "what damages are left on the table." Table 6.8-3 summarizes the equivalent annual without-project damages, damages reduced, and residual damages by measure and by future scenario.

Table 6.8-3.
Summary of Damages by Potential Measure and by Applicable Future Scenario

Measures	Equivalent annual damages Future 3 ($)	Equivalent Annual Damage Reduction Future 3 ($)	Residual Damage Future 3 ($)	Equivalent annual damages Future 5 ($)	Equivalent Annual Damage Reduction Future 5 ($)	Residual Damage Future 5 ($)
(No Action)	$0	$0	$0	$0	$0	$0
Measure A 20FT Ring Levee	$1,958,000	$1,276,000	$682,000	$2,190,000	$1,434,000	$757,000
Measure B 30FT Ring Levee	$1,958,000	$1,873,000	$85,000	$2,190,000	$2,093,000	$97,000
Measure C ABFE Nonstructural	$1,958,000	$818,000	$1,140,000	$2,190,000	$913,000	$1,277,000
Measure D 20FT Nonstructural	$1,958,000	$1,089,000	$869,000	$2,190,000	$1,235,000	$955,000
Measure E 30FT Nonstructural	$1,958,000	$1,466,000	$492,000	$2,190,000	$1,658,000	$532,000

Damages are rounded to the nearest thousand dollars.

6.8.6 Environmental Quality (EQ)

6.8.6.1 Impacts of Levee Measures

The Engineering Research and Development Center Wetlands and Coastal Ecology Branch were asked to conduct an assessment of potential impacts to wetlands as a result of constructing various levees and seawalls along the Mississippi Gulf Coastal Plain. This report summarizes the results of the assessment. The analysis of impacts included two components:

3) A calculation of total acreage of all wetlands (by type and planning reach) that is directly under the levee footprints.

4) A modified Hydrogeomorphic (HGM) wetland rapid assessment of impacted Estuarine/Tidal Fringe wetlands, based on the Mississippi and Alabama Gulf Coast HGM guidebook (Shafer et al., 2007), with impacts reported as loss of functional units. Tables 6.8-4 and 6.8-5 show the impacts of the Ocean Springs ring levees at elevations 20.0-feet NAVD88, and 30.0-feet NAVD88 respectively.

Table 6.8-4.
Wetland acres impacted by elevation 20' Ocean Springs ring levee

Reach ID	Estuarine and Marine Wetland	Freshwater Emergent Wetland	Freshwater Forested/Shrub Wetland	Total
22	3.7	0.3	1.1	5.1
24	1.1	0.0	0.2	1.2
Total	**4.8**	**0.3**	**1.2**	**6.3**

Table 6.8-5.
Wetland acres impacted by elevation 30' Ocean Springs ring levee

Reach ID	Estuarine and Marine Wetland	Freshwater Emergent Wetland	Freshwater Forested/Shrub Wetland	Total
22	5.2	0.4	4.7	10.3
24	2.4	0.0	2.6	5.0
Total	**7.5**	**0.4**	**7.3**	**15.2**

Nonstructural measures would have no construction activities other than demolition and disposal of building materials in an approved land fill occurs as a result of this measure. More detail on the impacts of the structural and nonstructural measures for the Ocean Springs area can be found in the Environmental Appendix.

6.8.7 Summary of Costs

Table 6.8-6 summarizes the ROM costs at an FY-08 price level by measure for the Ocean Springs area (planning sub-unit 22).

Table 6.8-6.
Summary of Costs by Measure for the Ocean Springs Area

Measures	Implementation Costs (FY-08) ($)	Capital Recovery Factor	Average Annual Implementation Cost ($)	Average Annual O&M ($)	IDC ($)	Total Average Annual Costs ($)
(No Action)	$0	0.049171225	$0	$0	$0	$0
Measure A 20FT Ring Levee	$152,100,000	0.049171225	$7,479,000	$1,414,000	N/A	$8,893,000
Measure B 30FT Ring Levee	$327,000,000	0.049171225	$16,079,000	$2,532,000	N/A	$18,611,000
Measure C ABFE Nonstructural	$59,219,000	0.049171225	$2,912,000	$10,000	N/A	$2,922,000
Measure D 20FT Nonstructural	$872,740,000	0.049171225	$42,914,000	$10,000	N/A	$42,924,000
Measure E 30FT Nonstructural	$872,740,000	0.049171225	$42,914,000	$10,000	N/A	$42,924,000

The implementation costs include 1/ supervision and administration (30 account), 2/ planning, engineering & design (31 account) and 3/ appropriate contingencies. See the Cost Appendix for more detail on the implementation cost breakdowns.

6.8.8 Regional Economic Development (RED)

This section summarizes how each of the measures would affect the local area of Jackson County, Mississippi. The expenditures for the measures are estimated to be $152,100,000 for the 20.0-feet NAVD88 measure, $327,000,000 for the 30.0-feet NAVD88 measure $59,219,000 for ABFE nonstructural measure, $617,965,000 for the 20.0-feet NAVD88 nonstructural measure, and $617,965,000 for the 30.0-feet NAVD88 nonstructural measure. Moreover, the total present worth of the operation and maintenance (O&M) expenditures are estimated to be $28,757,000 for the 20.0-feet NAVD88 ring levee measure, $51,494,000 for the 30.0-feet NAVD88 ring levee measure, $203,000 for the ABFE nonstructural measure, $203,000 for the 20.0-feet NAVD88 nonstructural measure, and $203,000 for the 30.0-feet NAVD88 nonstructural measure respectively (assuming a 100 - year period of analysis and an interest rate of 4.875-percent). Tables 6.8-7 through 6.8-10 summarize the inputs and outputs of the EIFS model runs for the Ocean Springs area (planning sub-unit 22).

Table 6.8-7.
EIFS Model Implementation Costs Inputs for the Ocean Springs Area

	20-foot Ring Levee	30-foot Ring Levee	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$152,100,000	$327,000,000	$59,219,000	$617,965,000	$872,740,000

Based of the given inputs the outputs are as follows:

Table 6.8-8.
EIFS Model Implementation Costs Outputs for the Ocean Springs Area

	20-foot Ring Levee	30-foot Ring Levee	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Direct Sales Volume	$152,100,000	$327,000,000	$59,219,000	$617,965,000	$872,740,000
Induced Sales Volume	$170,352,000	$366,240,000	$66,325,280	$692,120,800	$977,468,800
Total Sales Volume	$322,452,000	$693,240,000	$125,544,280	$1,310,085,800	$1,850,208,800
Direct Income	$29,663,388	$63,773,358	$11,549,219	$120,518,970	$170,206,607
Induced Income	$33,222,990	$71,426,152	$12,935,123	$134,981,230	$190,631,376
Total Income	$62,886,378	$135,199,510	24,484,342	$255,500,200	$360,837,984
Direct Employment	861	1,851	335	3,498	4,940
Induced Employment	964	2,073	375	3,918	5,533
Total Employment	1,825	3,924	711	7,416	10,473
Local Population	0	0	0	0	0

Table 6.8-9.
EIFS Model O&M Cost Inputs for the Ocean Springs Area

	20-foot Ring Levee	30-foot Ring Levee	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$28,757,000	$51,494,000	$203,000	$203,000	$203,000

Based of the given inputs the outputs are as follows:

Table 6.8-10.
EIFS Model O&M Cost Outputs for the Ocean Springs Area

	20-foot Ring Levee	30-foot Ring Levee	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Direct Sales Volume	$28,757,000	$51,494,000	$203,000	$203,000	$203,000
Induced Sales Volume	$32,207,840	$57,673,280	$227,360	$227,360	$227,360
Total Sales Volume	60,964,840	$109,167,280	$430,360	$430,360	$430,360
Direct Income	$5,608,350	$10,042,646	$39,590	$39,590	$39,590
Induced Income	$6,281,351	$11,247,762	$44,341	$44,341	$44,341
Total Income	$11,889,701	$21,290,409	$83,931	$83,931	$83,931
Direct Employment	163	291	1	1	1
Induced Employment	182	326	1	1	1
Total Employment	345	617	2	2	2
Local Population	0	0	0	0	0

6.9 Evaluation of Gautier Area Measures

6.9.1 General

The Gautier area, shown in Figure 6.9-1, is located in the southern portion of planning unit three along the Mississippi Sound. The area is denoted as planning sub-unit 30 and is depicted in the figure below. The pre-Hurricane Katrina conditions for this area represented a mostly residential community. As demonstrated in table 6.9-1, it was estimated from the field inventorying process that planning sub-unit 30 included 3,113 tax parcels, of which 2,555 contained a structure with some economic value and 558 were vacant land. Of those 2,555 parcels that contain structures, 2,166 were residential one-story, 118 were residential two-story, 28 were mobile homes, 182 were commercial, and 61 were municipal.

6.9.2 Opportunities

The following opportunity was identified for this area:

- Hurricane storm damage reduction or remediation

6.9.3 Assumptions

The following assumptions were used in this analysis.

- The FY 2008 discount rate of 4-7/8 percent was used in estimating average annual benefits and costs
- Price levels are October, 2007 unless otherwise stated.
- A 100-year period of analysis (2012 to 2111) was used to calculate average annual benefits and costs.

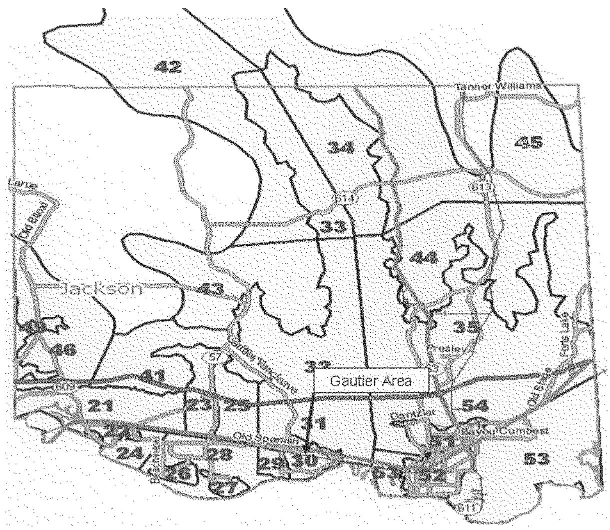


Figure 6.9-1. Gautier Area – Planning Sub-unit 30

Table 6.9-1.
Pre-Hurricane Katrina Estimate of Structures for the Gautier Area (Planning Sub-unit 30)

Asset Categories	Assets by Category
Residential	2,284
Mobile Homes	28
Commercial	182
Municipal	61
Vacant Land	558
Total Tax Parcels	**3,113**

6.9.4 Measures

Initially, a comprehensive list of measures was identified for flood damage reduction purposes for planning unit three. This list was screened and vetted for engineering and environmental feasibility and for policy compliance. The MsCIP Comprehensive Main Report and the Engineering and Environmental Appendices contain a detailed description of the measures that were initially screened.

Several potential measures were carried forward for this area for the purpose of flood damage reduction. These measures include both structural features and nonstructural actions. The measures evaluated for economic benefits include:

Measure A – Gautier Ring Levee

This measure will provide a ring levee with interior drainage, pumping stations, and roadway access up to a crest elevation of 20.0-feet NAVD88.

Measure B – Gautier Ring Levee

This measure will provide a ring levee with interior drainage, pumping stations, and roadway access up to a crest elevation of 30.0-feet NAVD88.

Measure C – Gautier Nonstructural One

This measure includes the acquisition and flood proofing (elevation-in-place) of structures to the FEMA advisory base flood elevation (ABFE).

Measure D – Gautier Nonstructural Two

This measure includes the acquisition and flood proofing of structures to approximately elevation 20-feet NAVD88.

Measure E – Gautier Nonstructural Three

This measure includes the acquisition and flood proofing of structures to approximately elevation 30-feet NAVD88.

Figure 6.9-2 shows the measures for the Gautier Area (planning sub-unit 30); the red line represents the approximate footprint of the ring levees, the dark green within the ring levee footprint represents potential ABFE buyout areas and the light green area within the ring levee footprint represents potential flood proof (elevate-in-place) areas.

6.9.5 National Economic Development (NED)

The purpose of this section is to document investigations conducted to identify the National Economic Development (NED) benefits of each of the potential measures previously listed. For this analysis, NED benefits are the reduced inundation damages of assets and their contents when one of the potential measures is in place. Typically, NED benefits are annualized over the period of the analysis (average annual benefits) and then compared to annualized costs over the period of analysis (average annual costs). This comparison is commonly known as the benefit-to-cost ratio (BCR). For purposes of this analysis, no benefit-to-cost ratios will be calculated as per the legislative Congressional language authorizing this study. The Coastal Mississippi Comprehensive Plan Report was authorized by the Department of Defense Appropriations Act, 2006 (P.L. 109-148) 30 December 2005, which states: "...***that the Secretary shall recommend a cost-effective project, but shall not perform an incremental benefit-cost analysis to identify the recommended project, and shall not make project plan features based upon maximizing net national economic development benefits...***" More detail on the authorizing language can be found in the MsCIP Comprehensive Plan Main Report.

6.9.5.1 Existing Conditions Post-Hurricane Katrina)

The effects of Hurricane Katrina storm surge were devastating to the Gautier Area. Peak water elevation in the area ranged from 15 to 18-feet NAVD88. It is estimated that 450 of the structures in the area, mostly residential structures, and sustained significant inundation damage (fifty-percent or more). Expected redevelopment of the area is described in the following section.

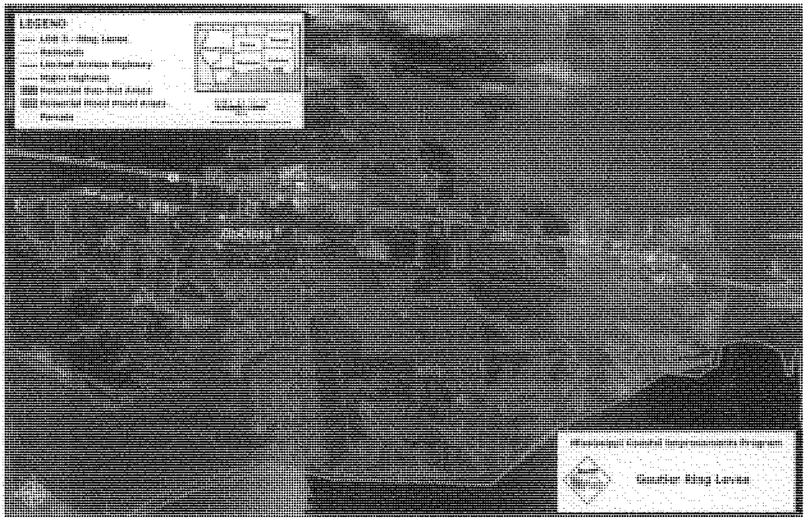


Figure 6.9-2. Display of Potential Measures for the Gautier Area (Planning Sub-Unit 30)

6.9.5.2 Future Without-Project Conditions

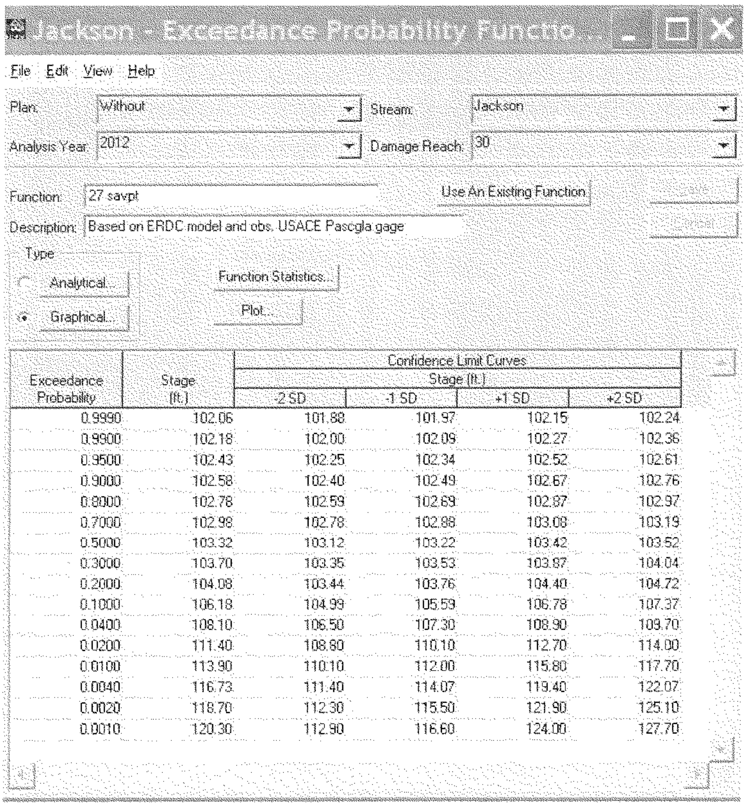
Equivalent annual flood damages for several future without-project scenarios were evaluated using the Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA) model. Each of the measures were evaluated and compared to future without-project scenarios three, and five, as previously discussed in section 5.3. These future scenarios were chosen because the redevelopment projected for this area is anticipated to return to the pre-Katrina development. Futures scenarios two, four, and six were not used for evaluation purposes since this area is not accommodative for commercial and condominium redevelopment under those mixed redevelopment scenarios (see section 5.3 for more detail).

Future scenario one is the full redevelopment of assets within the study area by the year 2012 with no relative sea level rise over the 100-year period of analysis. Table 6.9-2 shows structures by asset category and by elevation. The number of structures per elevation is added to the previous number of structures per elevation in each category. For example, in the residential category there are two structures with an elevation of 1-foot or lower, there are five structures with an elevation of 2-feet or less, etc. This future scenario, as previously noted in section 5.3, is for sensitivity purposes only and will not be evaluated against all of the potential measures for the Gautier area.

Table 6.9-2.
Cumulative Structures by Category and by Estimated First Floor Elevation Future Scenarios One, Three, and Five Applicable for Base Year and Most Likely Future Years

Estimated First Floor Elevation (NAVD88)	Residential	Mobile Homes	Commercial	Municipal	Total
1-foot	2	0	0	0	2
2-foot	5	0	0	0	5
3-foot	14	0	0	0	14
4-foot	27	0	0	0	27
5-foot	38	0	0	0	38
6-foot	55	0	0	0	55
7-foot	66	0	0	0	66
8-foot	84	0	0	0	84
9-foot	110	0	0	0	110
10-foot	131	0	0	0	131
11-foot	169	0	0	0	169
12-foot	238	2	5	2	247
13-foot	320	4	15	5	344
14-foot	400	6	23	7	436
15-foot	521	7	34	10	572
16-foot	710	10	51	14	785
17-foot	1,354	16	84	40	1,494
18-foot	1,979	19	106	49	2,153
19-foot	2,221	22	124	52	2,419
20-foot	2,267	24	156	57	2,504
21-foot	2,275	26	171	60	2,532
22-foot	2,279	28	178	61	2,546
23-foot	2,280	28	182	61	2,551
24-foot	2,280	28	182	61	2,551
25-foot	2,282	28	182	61	2,553
26-foot	2,282	28	182	61	2,553
27-foot	2,282	28	182	61	2,553
28-foot	2,282	28	182	61	2,553
29-foot	2,282	28	182	61	2,553
30-foot	2,282	28	182	61	2,553
31-foot	2,283	28	182	61	2,554
32-foot	2,284	28	182	61	2,555
Total	**2,284**	**28**	**182**	**61**	**2,555**

Future scenario three is the full redevelopment of assets within the study area by the year 2012. Under this scenario, assets will be rebuilt as they were pre-Hurricane Katrina. For example, if the asset was a residential structure pre-Hurricane Katrina it will be rebuilt as a residential structure; commercial structures will be built back to commercial structures; etc. Basically, future scenario three is the same structure inventory as future scenario one with the addition of an expected relative sea level rise over the 100-year period of analysis (2012–2111). Equivalent annual damages that could occur under this scenario are $5,831,000 (rounded to the nearest thousand dollars). The total number of structures in this scenario are the same as in scenario one and can be seen above in table 6.9-2. Figures 6.9-3 and 6.9-4 depict the base year and most likely future year exceedance probability functions for the Gautier area (planning sub-unit 30). The exceedance probability functions are for still water elevation (SWEL's) and based on a combination of observed data from USACE gauges and from modeling efforts conducted by the Engineer Research and Development Center (ERDC). The most likely future year exceedance probability function depicted in figure 6.9-4 includes an adjustment for expected relative sea level rise over the 100-year period of analysis. **Note**: Due to uncertainty issues regarding the first floor elevations, a base of 100-feet was applied to the exceedance probability functions and the first floor elevations. For example, if the stage for a given event probability shows 102-feet, the stage is really 2-feet. For more detail on the estimation and use of the exceedance probability functions see the Engineering Appendix.


Jackson - Exceedance Probability Functio...

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Plan: Without Stream: Jackson

Analysis Year: 2012 Damage Reach: 30

Function: 27 savpt Use An Existing Function

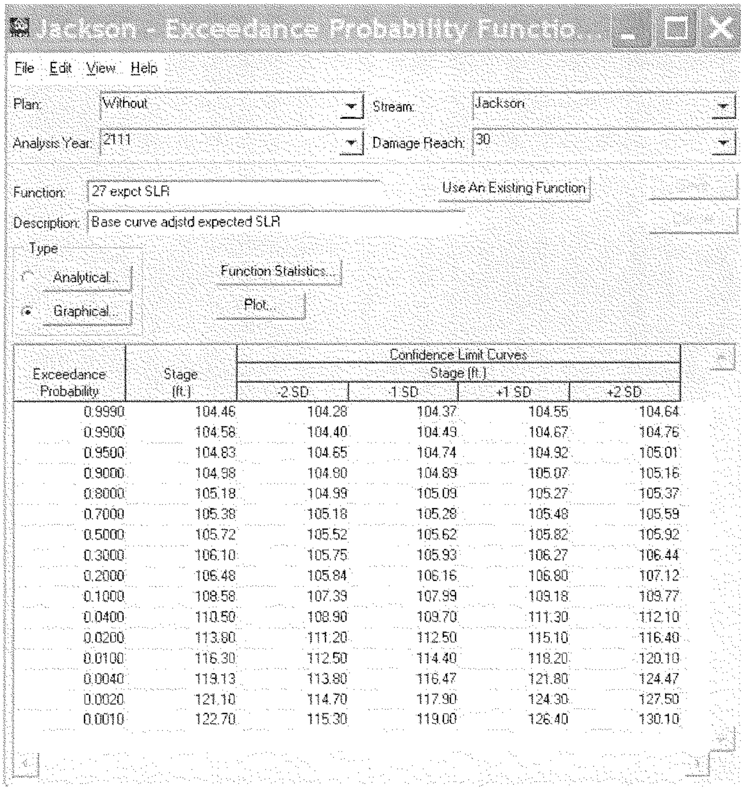
Description: Based on ERDC model and obs. USACE Pascgla gage

Type

Analytical... Function Statistics...

Graphical... Plot...

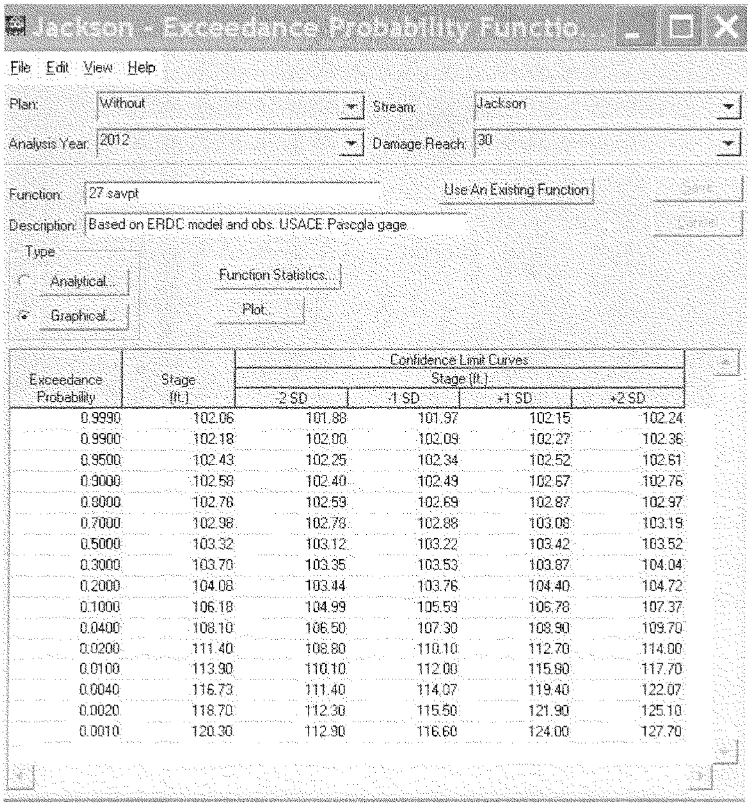
Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	102.06	101.88	101.97	102.15	102.24
0.9900	102.18	102.00	102.09	102.27	102.36
0.9500	102.43	102.25	102.34	102.52	102.61
0.9000	102.58	102.40	102.49	102.67	102.76
0.8000	102.78	102.59	102.69	102.87	102.97
0.7000	102.98	102.78	102.88	103.08	103.19
0.5000	103.32	103.12	103.22	103.42	103.52
0.3000	103.70	103.35	103.53	103.87	104.04
0.2000	104.08	103.44	103.76	104.40	104.72
0.1000	106.18	104.99	105.59	106.78	107.37
0.0400	108.10	106.50	107.30	108.90	109.70
0.0200	111.40	108.80	110.10	112.70	114.00
0.0100	113.90	110.10	112.00	115.80	117.70
0.0040	116.73	111.40	114.07	119.40	122.07
0.0020	118.70	112.30	115.50	121.90	125.10
0.0010	120.30	112.90	116.60	124.00	127.70



Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	104.46	104.28	104.37	104.55	104.64
0.9900	104.58	104.40	104.49	104.67	104.76
0.9500	104.83	104.65	104.74	104.92	105.01
0.9000	104.98	104.80	104.89	105.07	105.16
0.8000	105.18	104.99	105.09	105.27	105.37
0.7000	105.38	105.18	105.28	105.48	105.59
0.5000	105.72	105.52	105.62	105.82	105.92
0.3000	106.10	105.75	105.93	106.27	106.44
0.2000	106.48	105.84	106.16	106.80	107.12
0.1000	108.58	107.39	107.99	109.18	109.77
0.0400	110.50	108.90	109.70	111.30	112.10
0.0200	113.80	111.20	112.50	115.10	116.40
0.0100	116.30	112.50	114.40	118.20	120.10
0.0040	119.13	113.80	116.47	121.80	124.47
0.0020	121.10	114.70	117.90	124.30	127.50
0.0010	122.70	115.30	119.00	126.40	130.10

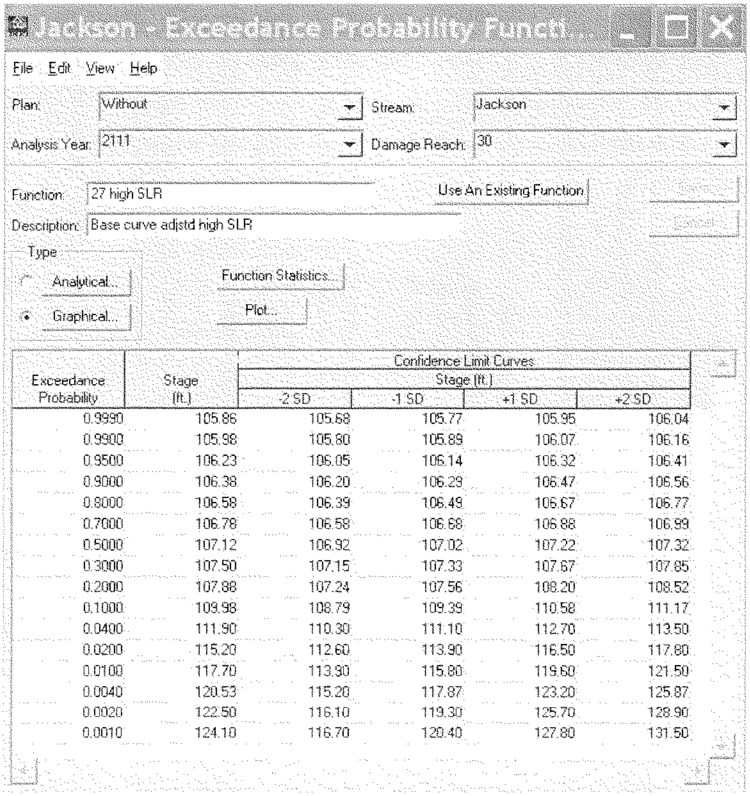
Figure 6.9-4. Future Scenario 3 Most Likely Future Year (2012) Exceedance Probability Function for the Gautier Area – Includes an adjustment for relative sea level rise

Future scenario five is the same as future scenario one with the addition of a high relative sea level rise 100-year period of analysis (2012–2111). Equivalent annual damages that could occur under this scenario are $6,702,000 (rounded to the nearest thousand). These damages represent approximately a ten-percent (10.2%) increase over the expected relative sea level rise accounted for in future scenario three. The total number of structures in this scenario is the same as in scenarios one and three and can be seen above in table 6.9-2. Figures 6.9-5 and 6.9-6 depict the base year and most likely future year exceedance probability functions for the Gautier area (planning sub-unit 30). The exceedance probability functions are for still water elevation (SWEL's) and based on a combination of observed data from USACE gauges and from modeling efforts conducted by the Engineer Research and Development Center (ERDC). The most likely future year exceedance probability function depicted in figure 6.9-6 includes an adjustment for expected relative sea level rise over the 100-year period of analysis. **Note**: Due to uncertainty issues regarding the first floor elevations, a base of 100-feet was applied to the exceedance probability functions and the first floor elevations. For example, if the stage for a given event probability shows 102-feet, the stage is really 2-feet. For more detail on the estimation and use of the exceedance probability functions see the Engineering Appendix.



Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	102.06	101.88	101.97	102.15	102.24
0.9900	102.18	102.00	102.09	102.27	102.36
0.9500	102.43	102.25	102.34	102.52	102.61
0.9000	102.58	102.40	102.49	102.67	102.76
0.8000	102.78	102.59	102.69	102.87	102.97
0.7000	102.98	102.78	102.88	103.08	103.19
0.5000	103.32	103.12	103.22	103.42	103.52
0.3000	103.70	103.35	103.53	103.87	104.04
0.2000	104.08	103.44	103.76	104.40	104.72
0.1000	106.18	104.99	105.59	106.78	107.37
0.0400	108.10	106.50	107.30	108.90	109.70
0.0200	111.40	108.80	110.10	112.70	114.00
0.0100	113.90	110.10	112.00	115.80	117.70
0.0040	116.73	111.40	114.07	119.40	122.07
0.0020	118.70	112.30	115.50	121.90	125.10
0.0010	120.30	112.90	116.60	124.00	127.70

Figure 6.9-5. Future Scenario 5 Base Year (2012) Exceedance Probability Function for the Gautier Area



Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	105.86	105.68	105.77	105.95	106.04
0.9900	105.98	105.80	105.89	106.07	106.16
0.9500	106.23	106.05	106.14	106.32	106.41
0.9000	106.38	106.20	106.29	106.47	106.56
0.8000	106.58	106.39	106.49	106.67	106.77
0.7000	106.78	106.58	106.68	106.88	106.99
0.5000	107.12	106.92	107.02	107.22	107.32
0.3000	107.50	107.15	107.33	107.67	107.85
0.2000	107.88	107.24	107.56	108.20	108.52
0.1000	109.98	108.79	109.39	110.58	111.17
0.0400	111.90	110.30	111.10	112.70	113.50
0.0200	115.20	112.60	113.90	116.50	117.80
0.0100	117.70	113.90	115.80	119.60	121.50
0.0040	120.53	115.20	117.87	123.20	125.87
0.0020	122.50	116.10	119.30	125.70	128.90
0.0010	124.10	116.70	120.40	127.80	131.50

Figure 6.9-6. Future Scenario 5 Most Likely Future Year (2012) Exceedance Probability Function for the Gautier Area – Includes an adjustment for relative sea level rise

6.9.5.3 Equivalent Annual Damages Reduced

Equivalent annual damages reduced are calculated as the difference between the damages under the future without-project scenarios three and five and the damages incurred with the measure in place. The HEC-FDA model was run for each measure to determine the damages reduced as compared to the without-project scenario.

In order to provide the HEC-FDA model with accurate information about the economic characteristics of each measure, separate inventories were created for each measure. The inventories are the same as the without-project inventory except that footprints of levees and acquisitions were deleted from the inventory and flood proofed structures (structures to be raised in place) were given a higher elevation. The structure inventories for each of the HEC-FDA measure runs are as follows:

- Measure A – Gautier Ring Levee at elevation 20.0-feet

This measure includes the without-project inventory less 177 parcels that were deleted out of the inventory. These parcels represent the footprint of the 20.0-feet NAVD88 elevation ring levee and some portion of the total would have to be purchased for its construction. At this level of analysis, it is assumed that all of the structures identified to be touched in any way by the ring levee would be purchased; therefore all were deleted from the without-project structure inventory. Some of the parcels are wetland impacts and are discussed below in the Environmental Quality section.

- Measure B – Gautier Ring Levee at elevation 30.0-feet

This measure includes the without-project inventory less 206 parcels that were deleted out of the inventory. These parcels represent the footprint of the 30.0-feet NAVD88 elevation ring levee and some portion of the total would have to be purchased for its construction. At this level of analysis, it is assumed that all of the structures identified to be touched in any way by the ring levee would be purchased; therefore all were deleted from the without-project structure inventory. Some of the parcels are wetland impacts and are discussed below in the Environmental Quality section.

- Measure C – Gautier ABFE Nonstructural One

This measure includes the acquisition of 66 parcels that include a structure and the flood proofing (raise structure in place) of 466 structures to an elevation of 16.1-feet NAVD88. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was determined to be approximately the ABFE level of protection and is defined as still water elevation, plus wave run-up, plus an estimate for waves (depth divided by two), and is the minimum implementation elevation that a nonstructural measure do to the requirements of the National Flood Insurance Program (NFIP).

- Measure D – Gautier Nonstructural Two to elevation 20.0-feet NAVD88

This measure includes the acquisition of 489 parcels that include a structure and the flood proofing (raise structure in place) of 44 structures to an elevation of 20.0-feet NAVD88. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was chosen to show a direct comparison to the ring levee at elevation 20.0-feet NAVD88.

- Measure E – Gautier Nonstructural Three to elevation 30.0-feet NAVD88

This measure includes the acquisition of 533 parcels that include a structure. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing

Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was chosen to show a direct comparison to the ring levee at elevation 30.0-feet NAVD88.

Residual damage is the equivalent annual damages that still remain even when a project is in place. Residual damage is calculated as the future without-project equivalent annual damages minus the damages reduced of the various measures. The purpose of residual damages is to calculate and communicate the portions of damages that will not be reduced by the implementation of a plan or "what damages are left on the table." Table 6.9-3 summarizes the equivalent annual without-project damages, damages reduced, and residual damages by measure and by future scenario.

Table 6.9-3.
Summary of Damages by Potential Measure and by Applicable Future Scenario

Measures	Equivalent annual damages Future 3 ($)	Equivalent Annual Damage Reduction Future 3 ($)	Residual Damage Future 3 ($)	Equivalent annual damages Future 5 ($)	Equivalent Annual Damage Reduction Future 5 ($)	Residual Damage Future 5 ($)
(No Action)	$0	$0	$0	$0	$0	$0
Measure A 20Ft Ring Levee	$5,831,000	$5,166,000	$665,000	$6,702,000	$5,923,000	$779,000
Measure B 30FT Ring Levee	$5,831,000	$5,800,000	$31,000	$6,702,000	$6,663,000	$39,000
Measure C ABFE Nonstructural	$5,831,000	$3,623,000	$2,208,000	$6,702,000	$3,984,000	$2,718,000
Measure D 20FT Nonstructural	$5,831,000	$ 2,457,000	$3,374,000	$6,702,000	$2,839,000	$3,863,000
Measure E 30FT Nonstructural	$5,831,000	$ 5,278,000	$553,000	$6,702,000	$6,033,000	$669,000

Damages are rounded to the nearest thousand dollars.

6.9.6 Environmental Quality (EQ)

The Engineering Research and Development Center Wetlands and Coastal Ecology Branch were asked to conduct an assessment of potential impacts to wetlands as a result of constructing various levees and seawalls along the Mississippi Gulf Coastal Plain. This report summarizes the results of the assessment. The analysis of impacts included two components:

1. A calculation of total acreage of all wetlands (by type and planning reach) that is directly under the levee footprints.
2. A modified Hydrogeomorphic (HGM) wetland rapid assessment of impacted Estuarine/Tidal Fringe wetlands, based on the Mississippi and Alabama Gulf Coast HGM guidebook (Shafer et al., 2007), with impacts reported as loss of functional units. Tables 6.9-4 and 6.9-5 show the impacts of the Gautier ring levees at elevations 20.0-feet NAVD88, and 30.0-feet NAVD88 respectively.

Table 6.9-4.
Wetland acres impacted by elevation 20' Gautier ring levee.

Reach ID	Estuarine and Marine Deepwater	Estuarine and Marine Wetland	Freshwater Emergent Wetland	Freshwater Forested/Shrub Wetland	Freshwater Pond	Total
29	0.0	0.0	0.0	5.6	0.0	5.6
30	0.2	5.0	0.3	9.0	0.0	14.5
31	0.5	7.1	0.0	2.0	0.1	9.7
Total	**0.7**	**12.1**	**0.3**	**16.9**	**0.1**	**29.8**

Table 6.9-5.
Wetland acres impacted by elevation 30' Gautier ring levee.

Reach ID	Estuarine and Marine Deepwater	Estuarine and Marine Wetland	Freshwater Emergent Wetland	Freshwater Forested/Shrub Wetland	Freshwater Pond	Total
29	0.0	0.0	0.4	9.7	0.0	10.2
30	0.3	7.2	1.2	19.8	0.0	28.5
31	1.2	10.3	0.0	6.1	0.2	17.9
Total	**1.5**	**17.5**	**1.6**	**35.7**	**0.2**	**56.5**

Nonstructural measures would have no construction activities other than demolition and disposal of building materials in an approved land fill occurs as a result of this measure. More detail on the impacts of the structural and nonstructural measures for the Gautier area can be found in the Environmental Appendix.

6.9.7 Summary of Costs

Table 6.9-6 summarizes the ROM costs at an FY-08 price level by measure for the Gautier Area (planning sub-unit 30).

Table 6.9-6.
Summary of Costs by Measure for the Gautier Area

Measures	Implementation Costs (FY-08) ($)	Capital Recovery Factor	Average Annual Implementation Cost ($)	Average Annual O&M ($)	IDC ($)	Total Average Annual Costs ($)
(No Action)	$0	0.049171225	$0	$0	$0	$0
Measure A 20Ft Ring Levee	$348,300,000	0.049171225	$17,126,000	$ 3,744,000	N/A	$20,870,000
Measure B 30FT Ring Levee	$450,100,000	0.049171225	$22,132,000	$ 4,904,000	N/A	$27,036,000
Measure C ABFE Nonstructural	$185,929,000	0.049171225	$9,142,000	$10,000	N/A	$9,152,000
Measure D 20FT Nonstructural	$783,100,000	0.049171225	$38,506,000	$10,000	N/A	$38,516,000
Measure E 30FT Nonstructural	$942,794,000	0.049171225	$46,358,000	$10,000	N/A	$46,368,000

6.9.8 Regional Economic Development (RED)

The purpose of this analysis is to determine the economic impact of the proposed project measures on business (sale volumes), income, employment, and population of the local area. Each of the measures would affect the local area of Jackson County, Mississippi. The expenditures for the measures are estimated to be $348,300,000 for the 20.0-feet NAVD88 measure, $450,100,000 for the 30.0-feet NAVD88 measure $185,929,000 for the ABFE nonstructural measure, $783,100,000 for the 20.0-feet NAVD88 nonstructural measure, and $783,100,000 for the 30.0-feet NAVD88 nonstructural measure. Moreover, the total present worth of the operation and maintenance (O&M) expenditures are estimated to be $76,142,000 for the 20.0-feet NAVD88 ring levee measure, $99,733,000 for the 30.0-feet NAVD88 ring levee measure, $203,000 for the ABFE nonstructural measure, $203,000 for the 20.0-feet NAVD88 nonstructural measure, and $203,000 for the 30.0-feet NAVD88 nonstructural measure respectively (assuming a 100- year period of analysis and an interest rate of 4.875-percent). The following tables 6.9-7 through 6.9-10 summarize the EIFS inputs and outputs for the Gautier area.

Table 6.9-7.
EIFS Model Construction Costs Inputs for the Gautier Area

	20-foot Ring Levee	30-foot Ring Levee	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$348,300,000	$450,100,000	$185,929,000	$783,100,000	$942,794,000

Based of the given inputs the outputs are as follows:

Table 6.9-8.
EIFS Model Construction Costs Outputs for the Gautier Area

	20-foot Ring Levee	30-foot Ring Levee	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Direct Sales Volume	$348,300,000	$450,100,000	$185,929,000	$783,100,000	$942,794,000
Induced Sales Volume	$390,096,000	$504,112,000	$208,240,480	$877,072,000	$1,055,929,280
Total Sales Volume	$738,396,000	$954,212,000	$394,169,480	$1,660,172,000	$1,998,723,280
Direct Income	$67,927,403	$87,781,005	$36,260,907	$152,724,516	$183,868,928
Induced Income	$76,078,681	$98,314,713	$40,612,211	$171,051,437	$205,933,174
Total Income	$144,006,084	$186,095,717	$76,873,119	$323,775,953	$389,802,101
Direct Employment	1,971	2,547	1,052	4,432	5,336
Induced Employment	2,208	2,853	1,179	4,965	5,977
Total Employment	4,179	5,400	2,231	9,397	11,314
Local Population	0	0	0	0	0

Table 6.9-9.
EIFS Model O&M Cost Inputs for the Gautier Area

	20-foot Ring Levee	30-foot Ring Levee	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$69,691,753	$91,284,283	$186,143	$186,143	$186,143

Based of the given inputs the outputs are as follows:

Table 6.9-10.
EIFS Model O&M Cost Outputs for the Gautier Area

	20-foot Ring Levee	30-foot Ring Levee	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Direct Sales Volume	$69,691,753	$91,284,283	$186,143	$186,143	$186,143
Induced Sales Volume	$78,054,763	$102,238,397	$208,480	$208,480	$208,480
Total Sales Volume	$147,746,516	$193,522,680	$394,622	$394,622	$394,622
Direct Income	$13,591,673	$17,802,768	$36,303	$36,303	$36,303
Induced Income	$15,222,672	$19,939,098	$40,659	$40,659	$40,659
Total Income	$28,814,345	$37,741,867	$76,961	$76,961	$76,961
Direct Employment	394	517	1	1	1
Induced Employment	442	579	1	1	1
Total Employment	836	1095	2	2	2
Local Population	0	0	0	0	0

6.10 Evaluation of Gulf Park Estates Area Measures

6.10.1 General

The Gulf Park Estates area is located in the southern portion of planning unit three along the Mississippi Sound. The area is denoted as planning sub-unit 26 and is depicted in the figure 6.10-1, shown below. The pre-Hurricane Katrina conditions for this area represented a mostly residential community. As shown in table 6.10-1, it was estimated from the field inventorying process that planning sub-unit 26 included 2,391 tax parcels, of which 1,782 contained a structure with some economic value and 609 were vacant land. Of those 1,782 parcels that contain structures, 1,663 were residential one-story, 0 were residential two-story, 95 were mobile homes, 22 were commercial, and 2 were municipal.

6.10.2 Opportunities

The following opportunities were identified for this area:

- Hurricane storm damage reduction or remediation

6.10.3 Assumptions

The following assumptions were used in this analysis.

- The FY 2008 discount rate of 4.875 percent was used in estimating average annual benefits and costs.
- Price levels are FY-08, unless otherwise stated.
- A 100-year period of analysis (2012 to 2111) was used to calculate average annual benefits and costs.

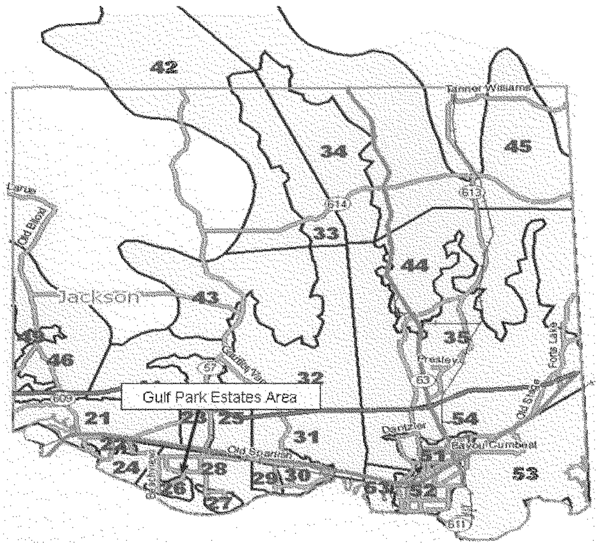


Figure 6.10-1. Gulf Park Estates Area – Planning sub-unit 26

Table 6.10-1.
Pre-Hurricane Katrina Estimate of Structures for the Gulf Park Estates Area Planning Sub-unit 26

Asset Categories	Assets by Category
Residential	1,663
Mobile Homes	95
Commercial	22
Municipal	2
Vacant Land	609
Total Tax Parcels	**2,391**

6.10.4 Measures

Initially, a comprehensive list of measures was identified for flood damage reduction purposes for planning unit three. This list was screened and vetted for engineering and environmental feasibility and for policy compliance. The MsCIP Comprehensive Main Report and the Engineering and Environmental Appendices contain a detailed description of the measures that were initially screened.

Several potential measures were carried forward for this area for the purpose of flood damage reduction. These measures include both structural features and nonstructural actions. The measures evaluated for economic benefits include:

- Measure A – Gulf Park Estates Ring Levee A

This measure will provide a ring levee with interior drainage, pumping stations, and roadway access up to a crest elevation of 20.0-feet NAVD88.

- Measure B – Gulf Park Estates Ring Levee B

This measure will provide a ring levee with interior drainage, pumping stations, and roadway access up to a crest elevation of 30.0-feet NAVD88.

- Measure C – Gulf Park Estates Ring Levee C

This measure would include a ring levee at 20-feet NAVD88 on an alternate footprint from Measure A and the acquisition of structures and parcels that would have been included in measure A but are not within the alternate footprint.

- Measure D – Gulf Park Estates Ring Levee D

This measure would include a ring levee at 30-feet NAVD88 on an alternate footprint from Measure B and the acquisition of structures and parcels that would have been included in measure B but are not within the alternate footprint.

- Measure E – Gulf Park Estates Nonstructural One

This measure includes the acquisition and flood proofing (elevation-in-place) of structures to the FEMA advisory base flood elevation (ABFE).

- Measure F – Gulf Park Estates Nonstructural Two

This measure includes the acquisition and flood proofing of structures to approximately elevation 20-feet NAVD88.

- Measure G – Gulf Park Estates Nonstructural Three

This measure includes the acquisition of structures to approximately elevation 30-feet NAVD88.

Figure 6.10-2 shows the measures for the Gulf Park Estates Area (planning sub-unit 26); the red line represents the approximate footprint of the ring levees A and B, the green line represents the approximate footprint of the ring levees C and D, the dark green within the ring levee footprint represents potential ABFE buyout areas and the light green area within the ring levee footprint represents potential flood proof (elevate-in-place) areas.

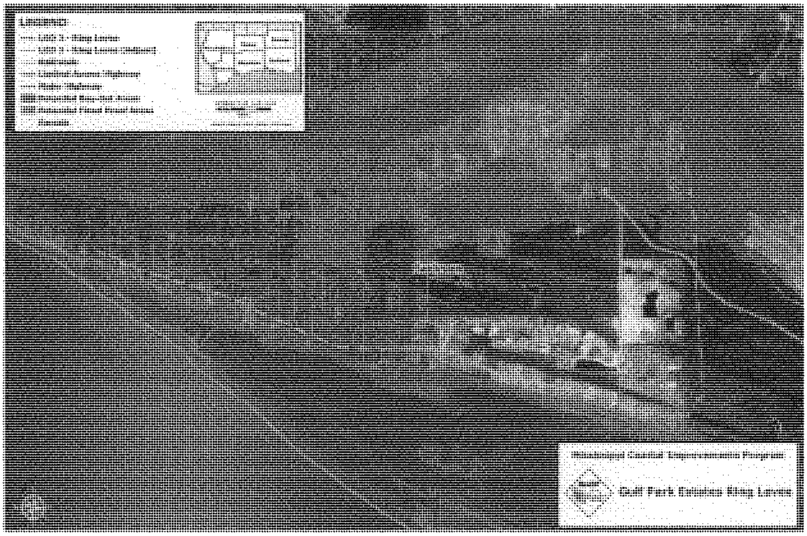


Figure 6.10-2. Display of Potential Measures for the Gulf Park Estates Area (Planning Sub-Unit 26)

6.10.5 National Economic Development (NED)

The purpose of this section is to document investigations conducted to identify the National Economic Development (NED) benefits of each of the potential measures previously listed. For this analysis, NED benefits are the reduced inundation damages of assets and their contents when one of the potential measures is in place. Typically, NED benefits are annualized over the period of the analysis (average annual benefits) and then compared to annualized costs over the period of analysis (average annual costs). This comparison is commonly known as the benefit-to-cost ratio (BCR). For purposes of this analysis, no benefit-to-cost ratios will be calculated as per the legislative Congressional language authorizing this study. The Coastal Mississippi Comprehensive Plan Report was authorized by the Department of Defense Appropriations Act, 2006 (P.L. 109-148) 30 December 2005, which states: "*...**that the Secretary shall recommend a cost-effective project, but shall not perform an incremental benefit-cost analysis to identify the recommended project, and shall not make project plan features based upon maximizing net national economic development benefits...***" More detail on the authorizing language can be found in the MsCIP Comprehensive Plan Main Report.

6.10.5.1 Existing Conditions Post-Hurricane Katrina)

The effects of Hurricane Katrina storm surge were devastating to the Gulf Park Estates Area. Peak water elevation in the area ranged from 19-to-20-feet NAVD88. It is estimated that 840 structures in the area, mostly residential, sustained significant inundation damage (fifty-percent or more). Expected redevelopment of the area is described in the following section.

6.10.5.2 Future Without-Project Conditions

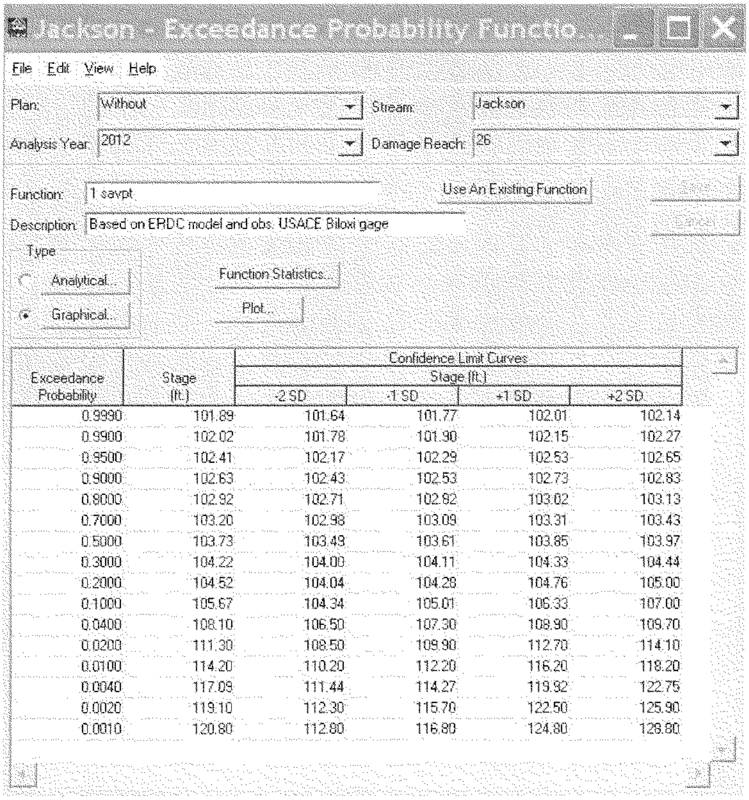
Equivalent annual flood damages for several future without-project scenarios were evaluated using the Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA) model. Each of the measures was evaluated and compared to future without-project scenarios three, and five, as previously discussed in section 5.3. These future scenarios were chosen because the redevelopment projected for this area is anticipated to return to the pre-Katrina development. Futures scenarios two, four, and six were not used for evaluation purposes since this area is not accommodative for commercial and condominium redevelopment under those mixed redevelopment scenarios (see section 5.3 for more detail).

Future scenario one is the full redevelopment of assets within the study area by the year 2012 with no relative sea level rise over the 100-year period of analysis. Table 6.10-2 shows structures by asset category and by elevation. The number of structures per elevation is added to the previous number of structures per elevation in each category. For example, in the residential category there are two structures with an elevation of 3-foot elevation or lower, there are six structures with an elevation of 4-feet or less, etc. This future scenario, as previously noted in section 5.3, is for sensitivity purposes only and will not be evaluated against all of the potential measures for the Gulf Park Estates area.

Future scenario three is the full redevelopment of assets within the study area by the year 2012. Under this scenario, assets will be rebuilt as they were pre-Hurricane Katrina. For example, if the asset was a residential structure pre-Hurricane Katrina it will be rebuilt as a residential structure; commercial structures will be built back to commercial structures; etc. Basically, future scenario three is the same structure inventory as future scenario one with the addition of an expected relative sea level rise over the 100-year period of analysis (2012–2111). Equivalent annual damages that could occur under this scenario are $6,273,000 (rounded to the nearest thousand dollars). The total number of structures in this scenario are the same as in scenario one and can be seen above in table 6.10-2. Figures 6.10-3 and 6.10-4 depict the base year and most likely future year exceedance probability functions for the Gulf Park Estates area (planning sub-unit 26). The exceedance probability functions are for still water elevation (SWEL's) and based on a combination of observed data from USACE gauges and from modeling efforts conducted by the Engineer Research and Development Center (ERDC). The most likely future year exceedance probability function depicted in figure 6.10-4 includes an adjustment for expected relative sea level rise over the 100-year period of analysis. **Note**: Due to uncertainty issues regarding the first floor elevations, a base of 100-feet was applied to the exceedance probability functions and the first floor elevations. For example, if the stage for a given event probability shows 102-feet, the stage is really 2-feet. For more detail on the estimation and use of the exceedance probability functions see the Engineering Appendix.

Table 6.10-2.
Cumulative Structures by Category and by Estimated First Floor Elevation
Future Scenarios One, Three, and Five
Applicable for Base Year and Most Likely Future Years

Estimated First Floor Elevation (NAVD88)	Residential	Mobile Homes	Commercial	Municipal	Total
1-foot	0	0	0	0	0
2-foot	0	0	0	0	0
3-foot	2	0	0	0	2
4-foot	6	0	0	0	6
5-foot	22	0	0	0	22
6-foot	66	0	0	0	66
7-foot	118	0	0	0	118
8-foot	174	0	0	0	174
9-foot	251	0	0	0	251
10-foot	295	0	0	0	295
11-foot	336	0	0	0	336
12-foot	382	7	1	0	390
13-foot	444	18	3	0	465
14-foot	469	29	4	0	502
15-foot	497	34	4	0	535
16-foot	512	44	5	0	561
17-foot	547	50	8	0	605
18-foot	671	53	8	0	732
19-foot	1,319	91	20	2	1,432
20-foot	1,532	92	22	2	1,648
21-foot	1,644	93	22	2	1,761
22-foot	1,663	94	22	2	1,781
23-foot	1,663	95	22	2	1,782
Total	**1,663**	**95**	**22**	**2**	**1,782**



Jackson - Exceedance Probability Functio...

File Edit View Help

Plan: Without Stream: Jackson

Analysis Year: 2012 Damage Reach: 26

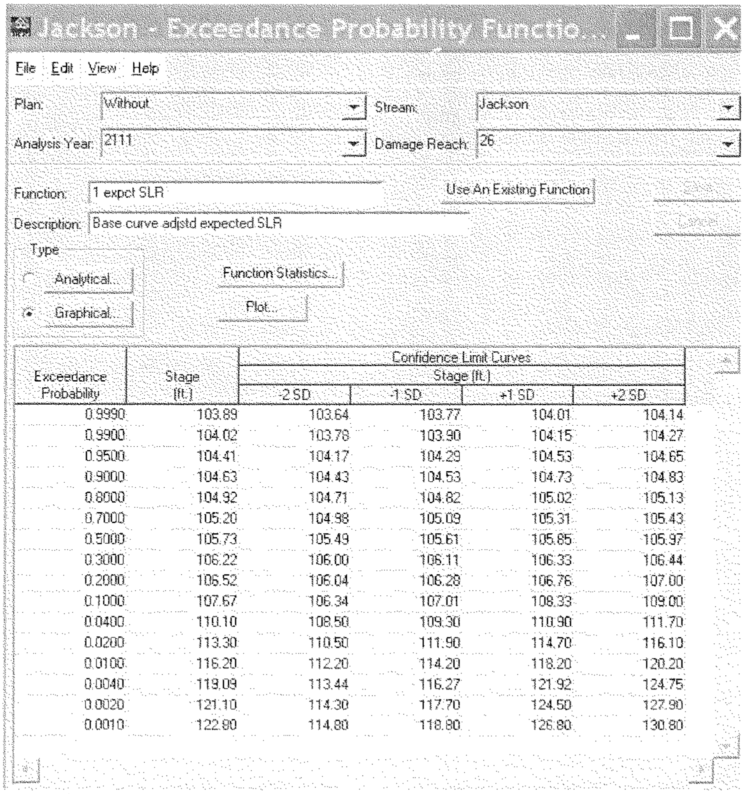
Function: 1 savpt Use An Existing Function

Description: Based on ERDC model and obs. USACE Biloxi gage

Type: Analytical... Graphical... Function Statistics... Plot...

Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	101.89	101.64	101.77	102.01	102.14
0.9900	102.02	101.78	101.90	102.15	102.27
0.9500	102.41	102.17	102.29	102.53	102.65
0.9000	102.63	102.43	102.53	102.73	102.83
0.8000	102.92	102.71	102.82	103.02	103.13
0.7000	103.20	102.98	103.09	103.31	103.43
0.5000	103.73	103.49	103.61	103.85	103.97
0.3000	104.22	104.00	104.11	104.33	104.44
0.2000	104.52	104.04	104.28	104.76	105.00
0.1000	105.67	104.34	105.01	106.33	107.00
0.0400	108.10	106.50	107.30	108.90	109.70
0.0200	111.30	108.50	109.90	112.70	114.10
0.0100	114.20	110.20	112.20	116.20	118.20
0.0040	117.09	111.44	114.27	119.92	122.75
0.0020	119.10	112.30	115.70	122.50	125.90
0.0010	120.80	112.80	116.80	124.80	128.80

Figure 6.10-3. Future Scenario 3 Base Year (2012) Exceedance Probability Function for the Gulf Park Estates Area


Jackson - Exceedance Probability Functio...

File Edit View Help

Plan: Without | Stream: Jackson

Analysis Year: 2111 | Damage Reach: 26

Function: 1 expct SLR | Use An Existing Function

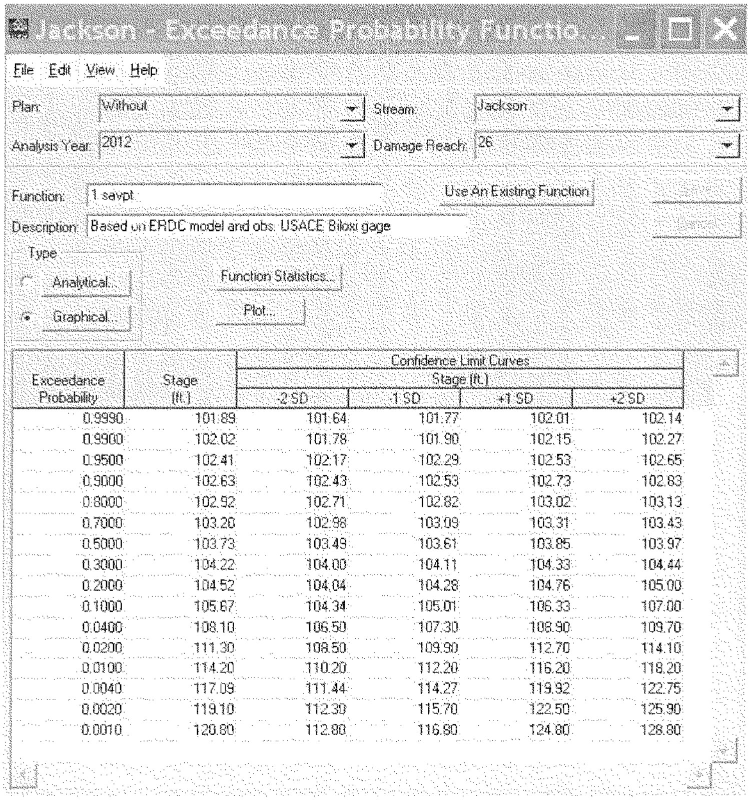
Description: Base curve adjstd expected SLR

Type: Analytical... | Graphical... | Function Statistics... | Plot...

Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	103.89	103.64	103.77	104.01	104.14
0.9900	104.02	103.78	103.90	104.15	104.27
0.9500	104.41	104.17	104.29	104.53	104.65
0.9000	104.63	104.43	104.53	104.73	104.83
0.8000	104.92	104.71	104.82	105.02	105.13
0.7000	105.20	104.98	105.09	105.31	105.43
0.5000	105.73	105.49	105.61	105.85	105.97
0.3000	106.22	106.00	106.11	106.33	106.44
0.2000	106.52	106.04	106.28	106.76	107.00
0.1000	107.67	106.34	107.01	108.33	109.00
0.0400	110.10	108.50	109.30	110.90	111.70
0.0200	113.30	110.50	111.90	114.70	116.10
0.0100	116.20	112.20	114.20	118.20	120.20
0.0040	119.09	113.44	116.27	121.92	124.75
0.0020	121.10	114.30	117.70	124.50	127.90
0.0010	122.80	114.80	118.80	126.80	130.80

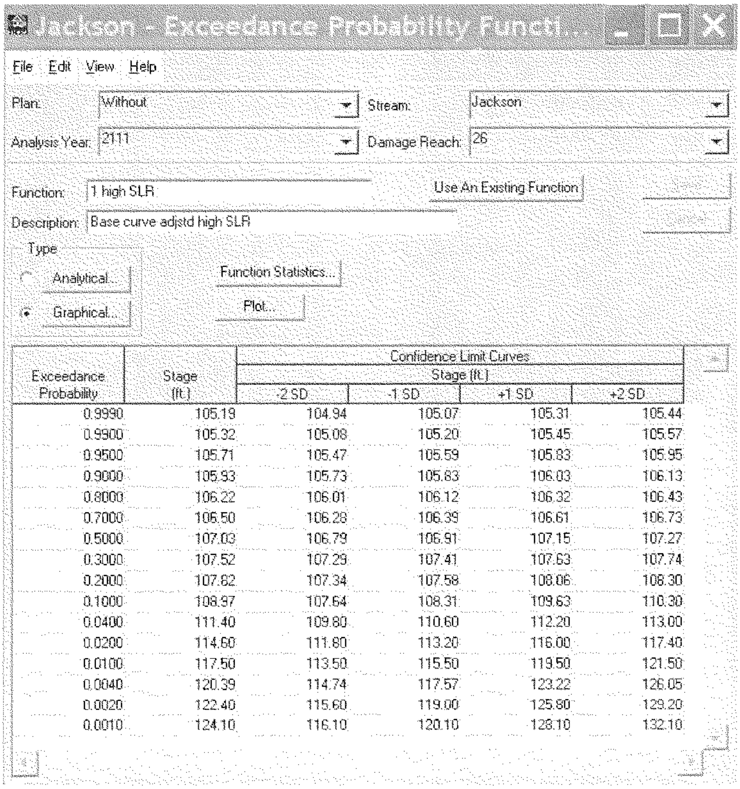
Figure 6.10-4. Future Scenario 3 Most Likely Future Year (2012) Exceedance Probability Function for the Gulf Park Estates Area – Includes an adjustment for relative sea level rise

Future scenario five is the same as future scenario one with the addition of a high relative sea level rise 100-year period of analysis (2012–2111). Equivalent annual damages that could occur under this scenario are $7,010,000 (rounded to the nearest thousand). These damages represent a approximately a seven-percent (6.8%) increase over the 2.0-feet relative sea level rise accounted for in future scenario three. The total number of structures in this scenario is the same as in scenarios one and three and can be seen above in table 6.10-2. Figures 6.10-5 and 6.10-6 depict the base year and most likely future year exceedance probability functions for the Gulf Park Estates area (planning sub-unit 26). The exceedance probability functions are for still water elevation (SWEL's) and based on a combination of observed data from USACE gauges and from modeling efforts conducted by the Engineer Research and Development Center (ERDC). The most likely future year exceedance probability function depicted in figure 6.10-6 includes an adjustment for expected relative sea level rise over the 100-year period of analysis. **Note**: Due to uncertainty issues regarding the first floor elevations, a base of 100-feet was applied to the exceedance probability functions and the first floor elevations. For example, if the stage for a given event probability shows 102-feet, the stage is really 2-feet. For more detail on the estimation and use of the exceedance probability functions see the Engineering Appendix.



Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	101.89	101.64	101.77	102.01	102.14
0.9900	102.02	101.78	101.90	102.15	102.27
0.9500	102.41	102.17	102.29	102.53	102.65
0.9000	102.63	102.43	102.53	102.73	102.83
0.8000	102.92	102.71	102.82	103.02	103.13
0.7000	103.20	102.98	103.09	103.31	103.43
0.5000	103.73	103.49	103.61	103.85	103.97
0.3000	104.22	104.00	104.11	104.33	104.44
0.2000	104.52	104.04	104.28	104.76	105.00
0.1000	105.67	104.34	105.01	106.33	107.00
0.0400	108.10	106.50	107.30	108.90	109.70
0.0200	111.30	108.50	109.90	112.70	114.10
0.0100	114.20	110.20	112.20	116.20	118.20
0.0040	117.09	111.44	114.27	119.92	122.75
0.0020	119.10	112.30	115.70	122.50	125.90
0.0010	120.80	112.80	116.80	124.80	128.80

Figure 6.10-5. Future Scenario 5 Base Year (2012) Exceedance Probability Function for the Gulf Park Estates Area


Jackson - Exceedance Probability Functi...

File Edit View Help

Plan: Without | Stream: Jackson

Analysis Year: 2111 | Damage Reach: 26

Function: 1 high SLR | Use An Existing Function

Description: Base curve adjstd high SLR

Type: Analytical... / Graphical... | Function Statistics... | Plot...

Exceedance Probability	Stage (ft)	Confidence Limit Curves Stage (ft) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	105.19	104.94	105.07	105.31	105.44
0.9900	105.32	105.08	105.20	105.45	105.57
0.9500	105.71	105.47	105.59	105.83	105.95
0.9000	105.93	105.73	105.83	106.03	106.13
0.8000	106.22	106.01	106.12	106.32	106.43
0.7000	106.50	106.28	106.39	106.61	106.73
0.5000	107.03	106.79	106.91	107.15	107.27
0.3000	107.52	107.29	107.41	107.63	107.74
0.2000	107.82	107.34	107.58	108.06	108.30
0.1000	108.97	107.64	108.31	109.63	110.30
0.0400	111.40	109.80	110.60	112.20	113.00
0.0200	114.60	111.80	113.20	116.00	117.40
0.0100	117.50	113.50	115.50	119.50	121.50
0.0040	120.39	114.74	117.57	123.22	126.05
0.0020	122.40	115.60	119.00	125.80	129.20
0.0010	124.10	116.10	120.10	128.10	132.10

Figure 6.10-6. Future Scenario 5 Most Likely Future Year (2012) Exceedance Probability Function for the Gulf Park Estates Area – Includes an adjustment for relative sea level rise

6.10.5.3 Equivalent annual damages Reduced and Residual Damages

Equivalent annual damages reduced are calculated as the difference between the damages under the future without-project scenarios three and five and the damages incurred with the measure in place. The HECFDA model was run for each measure to determine the damages reduced as compared to the without-project scenario.

In order to provide the HEC-FDA model with accurate information about the economic characteristics of each measure, separate inventories were created for each measure. The inventories are the same as the without-project inventory except that footprints of levees and acquisitions were deleted from the inventory and flood proofed structures (structures to be raised in place) were given a higher elevation. The structure inventories for each of the HEC-FDA measure runs are as follows:

- Measure A – Gulf Park Estates Ring Levee A at elevation 20.0-feet NAVD88

This measure includes the without-project inventory less 181 parcels that were deleted out of the inventory. These parcels represent the footprint of the 20.0-feet NAVD88 elevation ring levee and some portion of the total would have to be purchased for its construction. At this level of analysis, it is assumed that all of the structures identified to be touched in any way by the ring levee would be purchased; therefore all were deleted from the without-project structure inventory. Some of the parcels are wetland impacts and are discussed below in the Environmental Quality section.

- Measure B – Gulf Park Estates Ring Levee B at elevation 30.0-feet NAVD88

This measure includes the without-project inventory less 210 parcels that were deleted out of the inventory. These parcels represent the footprint of the 30.0-feet NAVD88 elevation ring levee and some portion of the total would have to be purchased for its construction. At this level of analysis, it is assumed that all of the structures identified to be touched in any way by the ring levee would be purchased; therefore all were deleted from the without-project structure inventory. Some of the parcels are wetland impacts and are discussed below in the Environmental Quality section.

- Measure C – Gulf Park Estates Ring Levee C at elevation 20.0-feet NAVD88

This measure would include a ring levee at 20-feet NAVD88 on an alternate footprint from Measure A and the acquisition of structures and parcels that would have been included in measure A but are not within the alternate footprint.

- Measure D – Gulf Park Estates Ring Levee D

This measure would include a ring levee at 30-feet NAVD88 on an alternate footprint from Measure B and the acquisition of structures and parcels that would have been included in measure B but are not within the alternate footprint.

- Measure E – Gulf Park Estates Nonstructural One

This measure includes the acquisition of 35 parcels that include a structure and the flood proofing (raise structure in place) of 951structures to an elevation of 18.3-feet NAVD88. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was determined to be approximately the ABFE level of protection and is defined as still water elevation, plus wave run-up plus an estimate for waves (depth divided by two), and is the minimum implementation elevation that a nonstructural measure do to the requirements of the National Flood Insurance Program (NFIP).

- Measure F – Gulf Park Estates Nonstructural Two to elevation 20.0-feet NAVD88

This measure includes the acquisition of 939 parcels that include a structure and the flood proofing (raise structure in place) of 47structures to an elevation of 20.0-feet NAVD88. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was chosen to show a direct comparison to the ring levee measures at elevation 20.0-feet NAVD88.

- Measure G – Gulf Park Estates Nonstructural Three to elevation 30.0-feet NAVD88

This measure includes the acquisition of 986 parcels that include a structure to an elevation of 30.0-feet NAVD88. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was chosen to show a direct comparison to the ring levee measures at elevation 30.0-feet NAVD88.

Residual damage is the equivalent annual damages that still remain even when a project is in place. Residual damage is calculated as the future without-project equivalent annual damages minus the damages reduced of the various measures. The purpose of residual damages is to calculate and communicate the portions of damages that will not be reduced by the implementation of a plan or "what damages are left on the table." Table 6.10-3 summarizes the equivalent annual without-project damages, damages reduced, and residual damages by measure and by future scenario.

Table 6.10-3.
Summary of Damages by Potential Measure and by Applicable Future Scenario

Measures	Equivalent annual damages Future 3 ($)	Equivalent Annual Damage Reduction Future 3 ($)	Residual Damage Future 3 ($)	Equivalent annual damages Future 5 ($)	Equivalent Annual Damage Reduction Future 5 ($)	Residual Damage Future 5 ($)
(No Action)	$0	$0	$0	$0	$0	$0
Measure A 20Ft Ring Levee	$6,273,000	$5,924,000	$349,000	$7,010,000	$6,616,000	$394,000
Measure B 30FT Ring Levee	$6,273,000	$6,251,000	$23,000	$7,010,000	$6,984,000	$26,000
Measure C 20Ft Ring Levee	$6,273,000	$6,021,000	$252,000	$7,010,000	$6,762,000	$248,000
Measure D 30FT Ring Levee	$6,273,000	$6,258,000	$15,000	$7,010,000	$7,010,000	$0
Measure E ABFE Nonstructural	$6,273,000	$5,668,000	$605,000	$7,010,000	$6,327,000	$683,000
Measure F 20FT Nonstructural	$6,273,000	$5,924,000	$349,000	$7,010,000	$6,616,000	$394,000
Measure G 30FT Nonstructural	$6,273,000	$6,273,000	$0	$7,010,000	$7,010,000	$0

Damages are rounded to the nearest thousand dollars.

6.10.6 Environmental Quality (EQ)

6.10.6.1 Impacts of Ring Levee Measures

The Engineering Research and Development Center Wetlands and Coastal Ecology Branch were asked to conduct an assessment of potential impacts to wetlands as a result of constructing various levees and seawalls along the Mississippi Gulf Coastal Plain. This report summarizes the results of the assessment. The analysis of impacts included two components:

1. A calculation of total acreage of all wetlands (by type and planning reach) that is directly under the levee footprints.

2. A modified Hydrogeomorphic (HGM) wetland rapid assessment of impacted Estuarine/Tidal Fringe wetlands, based on the Mississippi and Alabama Gulf Coast HGM guidebook (Shafer et al., 2007), with impacts reported as loss of functional units. Tables 6.10-4 and 6.10-5 show the impacts of the Gulf Park Estates ring levees at elevations 20.0-feet NAVD88, and 30.0-feet NAVD88 respectively.

Table 6.10-4.
Wetland Acres Impacted by Elevation 20' Gulf Park Estates Ring Levee

Reach ID	Estuarine and Marine Wetland	Freshwater Emergent Wetland	Freshwater Forested/Shrub Wetland	Freshwater Pond	Grand Total
26	1.1	1.2	8.1	0.0	10.4
28	3.4	0.3	9.6	0.2	13.4
Total	**4.5**	**1.5**	**17.7**	**0.2**	**23.9**

Table 6.10-5.
Wetland Acres Impacted by Elevation 30' Gulf Park Estates Ring Levee.

Reach ID	Estuarine and Marine Deepwater	Estuarine and Marine Wetland	Freshwater Emergent Wetland	Freshwater Forested/Shrub Wetland	Freshwater Pond	Total
26	0.0	1.5	1.9	10.6	0.0	14.0
28	0.1	5.9	0.5	14.0	0.3	20.8
Total	**0.1**	**7.4**	**2.3**	**24.6**	**0.3**	**34.8**

Nonstructural measures would have no construction activities other than demolition and disposal of building materials in an approved land fill occurs as a result of this measure. More detail on the impacts of the structural and nonstructural measures for the Gulf Park Estates area can be found in the Environmental Appendix.

6.10.7 Summary of Costs

Table 6.10-6 summarizes the ROM costs at an FY-08 price level for the Gulf Park Estates measures (planning sub-unit 26).

Table 6.10-6.
Summary of Costs by Measure for Gulf Park Estates Area

Measures	Implementation Costs (FY-08) ($)	Capital Recovery Factor	Average Annual Implementation Cost ($)	Average Annual O&M ($)	IDC ($)	Total Average Annual Costs ($)
(No Action)	$0	0.049171225	$0	$0	$0	$0
Measure A 20FT Ring Levee A	$149,200,000	0.049171225	$7,336,000	$1,499,000	N/A	$8,835,000
Measure B 30FT Ring Levee B	$220,600,000	0.049171225	$10,847,000	$2,404,000	N/A	$13,251,000
Measure C 20FT Ring Levee C	$158,900,000	0.049171225	$7,813,000	$1,295,000	N/A	$9,108,000
Measure D 30FT Ring Levee D	$208,700,000	0.049171225	$10,262,000	$1,906,000	N/A	$12,168,000
Measure E ABFE Nonstructural	$270,873,000	0.049171225	$13,319,000	$10,000	N/A	$13,329,000
Measure F 20FT Nonstructural	$294,188,000	0.049171225	$14,466,000	$10,000	N/A	$14,476,000
Measure G 30FT Nonstructural	$438,492,000	0.049171225	$21,561,000	$10,000	N/A	$21,571,000

The implementation costs include 1/ supervision and administration (30 account), 2/ planning, engineering & design (31 account) and 3/ appropriate contingencies. See the Cost Appendix for more detail on the implementation cost breakdowns. Numbers are rounded to the nearest thousand.

6.10.8 Regional Economic Development (RED)

The purpose of this section is to describe the economic impact of the proposed measures would affect the local area of Jackson County, Mississippi. The expenditures for the measures are estimated to be $149,200,000 for the 20.0-feet NAVD88 ring levee measure A, $220,600,000 for the 30.0-feet NAVD88 ring levee measure B, $158,900,000 for the 20.0-feet NAVD88 ring levee measure C, $208,700,000 for the 30-foot ring levee measure D, $270,873,000 for the ABFE nonstructural measure, $294,188,000 for the 20.0-feet NAVD88 nonstructural measure, and $294,188,000 for the 30.0-feet NAVD88 nonstructural measure. Moreover, the total present worth of the operation and maintenance (O&M) expenditures are estimated to be $30,485,000 for the 20.0-feet NAVD88 ring levee A measure, $48,890,000 for the 30.0-feet NAVD88 ring levee B measure, $26,337,000 the 20.0-feet NAVD88 ring levee C measure, $38,763,000 30.0-feet NAVD88 ring levee D measure, $203,000 for the ABFE nonstructural measure, $203,000 for the 20.0-feet NAVD88 nonstructural measure, and $203,000 for the 30.0-feet NAVD88 nonstructural measure respectively (assuming a 100- year period of analysis and an interest rate of 4.875-percent). The following tables, 6.10-7 through 6.10-10, summarize the EIFS model inputs and outputs for the Gulf Park Estates area.

Table 6.10-7.
EIFS Model Implementation Cost Inputs for the Gulf Park Estates Area

	20-foot Ring Levee A	30-foot Ring Levee B	20-foot Ring Levee C	30-foot Ring Levee D	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$149,200,000	$220,600,000	$158,900,000	$208,700,000	$270,873,000	$294,188,000	$438,492,000

Table 6.10-8.
EIFS Model Implementation Cost Outputs for the Gulf Park Estates Area

	20-foot Ring Levee A	30-foot Ring Levee B	20-foot Ring Levee C	30-foot Ring Levee D	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Direct Sales Volume	$149,200,000	$220,600,000	$158,900,000	$208,700,000	$270,873,000	$294,188,000	$438,492,000
Induced Sales Volume	$167,104,000	$247,072,000	$177,968,000	$233,744,000	$303,377,760	$329,490,560	$491,111,040
Total Sales Volume	$316,304,000	$467,672,000	$336,868,000	$442,444,000	$574,250,760	$623,678,560	$929,603,040
Direct Income	$29,097,814	$43,022,639	$30,989,561	$40,701,834	$52,827,159	$57,374,179	$85,517,148
Induced Income	$32,589,547	$48,185,349	$34,708,305	$45,586,049	$59,166,410	$64,259,073	$95,779,194
Total Income	$61,687,361	$91,207,988	$65,697,866	$86,287,883	$111,993,569	$121,633,252	$181,296,342
Direct Employment	844	1,249	899	1,181	1,533	1,665	2,482
Induced Employment	946	1,399	1,007	1,323	1,717	1,865	2,780
Total Employment	1,790	2,647	1,907	2,504	3,250	3,530	5,262
Local Population	0	0	0	0	0	0	0

Table 6.10-9.
EIFS Model O&M Cost Inputs for the Gulf Park Estates Area

	20-foot Ring Levee A	30-foot Ring Levee B	20-foot Ring Levee C	30-foot Ring Levee D	ABFE Nonstructl	20-foot Nonstructural	30-foot Nonstructural
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$30,485,000	$48,890,000	$26,337,000	$38,763,000	$203,000	$203,000	$203,000

Table 6.10-10.
EIFS Model O&M Cost Outputs for the Gulf Park Estates Area

	20-foot Ring Levee A	30-foot Ring Levee B	20-foot Ring Levee C	30-foot Ring Levee D	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Direct Sales Volume	$30,485,000	$48,890,000	$26,337,000	$38,763,000	$203,000	$203,000	$203,000
Induced Sales Volume	$34,143,200	$54,756,800	$29,497,440	$43,414,560	$227,360	$227,360	$227,360
Total Sales Volume	$64,628,200	$103,646,800	$55,834,440	$82,177,560	$430,360	$430,360	$430,360
Direct Income	$5,945,354	$9,534,800	$5,136,388	$7,559,776	$39,590	$39,590	$39,590
Induced Income	$6,658,796	$10,678,974	$5,752,754	$8,466,948	$44,341	$44,341	$44,341
Total Income	$12,604,150	$20,213,774	$10,889,142	$16,026,724	$83,931	$83,931	$83,931
Direct Employment	173	277	149	219	1	1	1
Induced Employment	193	310	167	246	1	1	1
Total Employment	366	587	316	465	2	2	2
Local Population	0	0	0	0	0	0	0

6.11 Evaluation of Belle Fontaine Area Measures

6.11.1 General

The Belle Fontaine area is located in the southern portion of planning unit three along the Mississippi Sound. The area is denoted as planning sub-unit 27 and is depicted in the figure, 6.11-1, below. The pre-Hurricane Katrina conditions for this area represented a mostly residential community. As demonstrated in Table 6.11-1, it was estimated from the field inventorying process that planning sub-unit 27 included 2,930 tax parcels, of which 1,389 contained a structure with some economic value and 1,541 were vacant land. Of those 1,389 parcels that contain structures, 1,357 were residential one-story, 0 were residential two-story, 17 were mobile homes, 12 were commercial, and 3 were municipal.

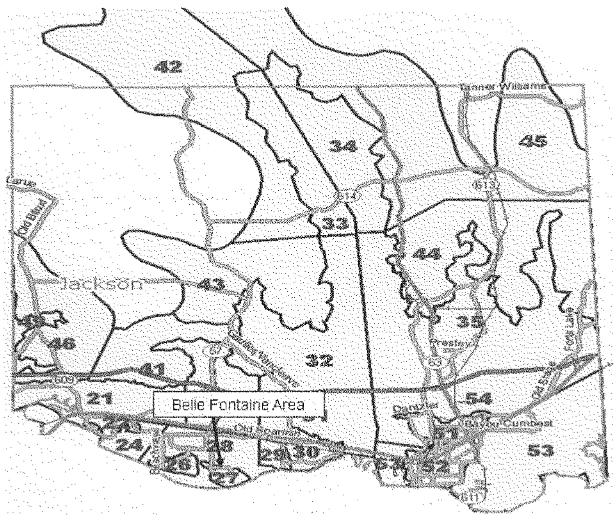


Figure 6.11-1. Belle Fontaine Area – Planning Sub-unit 27

Table 6.11-1.
Pre-Hurricane Katrina Estimate of Structures for the Belle Fontaine Area Planning Sub-unit 27

Structure Categories	Structures by Category
Residential	1,357
Mobile Homes	17
Commercial	12
Municipal	3
Vacant Land	1,541
Total Tax Parcels	**2,930**

6.11.2 Opportunities

The following opportunities were identified for this area:

- Hurricane storm damage reduction or remediation,
- Preservation of Fish and Wildlife Habitat.

6.11.3 Assumptions

The following assumptions were used in this analysis.

- The FY 2008 discount rate of 4-7/8 percent was used in estimating average annual benefits and costs
- Price levels are October, 2007 unless otherwise stated.
- A 100-year period of analysis (2012 to 2111) was used to calculate average annual benefits and costs pertaining to the evaluation of measures for hurricane and storm damage reduction.

6.11.4 Measures

Initially, a comprehensive list of measures was identified for flood damage reduction purposes for planning unit three. This list was screened and vetted for engineering and environmental feasibility and for policy compliance. The MsCIP Comprehensive Main Report and the Engineering and Environmental Appendices contain a detailed description of the measures that were initially screened.

Several potential measures were carried forward for this area for the purpose of flood damage reduction. These measures include both structural features and nonstructural actions. The measures evaluated for economic benefits include:

- Measure A – Belle Fontaine Ring Levee A

This measure will provide a ring levee with interior drainage, pumping stations, and roadway access up to a crest elevation of 20.0-feet NAVD88.

- Measure B – Belle Fontaine Ring Levee B

This measure will provide a ring levee with interior drainage, pumping stations, and roadway access up to a crest elevation of 30.0-feet NAVD88.

- Measure C – Belle Fontaine Ring Levee C

This measure would include a ring levee at 20-feet NAVD88 on an alternate footprint from Measure A and the acquisition of structures and parcels that would have been included in measure A but are not within the alternate footprint.

- Measure D – Belle Fontaine Ring Levee D

This measure would include a ring levee at 30-feet NAVD88 on an alternate footprint from Measure B and the acquisition of structures and parcels that would have been included in measure B but are not within the alternate footprint.

- Measure E – Belle Fontaine Nonstructural One

This measure includes the acquisition and flood proofing (elevate-in-place) of structures to the FEMA advisory base flood elevation (ABFE).

- Measure F – Belle Fontaine Nonstructural Two

This measure includes the acquisition and flood proofing of structures to approximately elevation 20-feet NAVD88.

- Measure G – Belle Fontaine Nonstructural Three

This measure includes the acquisition and flood proofing of structures to approximately elevation 30-feet NAVD88.

Figure 6.11-2 shows the measures for the Belle Fontaine Area (planning sub-unit 27); the red line represents the approximate footprint of the ring levee A and B measures, the green line represents the approximate footprint of the ring levee C and D measures, the dark green within the ring levee footprint represents potential ABFE buyout areas and the light green area within the ring levee footprint represents potential flood proof (elevate-in-place) areas.

Figure 6.11-2. Display of Potential Measures for the Belle Fontaine Area (Planning Sub-unit 27)

6.11.5 National Economic Development (NED)

The purpose of this section is to document investigations conducted to identify the National Economic Development (NED) benefits of each of the potential measures previously listed. For this analysis, NED benefits are the reduced inundation damages of assets and their contents when one of the potential measures is in place. Typically, NED benefits are annualized over the period of the analysis (average annual benefits) and then compared to annualized costs over the period of analysis (average annual costs). This comparison is commonly known as the benefit-to-cost ratio (BCR). For purposes of this analysis, no benefit-to-cost ratios will be calculated as per the legislative Congressional language authorizing this study. The Coastal Mississippi Comprehensive Plan Report was authorized by the Department of Defense Appropriations Act, 2006 (P.L. 109-148) 30 December 2005, which states: "...***that the Secretary shall recommend a cost-effective project, but shall not perform an incremental benefit-cost analysis to identify the recommended project, and shall not make project plan features based upon maximizing net national economic development benefits..."*** More detail on the authorizing language can be found in the MsCIP Comprehensive Plan Main Report.

6.11.5.1 Existing Conditions Post-Hurricane Katrina)

The effects of Hurricane Katrina storm surge were devastating to the Belle Fontaine Area. Peak water elevation in the area was approximately19-feet NAVD88. It is estimated that 420 of the structures in the area (mostly residential) sustained significant inundation damage (fifty-percent or more). Expected redevelopment of the area is described in the following section.

6.11.5.2 Future Without-Project Conditions

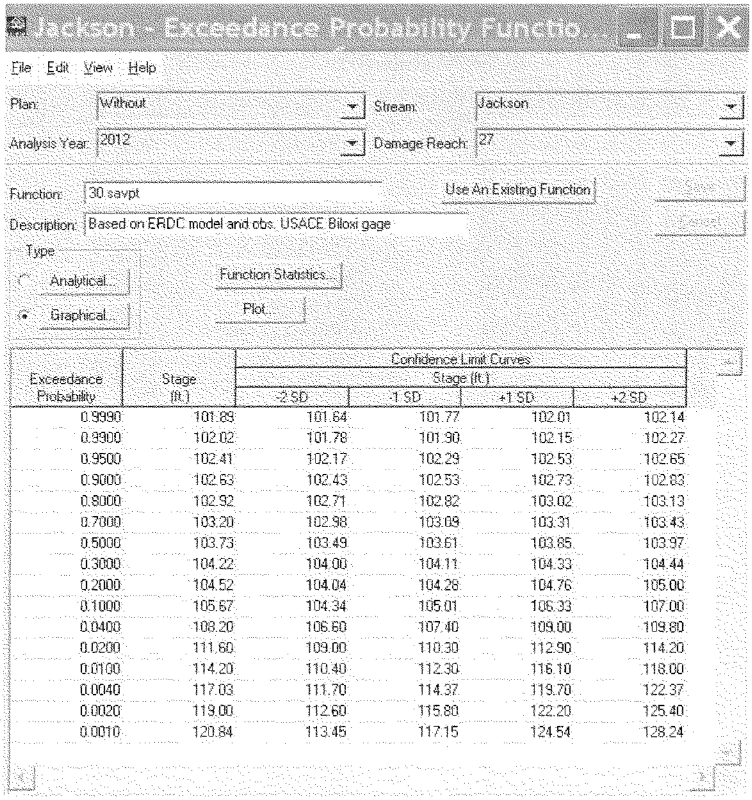
Equivalent annual flood damages for several future without-project scenarios were evaluated using the Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA) model. Each of the measures were evaluated and compared to future without-project scenarios three, and five, as previously discussed in section 5.3. These future scenarios were chosen because the redevelopment projected for this area is anticipated to return to the pre-Katrina development. Futures scenarios two, four, and six were not used for evaluation purposes since this area is not accommodative for commercial and condominium redevelopment under those mixed redevelopment scenarios (see section 5.3 for more detail).

Future scenario one is the full redevelopment of structures within the study area by the year 2012 with no relative sea level rise over the 100-year period of analysis. Table 6.11-2 shows structures by category and by elevation. The number of structures per elevation is added to the previous number of structures per elevation in each category. For example, in the residential category there are three structures with an elevation of 5-feet or lower, and there are fourteen structures with an elevation of 6-feet or less, etc. This future scenario, as previously noted in section 5.3, is for sensitivity purposes only and will not be evaluated against all of the potential measures for the Belle Fontaine area.

Table 6.11-2.
Cumulative Structures by Category and by Estimated First Floor Elevation Future Scenarios One, Three, and Five Applicable for Base Year and Most Likely Future Years

Estimated First Floor Elevation (NAVD88)	Residential	Mobile Homes	Commercial	Municipal	Total
1-foot	0	0	0	0	0
2-foot	0	0	0	0	0
3-foot	0	0	0	0	0
4-foot	0	0	0	0	0
5-foot	3	0	0	0	3
6-foot	14	0	0	0	14
7-foot	16	0	0	0	16
8-foot	18	0	0	0	18
9-foot	19	0	0	0	19
10-foot	28	0	0	0	28
11-foot	170	0	0	0	170
12-foot	208	0	1	0	209
13-foot	376	1	5	0	382
14-foot	707	2	7	0	716
15-foot	1,111	3	8	2	1,124
16-foot	1,166	5	9	3	1,183
17-foot	1,245	6	10	3	1,264
18-foot	1,298	7	11	3	1,319
19-foot	1,339	13	11	3	1,366
20-foot	1,346	17	12	3	1,378
21-foot	1,355	17	12	3	1,387
22-foot	1,357	17	12	3	1,389
Total	**1,357**	**17**	**12**	**3**	**1,389**

Future scenario three is the full redevelopment of assets within the study area by the year 2012. Under this scenario, assets will be rebuilt as they were pre-Hurricane Katrina. For example, if the asset was a residential structure pre-Hurricane Katrina it will be rebuilt as a residential structure; commercial structures will be built back to commercial structures; etc. Basically, future scenario three is the same structure inventory as future scenario one with the addition of an expected relative sea level rise over the 100-year period of analysis (2012–2111). Equivalent annual damages that could occur under this scenario are $2,506,000 (rounded to the nearest thousand dollars). The total number of structures in this scenario are the same as in scenario one and can be seen above in table 6.11-2. Figures 6.11-3 and 6.11-4 depict the base year and most likely future year exceedance probability functions for the Belle Fontaine area (planning sub-unit 27). The exceedance probability functions are for still water elevation (SWEL's) and based on a combination of observed data from USACE gauges and from modeling efforts conducted by the Engineer Research and Development Center (ERDC). The most likely future year exceedance probability function depicted in figure 6.11-4 includes an adjustment for expected relative sea level rise over the 100-year period of analysis. **Note**: Due to uncertainty issues regarding the first floor elevations, a base of 100-feet was applied to the exceedance probability functions and the first floor elevations. For example, if the stage for a given event probability shows 102-feet, the stage is really 2-feet.For more detail on the estimation and use of the exceedance probability functions see the Engineering Appendix.



Jackson - Exceedance Probability Functio...

File Edit View Help

Plan: Without | Stream: Jackson

Analysis Year: 2012 | Damage Reach: 27

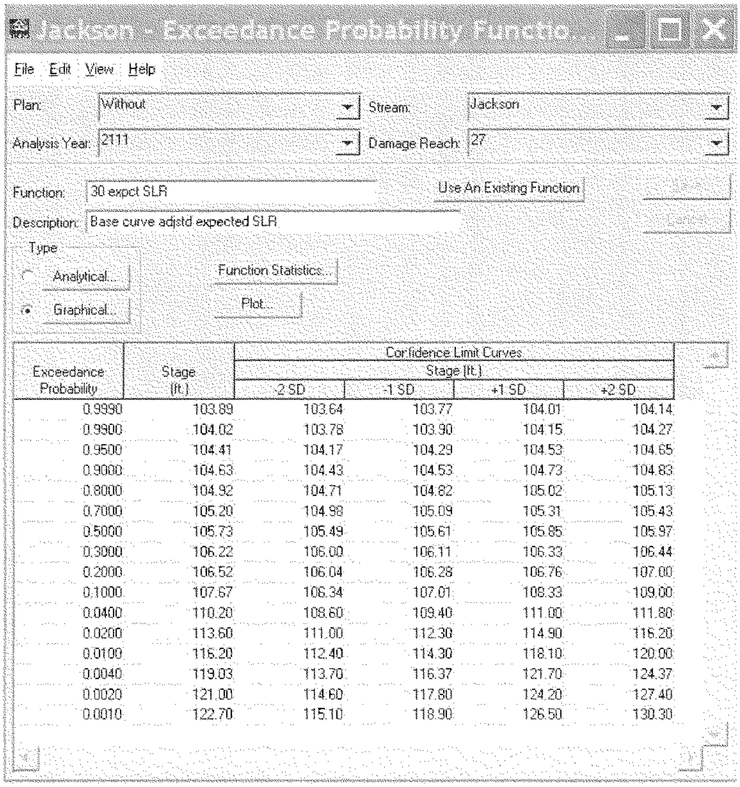
Function: 30 savpt | Use An Existing Function

Description: Based on ERDC model and obs. USACE Biloxi gage

Type: Analytical... | Graphical... | Function Statistics... | Plot...

Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.)			
		-2 SD	-1 SD	+1 SD	+2 SD
0.9990	101.83	101.64	101.77	102.01	102.14
0.9900	102.02	101.78	101.90	102.15	102.27
0.9500	102.41	102.17	102.29	102.53	102.65
0.9000	102.63	102.43	102.53	102.73	102.83
0.8000	102.92	102.71	102.82	103.02	103.13
0.7000	103.20	102.98	103.09	103.31	103.43
0.5000	103.73	103.49	103.61	103.85	103.97
0.3000	104.22	104.00	104.11	104.33	104.44
0.2000	104.52	104.04	104.28	104.76	105.00
0.1000	105.67	104.34	105.01	106.33	107.00
0.0400	108.20	106.60	107.40	109.00	109.80
0.0200	111.60	109.00	110.30	112.90	114.20
0.0100	114.20	110.40	112.30	116.10	118.00
0.0040	117.03	111.70	114.37	119.70	122.37
0.0020	119.00	112.60	115.80	122.20	125.40
0.0010	120.84	113.45	117.15	124.54	128.24

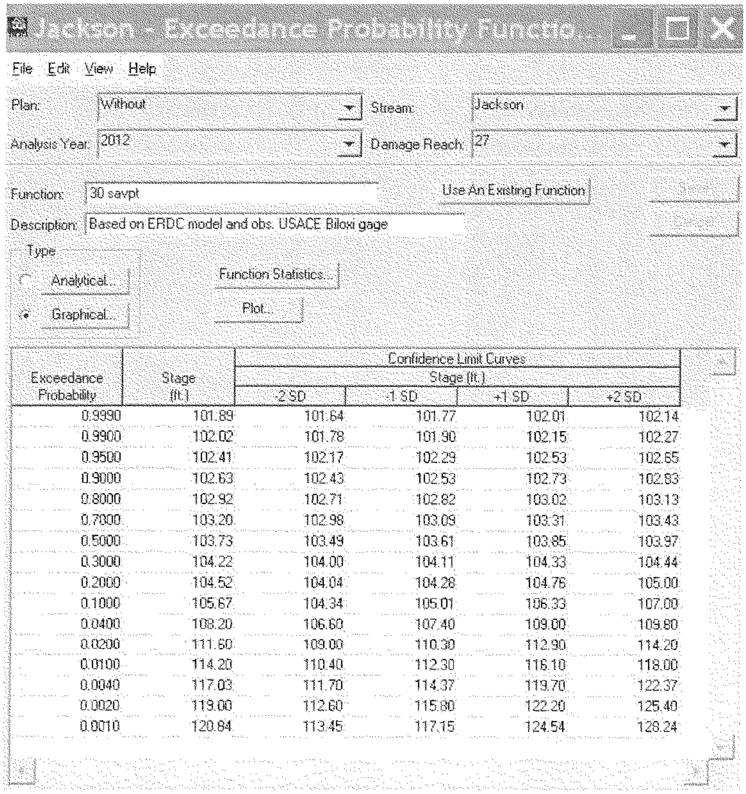
Figure 6.11-3. Future Scenario 3 Base Year (2012) Exceedance Probability Function for the Belle Fontaine Area



Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	103.89	103.64	103.77	104.01	104.14
0.9900	104.02	103.78	103.90	104.15	104.27
0.9500	104.41	104.17	104.29	104.53	104.65
0.9000	104.63	104.43	104.53	104.73	104.83
0.8000	104.92	104.71	104.82	105.02	105.13
0.7000	105.20	104.98	105.09	105.31	105.43
0.5000	105.73	105.49	105.61	105.85	105.97
0.3000	106.22	106.00	106.11	106.33	106.44
0.2000	106.52	106.04	106.28	106.76	107.00
0.1000	107.67	106.34	107.01	108.33	109.00
0.0400	110.20	108.60	109.40	111.00	111.80
0.0200	113.60	111.00	112.30	114.90	116.20
0.0100	116.20	112.40	114.30	118.10	120.00
0.0040	119.03	113.70	116.37	121.70	124.37
0.0020	121.00	114.60	117.80	124.20	127.40
0.0010	122.70	115.10	118.90	126.50	130.30

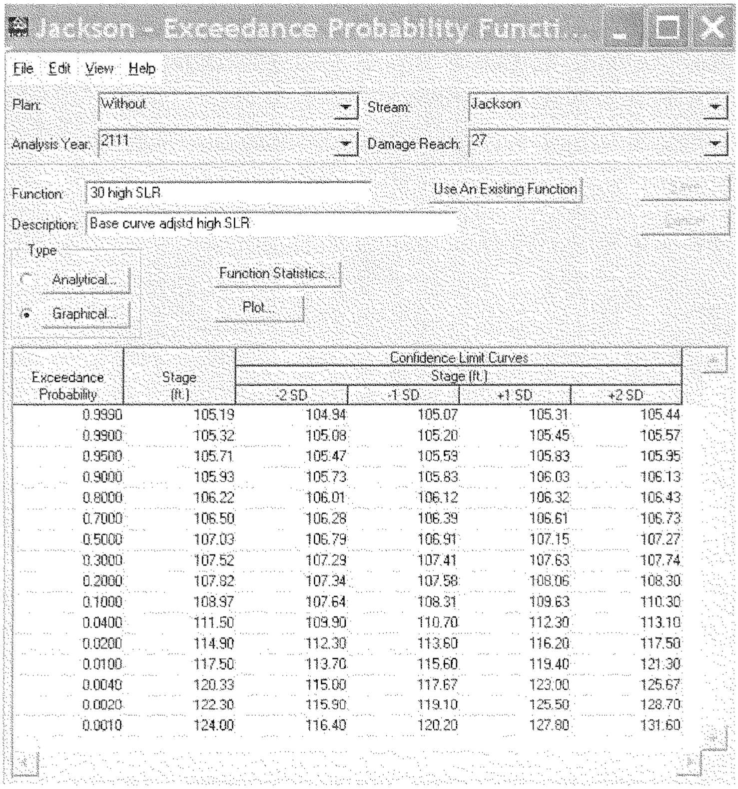
Figure 6.11-4. Future Scenario 3 Most Likely Future Year (2012) Exceedance Probability Function for the Belle Fontaine Area – Includes an adjustment for relative sea level rise

Future scenario five is the same as future scenario one with the addition of a high relative sea level rise 100-year period of analysis (2012–2111). Equivalent annual damages that could occur under this scenario are $2,950,000 (rounded to the nearest thousand). These damages represent approximately an eighteen-percent (17.7%) increase over the expected relative sea level rise accounted for in future scenario three. The total number of structures in this scenario is the same as in scenarios one and three and can be seen above in table 6.11-2. Figures 6.11-5 and 6.11-6 depict the base year and most likely future year exceedance probability functions for the Belle Fontaine area (planning sub-unit 27). The exceedance probability functions are for still water elevation (SWEL's) and based on a combination of observed data from USACE gauges and from modeling efforts conducted by the Engineer Research and Development Center (ERDC). The most likely future year exceedance probability function depicted in figure 6.11-6 includes an adjustment for expected relative sea level rise over the 100-year period of analysis. **Note**: Due to uncertainty issues regarding the first floor elevations, a base of 100-feet was applied to the exceedance probability functions and the first floor elevations. For example, if the stage for a given event probability shows 102-feet, the stage is really 2-feet.For more detail on the estimation and use of the exceedance probability functions see the Engineering Appendix.



Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.)			
		-2 SD	-1 SD	+1 SD	+2 SD
0.9990	101.89	101.64	101.77	102.01	102.14
0.9900	102.02	101.78	101.90	102.15	102.27
0.9500	102.41	102.17	102.29	102.53	102.65
0.9000	102.63	102.43	102.53	102.73	102.83
0.8000	102.92	102.71	102.82	103.02	103.13
0.7000	103.20	102.98	103.09	103.31	103.43
0.5000	103.73	103.49	103.61	103.85	103.97
0.3000	104.22	104.00	104.11	104.33	104.44
0.2000	104.52	104.04	104.28	104.76	105.00
0.1000	105.67	104.34	105.01	106.33	107.00
0.0400	108.20	106.60	107.40	109.00	109.80
0.0200	111.60	109.00	110.30	112.90	114.20
0.0100	114.20	110.40	112.30	116.10	118.00
0.0040	117.03	111.70	114.37	119.70	122.37
0.0020	119.00	112.60	115.80	122.20	125.40
0.0010	120.84	113.45	117.15	124.54	128.24

Figure 6.11-5. Future Scenario 5 Base Year (2012) Exceedance Probability Function for the Belle Fontaine Area



Exceedance Probability	Stage (ft)	Confidence Limit Curves Stage (ft)			
		-2 SD	-1 SD	+1 SD	+2 SD
0.9990	105.19	104.94	105.07	105.31	105.44
0.9900	105.32	105.08	105.20	105.45	105.57
0.9500	105.71	105.47	105.59	105.83	105.95
0.9000	105.93	105.73	105.83	106.03	106.13
0.8000	106.22	106.01	106.12	106.32	106.43
0.7000	106.50	106.28	106.39	106.61	106.73
0.5000	107.03	106.79	106.91	107.15	107.27
0.3000	107.52	107.29	107.41	107.63	107.74
0.2000	107.82	107.34	107.58	108.06	108.30
0.1000	108.97	107.64	108.31	109.63	110.30
0.0400	111.50	109.90	110.70	112.30	113.10
0.0200	114.90	112.30	113.60	116.20	117.50
0.0100	117.50	113.70	115.60	119.40	121.30
0.0040	120.33	115.00	117.67	123.00	125.67
0.0020	122.30	115.90	119.10	125.50	128.70
0.0010	124.00	116.40	120.20	127.80	131.60

Figure 6.11-6. Future Scenario 5 Most Likely Future Year (2012) Exceedance Probability Function for the Belle Fontaine Area – Includes an adjustment for relative sea level rise

6.11.5.3 Equivalent annual damages Reduced

Equivalent annual damages reduced are calculated as the difference between the damages under the future without-project scenarios three and five and the damages incurred with the measure in place. The HECFDA model was run for each measure to determine the damages reduced as compared to the without-project scenario.

In order to provide the HEC-FDA model with accurate information about the economic characteristics of each measure, separate inventories were created for each measure. The inventories are the same as the without project inventory except that footprints of levees and acquisitions were deleted from the inventory and flood proofed structures (structures to be raised in place) were given a higher elevation. The structure inventories for each of the HEC-FDA measure runs are as follows:

- Measure A – Belle Fontaine Ring Levee A at elevation 20.0-feet NAVD88

This measure includes the without-project inventory less 101 parcels that were deleted out of the inventory. These parcels represent the footprint of the 20.0-feet NAVD88 elevation ring levee and some portion of the total would have to be purchased for its construction. At this level of analysis, it is assumed that all of the structures identified to be touched in any way by the ring levee would be purchased; therefore all were deleted from the without-project structure inventory. Some of the parcels are wetland impacts and are discussed below in the Environmental Quality section.

- Measure B – Belle Fontaine Ring Levee B at elevation 30.0-feet NAVD88

This measure includes the without-project inventory less 118 parcels that were deleted out of the inventory. These parcels represent the footprint of the 30.0-feet NAVD88 elevation ring levee and some portion of the total would have to be purchased for its construction. At this level of analysis, it is assumed that all of the structures identified to be touched in any way by the ring levee would be purchased; therefore all were deleted from the without-project structure inventory. Some of the parcels are wetland impacts and are discussed below in the Environmental Quality section.

- Measure C – Belle Fontaine Ring Levee C at elevation 20.0-feet NAVD88

This measure would include a ring levee at 20-feet NAVD88 on an alternate footprint from Measure A and the acquisition of structures and parcels that would have been included in measure A but are not within the alternate footprint.

- Measure D – Belle Fontaine Ring Levee D

This measure would include a ring levee at 30-feet NAVD88 on an alternate footprint from Measure B and the acquisition of structures and parcels that would have been included in measure B but are not within the alternate footprint.

- Measure E – Belle Fontaine Nonstructural One

This measure includes the acquisition of 32 parcels that include a structure and the flood proofing (raise structure in place) of 1,028 structures to an elevation of 14.55-feet NAVD88. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was determined to be approximately the ABFE level of protection and is defined as still water elevation, plus wave run-up, plus an estimate for waves (depth divided by two), and is the minimum implementation elevation that a nonstructural measure do to the requirements of the National Flood Insurance Program (NFIP).

- Measure F – Belle Fontaine Nonstructural Two to elevation 20.0-feet NAVD88

This measure includes the acquisition of 177 parcels that include a structure and the flood proofing (raise structure in place) of 883 structures to an elevation of 20.0-feet NAVD88. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was chosen to show a direct comparison to the ring levee measures at elevation 20.0-feet NAVD88.

- Measure G – Belle Fontaine Nonstructural Three to elevation 30.0-feet NAVD88

This measure includes the acquisition of 1,060 parcels that include a structure. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing

Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was chosen to show a direct comparison to the ring levee measures at elevation 30.0-feet NAVD88.

Residual damage is the equivalent annual damages that still remain even when a project is in place. Residual damage is calculated as the future without-project equivalent annual damages minus the damages reduced of the various measures. The purpose of residual damages is to calculate and communicate the portions of damages that will not be reduced by the implementation of a plan or "what damages are left on the table." Table 6.11-3 summarizes the without project damages, damages reduced, and residual damages by measure and by future scenario.

Table 6.11-3.
Summary of Damages by Measure

Measures	Equivalent Annual Damages Future 3 ($)	Equivalent Annual Damage Reduction Future 3 ($)	Residual Damage Future 3 ($)	Equivalent Annual Damages Future 5 ($)	Equivalent Annual Damage Reduction Future 5 ($)	Residual Damage Future 5 ($)
(No Action)	$0	$0	$0	$0	$0	$0
Measure A 20FT Ring Levee A	$2,506,000	$2,235,000	$271,000	$2,950,000	$2,641,000	$309,000
Measure B 30FT Ring Levee B	$2,506,000	$2,493,000	$13,000	$2,950,000	$2,933,000	$17,000
Measure C 20FT Ring Levee C	$2,506,000	$2,350,000	$156,000	$2,950,000	$2,765,000	$185,000
Measure D 30FT Ring Levee D	$2,506,000	$2,506,000	$0	$2,950,000	$2,950,000	$0
Measure C ABFE Nonstructural	$2,506,000	$1,425,000	$1,081,000	$2,950,000	$1,652,000	$1,298,000
Measure D 20FT Nonstructural	$2,506,000	$2,235,000	$271,000	$2,950,000	$2,641,000	$309,000
Measure E 30FT Nonstructural	$2,506,000	$2,506,000	$0	$2,950,000	$2,950,000	$0

Damages are rounded to the nearest thousand dollars.

6.11.6 Environmental Quality (EQ)

6.11.6.1 Impacts of Ring Levee Measures

The Engineering Research and Development Center Wetlands and Coastal Ecology Branch were asked to conduct an assessment of potential impacts to wetlands as a result of constructing various levees and seawalls along the Mississippi Gulf Coastal Plain. This report summarizes the results of the assessment. The analysis of impacts included two components:

1. A calculation of total acreage of all wetlands (by type and planning reach) that is directly under the levee footprints.
2. A modified Hydrogeomorphic (HGM) wetland rapid assessment of impacted Estuarine/Tidal Fringe wetlands, based on the Mississippi and Alabama Gulf Coast HGM guidebook (Shafer et al., 2007), with impacts reported as loss of functional units. Tables 6.11-4 and 6.11-5 show the impacts of the Belle Fontaine ring levees at elevations 20.0-feet NAVD88, and 30.0-feet NAVD88 respectively.

Table 6.11-4.
Wetland Acres Impacted by Elevation 20' Belle Fontaine Ring Levee A

Reach ID	Estuarine and Marine Wetland	Freshwater Forested/ Shrub Wetland	Freshwater Pond	Total
27	4.7	14.2	0.4	19.3
28	9.5	18.0	0.2	27.6
Total	**14.2**	**32.2**	**0.5**	**46.9**

Table 6.11-5.
Wetland Acres Impacted by Elevation 30' Belle Fontaine Ring Levee B

Reach ID	Estuarine and Marine Wetland	Freshwater Forested/ Shrub Wetland	Freshwater Pond	Total
27	6.11	20.5	0.6	27.5
28	13.0	25.4	0.2	38.5
Total	**19.4**	**45.9**	**0.8**	**66.0**

Nonstructural measures would have no construction activities other than demolition and disposal of building materials in an approved land fill occurs as a result of this measure. More detail on the impacts of the structural and nonstructural measures for the Belle Fontaine area can be found in the Environmental Appendix.

6.11.7 Summary of Costs

Table 6.11-6 summarizes the ROM costs at an FY-08 price level by measure for the Belle Fontaine area (planning sub-unit 26).

Table 6.11-6.
Summary of Costs by Measure for the Belle Fontaine Area

Measures	Total Cost to Implement (First Cost) ($)	Average Annual Implementation Cost ($)	Average Annual O&M ($)	IDC ($)	Total Average Annual Costs ($)
(No Action)	$0	$0	$0	$0	$0
Measure A 20FT Ring Levee A	$137,600,000	$6,766,000	$1,371,000	N/A	$8,137,000
Measure B 30FT Ring Levee B	$191,900,000	$9,436,000	$1,939,000	N/A	$11,375,000
Measure C 20FT Ring Levee C	$103,900,000	$5,109,000	$989,000	N/A	$6,098,000
Measure D 30FT Ring Levee D	$142,900,000	$7,027,000	$1,414,000	N/A	$8,441,000
Measure E ABFE Nonstructural	$227,800,000	$11,201,000	$10,000	N/A	$11,211,000
Measure F 20FT Nonstructural	$290,726,000	$14,295,000	$10,000	N/A	$14,305,000
Measure G 30FT Nonstructural	$453,067,000	$22,278,000	$10,000	N/A	$22,288,000

The implementation costs include 1/ supervision and administration (30 account), 2/ planning, engineering & design (31 account) and 3/ appropriate contingencies. See the Cost Appendix for more detail on the implementation cost breakdowns. Numbers are rounded to the nearest thousand.

6.11.8 Regional Economic Development (RED)

The purpose of this analysis is to determine the economic impact of the proposed project measures on business (sale volumes), income, employment, and population of the local area. Each of the measures would affect the local area of Jackson County, Mississippi. The expenditures for the measures are estimated to be $137,600,000 for the 20.0-feet NAVD88 ring levee A measure, $191,900,000 for the 30.0-feet NAVD88 ring levee B measure, $103,900,000 for the 20.0-feet NAVD88 ring levee C measure, $142,900,000 for the 30.0-feet NAVD88 ring levee D measure, $227,800,000 for the ABFE nonstructural measures, $290,726,000 for the 20.0-feet NAVD88 nonstructural measures, and $290,726,000 for the 30.0-feet NAVD88 nonstructural measures. Moreover, the total present worth of the operation and maintenance (O&M) expenditures are estimated to be $27,882,000 for the 20.0-feet NAVD88 ring levee A measure, $39,434,000 for the 30.0-feet NAVD88 ring levee B measure, $20,113,000 for the 20.0-feet NAVD88 ring levee C measure, $28,757,000 for the 30.0-feet NAVD88 ring levee D measure, $203,000 for the ABFE nonstructural measure, $203,000 for the 20.0-feet NAVD88 nonstructural measure, and $203,000 for the 30.0-feet NAVD88 nonstructural measure respectively (assuming a 100 year period of analysis and an interest rate of 4.875 percent). The following tables, 6.11-7 through 6.11-10, summarize the EIFS model inputs and outputs for the Belle Fontaine area.

Table 6.11-7.
EIFS Model Construction Costs Inputs for the Belle Fontaine Area

	20-foot Ring Levee A	30-foot Ring Levee B	20-foot Ring Levee C	30-foot Ring Levee D	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$137,600,000	$191,900,000	$103,900,000	$142,900,000	$227,800,000	$290,726,000	$453,067,000

Based of the given inputs the outputs are as follows:

Table 6.11-8.
EIFS Model Construction Costs Outputs for the Belle Fontaine Area

	20-foot Ring Levee A	30-foot Ring Levee B	20-foot Ring Levee C	30-foot Ring Levee D	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Direct Sales Volume	$137,600,000	$191,900,000	$103,900,000	$142,900,000	$227,800,000	$290,726,000	$453,067,000
Induced Sales Volume	$154,112,000	$214,928,000	$116,368,000	$160,048,000	$255,136,000	$325,613,120	$507,435,040
Total Sales Volume	$291,712,000	$406,828,000	$220,268,000	$302,948,000	$482,936,000	$616,339,120	$960,502,040
Direct Income	$26,835,517	$37,425,405	$20,263,156	$27,869,153	$44,426,823	$56,699,001	$88,359,645
Induced Income	$30,055,775	$41,916,448	$22,694,732	$31,213,447	$49,758,035	$63,502,873	$98,962,791
Total Income	$56,891,292	$79,341,853	$42,957,887	$59,082,599	$94,184,858	$120,201,874	$187,322,436
Direct Employment	778	1,086	588	809	1,289	1,646	2,564
Induced Employment	872	1,216	659	906	1,444	1,843	2,872
Total Employment	1,650	2,302	1,247	1,715	2,734	3,489	5,437
Local Population	0	0	0	0	0	0	0

Table 6.11-9.
EIFS Model O&M Cost Inputs for the Belle Fontaine Area (Planning Sub-unit 27)

	20-foot Ring Levee A	30-foot Ring Levee B	20-foot Ring Levee C	30-foot Ring Levee D	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$27,882,000	$39,434,000	$20,113,000	$28,757,000	$203,000	$203,000	$203,000

Based of the given inputs the outputs are as follows:

Table 6.11-10.
EIFS Model O&M Cost Outputs for the Belle Fontaine Area (Planning Sub-unit 27)

	20-foot Ring Levee A	30-foot Ring Levee B	20-foot Ring Levee C	30-foot Ring Levee D	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Direct Sales Volume	$27,882,000	$39,434,000	$20,113,000	$28,757,000	$203,000	$203,000	$203,000
Induced Sales Volume	$31,227,840	$44,166,080	$22,526,560	$32,207,840	$227,360	$227,360	$227,360
Total Sales Volume	$59,109,840	$83,600,000	$42,639,560	$60,964,840	$430,360	$430,360	$430,360
Direct Income	$5,437,703	$7,690,638	$3,922,549	$5,608,350	$39,590	$39,590	$39,590
Induced Income	$6,090,226	$8,613,513	$4,393,254	$6,281,351	$44,341	$44,341	$44,341
Total Income	$11,527,929	$16,304,151	$8,315,804	$11,889,701	$83,931	$83,931	$83,931
Direct Employment	158	223	114	163	1	1	1
Induced Employment	177	250	128	182	1	1	1
Total Employment	335	473	241	345	2	2	2
Local Population	0	0	0	0	0	0	0

6.12 Evaluation of Pascagoula - Moss Point Area Measures

6.12.1 General

The Pascagoula - Moss Point area, shown in Figure 6.12-1, is located in the southeastern portion of planning unit three along the eastern bank of the Pascagoula River. The area is denoted as planning sub-units 51 and 52 and is depicted in the figure below. The pre-Hurricane Katrina conditions for this area represented a mostly residential community. As shown in table 6.12-1, it was estimated from the field inventorying process that planning sub-units 51 and 52 included 16,158 tax parcels; of which 13,638 contained a structure with some economic value and 2,520 were vacant land. Of those 13,638 parcels that contain structures, 11,449 were residential one-story, 314 were residential two-story, 52 were mobile homes, 1,565 were commercial, and 258 were municipal.

6.12.2 Opportunities

The following opportunities were identified for this area:

- Hurricane storm damage reduction or remediation
- Preservation of Fish and Wildlife

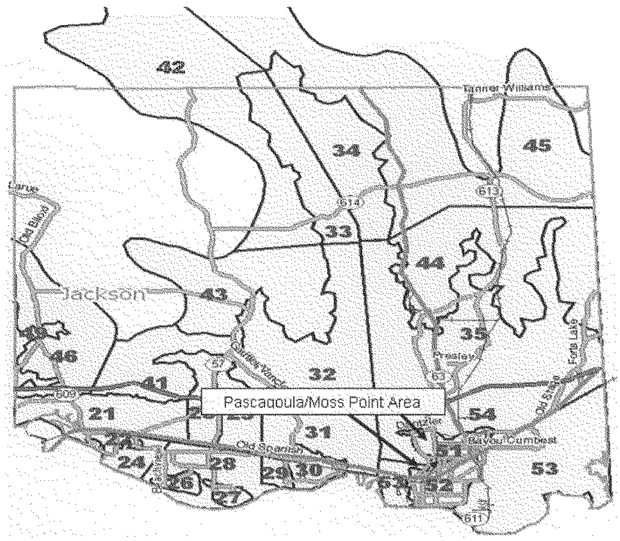


Figure 6.12-1. Pascagoula - Moss Point Area – Planning Sub-units 51 and 52

Table 6.12-1.
Pre-Hurricane Katrina Estimate of Structures for the Pascagoula-Moss Point Area Planning Sub-units 51 and 52

Structure Categories	Structures by Category
Residential	11,763
Mobile Homes	52
Commercial	1,565
Municipal	258
Vacant Land	2,520
Total Tax Parcels	**16,158**

6.12.3 Assumptions

The following assumptions were used in this analysis.

- The FY 2008 discount rate of 4.875 percent was used in estimating average annual benefits and costs
- Price levels are October, 2007 unless otherwise stated.
- A 100-year period of analysis (2012 to 2111) was used to calculate average annual benefits and costs.

6.12.4 Measures

Initially, a comprehensive list of measures was identified for flood damage reduction purposes for planning unit three. This list was screened and vetted for engineering and environmental feasibility and for policy compliance. The MsCIP Comprehensive Main Report and the Engineering and Environmental Appendices contain a detailed description of the measures that were initially screened.

Several potential measures were carried forward for this area for the purpose of flood damage reduction. These measures include both structural features and nonstructural actions. The measures evaluated for economic benefits include:

- Measure A – Pascagoula - Moss Point Ring Levee at Elevation 20.0-feet NAVD88

This measure will provide a ring levee with interior drainage, pumping stations, and roadway access up to a crest elevation of 20.0-feet NAVD88.

- Measure B – Pascagoula - Moss Point Ring Levee Elevation 30.0-feet NAVD88

This measure will provide a ring levee with interior drainage, pumping stations, and roadway access up to a crest elevation of 30.0-feet NAVD88.

- Measure C – Pascagoula - Moss Point Ring Levee at Elevation 20.0-feet NAVD88

This measure includes a combination of a ring levee at 20-feet NAVD88 on an alternate footprint from measure A that would include the acquisition of structures and parcels in the Moss Point area.

- Measure D – Pascagoula - Moss Point Ring Levee Elevation 30.0-feet NAVD88

This measure includes a combination of a ring levee at 30-feet NAVD88 on an alternate footprint from measure B that would include the acquisition of structures and parcels in the Moss Point area.

- Measure E – Pascagoula - Moss Point Ring Levee at Elevation 20.0-feet NAVD88

This measure includes a combination of a ring levee at 20-feet NAVD88 on an alternate footprint from measure A that would include the acquisition of structures and parcels in the Washington Avenue area.

- Measure F – Pascagoula - Moss Point Ring Levee Elevation 30.0-feet NAVD88

This measure includes a combination of a ring levee at 30-feet NAVD88 on an alternate footprint from measure B that would include the acquisition of structures and parcels in the Washington Avenue area.

- Measure G – Pascagoula - Moss Point Ring Levee at Elevation 20.0-feet NAVD88

This measure includes a combination of a ring levee at 20-feet NAVD88 on an alternate footprint from measure A that would include the acquisition of structures and parcels in the Moss Point and Washington Avenue areas.

- Measure H – Pascagoula - Moss Point Ring Levee Elevation 30.0-feet NAVD88

This measure includes a combination of a ring levee at 30-feet NAVD88 on an alternate footprint from measure B that would include the acquisition of structures and parcels in the Moss Point and Washington Avenue areas.

- Measure I – Pascagoula - Moss Point Nonstructural One

This measure includes the acquisition and flood proofing (elevate-in-place) of structures to the FEMA advisory base flood elevation (ABFE).

- Measure J – Pascagoula - Moss Point Nonstructural Two

This measure includes the acquisition and flood proofing of structures to approximately elevation 20-feet NAVD88.

- Measure K – Pascagoula - Moss Point Nonstructural Three

This measure includes the acquisition and flood proofing of structures to approximately elevation 30-feet NAVD88.

Figure 6.12-2 shows the measures for the Pascagoula-Moss Point Area (planning sub-units 51 and 52); the red line represents the approximate footprint of the ring levees A and B, the green line represents the approximate footprints of ring levees C through H, the dark green within the ring levee footprint represents potential ABFE buyout areas and the light green area within the ring levee footprint represents potential flood proof (elevate-in-place) areas.

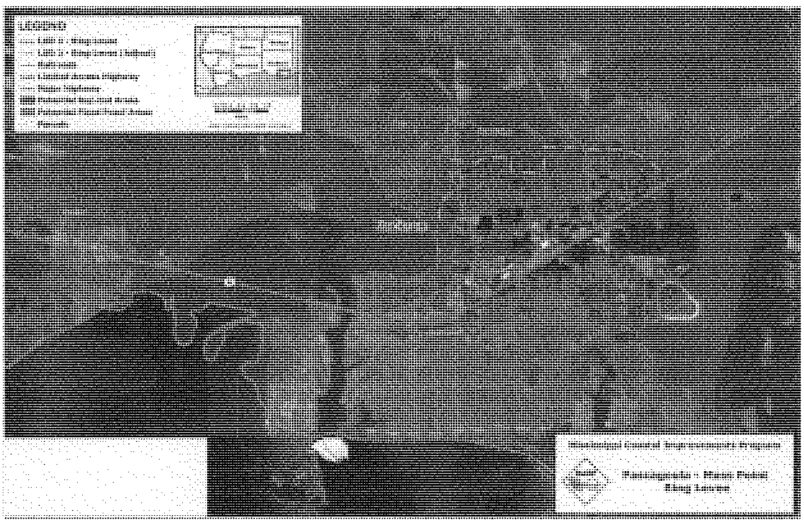


Figure 6.12-2. Display of Potential Measures for the Pascagoula-Moss Point Area (Planning Sub-units 51 and 52)

6.12.5 National Economic Development (NED)

The purpose of this section is to document investigations conducted to identify the National Economic Development (NED) benefits of each of the potential measures previously listed. For this analysis, NED benefits are the reduced inundation damages of assets and their contents when one of the potential measures is in place. Typically, NED benefits are annualized over the period of the analysis (average annual benefits) and then compared to annualized costs over the period of analysis (average annual costs). This comparison is commonly known as the benefit-to-cost ratio (BCR). For purposes of this analysis, no benefit-to-cost ratios will be calculated as per the legislative Congressional language authorizing this study. The Coastal Mississippi Comprehensive Plan Report was authorized by the Department of Defense Appropriations Act, 2006 (P.L. 109-148) 30 December 2005, which states: "...***that the Secretary shall recommend a cost-effective project, but shall not perform an incremental benefit-cost analysis to identify the recommended project, and shall not make project plan features based upon maximizing net national economic development benefits...***" More detail on the authorizing language can be found in the MsCIP Comprehensive Plan Main Report.

6.12.5.1 Existing Conditions Post-Hurricane Katrina)

The effects of Hurricane Katrina storm surge were devastating to the Pascagoula-Moss Point Area. Peak water elevation in the area ranged from 14 and 16-feet NAVD88. It is estimated that approximately 3,840 (101 in planning sub-unit 51 and 3,743 in planning sub-unit 52) of the structures in the area (sustained significant inundation damage (fifty-percent or more). Expected redevelopment of the area is described in the following section.

6.12.5.2 Future Without-Project Conditions

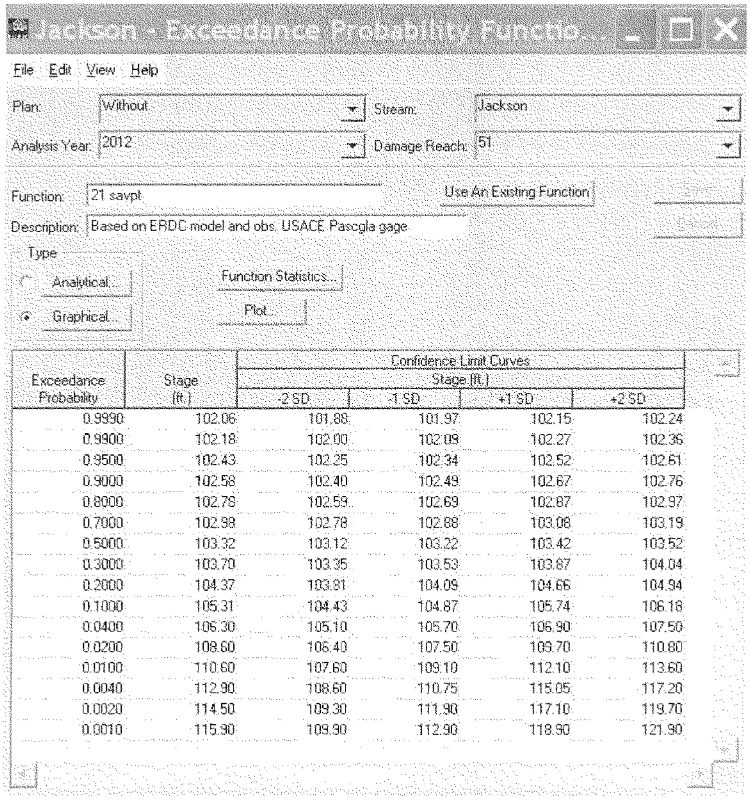
Equivalent annual flood damages for several future without-project scenarios were evaluated using the Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA) model. Each of the measures were evaluated and compared to future without-project scenarios three, and five, as previously discussed in section 5.3. These future scenarios were chosen because the redevelopment projected for this area is anticipated to return to the pre-Katrina development. Futures scenarios two, four, and six were not used for evaluation purposes since this area is not accommodative for commercial and condominium redevelopment under those mixed redevelopment scenarios (see section 5.3 for more detail).

Future scenario one is the full redevelopment of structures within the study area by the year 2012 with no relative sea level rise over the 100-year period of analysis. Table 6.12-2 shows structures by category and by elevation. The number of structures per elevation is added to the previous number of structures per elevation in each category. For example, in the residential category there are four structures with an elevation of 1-foot or lower, there are twelve structures with an elevation of 2-feet or less, etc. This future scenario, as previously noted in section 5.3, is for sensitivity purposes only and will not be evaluated against all of the potential measures for the Pascagoula-Moss Point area.

Table 6.12-2.
Cumulative Structures by Category and by Estimated First Floor Elevation
Future Scenarios One, Three, and Five
Applicable for Base Year and Most Likely Future Years

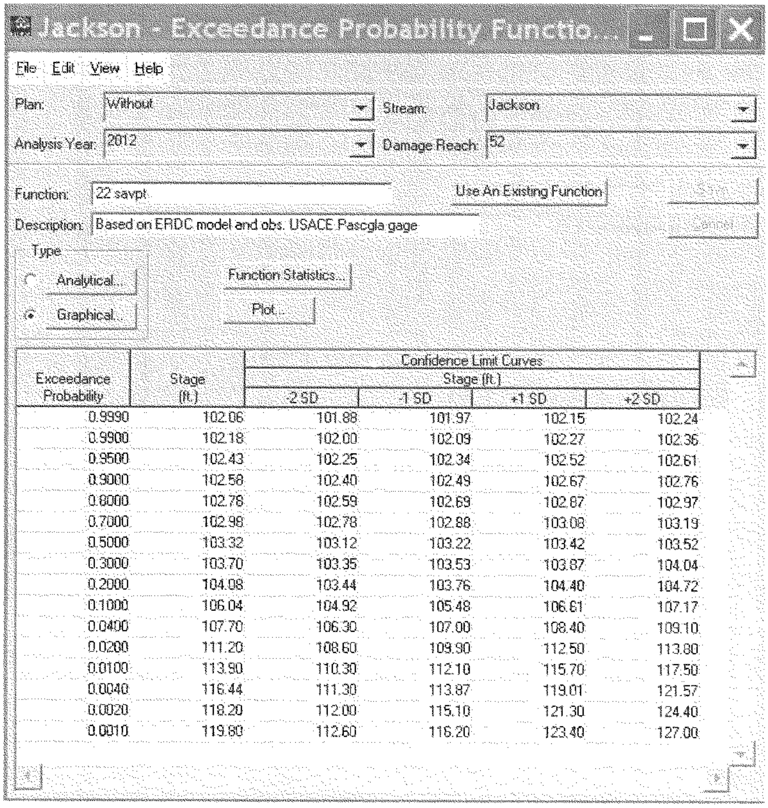
Estimated First Floor Elevation (NAVD88)	Residential	Mobile Homes	Commercial	Municipal	Total
1-foot	4	0	0	0	4
2-foot	12	0	0	0	12
3-foot	31	0	0	0	31
4-foot	62	0	0	0	62
5-foot	107	0	0	0	107
6-foot	158	0	2	1	161
7-foot	263	0	8	2	273
8-foot	435	0	16	5	456
9-foot	691	0	35	8	734
10-foot	1,002	1	50	11	1,064
11-foot	1,574	1	59	13	1,647
12-foot	2,850	2	148	32	3,032
13-foot	4,367	9	330	74	4,780
14-foot	5,344	13	597	104	6,058
15-foot	7,951	21	1,090	165	9,227
16-foot	8,367	22	1,231	174	9,794
17-foot	9,053	23	1,294	180	10,550
18-foot	10,153	23	1,384	202	11,762
19-foot	10,966	36	1,464	222	12,688
20-foot	11,346	51	1,499	231	13,127
21-foot	11529	52	1,531	237	13,349
22-foot	11,612	52	1,549	245	13,458
23-foot	11,650	52	1,557	248	13,507
24-foot	11,700	52	1,564	252	13,568
25-foot	11,749	52	1,565	256	13,622
26-foot	11,763	52	1,565	258	13,638
Total	**11,763**	**52**	**1,565**	**258**	**13,638**

Future scenario three is the full redevelopment of assets within the study area by the year 2012. Under this scenario, assets will be rebuilt as they were pre-Hurricane Katrina. For example, if the asset was a residential structure pre-Hurricane Katrina it will be rebuilt as a residential structure; commercial structures will be built back to commercial structures; etc. Basically, future scenario three is the same structure inventory as future scenario one with the addition of an expected relative sea level rise over the 100-year period of analysis (2012–2111). Equivalent annual damages that could occur under this scenario are $26,078,000 (rounded to the nearest thousand dollars). The total number of structures in this scenario are the same as in scenario one and can be seen above in table 6.12-2. Figures 6.12-3 and 6.12-4 depict the base years for planning sub-units 51 and 52 respectively, and figures 6.12-5 and 6.12-6 show the most likely future year exceedance probability functions for planning sub-units 51 and 52. The exceedance probability functions are for still water elevation (SWEL's) and based on a combination of observed data from USACE gauges and from modeling efforts conducted by the Engineer Research and Development Center (ERDC). The most likely future year exceedance probability function depicted in figure 6.12-5 ad 6.12-6 includes an adjustment for expected relative sea level rise over the 100-year period of analysis. **Note**: Due to uncertainty issues regarding the first floor elevations, a base of 100-feet was applied to the exceedance probability functions and the first floor elevations. For example, if the stage for a given event probability shows 102-feet, the stage is really 2-feet. For more detail on the estimation and use of the exceedance probability functions see the Engineering Appendix.



Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	102.06	101.88	101.97	102.15	102.24
0.9900	102.18	102.00	102.09	102.27	102.36
0.9500	102.43	102.25	102.34	102.52	102.61
0.9000	102.58	102.40	102.49	102.67	102.76
0.8000	102.78	102.59	102.69	102.87	102.97
0.7000	102.98	102.78	102.88	103.08	103.19
0.5000	103.32	103.12	103.22	103.42	103.52
0.3000	103.70	103.35	103.53	103.87	104.04
0.2000	104.37	103.81	104.09	104.66	104.94
0.1000	105.31	104.43	104.87	105.74	106.18
0.0400	106.30	105.10	105.70	106.90	107.50
0.0200	108.60	106.40	107.50	109.70	110.80
0.0100	110.60	107.60	109.10	112.10	113.60
0.0040	112.90	108.60	110.75	115.05	117.20
0.0020	114.50	109.30	111.90	117.10	119.70
0.0010	115.90	109.90	112.90	118.90	121.90

Figure 6.12-3. Future Scenario 3 Base Year (2012) Exceedance Probability Function for the Planning Sub-unit 51



Jackson - Exceedance Probability Functio...

File Edit View Help

Plan: Without | Stream: Jackson

Analysis Year: 2012 | Damage Reach: 52

Function: 22 savpt | Use An Existing Function

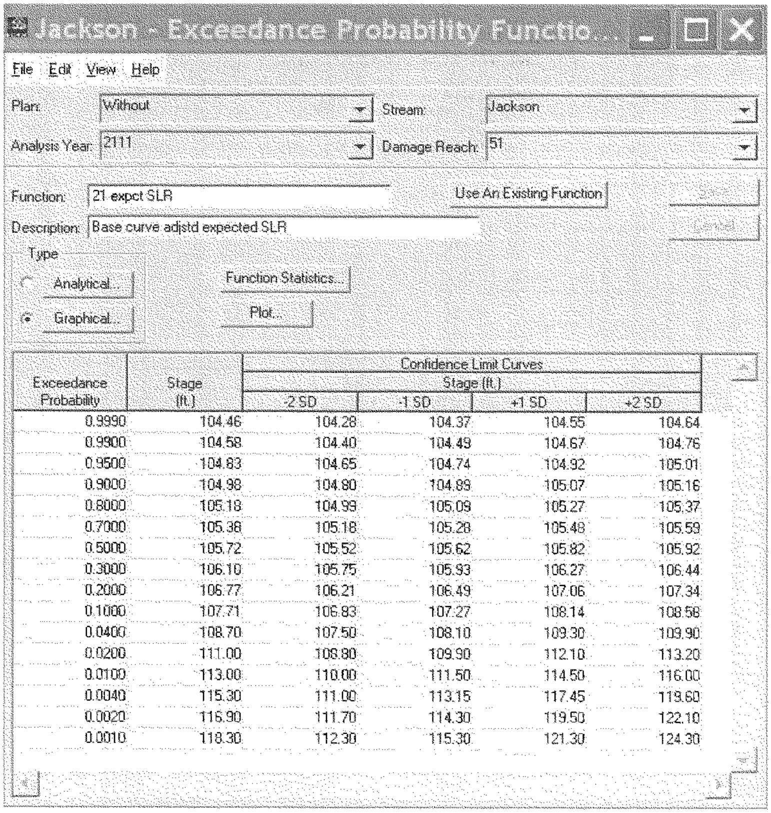
Description: Based on ERDC model and obs. USACE Pascgla gage

Type: Analytical... / Graphical...

Function Statistics... | Plot...

Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	102.06	101.88	101.97	102.15	102.24
0.9900	102.18	102.00	102.09	102.27	102.36
0.9500	102.43	102.25	102.34	102.52	102.61
0.9000	102.58	102.40	102.49	102.67	102.76
0.8000	102.78	102.59	102.69	102.87	102.97
0.7000	102.98	102.78	102.88	103.08	103.19
0.5000	103.32	103.12	103.22	103.42	103.52
0.3000	103.70	103.35	103.53	103.87	104.04
0.2000	104.08	103.44	103.76	104.40	104.72
0.1000	106.04	104.92	105.48	106.61	107.17
0.0400	107.70	106.30	107.00	108.40	109.10
0.0200	111.20	108.60	109.90	112.50	113.80
0.0100	113.90	110.30	112.10	115.70	117.50
0.0040	116.44	111.30	113.87	119.01	121.57
0.0020	118.20	112.00	115.10	121.30	124.40
0.0010	119.80	112.60	116.20	123.40	127.00

Figure 6.12-4. Future Scenario 3 Base Year (2012) Exceedance Probability Function for the Planning Sub-unit 52



Jackson - Exceedance Probability Functio...

File Edit View Help

Plan: Without | Stream: Jackson

Analysis Year: 2111 | Damage Reach: 51

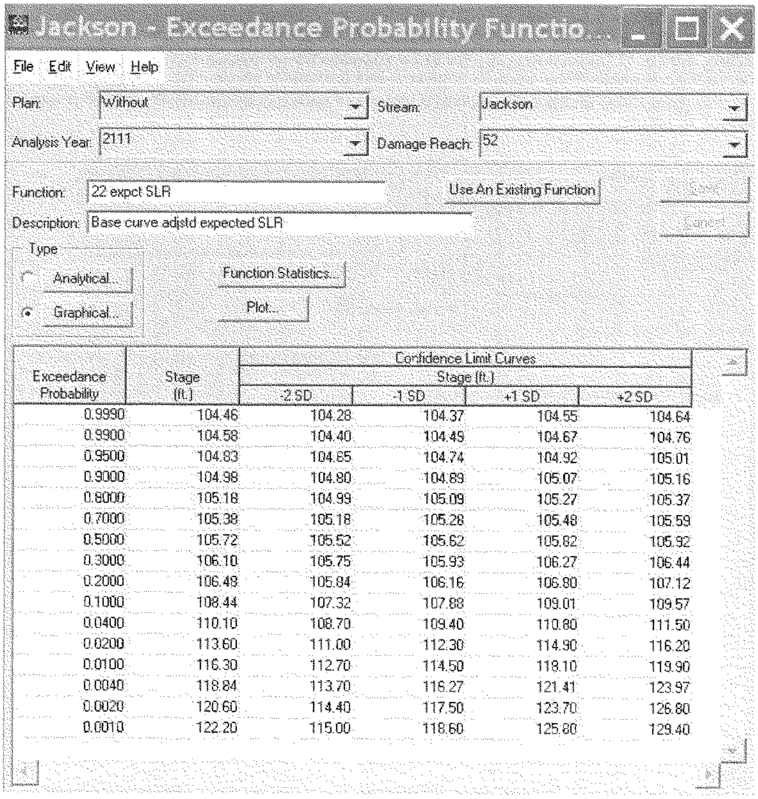
Function: 21 expct SLR | Use An Existing Function

Description: Base curve adjstd expected SLR

Type: Analytical... / Graphical... | Function Statistics... | Plot...

Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	104.46	104.28	104.37	104.55	104.64
0.9900	104.58	104.40	104.49	104.67	104.76
0.9500	104.83	104.65	104.74	104.92	105.01
0.9000	104.98	104.80	104.89	105.07	105.16
0.8000	105.18	104.99	105.09	105.27	105.37
0.7000	105.38	105.18	105.28	105.48	105.59
0.5000	105.72	105.52	105.62	105.82	105.92
0.3000	106.10	105.75	105.93	106.27	106.44
0.2000	106.77	106.21	106.49	107.06	107.34
0.1000	107.71	106.83	107.27	108.14	108.58
0.0400	108.70	107.50	108.10	109.30	109.90
0.0200	111.00	108.80	109.90	112.10	113.20
0.0100	113.00	110.00	111.50	114.50	116.00
0.0040	115.30	111.00	113.15	117.45	119.60
0.0020	116.90	111.70	114.30	119.50	122.10
0.0010	118.30	112.30	115.30	121.30	124.30

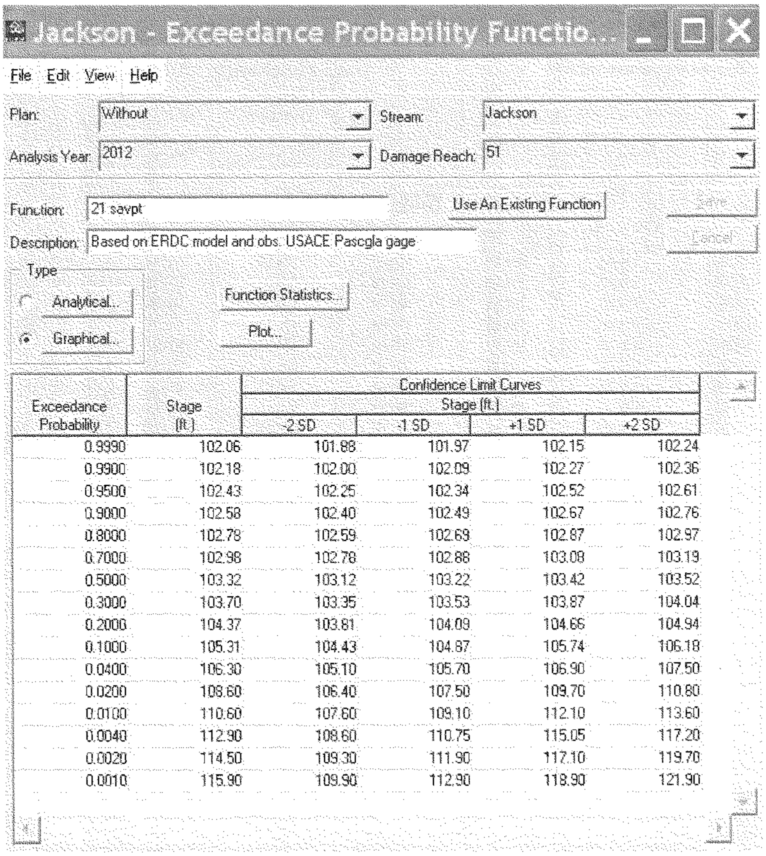
Figure 6.12-5. Future Scenario 3 Most Likely Future Year (2012) Exceedance Probability Function for the Planning Sub-unit 51 – Includes an adjustment for relative sea level rise



Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	104.46	104.28	104.37	104.55	104.64
0.9900	104.58	104.40	104.49	104.67	104.76
0.9500	104.83	104.65	104.74	104.92	105.01
0.9000	104.98	104.80	104.89	105.07	105.16
0.8000	105.18	104.99	105.09	105.27	105.37
0.7000	105.38	105.18	105.28	105.48	105.59
0.5000	105.72	105.52	105.62	105.82	105.92
0.3000	106.10	105.75	105.93	106.27	106.44
0.2000	106.48	105.84	106.16	106.80	107.12
0.1000	108.44	107.32	107.88	109.01	109.57
0.0400	110.10	108.70	109.40	110.80	111.50
0.0200	113.60	111.00	112.30	114.90	116.20
0.0100	116.30	112.70	114.50	118.10	119.90
0.0040	118.84	113.70	116.27	121.41	123.97
0.0020	120.60	114.40	117.50	123.70	126.80
0.0010	122.20	115.00	118.60	125.80	129.40

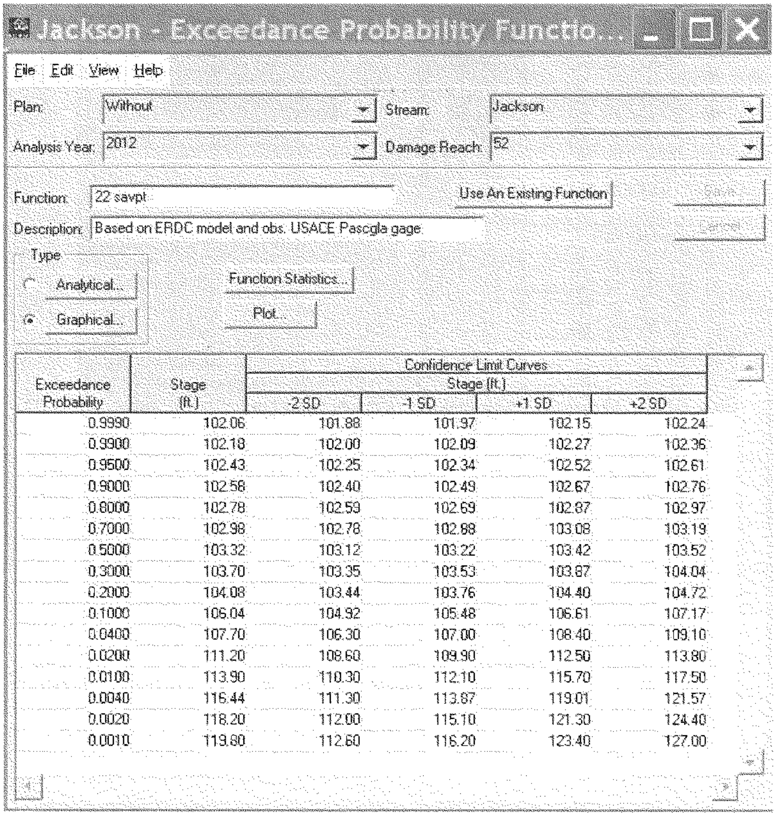
Figure 6.12-6. Future Scenario 3 Most Likely Future Year (2012) Exceedance Probability Function for the Planning Sub-unit 52 – Includes an adjustment for relative sea level rise.

Future scenario five is the same as future scenario one with the addition of a high relative sea level rise 100-year period of analysis (2012–2111). Equivalent annual damages that could occur under this scenario are $32,812,000 (rounded to the nearest thousand). These damages represent a approximately a twenty-six-percent (25.8%) increase over the expected relative sea level rise accounted for in future scenario three. The total number of structures in this scenario is the same as in scenarios one and three and can be seen above in table 6.12-2. Figures 6.12-7 and 6.12-8 depict the base year for planning sub-units 51 and 52 respectively, and figures 6.12-9 and 6.12-10 show the most likely future year exceedance probability functions for planning sub-units 51 and 52. The exceedance probability functions are for still water elevation (SWEL's) and based on a combination of observed data from USACE gauges and from modeling efforts conducted by the Engineer Research and Development Center (ERDC). The most likely future year exceedance probability function depicted in figures 6.12-9 and 6.12-10 includes an adjustment for expected relative sea level rise over the 100-year period of analysis. **Note**: Due to uncertainty issues regarding the first floor elevations, a base of 100-feet was applied to the exceedance probability functions and the first floor elevations. For example, if the stage for a given event probability shows 102-feet, the stage is really 2-feet. For more detail on the estimation and use of the exceedance probability functions see the Engineering Appendix.



Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	102.06	101.88	101.97	102.15	102.24
0.9900	102.18	102.00	102.09	102.27	102.36
0.9500	102.43	102.25	102.34	102.52	102.61
0.9000	102.58	102.40	102.49	102.67	102.76
0.8000	102.78	102.59	102.69	102.87	102.97
0.7000	102.98	102.78	102.88	103.08	103.19
0.5000	103.32	103.12	103.22	103.42	103.52
0.3000	103.70	103.35	103.53	103.87	104.04
0.2000	104.37	103.81	104.09	104.66	104.94
0.1000	105.31	104.43	104.87	105.74	106.18
0.0400	106.30	105.10	105.70	106.90	107.50
0.0200	108.60	106.40	107.50	109.70	110.80
0.0100	110.60	107.60	109.10	112.10	113.60
0.0040	112.90	108.60	110.75	115.05	117.20
0.0020	114.50	109.30	111.90	117.10	119.70
0.0010	115.90	109.90	112.90	118.90	121.90

Figure 6.12-7. Future Scenario 3 Base Year (2012) Exceedance Probability Function for the Planning Sub-unit 51



Jackson - Exceedance Probability Functio...

File Edit View Help

Plan: Without | Stream: Jackson

Analysis Year: 2012 | Damage Reach: 52

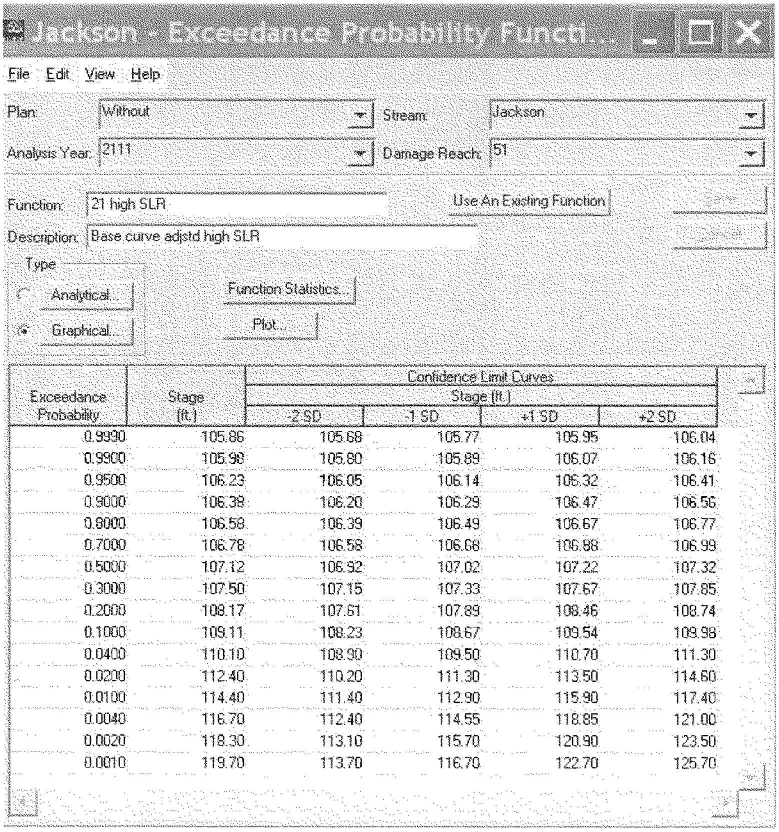
Function: 22 savpt | Use An Existing Function | Save

Description: Based on ERDC model and obs. USACE Pascgla gage | Cancel

Type: Analytical... / Graphical... | Function Statistics... | Plot...

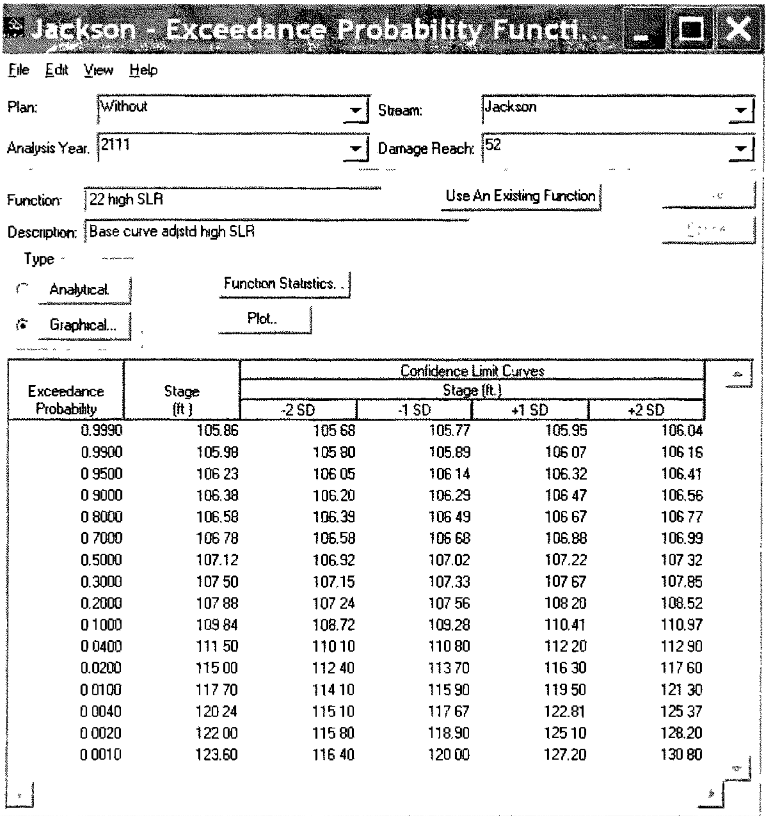
Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	102.06	101.88	101.97	102.15	102.24
0.9900	102.18	102.00	102.09	102.27	102.36
0.9500	102.43	102.25	102.34	102.52	102.61
0.9000	102.58	102.40	102.49	102.67	102.76
0.8000	102.78	102.59	102.69	102.87	102.97
0.7000	102.98	102.78	102.88	103.08	103.19
0.5000	103.32	103.12	103.22	103.42	103.52
0.3000	103.70	103.35	103.53	103.87	104.04
0.2000	104.08	103.44	103.76	104.40	104.72
0.1000	106.04	104.92	105.48	106.61	107.17
0.0400	107.70	106.30	107.00	108.40	109.10
0.0200	111.20	108.60	109.90	112.50	113.80
0.0100	113.90	110.30	112.10	115.70	117.50
0.0040	116.44	111.30	113.87	119.01	121.57
0.0020	118.20	112.00	115.10	121.30	124.40
0.0010	119.80	112.60	116.20	123.40	127.00

Figure 6.12-8. Future Scenario 3 Base Year (2012) Exceedance Probability Function for the Planning Sub-unit 52



Exceedance Probability	Stage (ft.)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	105.86	105.68	105.77	105.95	106.04
0.9900	105.98	105.80	105.89	106.07	106.16
0.9500	106.23	106.05	106.14	106.32	106.41
0.9000	106.38	106.20	106.29	106.47	106.56
0.8000	106.58	106.39	106.49	106.67	106.77
0.7000	106.78	106.58	106.68	106.88	106.99
0.5000	107.12	106.92	107.02	107.22	107.32
0.3000	107.50	107.15	107.33	107.67	107.85
0.2000	108.17	107.61	107.89	108.46	108.74
0.1000	109.11	108.23	108.67	109.54	109.98
0.0400	110.10	108.90	109.50	110.70	111.30
0.0200	112.40	110.20	111.30	113.50	114.60
0.0100	114.40	111.40	112.90	115.90	117.40
0.0040	116.70	112.40	114.55	118.85	121.00
0.0020	118.30	113.10	115.70	120.90	123.50
0.0010	119.70	113.70	116.70	122.70	125.70

Figure 6.12-9. Future Scenario 5 Most Likely Future Year (2012) Exceedance Probability Function for the Planning Sub-unit 51 – Includes an adjustment for high relative sea level rise



Exceedance Probability	Stage (ft)	Confidence Limit Curves Stage (ft.) -2 SD	-1 SD	+1 SD	+2 SD
0.9990	105.86	105.68	105.77	105.95	106.04
0.9900	105.98	105.80	105.89	106.07	106.16
0.9500	106.23	106.05	106.14	106.32	106.41
0.9000	106.38	106.20	106.29	106.47	106.56
0.8000	106.58	106.39	106.49	106.67	106.77
0.7000	106.78	106.58	106.68	106.88	106.99
0.5000	107.12	106.92	107.02	107.22	107.32
0.3000	107.50	107.15	107.33	107.67	107.85
0.2000	107.88	107.24	107.56	108.20	108.52
0.1000	109.84	108.72	109.28	110.41	110.97
0.0400	111.50	110.10	110.80	112.20	112.90
0.0200	115.00	112.40	113.70	116.30	117.60
0.0100	117.70	114.10	115.90	119.50	121.30
0.0040	120.24	115.10	117.67	122.81	125.37
0.0020	122.00	115.80	118.90	125.10	128.20
0.0010	123.60	116.40	120.00	127.20	130.80

Figure 6.12-10. Future Scenario 5 Most Likely Future Year (2012) Exceedance Probability Function for the Planning Sub-unit 52 – Includes an adjustment for high relative sea level rise

6.12.5.3 Equivalent annual damages Reduced

Equivalent annual damages reduced are calculated as the difference between the damages under the future without-project scenarios three and five and the damages incurred with the measure in place. The HECFDA model was run for each measure to determine the damages reduced as compared to the without-project scenario.

In order to provide the HEC-FDA model with accurate information about the economic characteristics of each measure, separate inventories were created for each measure. The inventories are the same as the without project inventory except that footprints of levees and acquisitions were deleted from the inventory and flood proofed structures (structures to be raised in place) were given a higher elevation. The structure inventories for each of the HEC-FDA measure runs are as follows:

- Measure A – Pascagoula - Moss Point Ring Levee A at elevation 20.0-feet NAVD88

This measure includes the without-project inventory less 589 parcels that were deleted out of the inventory. These parcels represent the footprint of the 20.0-feet NAVD88 elevation ring levee and some portion of the total would have to be purchased for its implementation. At this level of analysis, it is assumed that all of the structures identified to be touched in any way by the ring levee would be purchased; therefore all were deleted from the without-project structure inventory. Some of the parcels are wetland impacts and are discussed below in the Environmental Quality section.

- Measure B – Pascagoula - Moss Point Ring Levee B at elevation 30.0-feet NAVD88

This measure includes the without-project inventory less 666 parcels that were deleted out of the inventory. These parcels represent the footprint of the 30.0-feet NAVD88 elevation ring levee and some portion of the total would have to be purchased for its implementation. At this level of analysis, it is assumed that all of the structures identified to be touched in any way by the ring levee would be purchased; therefore all were deleted from the without-project structure inventory. Some of the parcels are wetland impacts and are discussed below in the Environmental Quality section.

- Measure C – Pascagoula - Moss Point Ring Levee at Elevation 20.0-feet NAVD88

This measure includes a combination of a ring levee at 20-feet NAVD88 on an alternate footprint from measure A that would include the acquisition of structures and parcels in the Moss Point area.

- Measure D – Pascagoula - Moss Point Ring Levee Elevation 30.0-feet NAVD88

This measure includes a combination of a ring levee at 30-feet NAVD88 on an alternate footprint from measure B that would include the acquisition of structures and parcels in the Moss Point area.

- Measure E – Pascagoula - Moss Point Ring Levee at Elevation 20.0-feet NAVD88

This measure includes a combination of a ring levee at 20-feet NAVD88 on an alternate footprint from measure A that would include the acquisition of structures and parcels in the Washington Avenue area.

- Measure F – Pascagoula - Moss Point Ring Levee Elevation 30.0-feet NAVD88

This measure includes a combination of a ring levee at 30-feet NAVD88 on an alternate footprint from measure B that would include the acquisition of structures and parcels in the Washington Avenue area.

- Measure G – Pascagoula - Moss Point Ring Levee at Elevation 20.0-feet NAVD88

This measure includes a combination of a ring levee at 20-feet NAVD88 on an alternate footprint from measure A that would include the acquisition of structures and parcels in the Moss Point and Washington Avenue areas.

- Measure H – Pascagoula - Moss Point Ring Levee Elevation 30.0-feet NAVD88

This measure includes a combination of a ring levee at 30-feet NAVD88 on an alternate footprint from measure B that would include the acquisition of structures and parcels in the Moss Point and Washington Avenue areas.

- Measure I – Pascagoula - Moss Point Nonstructural One

This measure includes the acquisition of 145 (0 in planning sub-unit 51 and 145 in planning sub-unit 52) parcels that include a structure and the flood proofing (raise structure in place) of 7,603 (781 in planning sub-unit 51 and 6,822 in planning sub-unit 52) structures to an elevation of 12.0-feet NAVD88 for planning sub-unit 51 and 14.95-feet for planning sub-unit 52. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was determined to be approximately the 100-year level of protection and is defined as still water elevation, plus wave run-up plus an estimate for waves (depth divided by two), and is the minimum elevation that a nonstructural plan could provide.

- Measure J – Pascagoula - Moss Point Nonstructural Two to elevation 20.0-feet NAVD88

This measure includes the acquisition of 2,333 (718 in planning sub-unit 51 and 1,615 in planning sub-unit 52) parcels that include a structure and the flood proofing (raise structure in place) of 5,427 (64 in planning sub-unit 51 and 5,363 in planning sub-unit 52) structures to an elevation of 20.0-feet NAVD88. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was chosen to show a direct comparison to the ring levees at elevation 20.0-feet NAVD88.

- Measure K – Pascagoula - Moss Point Nonstructural Three to elevation 30.0-feet NAVD88

This measure includes the acquisition of 7,760 (782 in planning sub-unit 51 and 6,978 in planning sub-unit 52) parcels that include a structure to an elevation of 30.0-feet NAVD88. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and is detailed in the Nonstructural Appendix. This elevation was chosen to show a direct comparison to the ring levees at elevation 30.0-feet NAVD88.

Residual damage is the equivalent annual damages that still remain even when a project is in place. Residual damage is calculated as the future without-project equivalent annual damages minus the damages reduced of the various measures. The purpose of residual damage is to calculate and communicate the portions of damages that will not be reduced by the implementation of a plan or "what damages are left on the table." Table 6.12-3 summarizes the equivalent annual without-project damages, damages reduced, and residual damages by measure and by future scenario.

Table 6.12-3.
Summary of Damages by Measure

Measures	Equivalent annual damages Future 3 ($)	Equivalent Annual Damage Reduction Future 3 ($)	Residual Damage Future 3 ($)	Equivalent annual damages Future 5 ($)	Equivalent Annual Damage Reduction Future 5 ($)	Residual Damage Future 5 ($)
(No Action)	$0	$0	$0	$0	$0	$0
Measure A 20FT Ring Levee A	$26,078,000	$24,244,000	$1,834,000	$32,812,000	$30,616,000	$2,196,000
Measure B 30FT Ring Levee B	$26,078,000	$26,078,000	$0	$32,812,000	$32,733,000	$79,000
Measure C 20FT Ring Levee C	$26,078,000	$24,901,000	$1,177,000	$32,812,000	$29,504,000	$3,308,000
Measure D 30FT Ring Levee D	$26,078,000	$26,078,000	$0	$32,812,000	$31,212,000	$1,600,000
Measure E 20FT Ring Levee E	$26,078,000	$24,910,000	$1,168,000	$32,812,000	$29,518,000	$3,294,000
Measure F 30FT Ring Levee F	$26,078,000	$26,078,000	$0	$32,812,000	$31,211,000	$1,601,000
Measure G 20FT Ring Levee G	$26,078,000	$24,933,000	$1,145,000	$32,812,000	$29,545,000	$3,267,000
Measure H 30FT Ring Levee H	$26,078,000	$26,078,000	$0	$32,812,000	$31,212,000	$1,600,000
Measure I ABFE Nonstructural	$26,078,000	$17,199,000	$8,879,000	$32,812,000	$21,629,000	$11,183,000
Measure J 20FT Nonstructural	$26,078,000	$24,349,000	$1,729,000	$32,812,000	$28,815,000	$3,997,000
Measure K 30FT Nonstructural	$26,078,000	$25,454,000	$624,000	$32,812,000	$30,115,000	$2,697,000

Damages are rounded to the nearest thousand dollars.

6.12.6 Environmental Quality (EQ)

6.12.6.1 Impacts of Ring Levee Measures

The Engineering Research and Development Center Wetlands and Coastal Ecology Branch were asked to conduct an assessment of potential impacts to wetlands as a result of constructing various levees and seawalls along the Mississippi Gulf Coastal Plain. This report summarizes the results of the assessment. The analysis of impacts included two components:

1. A calculation of total acreage of all wetlands (by type and planning reach) that is directly under the levee footprints.

2. A modified Hydrogeomorphic (HGM) wetland rapid assessment of impacted Estuarine/Tidal Fringe wetlands, based on the Mississippi and Alabama Gulf Coast HGM guidebook (Shafer et al., 2007), with impacts reported as loss of functional units. Tables 6.12-4 and 6.12-5 show the impacts of the Pascagoula/Moss Point ring levees at elevations 20.0-feet NAVD88, and 30.0-feet NAVD88 respectively.

Table 6.12-4.
Wetland Acres Impacted by Elevation 20' Pascagoula/Moss Point Ring Levee A

Reach ID	Estuarine and Marine Deepwater	Estuarine and Marine Wetland	Freshwater Emergent Wetland	Freshwater Forested/Shrub Wetland	Freshwater Pond	Total
51	0.5	2.8	0.1	3.2	0.5	7.0
52	0.0	2.4	0.0	14.3	0.1	16.8
53	0.3	3.2	0.0	3.8	0.0	7.2
54	0.6	5.2	0.5	19.6	0.1	25.9
Total	**1.4**	**13.6**	**0.5**	**40.8**	**0.7**	**57.0**

Table 6.12-5.
Wetland Acres Impacted by Elevation 30' Pascagoula/Moss Point Ring Levee B

Reach ID	Estuarine and Marine Deepwater	Estuarine and Marine Wetland	Freshwater Emergent Wetland	Freshwater Forested/Shrub Wetland	Freshwater Pond	Total
51	0.5	3.5	0.1	4.8	0.8	9.7
52	0.0	3.2	0.0	22.7	0.1	26.0
53	1.5	4.8	0.0	5.8	0.0	12.1
54	1.2	7.9	0.6	26.3	0.2	36.2
Total	**3.2**	**19.3**	**0.7**	**59.7**	**1.1**	**84.1**

Nonstructural measures would have no construction activities other than demolition and disposal of building materials in an approved land fill occurs as a result of this measure. More detail on the impacts of the structural and nonstructural measures for the Pascagoula-Moss Point area can be found in the Environmental Appendix.

6.12.7 Summary of Costs

Table 6.12-6 summarizes the ROM costs by measure for the Pascagoula-Moss Point area.

Table 6.12-6.
Summary of Costs by Measure for the Pascagoula-Moss Point Area

Measures	Implement Costs (FY-08) ($)	Average Annual Implementation Cost ($)	Average Annual O&M ($)	IDC ($)	Total Average Annual Costs ($)
(No Action)	$0	$0	$0	$0	$0
Measure A 20FT Ring Levee A	$699,000,000	$34,371,000	$5,719,000	N/A	$40,090,000
Measure B 30FT Ring Levee B	$916,000,000	$45,041,000	$8,309,000	N/A	$53,350,000
Measure C 20FT Ring Levee C	$671,600,000	$33,023,000	$4,658,000	N/A	$37,681,000
Measure D 30FT Ring Levee D	$849,900,000	$41,791,000	$6,707,000	N/A	$48,498,000
Measure E 20FT Ring Levee E	$874,400,000	$42,995,000	$3,761,000	N/A	$46,756,000
Measure F 30FT Ring Levee F	$1,013,200,000	$49,820,000	$5,423,000	N/A	$55,243,000
Measure G 20FT Ring Levee G	$921,400,000	$45,306,000	$3,537,000	N/A	$48,843,000
Measure H 30FT Ring Levee H	$1,057,700,000	$52,008,000	$5,197,000	N/A	$57,205,000
Measure I ABFE Nonstructural	$2,272,975,000	$111,765,000	$20,000	N/A	$111,785,000
Measure J 20FT Nonstructural	$5,105,777,000	$251,057,000	$20,000	N/A	$251,077,000
Measure K 30FT Nonstructural	$5,105,777,000	$251,057,000	$20,000	N/A	$251,077,000

The implementation costs include 1/ supervision and administration (30 account), 2/ planning, engineering & design (31 account) and 3/ appropriate contingencies. See the Cost Appendix for more detail on the implementation cost breakdowns. Numbers are rounded to the nearest thousand

6.12.8 Regional Economic Development (RED)

The purpose of this analysis is to determine the economic impact of the proposed project measures on business (sale volumes), income, employment, and population of the local area. Each of the measures would affect the local area of Jackson County, Mississippi. The expenditures, shown in Table 6.12-6, for the measures are estimated to be $699,000,000 for the 20.0-feet ring levee A measure, $916,000,000 for the 30.0-feet ring levee B measure, $671,600,000 for the 20.0-feet NAVD88 ring levee C measure, $849,900,000 for the 30.0-feet NAVD88 ring levee D measure, $874,400,000 for the 20.0-feet NAVD88 ring levee E measure, $1,013,200,000 for the 30.0-feet NAVD88 ring levee F measure, $921,400,000 for the 20.0-feet NAVD88 ring levee G measure, $1,057,700,000 for the 30.0-feet NAVD88 ring levee H measure, $2,272,975,000 for the ABFE nonstructural measure, $5,105,777,000 for the 20.0-feet NAVD88 nonstructural measure, and $5,105,777,000 for the 30.0-feet NAVD88 nonstructural measure. Moreover, the total present worth of the operation and maintenance (O&M) expenditures are estimated to be $116,308,000 for the 20.0-feet NAVD88 ring levee A measure, $168,981,000 for the 30.0-feet NAVD88 ring levee B measure, $94,730,000 for the 20.0-feet NAVD88 ring levee C measure, $136,401,000 for the 30.0-feet NAVD88 ring levee D measure, $76,488,000 for the 20.0-feet NAVD88 ring levee E measure, $110,288,000 for the 30.0-feet NAVD88 ring levee F measure, $71,932,000 for the 20.0-feet NAVD88 ring levee G measure, $105,692,000 for the 30.0-feet NAVD88 ring levee H measure $406,000 for the ABFE nonstructural measure, $406,000 for the 20.0-feet NAVD88 nonstructural measure, and $406,000 for the 30.0-feet NAVD88 nonstructural measure respectively (assuming a 100- year period of analysis and an interest rate of 4.875-percent). The following tables, 6.12-7 through 6.12-14, summarize the EIFS model inputs and outputs for the Pascagoula-Moss Point Area measures.

Table 6.12-7.
EIFS Model Implementation Cost Inputs for the Pascagoula/Moss Point Area

	20-foot Ring Levee A	30-foot Ring Levee B	20-foot Ring Levee C	30-foot Ring Levee D	20-foot Ring Levee E	30-foot Ring Levee F
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$699,000,000	$916,000,000	$671,600,000	$849,900,000	$874,400,000	$1,013,200,000

Table 6.12-8.
EIFS Model Implementation Cost Inputs for the Pascagoula/Moss Point Area

	20-foot Ring Levee G	30-foot Ring Levee H	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$921,400,000	$1,057,700,000	$2,272,975,000	$5,105,777,000	$5,105,777,000

Based of the given implementation cost inputs the outputs are as follows:

Table 6.12-9.
EIFS Model Implementation Cost Outputs for the Pascagoula/Moss Point Area

	20-foot Ring Levee A	30-foot Ring Levee B	20-foot Ring Levee C	30-foot Ring Levee D	20-foot Ring Levee E	30-foot Ring Levee F
Direct Sales Volume	$699,000,000	$916,000,000	$671,600,000	$849,900,000	$874,400,000	$1,013,200,000
Induced Sales Volume	$782,880,000	$1,025,920,000	$752,192,000	$951,888,000	$979,328,000	$1,134,784,000
Total Sales Volume	$1,481,880,000	$1,941,920,000	$1,423,792,000	$1,801,788,000	$1,853,728,000	$2,147,984,000
Direct Income	$136,322,866	$178,643,413	$130,979,166	$165,752,223	$170,530,350	$197,599,897
Induced Income	$152,681,591	$200,080,598	$146,696,648	$185,642,467	$190,993,968	$221,311,858
Total Income	$289,004,458	$378,724,011	$277,675,814	$351,394,691	$361,524,318	$418,911,755
Direct Employment	3,956	5,185	3,801	4,810	4,949	5,735
Induced Employment	4,432	5,807	4,258	5,388	5,544	6,424
Total Employment	8,388	10,992	8,059	10,199	10,493	12,158
Local Population	0	0	0	0	0	0

Table 6.12-10.
EIFS Model Implementation Cost Outputs for the Pascagoula/Moss Point Area

	20-foot Ring Levee G	30-foot Ring Levee H	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Direct Sales Volume	$921,400,000	$1,057,700,000	$2,272,975,000	$5,105,777,000	$5,105,777,000
Induced Sales Volume	$1,031,968,000	$1,184,624,000	$2,545,732,000	$5,718,470,240	$5,718,470,240
Total Sales Volume	$1,953,368,000	$2,242,324,000	$4,818,707,000	$10,824,247,240	$10,824,247,240
Direct Income	$179,696,551	$206,278,535	$443,288,222	$995,757,019	$995,757,019
Induced Income	$201,260,112	$231,031,930	$496,482,747	$1,115,247,722	$1,115,247,722
Total Income	$380,956,663	$437,310,465	$939,770,969	$2,111,004,741	$2,111,004,741
Direct Employment	5,215	5,987	12,865	28,899	28,899
Induced Employment	5,842	6,706	14,411	32,371	32,371
Total Employment	11,057	12,692	27,276	61,269	61,269
Local Population	0	0	0	0	0

Table 6.12-11.
EIFS Model Operation and Maintenance Cost Inputs for the Pascagoula/Moss Point Area

	20-foot Ring Levee A	30-foot Ring Levee B	20-foot Ring Levee C	30-foot Ring Levee D	20-foot Ring Levee E	30-foot Ring Levee F
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$116,308,000	$168,981,000	$94,730,000	$136,401,000	$76,488,000	$110,288,000

Table 6.12-12.
EIFS Model Operation and Maintenance Cost Inputs for the Pascagoula/Moss Point Area

	20-foot Ring Levee G	30-foot Ring Levee H	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$71,932,000	$105,692,000	$407,000	$407,000	$407,000

Based of the given implementation cost inputs the outputs are as follows:

Table 6.12-13.
EIFS Model Operation and Maintenance Cost Outputs for the Pascagoula/Moss Point Area

	20-foot Ring Levee A	30-foot Ring Levee B	20-foot Ring Levee C	30-foot Ring Levee D	20-foot Ring Levee E	30-foot Ring Levee F
Direct Sales Volume	$116,308,000	$168,981,000	$94,730,000	$136,401,000	$76,488,000	$110,288,000
Induced Sales Volume	$130,264,960	$189,258,720	$106,097,600	$152,769,120	$85,666,560	$123,522,560
Total Sales Volume	$246,572,960	$358,239,720	$200,827,600	$289,170,120	$162,154,560	$233,810,560
Direct Income	$22,683,033	$32,955,614	$18,474,771	$26,601,681	$14,917,115	$21,508,979
Induced Income	$25,404,994	$36,910,283	$20,691,741	$29,793,879	$16,707,167	$24,090,053
Total Income	$48,088,026	$69,865,897	$39,166,513	$56,395,561	$31,624,282	$45,599,032
Direct Employment	658	956	536	772	433	624
Induced Employment	737	1,071	601	865	485	699
Total Employment	1,396	2,028	1,137	1,637	918	1,323
Local Population	0	0	0	0	0	0

Table 6.12-14.
EIFS Model Operation and Maintenance Cost Outputs for the Pascagoula/Moss Point Area

	20-foot Ring Levee G	30-foot Ring Levee H	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural
Direct Sales Volume	$71,932,000	$105,692,000	$407,000	$407,000	$407,000
Induced Sales Volume	$80,563,840	$118,375,040	$455,840	$455,840	$455,840
Total Sales Volume	$152,495,840	$224,067,040	$862,840	$862,840	$862,840
Direct Income	$14,028,579	$20,612,641	$79,375	$79,375	$79,375
Induced Income	$15,712,006	$23,086,156	$88,900	$88,900	$88,900
Total Income	$29,740,585	$43,698,797	$168,276	$168,276	$168,276
Direct Employment	407	598	2	2	2
Induced Employment	456	670	3	3	3
Total Employment	863	1,268	5	5	5
Local Population	0	0	0	0	0

6.13 Evaluation of Bayou Cumbest Area Ecosystem Restoration Measures

This Section describes the evaluation of measures for the Bayou Cumbest area. Bayou Cumbest is approximately 373 acres in planning unit three, planning sub-unit fifty-three just west of the Mississippi and Alabama state line. This area experienced water elevations between 16.0 and 18.0 ft. NAVD88 from Hurricane Katrina storm surge. Figure 6.13-1 shows the location of the Bayou Cumbest area.

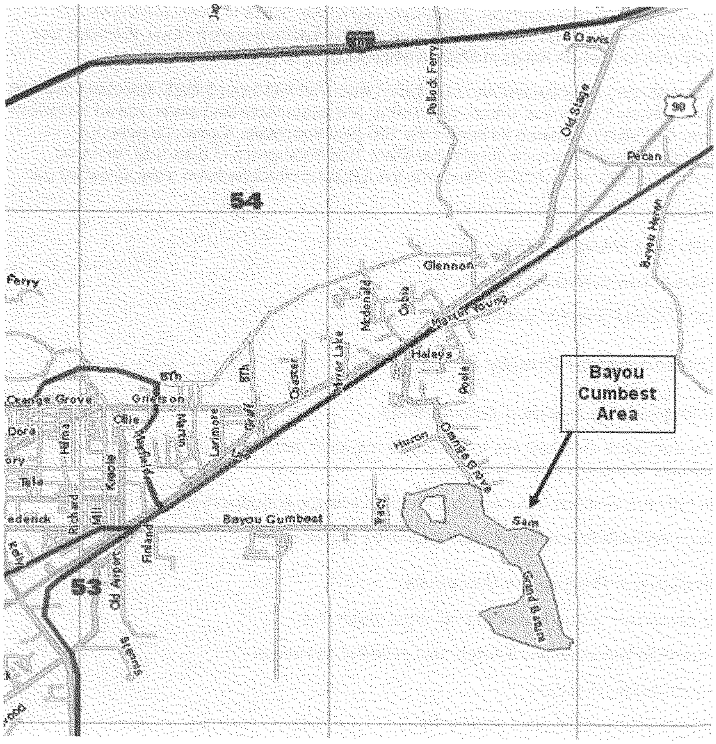


Figure 6.13-1 Bayou Cumbest Area, Planning Unit Three, Planning Sub-Unit fifty-three

This area was specifically identified for its ecosystem restoration potential using a Spatial Decision Support System (SDSS) tool, which was developed for the MsCIP Comprehensive Plan by the Engineer Research and Development Center (ERDC). The development of the GIS based SDSS tool allowed the Corps, Mobile District, working in cooperation with the USFWS and MDMR, to identify and prioritize potential wetland restoration areas throughout Coastal Mississippi. A subset of potential restoration sites were identified by the SDSS tool and then ground-truthed by the MsCIP environmental team, including ERDC, Corps, MDMR, and USFWS. This interagency team allowed us to both confirm the accuracy of the SDSS results and to collect additional on-site information pertinent to restoration efforts.

There are some major benefits in using a GIS-based SDSS approach to wetland restoration. First, it allows for the relatively rapid assessment of the large number of restoration sites across the wide study area. Second, potential sites can be evaluated and restored in a watershed or landscape context, which allows us to comprehensively evaluate the overall natural system. This approach can maximize the benefits of wetland restoration, as opposed to simply restoring wetlands where convenient or where property is available. Essentially use of this SDSS tool allowed the MsCIP environmental team to assess the entire coastline as a holistic natural system; thus, the team was more effectively able to analyze needs in Coastal Mississippi.

The SDSS tool evaluated potential wetland restoration sites that had been initially selected based on having a non-natural land cover (i.e. urban, deforested, and agricultural land cover, based on MDMR 2001 land cover GIS layer) and were located in the 100-year floodplain. Numerous potential environmental restorations sites were initially identified. This initial group of sites was narrowed down based on the results of the SDSS. Sites with the following characteristics were screened out:

- < 5 acres in size
- Restorability class of Low or Medium Low
- Habitat class of Low or Medium Low
- Storm Surge/Flood Protection class of Low

6.13.1 Environmental Quality (EQ)

6.13.1.1 Ecosystem Restoration Assumptions

- In order for the Bayou Cumbest site to undergo ecosystem restoration, it is assumed that there will be buy-outs of properties within the area.
- A 50-year period of analysis was used to determine average annual outputs and costs.
- Construction implementation time is estimated to be twelve months.

6.13.1.2 Ecosystem Restoration Objectives

The following ecosystem restoration objectives were developed:

- Restore marsh to historical (pre-development ~1950's) conditions
- Provide storm surge protection
- Restore native tidal wetland plant community
- Provide fish and tidal wildlife habitat

6.13.1.3 Ecosystem Restoration Management Measures

Proposed restoration management measures are listed in table 6.13-1. Narrative descriptions of each management measure follow this table.

Table 6.13-1.
Ecosystem Restoration Management Measures

Management Measure	Description
No Action	No Action
1	Excavate Old Fill Material
2	Remove Exotic Species
3	Fill Existing Artificial Ditches
4	Plant Native Vegetation
a	- 0.5 meter spacing
b	- 1.0 meter spacing
c	- 2.0 meter spacing

6.13.1.4 Excavate Old Fill Material (1)

This management measure must be included in all measures for the restoration to be successful. It includes 90-95 percent removal of existing exotic species in the excavated areas. This measure positively affects the hydrologic regime.

6.13.1.5 Remove Exotic Species from Non-Excavated Areas and Maintenance of Exotics in All Areas over the Project Life (2)

This management measure must be included in all measures for the restoration to be successful. It includes 100 percent removal of exotic species from non-excavated areas over the life of the project. The exotic species include Chinese Tallow, Phragmites, and Cogon Grass. This measure affects the percentage of the area covered by exotic species.

6.13.1.6 Fill Existing Artificial Ditches and Channels (3)

This management measure does not need to be included in all measures for the restoration to be successful. It includes 100 percent removal of existing artificial ditches and channels. This measure provides additional positive affects to the hydrologic regime.

6.13.1.7 Plant Native Vegetation (4)

This management measure must be included in all measures for the restoration to be successful. There are three different planting density options: (a) 0.5 meters spacing, (b) 1.0 meter spacing, and (c) 2.0 meter spacing. Planting emergent tidal marsh at varying densities will result in obtaining desired environmental output at varying years and costs. It is estimated that 2 re-planting efforts would be required for the two least dense plantings: 1.0 and 2.0 meter spacing. It is estimated that the 0.5 meter spacing will achieve full benefits in about 5 years while the 1.0 meter spacing and 2.0 meter spacing will achieve full benefits in about 7 and 10 years, respectively.

This measure affects the percent cover by woody plant species, wildlife habitat diversity, vegetation height, wetland indicator status and the mean percent cover emergent plant species.

6.13.1.8 Ecosystem Restoration Measures

These management measures were combined to create six measures. Each measure includes the mandatory management measures of excavating old fill material, removing exotic plant species from non-excavated areas, and planting native vegetation. Since there are three different planting densities, three measures are created with this combination of management measures. When the management measure of filling existing artificial ditches is added to this combination, this creates another three measures.

All measures will restore 110 acres to tidal marsh. Measure 1 consists of restoring the study area by excavating old fill material, removing exotic plant species from non-excavated areas, filling existing artificial ditches, and planting native vegetation such as Spartina alterniflora (Smooth Cordgrass) at the seaward edge of marsh; Juncus roemerianus (Black Needle Rush) at a slightly higher elevation; and Spartina patens (Saltmeadow Cordgrass) at a slightly higher elevation at a density of 0.5 meter. Measure 2 consists of restoring the study area by excavating old fill material, removing exotic plant species from non-excavated areas, filling existing artificial ditches, and planting native vegetation at a density of 1.0 meter. Measure 3 consists of restoring the study area by excavating old fill material, removing exotic plant species from non-excavated areas, filling existing artificial ditches, and planting native vegetation at a density of 2.0 meter. Measure 4 consists of restoring the study area by excavating old fill material, removing exotic plant species from non-excavated areas, and planting native vegetation at a density of 0.5 meters. Measure 5 consists of restoring the study area by excavating old fill material, removing exotic plant species from non-excavated areas and planting native vegetation at a density of 1.0 meter. Measure 6 consists of restoring the study area by excavating old fill material, removing exotic plant species from non-excavated areas and planting native vegetation at a density of 2.0 meters. Figure 6.13-2 shows the location of the Bayou Cumbest restoration site. Table 6.13-2 displays a description of each ecosystem restoration measure.

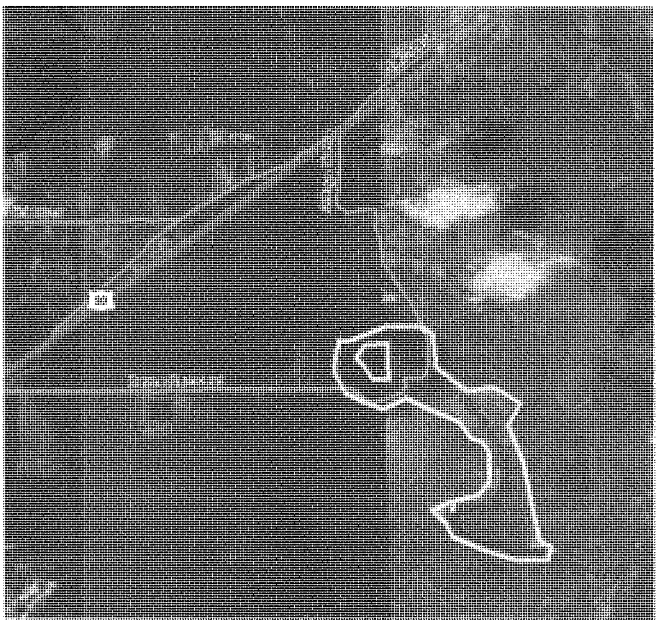


Figure 6.13-2 Bayou Cumbest restoration site

Table 6.13-2.
Ecosystem Restoration Measures

Measure	Management Measure	Description
0	No Action	No Action
1	1 + 2 + 3+ 4a	Excavate Fill Remove Exotics Fill Ditches Plant at Density 0.5m
2	1 + 2 + 3 + 4b	Excavate Fill Remove Exotics Fill Ditches Plant at Density 1.0m
3	1 + 2 + 3 + 4c	Excavate Fill Remove Exotics Fill Ditches Plant at Density 2.0m
4	1 + 2 + 4a	Excavate Fill Remove Exotics Plant at Density 0.5m
5	1 + 2 +4b	Excavate Fill Remove Exotics Plant at Density 1.0m
6	1 + 2 + 4c	Excavate Fill Remove Exotics Plant at Density 2.0m

6.13.3.9 Ecosystem Restoration Benefits and Costs

Benefits are measured in terms of Average Annual Functional Units (AAFU). The Hydrogeomorphic (HGM) approach was used to assess wetland function. A HGM assessment was performed in 2000 using the Regional Guidebook for Applying the HGM Approach to Assessing Wetland Functions of Wet Pine Flats on Mineral Soils in the Atlantic and Gulf Coastal Plains. Results from this assessment were used to establish baseline (current) conditions and, ultimately, to measure the functional unit benefits resulting from different restoration measures. Table 6.13-3 shows the total functional units under each measure and the AAFU net benefit. It is assumed that functional units will remain the same under existing conditions and the no action measure. To calculate the AAFU net benefit, it is assumed all benefits are immediately accrued following measure implementation, and that the benefits are sustainable over the life of the project. Therefore, the AAFU net benefit was calculated as the difference between the total functional units for the ecosystem restoration measure and the total functional units for the no action measure. Table 6.13-4 summarizes the ROM costs at an FY-08 price level Bayou Cumbest ecosystem restoration measures.

Table 6.13-3.
Summary of Benefits

Measure	Measure Description	AAFU Units Benefits
No Action	No Action	0
Measure 1	Excavate Fill Remove Exotics Fill Ditches Plant at Density 0.5m	191
Measure 2	Excavate Fill Remove Exotics Fill Ditches Plant at Density 1.0m	188
Measure 3	Excavate Fill Remove Exotics Fill Ditches Plant at Density 2.0m	184
Measure 4	Excavate Fill Remove Exotics Plant at Density 0.5m	172
Measure 5	Excavate Fill Remove Exotics Plant at Density 1.0m	169
Measure 6	Excavate Fill Remove Exotics Plant at Density 2.0m	164

Table 6.13-4.
Summary of Costs by Measure for Bayou Cumbest

Measure	Measure Description	Implementation Cost (FY-08)	IDC	Investment Cost	AAIC[1]	AAO&M[2]	AAC[3]
0	No Action	$0	$0	$0	$0	$0	$0
1	Excavate Fill Remove Exotics Fill Ditches Plant at Density 0.5m	$28,000,000	$620,000	$28,600,000	$1,538,000	$2,000	$1,540,000
2	Excavate Fill Remove Exotics Fill Ditches Plant at Density 1.0m	$23,350,000	$520,000	$23,870,000	$1,282,000	$114,000	$1,396,000
3	Excavate Fill Remove Exotics Fill Ditches Plant at Density 2.0m	$21,030,000	$470,000	$21,500,000	$1,155,000	$112,000	$1,267,000
4	Excavate Fill Remove Exotics Plant at Density 0.5m	$27,990,000	$620,000	$28,610,000	$1,537,000	$2,000	$1,539,000
5	Excavate Fill Remove Exotics Plant at Density 1.0m	$23,340,000	$520,000	$23,860,000	$1,282,000	$114,000	$1,396,000
6	Excavate Fill Remove Exotics Plant at Density 2.0m	$21,020,000	$470,000	$21,480,000	$1,154,000	$112,000	$1,266,000

Note: Numbers are rounded to the nearest thousand.
1.Average Annual Investment Cost
2.Average Annual Operations and Maintenance Cost
3.Average Annual Cost (total)

6.13.3.10 Comparison of Measures

Table 6.13-5 display all measures with their respective AAC and AAFU in increasing order of AAFU.

Table 6.13-5.
All Measures: Average Annual Costs and Average Annual Functional Units

Measure	AAC	AAFU
No Action	$0	0
6	$1,266,000	164
5	$1,396,000	169
4	$1,539,000	172
3	$1,267,000	184
2	$1,396,000	188
1	$1,540,000	191

Note: The AAC values are rounded to the nearest thousand.

To determine if a measure is cost effective, economically inefficient measures must first be identified and eliminated. An economically inefficient measure is a measure that cost more for the same level of benefit. No measures are eliminated for the reason of economic inefficiency because each measure produces a different level of benefit.

Lastly, economically ineffective measures are identified and eliminated to determine which measures are cost effective. An economically ineffective measure is a measure that cost more or the same as a subsequent measure but produces less benefit than that subsequent measure. As shaded in table 6.13-6, the measures 4 and 5 were eliminated because they produced less benefit at greater cost than a subsequent measure. For example, Measure 4 produces 172 AAFU at an AAC of $1,539,000 while Measure 3 produces 184 AAFU at an AAC $1,267,000. Measure 4 produces less AAFU at a greater cost than Measure 3. Therefore, Measure 4 is eliminated. As shown in table 6.13-7 and plotted in figure 6.13-3, the cost effective measures are Measure 1, Measure 2, Measure 3, and Measure 6.

Table 6.13-6.
Elimination of Economically Ineffective Measures

Measure	Measure Description	AAC	AAFUs	Cost Effective?
No Action	No Action	$0	0	Yes
6	Excavate Fill Remove Exotics Plant at Density 2.0m	$1,266,000	164	Yes
5	Excavate Fill Remove Exotics Plant at Density 1.0m	$1,396,000	169	No
4	Excavate Fill Remove Exotics Plant at Density 0.5m	$1,539,000	172	No
3	Excavate Fill Remove Exotics Fill Ditches Plant at Density 2.0m	$1,267,000	184	Yes
2	Excavate Fill Remove Exotics Fill Ditches Plant at Density 1.0m	$1,396,000	188	Yes
1	Excavate Fill Remove Exotics Fill Ditches Plant at Density 0.5m	$1,540,000	191	Yes

Note: The AAC values are rounded to the nearest thousand.

Table 6.13-7.
Cost Effective Measures for Bayou Cumbest

Measure	Measure Description	AAC	AAFUs	Cost Effective?
No Action	No Action	$0	0	Yes
6	Excavate Fill Remove Exotics Plant at Density 2.0m	$1,266,000	164	Yes
3	Excavate Fill Remove Exotics Fill Ditches Plant at Density 2.0m	$1,267,000	184	Yes
2	Excavate Fill Remove Exotics Fill Ditches Plant at Density 1.0m	$1,396,000	188	Yes
1	Excavate Fill Remove Exotics Fill Ditches Plant at Density 0.5m	$1,540,000	191	Yes

Note: The AAC values are rounded to the nearest thousand.

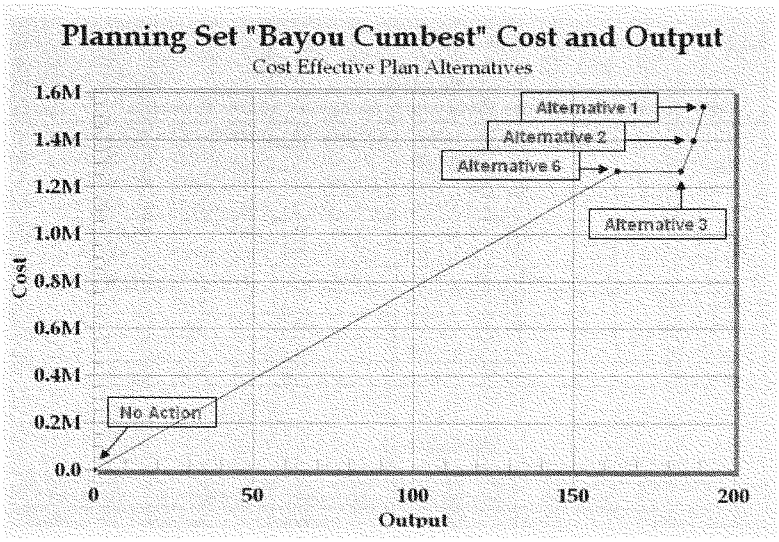


Figure 6.13-3 Cost Effective Measures for Bayou Cumbest Area

6.13.4 Regional Economic Development (RED)

The purpose of this section is to show the economic impact of the proposed project alternatives on business (sales volumes), income, employment, and population of the local area. Each of the alternatives would affect the local area of Jackson County, Mississippi. The expenditures for the alternatives are estimated to be $28,000,000 for Alternative 1, $23,400,000 for the Alternative 2, $21,000,000 for Alternative 3, and $21,000,000 for Alternative 6. Moreover, the present worth of the operation and maintenance (O&M) expenditures are estimated to be $43,000 for Alternative 1, $2,106,000 for Alternative 2, $2,071,000 for Alternative 3, and $2,071,000 for Alternative 6, (assuming a 50 year period of analysis and an interest rate of 4.875 percent). The following tables, 6.13-8 through 6.13-11 summarize the EIFS model inputs and outputs for the cost effective measures.

Table 6.13-8.
EIFS Model Implementation Cost Inputs for Bayou Cumbest Ecosystem

	No Action	Alternative 1	Alternative 2	Alternative 3	Alternative 6
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$0	$28,000,000	$23,400,000	$21,000,000	$21,000,000

Based of the given inputs the outputs are as follows:

Table 6.13-9.
EIFS Model Implementation Cost Outputs for Bayou Cumbest Ecosystem

	No Action	Alternative 1	Alternative 2	Alternative 3	Alternative 6
Direct Sales Volume	$0	$28,000,000	$23,400,000	$21,000,000	$21,000,000
Induced Sales Volume	$0	$31,360,000	$26,208,000	$23,520,000	$23,520,000
Total Sales Volume	$0	$59,360,000	$49,608,000	$44,520,000	$44,520,000
Direct Income	$0	$5,460,716	$4,563,598	$4,095,537	$4,095,537
Induced Income	$0	$6,116,001	$5,111,229	$4,587,001	$4,587,001
Total Income	$0	$11,576,716	$9,674,827	$8,682,537	$8,682,537
Direct Employment	0	158	132	119	119
Induced Employment	0	178	148	133	133
Total Employment	0	336	281	252	252
Local Population	0	0	0	0	0

Table 6.13-10.
EIFS Model O&M Cost Inputs for Bayou Cumbest Ecosystem

	No Action	Alternative 1	Alternative 2	Alternative 3	Alternative 6
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$0	$43,000	$2,106,000	$2,071,000	$2,071,000

Based of the given inputs the outputs are as followed:

Table 6.13-11.
EIFS Model O&M Cost Outputs for Bayou Cumbest Ecosystem

	No Action	Alternative 1	Alternative 2	Alternative 3	Alternative 6
Direct Sales Volume	$0	$43,000	$2,106,000	$2,071,000	$2,071,000
Induced Sales Volume	$0	$48,160	$2,358,720	$2,319,520	$2,319,520
Total Sales Volume	$0	$91,160	$4,464,720	$4,390,520	$4,390,520
Direct Income	$0	$8,386	$410,724	$403,898	$403,898
Induced Income	$0	$9,392	$460,011	$452,366	$452,366
Total Income	$0	$17,779	$870,734	$856,264	$856,264
Direct Employment	0	0	12	12	12
Induced Employment	0	0	13	13	13
Total Employment	0	0	25	25	25
Local Population	0	0	0	0	0

6.14 Dantzler Area Ecosystem Restoration Measures

This section describes the evaluation of ecosystem restoration measures at the Dantzler area that is located within planning sub-unit 53, which is part of planning unit three. The total area includes 385 acres of state owned land. This area was selected for ecosystem restoration using the Decision Support System, a GIS based model created by the Corps' Engineer Research and Development Center (ERDC). For more details on the selection process for ecosystem restoration sites see the Economic Appendix. Figure 6.14-1 shows the location of the Dantzler area.

6.14.1 Formulation of Measures

6.14.1.1 Assumptions

In order for the Dantzler site to undergo ecosystem restoration, it is assumed that all property and rights of way are owned by the State of Mississippi. Costs and benefits are based on a 50-year period of analysis and an FY-08 discount rate of 4.875-percent.

6.14.1.2 Objectives

The following objectives were developed for ecosystem restoration:

- Restore native wetland plant communities
- Restore natural fire regime
- Restore natural hydrology
- Restore fish and wildlife habitat
- Provide storm surge protection

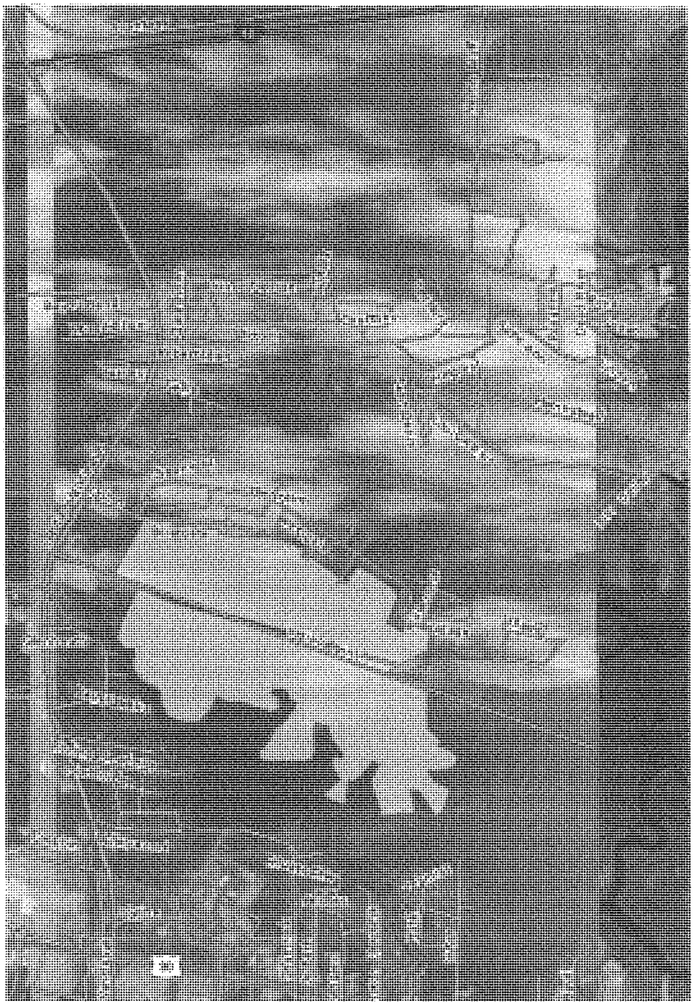


Figure 6.14-1. Location of the Dantzler Ecosystem Restoration Area

6.14.1.3 Ecosystem Restoration Management Measures

Proposed restoration management measures are listed in table 6.14-1. Narrative descriptions of each management measure follow this table.

Table 6.14-1.
Ecosystem Restoration Management Measures

Management Measure	Description
No Action	No Action
1	Maintain Native Savannah Vegetation
a	*By Burning Every 3Years*
b	*By Mowing Annually*
2	Remove Exotics and Plantation Pine
3	Fill Artificial Ditches

6.14.1.3.1 Maintain Native Savannah Vegetation (1)

This management measure must be included in all measures for the restoration to be successful. There are two methods that will be analyzed for maintaining vegetation: (a) burning and (b) mowing. Fire benefits this ecosystem in many different ways. It creates a bare seedbed for pine seedlings and other fire dependent plants, reduces fuel loads and recycles nutrients. Periodic burning promotes early successional plants that are important to many species of wildlife indigenous to this ecosystem. Many of the plant species found in this ecosystem are fire dependent; for example, the federally endangered American Chaff seed flowers almost exclusively after a fire. It has been reduced to a fraction of its original range due to fire suppression and habitat destruction. Fire suppression is mainly due to liability issues and fear of litigation.

Mowing is a mechanical alternative that many land managers use to maintain early successional habitats. Although it is successful to some extent, it fails to provide all the necessary components that come from prescribed fire. This method also has a negative effect. Mowing requires the use of heavy equipment in sensitive areas. Tractors can create ruts in saturated soils, creating hydrologic problems and micro site conditions. Mowing can also introduce non-native species through the use of contaminated equipment. Another disadvantage of mowing is that the duff or litter layer remains on the ground, preventing seeds from reaching the bare ground needed for germination. This thick litter layer can also provide heavy fuel loads increasing the risk of wildfires during dry periods. Although mowing provides some level of habitat management in pine savannahs, it is not a substitute for prescribed fire. Mowing can maintain succession, but may inhibit other functions of the system.

6.14.1.3.2 Removal of Exotics and Plantation Pines (2)

This management measure must be included in all measures for the restoration to be successful. This measure positively affects the percent cover by invasive or exotic species.

6.14.1.3.3 Fill Ditches (3)

This management measure must be included in all measures for the restoration to be successful. This measure positively affects the outflow of water. It measures the removal of water by ditches or drains.

6.14.1.3.4 Ecosystem Restoration Measures

These management measures were combined to create six measures. Each measure requires burning and mowing the project area in the initial year on construction and maintaining native savanna vegetation by either burning every three years or mowing every year, removing all exotics and plantation pine and maintaining their elimination over the project life, and filling all artificial ditches. The difference between each measure includes the number of acres restored and the method of maintaining vegetation over the life of the project.

Measures 1 and 2 consist of restoring the project areas north and south of the road: 385 acres. Measure 1 maintains vegetation by burning once every three years. Measure 2 maintains vegetation by mowing every year. Measures 3 and 4 consist of restoring only the project area north of the road: 151 acres. Measure 3 maintains vegetation by burning once every three years. Measure 4 maintains vegetation by mowing every year. Measures 5 and 6 consist of restoring only the project area south of the railroad: 234 acres. Measure 5 maintains vegetation by burning once every three years. Measure 6 maintains vegetation by mowing every year. Table 6.14-2 displays a description of each ecosystem restoration measure. Figure 6.14-2 shows the Dantzler restoration site.

Table 6.14-2.
Ecosystem Restoration Measures

Measure	Management Measures	Measure Description
0	No Action	No Action
1	1a + 2 +3	385 Acre Restoration Maintain by Burning
2	1b + 2 + 3	385 Acre Restoration Maintain by Mowing
3	1a + 2 +3	151 Acre Restoration Maintain by Burning
4	1b + 2 + 3	151 Acre Restoration Maintain by Mowing
5	1a + 2 +3	234 Acre Restoration Maintain by Burning
6	1b + 2 + 3	234 Acre Restoration Maintain by Mowing

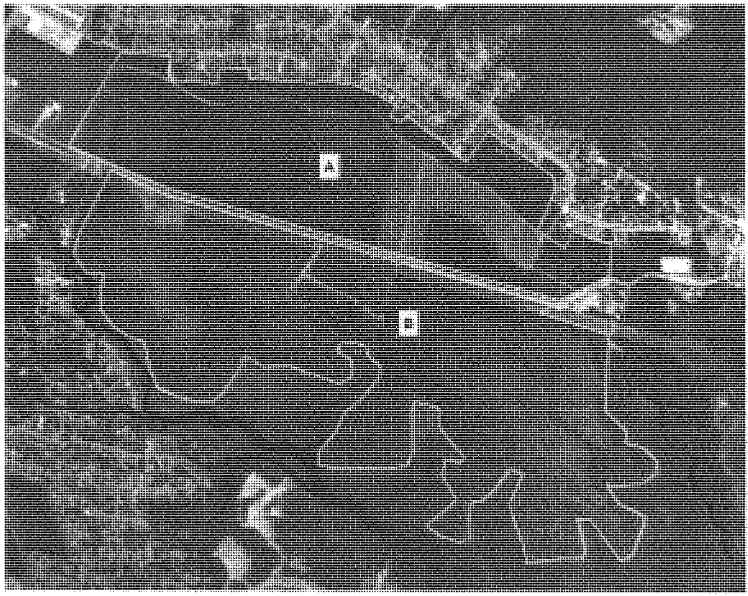


Figure 6.14-2. Dantzler Restoration Site

6.14.1.4 Benefits

In order to restore this area to a Wet Pine Savannah habitat, the higher areas will be designated as Wet Pine Savannah. These areas have depression areas within them which will enable water to flow down to the depression areas; thus, holding water. The Wet Pine Savannah habitat will be restored with Wet Pine Flatwoods, such as Pinus elliotti, Morella cerifera, Llex glabra, Spartina patens and Panicum virgatum.

Many species of wildlife are indigenous to the Wet Pine Savannah habitat. Understory plant communities may contain wiregrass, sedges, orchids, American Chaff seed and rough-leaved loosestrife. Insectivorous plants that may be found include pitcher plants, bladderworts, venus flytrap, and sundews. Rare, threatened or endangered birds that may occur in these areas include Henslowe's sparrow, Bachman's sparrow, red-cockaded woodpecker, and Mississippi Sandhill Crane. This ecosystem may also benefit the Mississippi Gopher frog and in drier areas along ridges, the black pine snake and the gopher tortoise.

Benefits are measured in terms of Average Annual Functional Units (AAFU). The Hydrogeomorphic (HGM) approach was used to assess wetland function. A HGM assessment was performed in 2000 using the Regional Guidebook for Applying the HGM Approach to Assessing Wetland Functions of Wet Pine Flats on Mineral Soils in the Atlantic and Gulf Coastal Plains. Results from this assessment were used to establish baseline (current) conditions and, ultimately, to measure the functional unit benefits resulting from different restoration measures. Table 6.14-3 shows the AAFU net benefit under each measure. The AAFU net benefit was calculated as the difference between the total functional units for the ecosystem restoration measure and the total functional units for the no action measure.

Table 6.14-3.
Summary of Benefits

Measure	Measure Description	AAFU Net Benefit
No Action	No Action	0
Measure 1	385 Acre Restoration Maintain by Burning	1,244
Measure 2	385 Acre Restoration Maintain by Mowing	943
Measure 3	151 Acre Restoration Maintain by Burning	488
Measure 4	151 Acre Restoration Maintain by Mowing	370
Measure 5	234 Acre Restoration Maintain by Burning	756
Measure 6	234 Acre Restoration Maintain by Mowing	573

6.14.1.5 Costs

A rough order magnitude (ROM) cost estimate was developed for the 385, 151, and 234 acres of restoration. It included the cost of filling ditches with 65,560, 30,560, and 36,000 cubic yards of material for $798,720, $366,720, and $432,000, respectively; burning 385, 151, and 234 acres of vegetation for $57,750, $22,650, and $35,100, respectively; mowing 385, 151, and 234 acres for $32,725, $12,835, and $19,890, respectively; removing roads and utilities for $275,000, $121,000, and $154,000; mobilizing and demobilizing for $40,000, $20,000, and $20,000, respectively; and miscellaneous site items for $90,000, $45,000, and $45,000, respectively. Total construction costs for the 385, 151, and 234 acres of restoration equaled $1,294,195, $588,205, and $882,488. A contingency cost of 25 percent and lands and damages costs of $25,000 were added to the construction cost. Then, Planning, Engineering and Design (PED) costs of 8 percent and a Construction Management cost of 6 percent were added for a total first cost of construction of $1,881,000, $870,000, and $1,039,000.

For each measure, these first costs of construction are presented in Table 6.14-4 at October 2007 price levels along with the Interest During Construction (IDC), investment cost (first cost plus IDC), Average Annual Investment Cost (AAIC), Average Annual Operations and Maintenance (AAO&M) cost and, ultimately, the Average Annual Costs (AAC).

Investment cost, O&M cost and AAC for Measure 1 are $1,922,000, $1,328,000, and $129,000, respectively. The investment cost, O&M cost and AAC for Measure 2 are $1,922,000, $2,303,000, and $150,000, respectively. The investment cost, O&M cost and AAC for Measure 3 are $889,000, $528,000, and $58,000, respectively. The investment cost, O&M cost and AAC for Measure 4 are $889,000, $931,000, and $67,000, respectively. The investment cost, O&M cost and AAC for Measure 5 are $1,039,000, $816,000, and $73,000, respectively. The investment cost, O&M cost and AAC for Measure 6 are $1,039,000, $1,421,000, and $86,000, respectively.

Table 6.14-4.
Summary of Costs by Measure for Dantzler Area

Measure	Measure Description	Implementation Cost (FY-08)	IDC	Investment Cost	AAIC	AAO&M	AAC
0	No Action	$0	$0	$0	$0	$0	$0
1	879 Acre Restoration Maintain by Burning	$1,880,000	$41,000	$1,922,000	$103,000	$26,000	$129,000
2	879 Acre Restoration Maintain by Mowing	$1,880,000	$41,000	$1,922,000	$103,000	$47,000	$150,000
3	689 Acre Restoration Maintain by Burning	$870,000	$19,000	$889,000	$48,000	$10,000	$58,000
4	689 Acre Restoration Maintain by Mowing	$870,000	$19,000	$889,000	$48,000	$19,000	$67,000
5	190 Acre Restoration Maintain by Burning	$1,040,000	$23,000	$1,062,000	$57,000	$16,000	$73,000
6	190 Acre Restoration Maintain by Mowing	$1,040,000	$23,000	$1,062,000	$57,000	$29,000	$86,000

Note: Numbers are rounded to the nearest thousand dollars.

First cost of construction is used along with the duration of 12 months of construction and a discount rate of 4.875 percent to calculate Interest During Construction (IDC). The sum of the first cost of construction and IDC cost equals the investment cost. This cost is amortized at the FY 2007 federal discount rate of 4.875 percent over a 50-year economic period of analysis to calculate the Average Annual Investment Cost (AAIC). Average Annual O&M (AAO&M) costs for burning once every three years or mowing every year were present valued and amortized at an interest rate of 4.875 percent over a 50-year economic period of analysis. The sum of the AAIC and AAO&M cost equals the Average Annual Costs (AAC).

6.14.2 Comparison of Measures

Table 6.14-5 displays all measures with their respective AAC and AAFU.

Table 6.14-5.
All Measures: AAC and AAFU

Measure	AAC	AAFU
No Action	$0	0
1	$129,000	1,244
2	$150,000	943
3	$20,000	488
4	$29,000	370
5	$60,000	756
6	$73,000	573

Note: The AAC values are rounded to the nearest thousand dollars.

In order to determine the cost effectiveness of each measure, the list of measures is reordered so that they are listed in increasing order of their outputs (AAFU). This list is shown in Table 6.14-6.

Table 6.14-6.
All Measures Arrayed by Increasing Output

Measure	AAC	AAFU
No Action	$0	0
4	$29,000	370
3	$20,000	488
6	$73,000	573
5	$60,000	756
2	$150,000	943
1	$129,000	1,244

Note: The AAC values are rounded to the nearest thousand dollars.

To determine if a measure is cost effective, economically inefficient measures must first be identified and eliminated. An economically inefficient measure is a measure that cost more for the same level of benefit. No measures are eliminated for the reason of economic inefficiency because each measure produces a different level of benefit.

Lastly, economically ineffective measures are identified and eliminated to determine which measures are cost effective. An economically ineffective measure is a measure that cost more or the same as a subsequent measure but produces less benefit than that subsequent measure. As shown in Table 6.14-7, the three shaded measures, 2, 4, and 6 were eliminated because they produced less benefit at greater cost than a subsequent measure. For example, Measure 4 produces 370 AAFU at an AAC of $29,000 while Measure 3 produces 488 AAFU at an AAC $20,000. Measure 4 produces less AAFU at a greater cost than Measure 3. Therefore, Measure 4 is eliminated. As shown in table 6.14-8 and plotted in figure 6.14-3, the cost effective measures are Measure 1 (385 acres of restoration maintained by burning), Measure 3 (151 acres of restoration maintained by burning) and Measure 5 (234 acres of restoration maintained by burning).

Table 6.14-7.
Elimination of Economically Ineffective Measures

Measure	Measure Description	AAC	AAFUs	Cost Effective?
No Action	No Action	$0	0	Yes
4	151 Acre Restoration Maintain by Mowing	$29,000	370	No
3	151 Acre Restoration Maintain by Burning	$20,000	488	Yes
6	234 Acre Restoration Maintain by Mowing	$73,000	573	No
5	234 Acre Restoration Maintain by Burning	$60,000	756	Yes
2	385 Acre Restoration Maintain by Mowing	$150,000	943	No
1	385 Acre Restoration Maintain by Burning	$129,000	1,244	Yes

Note. The AAC values are rounded to the nearest thousand dollars.

Table 6.14-8.
Cost Effective Measures for Dantzler Area

Measure	Measure Description	AAC	AAFUs	Cost Effective?
No Action	No Action	$0	0	Yes
3	151 Acre Restoration Maintain by Burning	$20,000	488	Yes
5	234 Acre Restoration Maintain by Burning	$60,000	756	Yes
1	385 Acre Restoration Maintain by Burning	$129,000	1,244	Yes

Note: The AAC values are rounded to the nearest thousand dollars.

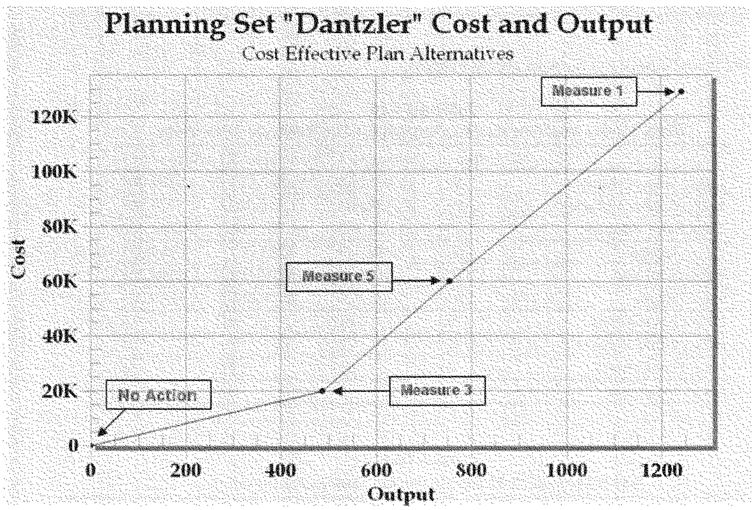


Figure 6.14-3. Display of Cost Effective Alternatives for the Dantzler Area

6.14.3 Regional Economic Development (RED) Benefits

6.14.3.1 Socioeconomic Impacts using the Economic Impact Forecast System

The purpose of this section is to show the economic impact of the cost effective alternatives on business (sale volumes), income, employment, and population of the local area. Each of the alternatives would affect the local area of Jackson County, Mississippi. The expenditures for the alternatives are estimated to be $1,900,000 for Alternative 1, $1,040,000 for Alternative 3, $870,000 for Alternative 5. Moreover, the total present worth of the operation and maintenance (O&M) expenditures are estimated to be $484,000 for Alternative 1, $186,000 for Alternative 3, and

$298,000 for Alternative 5 (assuming a 50 year period of analysis and an interest rate of 4.875 percent).

6.14.4 Summary Explanation of the EIFS Model Output

The outputs shown in this section are based on the following input from the proposed project alternatives. EIFS model inputs and outputs are shown in tables 6.14-9 through 6.14-12. The inputs are as follows:

Table 6.14-9.
EIFS Model Implementation Inputs for the Dantzler Ecosystem

	No Action	Alternative 1	Alternative 3	Alternative 5
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$0	$1,900,000	$1,040,000	$870,000

Based of the given inputs the outputs are as follows:

Table 6.14-10.
EIFS Model Implementation Outputs for the Dantzler Ecosystem

	No Action	Alternative 1	Alternative 3	Alternative 5
Direct Sales Volume	$0	$1,900,000	$1,040,000	$870,000
Induced Sales Volume	$0	$2,128,000	$1,164,800	$974,400
Total Sales Volume	$0	$4,028,000	$2,204,800	$1,844,400
Direct Income	$0	$370,549	$202,827	$169,672
Induced Income	$0	$415,014	$227,166	$190,033
Total Income	$0	$785,563	$429,992	$359,705
Direct Employment	0	11	6	5
Induced Employment	0	12	7	6
Total Employment	0	23	12	10
Local Population	0	0	0	0

Table 6.14-11.
EIFS Model O&M Inputs for the Dantzler Ecosystem

	No Action	Alternative 1	Alternative 3	Alternative 5
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$0	$484,000	$186,000	$298,000

Based of the given inputs the outputs are as follows:

Table 6.14-12.
EIFS Model O&M Outputs for the Dantzler Ecosystem

	No Action	Alternative 1	Alternative 3	Alternative 5
Direct Sales Volume	$0	$484,000	$186,000	$298,000
Induced Sales Volume	$0	$542,080	$208,320	$333,760
Total Sales Volume	$0	$1,026,080	$394,320	$631,760
Direct Income	$0	$94,392	$36,275	$58,118
Induced Income	$0	$105,719	$40,628	$65,092
Total Income	$0	$200,112	$76,902	$123,209
Direct Employment	0	3	1	2
Induced Employment	0	3	1	2
Total Employment	0	6	2	4
Local Population	0	0	0	0

6.15 Franklin Ecosystem Restoration Measures

This section describes the evaluation of ecosystem restoration measures at the Franklin Creek area that is located within planning sub-unit 53, which is part of planning unit three. The total area includes 149 acres of land that was acquired during the interim phase of the MsCIP. This area was selected for ecosystem restoration using the Decision Support System, a GIS based model created by the Corps' Engineer Research and Development Center (ERDC). For more details on the selection process for ecosystem restoration sites see the Economic Appendix. Figure 6.15-1 shows the location of the Franklin Creek area.

6.15.1 Formulation of Alternatives

6.15.1.1 Assumptions

In order for the Franklin Creek site to undergo ecosystem restoration, it is assumed that all of the property is being acquired under the Mississippi Coastal Improvements Program Interim Projects.

6.15.1.2 Objectives

The following objectives were developed for ecosystem restoration:

- Restore native vegetation
- Restore natural fire regime
- Restore natural hydrology
- Restore fish and wildlife habitat
- Provide storm water storage protection

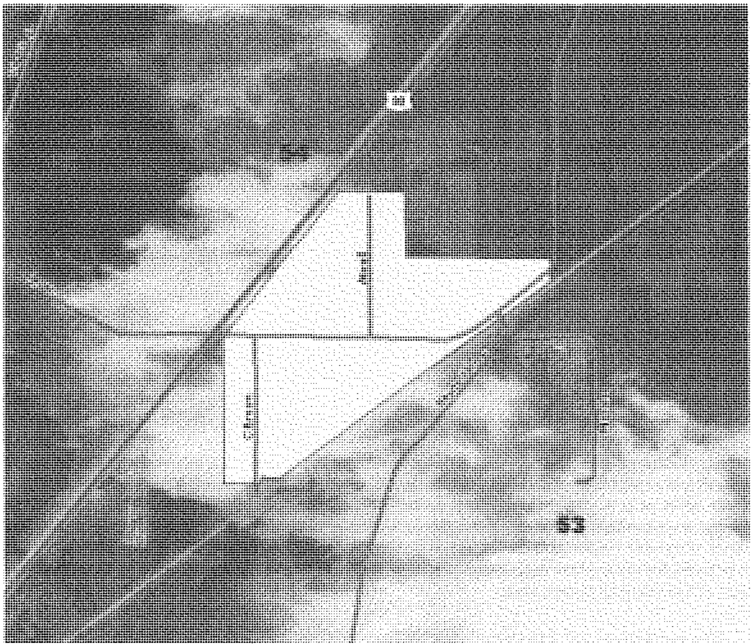


Figure 6.15-1. Franklin Creek Restoration Area.

6.15.1.3 Ecosystem Restoration Management Measures

Proposed restoration management measures are listed in table 6.15-1. Narrative descriptions of each management measure follow this table.

Table 6.15-1
Ecosystem Restoration Management Measures

Management Measure	Description
No Action	No Action
1	Fill Artificial Ditches
2	Maintain Native Savannah Vegetation
a	*By Burning Every 3Years*
b	*By Mowing Annually*
3	Excavate & Remove Roadbeds & Fill
4	Add Culverts

6.15.1.4 Fill Ditches (1)

This management measure must be included in all alternatives for the restoration to be successful. This measure positively affects the outflow of water. It measures the removal of water by ditches or drains.

6.15.1.5 Maintain Native Savannah Vegetation (2)

This management measure must be included in all alternatives for the restoration to be successful. There are two methods that will be analyzed for maintaining vegetation: (a) burning and (b) mowing. Fire benefits this ecosystem in many different ways. It creates a bare seedbed for pine seedlings and other fire dependent plants, reduces fuel loads and recycles nutrients. Periodic burning promotes early successional plants that are important to many species of wildlife indigenous to this ecosystem. Many of the plant species found in this ecosystem are fire dependent; for example, the federally endangered American Chaff seed flowers almost exclusively after a fire. It has been reduced to a fraction of its original range due to fire suppression and habitat destruction. Fire suppression is mainly due to liability issues and fear of litigation.

Mowing is a mechanical alternative that many land managers use to maintain early successional habitats. Although it is successful to some extent, it fails to provide all the necessary components that come from prescribed fire. This method also has a negative effect. Mowing requires the use of heavy equipment in sensitive areas. Tractors can create ruts in saturated soils, creating hydrologic problems and micro site conditions. Mowing can also introduce non-native species through the use of contaminated equipment. Another disadvantage of mowing is that the duff or litter layer remains on the ground, preventing seeds from reaching the bare ground needed for germination. This thick litter layer can also provide heavy fuel loads increasing the risk of wildfires during dry periods. Although mowing provides some level of habitat management in pine savannahs, it is not a substitute for prescribed fire. Mowing can maintain succession, but may inhibit other functions of the system.

6.15.1.6 Excavate and Remove Existing Roadbeds and Fill (3)

This management measure must be included in all alternatives for the restoration to be successful. This measure affects the surface water storage. An ecological improvement would occur where existing roadbeds and fill are removed.

6.15.1.7 Add Culverts (4)

This measure increases the hydrologic connection between the two existing wetland areas separated by the elevated railway. The wetlands are primarily precipitation driven resulting in sheet flow drainage. Additional culverts will result in increased sheet flow drainage reducing standing surface water in the northern wetland area.

6.15.1.8 Ecosystem Restoration Alternatives

These management measures were combined to create four alternatives. Each alternative requires filling in ditches, maintaining native savannah vegetation by burning and mowing the project area in the initial year of construction with followed-up maintenance throughout the life of the project with either burning every 3 years or mowing every year, and excavating and removing existing roadbeds and any additional fill. Restoring the north and south acres together also includes adding culverts to increase hydrologic connectivity whereas restoring only the south portion does not include the culvert measure. Otherwise, the difference between each alternative includes the number of acres restored and/or the method of maintaining vegetation over the life of the project. Restoring only the north portion was not considered as an alternative since it would make the ecology worse off.

Alternatives 1 and 2 consist of restoring the project areas north and south of the railway: 149 acres. Alternative 1 maintains vegetation by burning once every three years. Alternative 2 maintains vegetation by mowing every year. Alternatives 3 and 4 consist of restoring only the project area south of the railway: 56 acres. Alternative 3 maintains vegetation by burning once every three years. Alternative 4 maintains vegetation by mowing every year. Table 6.15-2 displays a description of each ecosystem restoration alternative. Figure 6.15-2 shows the Franklin Creek restoration site divided by the railroad into the north (A) and south (B) acreages.

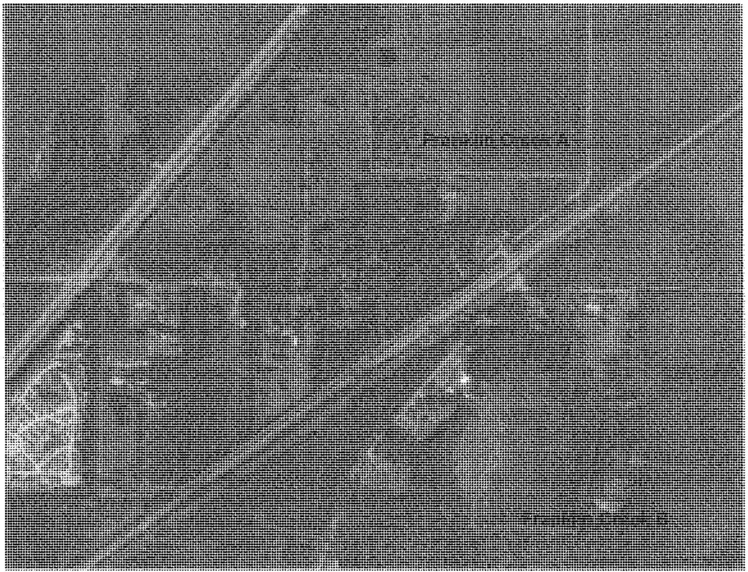


Figure 6.15-2. Franklin Creek Restoration Site

Table 6.15-2.
Ecosystem Restoration Alternatives

Alternative	Management Measures	Alternative Description
0	No Action	No Action
1	1 + 2a + 3 + 4	149 Acre Restoration Maintain by Burning
2	1 + 2b + 3 + 4	149 Acre Restoration Maintain by Mowing
3	1 + 2a +3	56 Acre Restoration Maintain by Burning
4	1 + 2b + 3	56 Acre Restoration Maintain by Mowing

6.15.1.9 Benefits

In order to restore this area to a Wet Pine Savannah habitat, the higher areas will be designated as Wet Pine Savannah. These areas have depression areas within them which will enable water to flow down to the depression areas; thus, holding water. The Wet Pine Savannah habitat will be restored with Wet Pine Flatwoods, such as Pinus elliotti, Morella cerifera, Ilex glabra, Spartina patens and Panicum virgatum.

Many species of wildlife are indigenous to the Wet Pine Savannah habitat. Understory plant communities may contain wiregrass, sedges, orchids, American Chaff seed and rough-leaved loosestrife. Insectivorous plants that may be found include pitcher plants, bladderworts, venus flytrap, and sundews. Rare, threatened or endangered birds that may occur in these areas include Henslowe's sparrow, Bachman's sparrow, red-cockaded woodpecker, and Mississippi Sandhill Crane. This ecosystem may also benefit the Mississippi Gopher frog and in drier areas along ridges, the black pine snake and the gopher tortoise.

Benefits are measured in terms of Average Annual Functional Units (AAFU). The Hydrogeomorphic (HGM) approach was used to assess wetland function. A HGM assessment was performed in 2000 using the Regional Guidebook for Applying the HGM Approach to Assessing Wetland Functions of Wet Pine Flats on Mineral Soils in the Atlantic and Gulf Coastal Plains. Results from this assessment were used to establish baseline (current) conditions and, ultimately, to measure the functional unit benefits resulting from different restoration alternatives. Table 6.15-3 shows the AAFU net benefit under each alternative. The AAFU net benefit was calculated as the difference between the total functional units for the ecosystem restoration alternative and the total functional units for the no action alternative.

Table 6.15-3.
Summary of Benefits

Alternative	Alternative Description	AAFU Net Benefit
No Action (alternatives 1-2)	No Action (149 acres)	0
No Action (alternatives 3-4)	No Action (56 acres)	0
Alternative 1	149 Acre Restoration Maintain by Burning	516
Alternative 2	149 Acre Restoration Maintain by Mowing	399
Alternative 3	56 Acre Restoration Maintain by Burning	194
Alternative 4	56 Acre Restoration Maintain by Mowing	150

6.15.1.10 Costs

A rough order magnitude (ROM) cost estimate was developed for the 149 acres of restoration represented in Alternatives 1 and 2. The first costs for Alternatives 1 and 2 are estimated at $1,634,000. First costs include construction, contingency, lands and damages, PED, and construction management costs. Investment cost (first cost plus IDC) for Alternatives 1 and 2 are estimated at $1,670,000. The equivalent average annual cost (AAC), which includes AAC of investment of $90,000 and O&M of $11,000 and $19,000, for Alternatives 1 and 2 are $101,000 and $109,000, respectively. The first costs for Alternatives 3 and 4 representing 56 acres of restoration south of the railway are estimated at $548,000. Investment cost (first cost plus IDC) for Alternatives 1 and 2 are estimated at $560,000. The AAC, which includes AAC of investment of $30,000 and

O&M of $4,000 and $7,000, respectively, for Alternatives 3 and 4 are $34,000 and $37,000, respectively.

For each alternative, first costs of construction, Interest During Construction (IDC), total investment cost, Average Annual Investment Cost (AAIC), Average Annual Operations and Maintenance (AAO&M) cost and, ultimately, the Average Annual Costs (AAC) are presented in table 6.15-4 at October 2007 price levels.

Table 6.15-4.
Summary of Costs by Measure for Franklin Creek

Alternative	Alternative Description	Implementation Cost (FY-08)	IDC	Investment Cost	AAIC	AAO&M	AAC
0	No Action	$0	$0	$0	$0	$0	$0
1	149 Acre Restoration Maintain by Burning	$1,630,000	$36,000	$1,670,000	$90,000	$11,000	$101,000
2	149 Acre Restoration Maintain by Mowing	$1,630,000	$36,000	$1,670,000	$90,000	$19,000	$109,000
3	56 Acre Restoration Maintain by Burning	$550,000	$12,000	$560,000	$30,000	$4,000	$34,000
4	56 Acre Restoration Maintain by Mowing	$550,000	$12,000	$560,000	$30,000	$7,000	$37,000

Note: Values are rounded to the nearest thousand dollars.

First cost of construction is used along with the duration of 12 months of construction and a discount rate of 4.875 percent to calculate Interest During Construction (IDC). The sum of the first cost of construction and IDC cost equals the investment cost. This cost is amortized at the FY 2007 federal discount rate of 4.875 percent over a 50-year economic period of analysis to calculate the Average Annual Investment Cost (AAIC). Average Annual O&M (AAO&M) costs for burning once every three years or mowing every year were present valued and amortized at an interest rate of 4.875 percent over a 50-year economic period of analysis. The sum of the AAIC and AAO&M cost equals the Average Annual Costs (AAC).

6.15.2 Comparison of Alternatives

Table 6.15-5 displays all alternatives with their respective AAC and AAFU.

Table 6.15-5.
All Alternatives: AAC and AAFU

Alternative	AAC	AAFU
No Action	$0	0
1	$101,000	516
2	$109,000	399
3	$34,000	194
4	$37,000	150

Note: The AAC values are rounded to the nearest thousand dollars

In order to determine the cost effectiveness of each alternative, the list of alternatives is reordered so that they are listed in increasing order of their outputs (AAFU). This list is shown in table 6.15-6.

Table 6.15-6.
All Alternatives Arrayed by Increasing Output

Alternative	AAC	AAFU
No Action	$0	0
4	$37,000	150
3	$34,000	194
2	$109,000	399
1	$101,000	516

Note: The AAC values are rounded to the nearest thousand dollars.

To determine if an alternative is cost effective, economically inefficient alternatives must first be identified and eliminated. An economically inefficient alternative is an alternative that cost more for the same level of benefit. No alternatives are eliminated for the reason of economic inefficiency because each alternative produces a different level of benefit.

Lastly, economically ineffective alternatives are identified and eliminated to determine which alternatives are cost effective. An economically ineffective alternative is an alternative that costs more or the same as a subsequent alternative but produces less benefit than that subsequent alternative. As shown in table 6.15-7, the two shaded alternatives 4 and 2 were eliminated because they produced less benefit at greater cost than a subsequent alternative. For example, Alternative 4 produces 150 AAFU at an AAC of $37,000 while Alternative 3 produces 194 AAFU at an AAC $34,000. Alternative 4 produces less AAFU at a greater cost than Alternative 3. Therefore, Alternative 4 is eliminated. As shown in table 6.15-8 and plotted in figure 6.15-3, the cost effective alternatives are Alternative 3 (56 acres of restoration maintained by burning) and Alternative 1 (149 acres of restoration maintained by burning).

Table 6.15-7.
Elimination of Economically Ineffective Alternatives

Alternative	Alternative Description	AAC	AAFUs	Cost Effective?
No Action	No Action	$0	0	Yes
4	56 Acre Restoration Maintain by Mowing	$37,000	150	No
3	56 Acre Restoration Maintain by Burning	$34,000	194	Yes
2	149 Acre Restoration Maintain by Mowing	$109,000	399	No
1	149 Acre Restoration Maintain by Burning	$101,000	516	Yes

Note: The AAC values are rounded to the nearest thousand dollars.

Table 6.15-8.
Cost Effective Alternatives for Franklin Creek Area

Alternative	Alternative Description	AAC	AAFUs	Cost Effective?
No Action	No Action	$0	0	Yes
3	56 Acre Restoration Maintain by Burning	$34,000	194	Yes
1	149 Acre Restoration Maintain by Burning	$101,000	516	Yes

Note. The AAC values are rounded to the nearest thousand dollars.

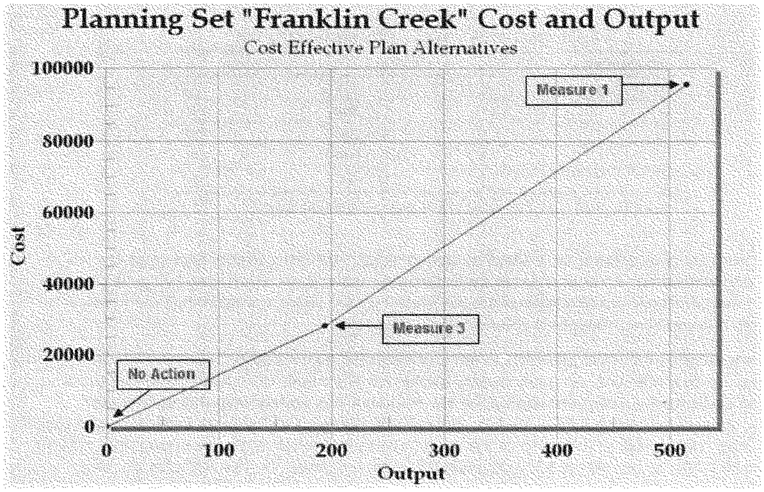


Figure 6.15-3. Display of Cost Effective Alternatives for the Franklin Creek Area

6.15.3 Regional Economic Development (RED) Benefits

6.15.3.1 Summary of Socioeconomic Impacts using the Economic Impact Forecast System

The purpose of this analysis is to show the economic impact of the cost effective alternatives on business (sale volumes), income, employment, and population of the local area. Each of the alternatives would affect the local area of Jackson County, Mississippi. The expenditures for the alternatives are estimated to be $960,000 for Alternative 1, $1,530,000 for Alternative 3. Moreover, the total present worth of the operation and maintenance (O&M) expenditures are estimated to be $205,000 for Alternative 1 and $74,000 for Alternative 3 (assuming a 50 year period of analysis and an interest rate of 4.875 percent).

The outputs shown in this section are based on the following input from the proposed project measures. The inputs and outputs are shown in tables 6.15-9 through 6.15-12. The inputs are as follows:

Table 6.15-9.
EIFS Model Implementation Inputs for Franklin Creek Ecosystem

	No Action	Alternative 1	Alternative 3
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$0	$1,630,000	$550,000

Based of the given inputs the outputs are as follows:

Table 6.15-10.
EIFS Model Implementation Outputs for Franklin Creek Ecosystem

	No Action	Alternative 1	Alternative 3
Direct Sales Volume	$0	$1,630,000	$550,000
Induced Sales Volume	$0	$1,825,600	$616,000
Total Sales Volume	$0	$3,455,600	$1,166,000
Direct Income	$0	$317,892	$107,264
Induced Income	$0	$356,039	$120,136
Total Income	$0	$673,930	$227,400
Direct Employment	0	9	3
Induced Employment	0	10	3
Total Employment	0	19	6
Local Population	0	0	0

Table 6.15-11.
EIFS Model O&M Inputs for Franklin Creek Ecosystem

	No Action	Alternative 1	Alternative 3
Region of Influence (ROI)	Jackson County	Jackson County	Jackson County
Change in Local Expenditures	$0	$205,000	$74,000

Based of the given inputs the outputs are as follows:

Table 6.15-12.
EIFS Model O&M Outputs for Franklin Creek Ecosystem

	No Action	Alternative 1	Alternative 3
Direct Sales Volume	$0	$205,000	$74,000
Induced Sales Volume	$0	$229,600	$82,880
Total Sales Volume	$0	$434,600	$156,880
Direct Income	$0	$39,980	$14,432
Induced Income	$0	$44,778	$16,164
Total Income	$0	$84,758	$30,596
Direct Employment	0	1	1
Induced Employment	0	1	0
Total Employment	0	2	1
Local Population	0	0	0

6.16 Evaluation of Inland Barrier and Surge Barrier Flood Damage Reduction Measures

6.16.1 General

The Inland barrier and surge barrier area is located in all three planning units just north of the roadways that run parallel to the beach. These areas are denoted by the inland zone planning area. In planning unit one, the inland barrier area includes planning sub-units one, two, seven, thirty-seven, and thirty-eight; in planning unit two, planning sub-units eight, eleven, twelve, fourteen, sixteen, seventeen, twenty, thirty-nine, forty, forty-seven, forty-eight, and fifty; and in planning unit three the planning sub-units are twenty-one, twenty-three, forty-one, forty-six, and forty-nine.

6.16.2 Historic (Pre-Hurricane Katrina) Conditions

The pre-Hurricane Katrina conditions for planning sub-units three and four in planning unit one represented a mostly residential community as shown in Table 6.16-1. The areas in planning unit one included 35,770 tax parcels, of which 17,914 contained an asset with some economic value and 17,856, were vacant land. Of the 17,914 parcels that contain assets, 13,961 were residential one-story, 763 were residential two-story, 463 were mobile homes, 2,236 were commercial, and 491 were municipal. The areas in planning unit two included 76,487 tax parcels, of which 48,962 contained an asset with some economic value and 27,525 were vacant land. Of the 48,962 parcels that contain assets, 40,456 were residential one-story, 1,594 were residential two-story, 2,487 were mobile homes, 4,136 were commercial, and 289 were municipal. The areas in planning unit three included 21,353 tax parcels, of which 14,575 contained an asset with some economic value and 6,778 were vacant land. Of the 14,575 parcels that contain assets, 12,551 were residential one-story, 311 were residential two-story, 828 were mobile homes, 789 were commercial, and 96 were municipal.

Table 6.16-1.
Pre-Hurricane Katrina Estimate of Structures for Inland Zone Area

	Planning Unit One	Planning Unit Two	Planning Unit Three	
Asset Categories	**Assets by Category**	**Assets by Category**	**Assets by Category**	**Total**
Residential	14,724	42,050	12,862	**69,636**
Mobile Homes	463	2,487	828	**3,778**
Commercial	2,236	4,136	789	**7,161**
Municipal	491	289	96	**876**
Vacant Land	17,856	27,525	6,778	**52,159**
Total	**35,770**	**76,487**	**21,353**	**133,610**

Figure 6.16-1 denotes the various zones and shows the inland zone in green. Figures 6.16-2 shows the planning sub-units of the area by planning unit.

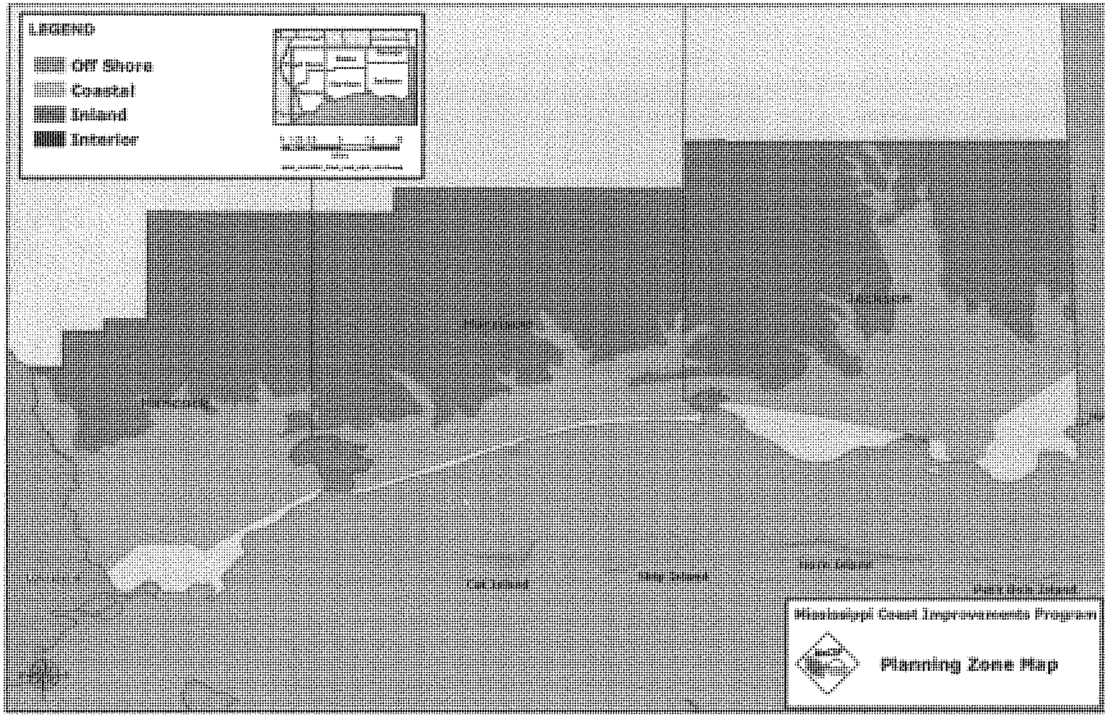


Figure 6.16-1. Planning Zones – Impacted area is the inland zone

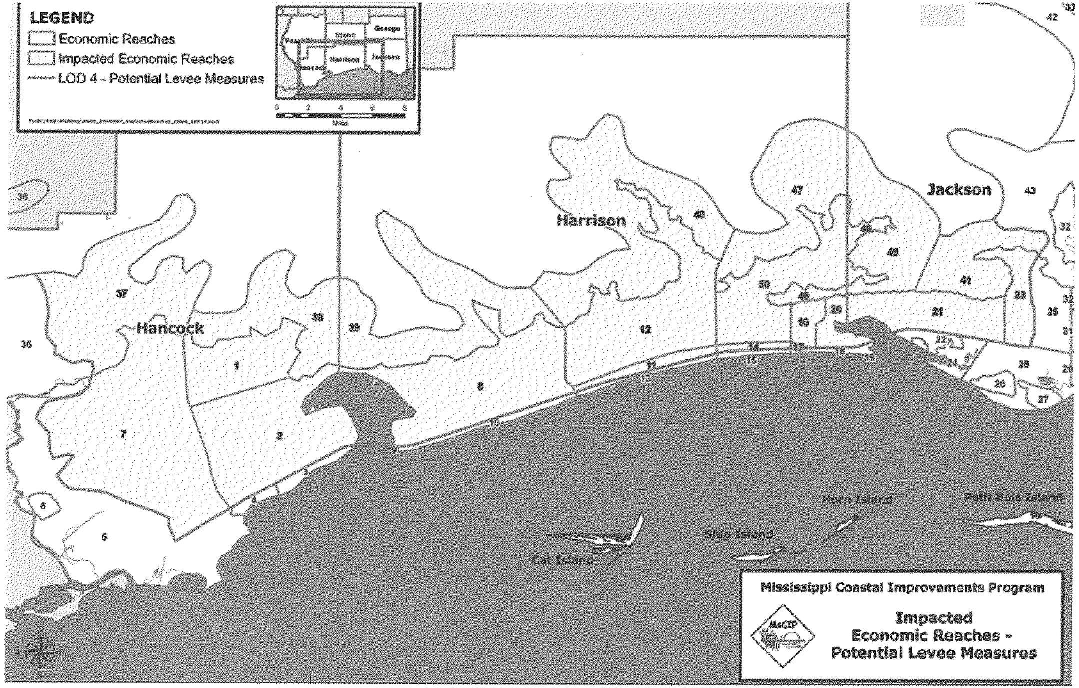


Figure 6.16-2 Planning sub-units in Inland Area for Planning Units One, Two, and Three

6.16.2.1 Existing (Post-Hurricane Katrina) Conditions

Hurricane Katrina made its Mississippi landfall just west of planning sub-units three and four. Damage from the surge was devastating across the three planning units. In the inland barrier impact area, it is estimated that 12,857 structures sustained significant damage (50-percent or more). Of those, 5,610 were destroyed in planning unit one, 6,850 in planning unit two, and 397 were destroyed in planning unit three. Table 6.16-2 displays the destroyed structures by category and by planning unit for these areas.

Table 6.16-2.
Destroyed Structures by Category and Planning Unit

	Planning Unit One	Planning Unit Two	Planning Unit Three	
Asset Categories	**Assets by Category**	**Assets by Category**	**Assets by Category**	**Total**
Residential	5,213	6,115	349	**11,677**
Mobile Homes	33	60	10	**103**
Commercial	311	648	38	**997**
Municipal	53	27	0	**80**
Total	**5,610**	**6,850**	**397**	**12,857**

6.16.3 Opportunities

The following opportunities were identified for this area:

- Hurricane storm damage reduction or remediation.

6.16.4 Assumptions

The following assumptions were used in this analysis.

- The FY 2008 discount rate of 4-7/8 percent was used in estimating average annual benefits and costs.
- Price levels are FY-08, unless otherwise stated.
- A 100-year period of analysis (2012 to 2111) was used to calculate average annual benefits and costs for initial screening.
- Full redevelopment of the area will take place by the base year 2012.

6.16.5 Measures

Initially, a comprehensive list of measures was identified for flood damage reduction purposes for planning unit one. This list was screened and vetted for engineering and environmental feasibility and for policy compliance. The MsCIP Comprehensive Main Report and the Engineering and Environmental Appendices contain a detailed description of the measures that were initially screened.

Several potential measures were carried forward for this area for the purpose of flood damage reduction. These measures include both structural features and nonstructural actions. The measures evaluated for economic benefits include:

- Measure A - LOD-4, Inland Barrier and Surge Barrier at 20.0-feet NAVD88 Elevation

This measure will consist of an elevation 20.0-feet NAVD88 earthen levee construction in planning unit one along an alignment that extends southward from the same ground surface elevation as the levee along the last watershed divide before entering the Pearl River basin and then turn eastward and extend along the south side of the CSX railroad track to the Bay St. Louis Surge Barrier. An elevation 20.0-feet NAVD88 surge barrier will extend across the mouth of St. Louis Bay from the western shore in Hancock County to the eastern shore in Harrison County. The structure will be located just south of the railway bridge. The barrier will consist of abutments extending from each shore with rising sector gates spanning most of the distance. The abutments will include gated culverts to provide proper circulation and tidal exchange. The earthen levee will then continue in planning unit two along an alignment that extends eastward from the Bay St. Louis Surge Barrier along the south side of the CSX railroad track to the Biloxi Bay Surge Barrier.

A second elevation 20.0-feet NAVD88 surge barrier will extend across the mouth of Biloxi Bay from the western shore in Harrison County to the eastern shore in Jackson County. The structure will be located just south of the existing railway bridge. The barrier will consist of abutments extending from each shore with rising sector gates spanning most of the distance. The abutments will include gated culverts to provide proper circulation and tidal exchange. In planning unit three, the earthen levee construction will continue along an alignment that extends eastward from the Biloxi Bay Surge Barrier along the south side of the CSX railroad track to the last watershed divide before entering the Pascagoula River basin. At the watershed divide, the alignment will follow the divide northward until it intersects the same ground surface elevation as the levee. This system will include interior drainage, pumping stations, and required road crossings. All required maintenance for the surge barrier facilities will be included.

- Measure B – LOD-4, Inland Barrier and Surge Barrier at 30.0-feet NAVD88 Elevation

This measure will consist of an elevation 30.0-feet NAVD88 earthen levee construction in planning unit one along an alignment that extends southward from the same ground surface elevation as the levee along the last watershed divide before entering the Pearl River basin and then turn eastward and extend along the south side of the CSX railroad track to the Bay St. Louis Surge Barrier. An elevation 30.0-feet NAVD88 surge barrier will extend across the mouth of St. Louis Bay from the western shore in Hancock County to the eastern shore in Harrison County. The structure will be located just south of the railway bridge. The barrier will consist of abutments extending from each shore with rising sector gates spanning most of the distance. The abutments will include gated culverts to provide proper circulation and tidal exchange. The earthen levee will then continue in planning unit two along an alignment that extends eastward from the Bay St. Louis Surge Barrier along the south side of the CSX railroad track to the Biloxi Bay Surge Barrier.

A second elevation 30.0-feet NAVD88 surge barrier will extend across the mouth of Biloxi Bay from the western shore in Harrison County to the eastern shore in Jackson County. The structure will be located just south of the existing railway bridge. The barrier will consist of abutments extending from each shore with rising sector gates spanning most of the distance. The abutments will include gated culverts to provide proper circulation and tidal exchange. In planning unit three, the earthen levee construction will continue along an alignment that extends eastward from the Biloxi Bay Surge Barrier along the south side of the CSX railroad track to the last watershed divide before entering the Pascagoula River basin. At the watershed divide, the alignment will follow the divide northward until it intersects the same ground surface elevation as the levee. This system will include interior drainage, pumping stations, and required road crossings. All required maintenance for the surge barrier facilities will be included.

- Measure C - LOD-4, Inland Barrier and Surge Barrier at 40.0-feet NAVD88 Elevation

This measure will consist of an elevation 40.0-feet NAVD88 earthen levee construction in planning unit one along an alignment that extends southward from the same ground surface elevation as the levee along the last watershed divide before entering the Pearl River basin and then turn eastward and extend along the south side of the CSX railroad track to the Bay St. Louis Surge Barrier. An elevation 40.0-feet NAVD88 surge barrier will extend across the mouth of St. Louis Bay from the western shore in Hancock County to the eastern shore in Harrison County. The structure will be located just south of the railway bridge. The barrier will consist of abutments extending from each shore with rising sector gates spanning most of the distance. The abutments will include gated culverts to provide proper circulation and tidal exchange. The earthen levee will then continue in planning unit two along an alignment that extends eastward from the Bay St. Louis Surge Barrier along the south side of the CSX railroad track to the Biloxi Bay Surge Barrier.

A second elevation 40.0-feet NAVD88 surge barrier will extend across the mouth of Biloxi Bay from the western shore in Harrison County to the eastern shore in Jackson County. The structure will be located just south of the existing railway bridge. The barrier will consist of abutments extending from each shore with rising sector gates spanning most of the distance. The abutments will include gated culverts to provide proper circulation and tidal exchange. In planning unit three, the earthen levee construction will continue along an alignment that extends eastward from the Biloxi Bay Surge Barrier along the south side of the CSX railroad track to the last watershed divide before entering the Pascagoula River basin. At the watershed divide, the alignment will follow the divide northward until it intersects the same ground surface elevation as the levee. This system will include interior drainage, pumping stations, and required road crossings. All required maintenance for the surge barrier facilities will be included.

- Measure D – Levee for Roadway - Elevation 20.0-feet NAVD88

REQUIRES FUTHER STUDY

- Measure E – Levee for Roadway - Elevation 30.0-feet NAVD88

REQUIRES FUTHER STUDY

- Measure F - Menge Ave. - Elevation 20.0-feet NAVD88

REQUIRES FUTHER STUDY

- Measure G - Menge Ave. - Elevation 30.0-feet NAVD88

REQUIRES FUTHER STUDY

- Measure H – Menge Ave. - Elevation 40.0-feet NAVD88

REQUIRES FUTHER STUDY

- Measure I – Levee for Roadway with Menge Ave. Alt - Elevation 20.0-feet NAVD88

REQUIRES FUTHER STUDY

- Measure J - Levee for Roadway with Menge Ave. Alt - Elevation 30.0-feet NAVD88

REQUIRES FUTHER STUDY

- Measure K - Non-structural One

This measure includes the acquisition and flood proofing (elevate in place) of structures to a 100-year level of protection. See the Non-structural Appendix for more detail on this measure.

- Measure L – Non-structural Two

REQUIRES FUTHER STUDY

- Measure M – Non-structural Three

REQUIRES FUTHER STUDY

- Measure N – Non-structural Four

REQUIRES FUTHER STUDY

Figure 6.16-3 shows the footprints for measures A through J. The alignment running from Hancock County to Jackson County is the footprint for measures A, through E, and the alignment going from Harrison County east to Jackson County is the footprint for measures F through J. The highlighted areas in figure 6.16-2 above represent the footprint of the nonstructural measures K through N.

6.16.6 National Economic Development (NED)

The purpose of this section is to document investigations conducted to identify the National Economic Development (NED) benefits of each of the potential measures previously listed. For this analysis, NED benefits are the reduced inundation damages of assets and their contents when one of the potential measures is in place. Typically, NED benefits are annualized over the period of the analysis (average annual benefits) and then compared to annualized costs over the period of analysis (average annual costs). This comparison is commonly known as the benefit-to-cost ratio (BCR). For purposes of this analysis, no benefit-to-cost ratios will be calculated as per the legislative Congressional language authorizing this study. The Coastal Mississippi Comprehensive Plan Report was authorized by the Department of Defense Appropriations Act, 2006 (P.L. 109-148) 30 December 2005, which states: "...***that the Secretary shall recommend a cost-effective project, but shall not perform an incremental benefit-cost analysis to identify the recommended project, and shall not make project plan features based upon maximizing net national economic development benefits...***" More detail on the authorizing language can be found in the MsCIP Comprehensive Plan Main Report.

6.16.6.1 Future Without-Project Conditions

Equivalent annual surge damages for several future without-project scenarios were evaluated using the Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA) model. Each of the measures were evaluated and compared to the without-project conditions in order to calculate equivalent annual damage reduction. Future without-project scenarios three, four, five, and six were applicable for the inland barrier area.

Future scenario one is the full redevelopment of structures within the study area by the year 2012 with no relative sea level rise over the 100-year period of analysis. Structures will be rebuilt to what they were pre-Hurricane Katrina; residential back to residential, commercial back to commercial, etc. This future scenario, as previously noted in section 5.3, is for sensitivity purposes only and will not be evaluated against all of the potential measures for the Inland Barrier area.

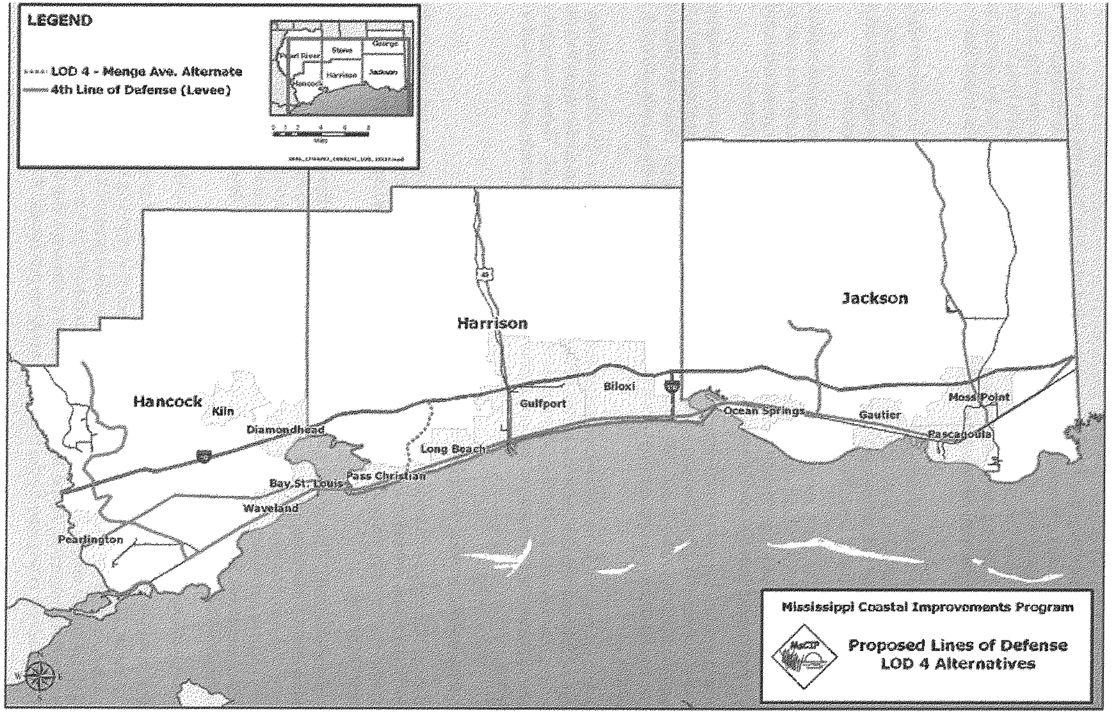


Figure 6.16-3. Footprints for the Inland Barrier Levees Alignments

Future scenario two is the full redevelopment of structures within the study area by the year 2012 with no relative sea level rise over the 100-year period of analysis. Structures will be rebuilt to what they were pre-Hurricane Katrina; residential back to residential, commercial back to commercial, etc, with the exception of the water front areas for planning units one and two. In these planning units, the scenario will address what if commercial and casino redevelopment would occur along the water front and Back Bay areas. This future scenario, as previously noted in section 5.3, is for sensitivity purposes only and will not be evaluated against all of the potential measures for the Inland Barrier area.

Future scenario three has the same redevelopment as future scenario one with a maximum relative sea level rise of 2.0-feet NAVD88. Equivalent annual damages that could occur under this scenario are $426,040,000 (rounded to the nearest thousand). These damages are the damages expected for this scenario that are attributed to all fifty-four planning units without a project in place.

Future scenario four has the same redevelopment as future scenario two with a maximum relative sea level rise of 2.0-feet NAVD88. Equivalent annual damages that could occur under this scenario are $434,040,000 (rounded to the nearest thousand). These damages are the damages expected for this scenario that are attributed to all fifty-four planning units without a project in place.

Future scenario five has the same redevelopment as future scenario one with a maximum relative sea level rise of 3.4-feet NAVD88 over the period of analysis. Equivalent annual damages that could occur under this scenario are $475,200,000 (rounded to the nearest thousand). These damages are the damages expected for this scenario that are attributed to all fifty-four planning units without a project in place.

Future scenario six has the same redevelopment as future scenario two with a maximum relative sea level rise of 3.4-feet NAVD88 over the period of analysis. Equivalent annual damages that could occur under this scenario are $483,700,000 (rounded to the nearest thousand). These damages are the damages expected for this scenario that are attributed to all fifty-four planning units without a project in place.

6.16.6.2 Equivalent annual damages Reduced

Equivalent annual damages reduced are calculated as the difference between the damages under the future without-project scenarios and the damages incurred with the measure in place. The HEC-FDA model was run for each measure to determine the damages reduced as compared to the without-project scenario.

In order to provide the HEC-FDA model with accurate information about the economic characteristics of each measure, separate inventories were created for each measure. The inventories are the same as the without-project inventory except that footprints of inland barrier and surge barrier and the acquisitions were deleted from the inventory and flood proofed (structure to be raised in place) structures were given a specific first floor elevation. The structure inventories for each of the HEC-FDA with-measure runs are as follows:

- Measure A – Inland Barrier and Surge Barrier at Elevation 20.0-feet NAVD88

This measure includes the without-project inventory less 2,426 parcels that were deleted out of the inventory. Of those, 506 parcels were estimated to be impacted in planning unit one, 1,580 in planning unit two, and 340 in planning unit three. These parcels represent the footprint of the inland barrier and surge barrier across the three planning units and some portion of the total would have to be purchase for its construction. At this level of analysis, it is assumed that all of the structures identified to be touched in any way by the ring levee would be purchased; therefore all were deleted from the without-project structure inventory. Some of the parcels are wetland impacts and are discussed below in the Environmental Quality section.

- Measure B – Inland Barrier and Surge Barrier at Elevation 30.0-feet NAVD88

This measure includes the without-project inventory less 2,746 parcels that were deleted out of the inventory. Of those, 576 parcels were estimated to be impacted in planning unit one, 1,784 in planning unit two, and 386 in planning unit three. These parcels represent the footprint of the inland barrier and surge barrier across the three planning units and some portion of the total would have to be purchase for its construction. At this level of analysis, it is assumed that all of the structures identified to be touched in any way by the ring levee would be purchased; therefore all were deleted from the without-project structure inventory. Some of the parcels are wetland impacts and are discussed below in the Environmental Quality section.

- Measure C – Inland Barrier and Surge Barrier at Elevation 40.0-feet NAVD88

This measure includes the without-project inventory less 3,087 parcels that were deleted out of the inventory. Of those, 634 parcels were estimated to be impacted in planning unit one, 2,025 in planning unit two, and 428 in planning unit three. These parcels represent the footprint of the inland barrier and surge barrier across the three planning units and some portion of the total would have to be purchase for its construction. At this level of analysis, it is assumed that all of the structures identified to be touched in any way by the ring levee would be purchased; therefore all were deleted from the without-project structure inventory. Some of the parcels are wetland impacts and are discussed below in the Environmental Quality section.

- Measure D – Levee for Roadway - Elevation 20.0-feet NAVD88

REQUIRES FUTHER STUDY

- Measure E – Levee for Roadway - Elevation 30.0-feet NAVD88

REQUIRES FUTHER STUDY

- Measure F - Menge Ave. - Elevation 20.0-feet NAVD88

REQUIRES FUTHER STUDY

- Measure G - Menge Ave. - Elevation 30.0-feet NAVD88

REQUIRES FUTHER STUDY

- Measure H – Menge Ave. - Elevation 40.0-feet NAVD88

REQUIRES FUTHER STUDY

- Measure I – Levee for Roadway with Menge Ave Alt - Elevation 20.0-feet NAVD88

REQUIRES FUTHER STUDY

- Measure J - Levee for Roadway with Menge Ave Alt - Elevation 30.0-feet NAVD88

REQUIRES FUTHER STUDY

- Measure K - Non-structural One

This measure includes the acquisition of 20,308 parcels with structures and vacant land, and the flood proofing (elevate in place) of 10,524 structures to a range of elevations from 11.0-feet to 22.35-feet NAVD88 depending on the planning sub-unit. The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and is detailed in the Non-structural Appendix. This elevation was determined to be approximately the ABFE level of protection is defined as still water elevation, plus wave run-up plus and estimate for waves (depth divided by two), and is the minimum elevation that a non-structural plan could provide.

- Measure L – Non-structural Two to Elevation 20.0-feet NAVD88

REQUIRES FUTHER STUDY

- Measure M – Non-structural Three to Elevation 30.0-feet NAVD88

REQUIRES FUTHER STUDY

- Measure N – Non-structural Three to Elevation 30.0-feet NAVD88

REQUIRES FUTHER STUDY

The equivalent annual damage reduction by measure for the Inland barrier and surge barrier is shown in table 6.16-3.

Table 6.16-3.
Equivalent Annual Damage Reduction by Future Scenario

Measures	Equivalent Annual Damage Reduction Future 3 ($)	Equivalent Annual Damage Reduction Future 4 ($)	Equivalent Annual Damage Reduction Future 5 ($)	Equivalent Annual Damage Reduction Future 6 ($)
(No Action)	$0	$0	$0	$0
Measure A	$46,818,000	$38,660,000	$51,650,000	$41,400,000
Measure B	$75,548,000	$84,460,000	$81,980,000	$77,840,000
Measure C	$77,066,000	$74,230,000	$84,520,000	$79,750,000
Measure D	RFS	RFS	RFS	RFS
Measure E	RFS	RFS	RFS	RFS
Measure F	RFS	RFS	RFS	RFS
Measure G	RFS	RFS	RFS	RFS
Measure H	RFS	RFS	RFS	RFS
Measure I	RFS	RFS	RFS	RFS
Measure J	RFS	RFS	RFS	RFS
Measure K	$207,760,000	$211,820,000	$303,000,000	$231,340,000
Measure L	RFS	RFS	RFS	RFS
Measure M	RFS	RFS	RFS	RFS
Measure N	RFS	RFS	RFS	RFS

Damages are rounded to the nearest thousand
RFS – Requires Further Study

6.16.6.3 Residual Damage

Residual damage is the equivalent annual damages that still remain even when a project is in place. Residual damage is calculated as the future without-project equivalent annual damages minus the damages reduced of the various measures. The purpose of residual damage is to calculate and communicate the portions of damages that will not be reduced by the implementation of a plan or "what damages are left on the table". Residual damage by measure is shown in table 6.16-4.

Table 6.16-4.
Residual Damage by Measure and by Future Scenario

Measures	Residual Damage Future 3 ($)	Residual Damage Future 4 ($)	Residual Damage Future 5 ($)	Residual Damage Future 6 ($)
(No Action)	$0	$0	$0	$0
Measure A	$199,082,000	$395,380,000	$423,550,000	$442,300,000
Measure B	$170,352,000	$349,580,000	$393,220,000	$405,860,000
Measure C	$168,834,000	$359,810,000	$390,680,000	$403,950,000
Measure D	RFS	RFS	RFS	RFS
Measure E	RFS	RFS	RFS	RFS
Measure F	RFS	RFS	RFS	RFS
Measure G	RFS	RFS	RFS	RFS
Measure H	RFS	RFS	RFS	RFS
Measure I	RFS	RFS	RFS	RFS
Measure J	RFS	RFS	RFS	RFS
Measure K	$38,140,000	$222,220,000	$172,200,000	$252,360,000
Measure L	RFS	RFS	RFS	RFS
Measure M	RFS	RFS	RFS	RFS
Measure N	RFS	RFS	RFS	RFS

Damages are rounded to the nearest thousand.
RFS – Requires Further Study

6.16.7 Environmental Quality (EQ)

6.16.7.1 Impacts of Inland Barrier Area Measure

The Engineering Research and Development Center Wetlands and Coastal Ecology Branch were asked to conduct an assessment of potential impacts to wetlands as a result of constructing various levees and seawalls along the Mississippi Gulf Coastal Plain. This report summarizes the results of the assessment. The analysis of impacts included two components:

1. A calculation of total acreage of all wetlands (by type and planning reach) that is directly under the levee footprints.
2. A modified Hydrogeomorphic (HGM) wetland rapid assessment of impacted Estuarine/Tidal Fringe wetlands, based on the Mississippi and Alabama Gulf Coast HGM guidebook (Shafer et al., 2007), with impacts reported as loss of functional units. Tables 6.16-5, and 6.16-6, and 6.16-7 show the impacts of the inland barrier and surge barrier at elevations 20.0, 30.0, and 40.0-feet NAVD88 respectively.

Nonstructural measures would have no construction activities other than demolition and disposal of building materials in an approved land fill occurs as a result of this measure. More detail on the impacts of the structural and nonstructural measures for the Inland Barrier area can be found in the Environmental Appendix.

Table 6.16-5.
Wetland Acres Impacted by Inland Barrier A, elevation 20.0-feet NAVD88

Reach ID	Estuarine and Marine Deepwater	Estuarine and Marine Wetland	Freshwater Emergent Wetland	Freshwater Forested/Shrub Wetland	Freshwater Pond	Total
3	0	0	0	2.9	0	2.9
4	4.1	11.9	0	0	0	16.0
5	0.5	36.3	0	12.3	0	49.0
7	0	0	0	3.9	0	3.9
10	0	1.6	0.1	13.3	0	15.0
13	0	0	0	0.2	0	0.2
23	0	0	0.2	4.1	0	4.3
24	0	0	0	2.5	0	2.5
25	0	0	0.3	2.3	0.1	2.6
28	0	0.7	0	4.3	0	4.9
Total	**4.6**	**50.5**	**0.6**	**45.6**	**0.1**	**101.4**

Table 6.16-6.
Wetland Acres Impacted by Inland Barrier B, elevation 30.0-feet NAVD88

Reach ID	Estuarine and Marine Deepwater	Estuarine and Marine Wetland	Freshwater Emergent Wetland	Freshwater Forested/Shrub Wetland	Freshwater Pond	Total
3	0	0	0.2	6.1	0	6.3
4	8.0	25.0	0	0	0	33.0
5	0.9	75.2	0	40.7	0	116.8
7	0	0	0	16.9	0	16.9
10	0	3.4	0.5	34.7	0	38.5
13	0	0	0	0.9	0	0.9
23	0	0	1.9	14.2	0	16.0
24	0	0	0	11.6	0	11.6
25	0	0	2.6	10.8	0.3	13.6
28	0	1.3	0	17.1	0	18.4
36	0	0	0.2	19.3	0	19.5
37	0	0	0.1	9.6	0	9.8
41	0	0	0	0.5	0	0.5
43	0	0	0	0.3	0	0.3
Total	**8.9**	**104.8**	**5.5**	**182.8**	**0.3**	**302.4**

Table 6.16-7.
Wetland Acres Impacted by Inland Barrier C, elevation 40.0-feet NAVD88

Reach ID	Estuarine and Marine Deepwater	Estuarine and Marine Wetland	Freshwater Emergent Wetland	Freshwater Forested/Shrub Wetland	Freshwater Pond	Total
3	0	0	0.1	8.1	0	8.3
4	9.2	30.8	0	0.2	0	40.3
5	1.1	91.3	0	52.0	0	144.4
7	0	0	0	23.3	0	23.3
10	0	4.1	0.7	41.5	0	46.2
13	0	0	0	1.2	0	1.2
23	0	0	2.3	18.1	0	20.4
24	0	0	0	14.8	0	14.8
25	0	0	3.6	15.5	0.3	19.5
28	0	1.5	0	21.5	0	23.0
36	0	0	3.6	44.4	0	48.0
37	0	0	3.5	31.5	0	35.0
41	0	0	0	0.8	0	0.8
43	0	0	0	0.5	0	0.5
Total	**10.4**	**127.7**	**13.9**	**273.2**	**0.3**	**425.5**

6.16.8 Summary of Costs

Table 6.16-8 summarizes the ROM costs at an FY-08 price level by measure.

Table 6.16-8.
Summary of Costs by Measure for the Inland Barrier Area

Measures	Implement Cost (FY-08) ($)	Average Annual Implementation Cost ($)	Average Annual O&M ($)	IDC ($)	Total Average Annual Costs ($)
(No Action)	$0	$0	$0	N/A	$0
Measure A	$3,559,900,000	$175,045,000	$42,660,000	N/A	$217,705,000
Measure B	$5,039,300,000	$247,789,000	$61,777,000	N/A	$309,566,000
Measure C	$6,176,800,000	$303,721,000	$76,522,000	N/A	$380,243,000
Measure D	$ 3,329,500,000	$163,716,000	$42,521,000	N/A	$206,237,000
Measure E	$ 5,076,000,000	$249,593,000	$61,843,000	N/A	$311,436,000
Measure F	$ 1,257,100,000	$61,813,000	$16,389,000	N/A	$78,202,000
Measure G	$ 1,809,000,000	$88,951,000	$23,726,000	N/A	$112,677,000
Measure H	$ 2,583,000,000	$127,009,000	$34,245,000	N/A	$161,254,000
Measure I	$ 1,295,300,000	$63,691,000	$16,662,000	N/A	$80,353,000
Measure J	$ 1,954,800,000	$96,120,000	$25,690,000	N/A	$121,810,000
Measure K	$7,395,182,000	$363,630,000	$210,000	N/A	$363,840,000
Measure L	RFS	RFS	RFS	N/A	RFS
Measure M	RFS	RFS	RFS	N/A	RFS
Measure N	RFS	RFS	RFS	N/A	RFS

6.16.9 *Regional Economic Development (RED)*

The purpose of this analysis is to show the economic impact of the proposed project measures on business (sale volumes), income, employment, and population of the local area. Each of the measures would affect the local areas of Jackson County, Harrison County and Hancock County, Mississippi. The expenditures for the measures are estimated to be $3,559,900,000 for the Inland Barrier A measure, $5,039,300,000 for the Inland Barrier B measure, $6,176,800,000 for the Inland Barrier C measure, $3,329,500,000 for the Inland Barrier D measure, $5,076,000,000 for the Inland Barrier E measure, $1,257,100,000 for the Inland Barrier F measure, $1,809,000,000 for the Inland Barrier G measure, $2,583,000,000 for the Inland Barrier H measure, $1,295,300,000 for the Inland Barrier I measure, $1,954,800,000 for the Inland Barrier J measure. Moreover, the total Operation and Maintenance (O&M) expenditures, which are based on the total present worth O&M costs over the period of analysis, are estimated to be $867,581,000 for the Inland Barrier A measure, $1,256,365,000 for the Inland Barrier B measure, $1,5556,235,000 for the Inland Barrier C measure, $864,754,000 for the Inland Barrier D measure, $1,257,707,000 for the Inland Barrier E measure, $333,305,000 for the Inland Barrier F measure, $482,518,000 for the Inland Barrier G measure, $696,444,000 for the Inland Barrier H measure, $338,857,000 for the Inland Barrier I measure, $522,460,000 for the Inland Barrier J measure. The following tables, 6.16-9 through 6.16-16, summarize the EIFS model inputs and outputs for the various measures.

6.17 Evaluation of Coast Wide Nonstructural Flood Damage Reduction Measures

6.17.1 *General*

This section describes the evaluation of nonstructural measures for the entire fifty-four planning sub-units that compose the MsCIP study area. Formulation of potential measures evaluated in this section was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC). There are a number of measures that can be classified as "nonstructural". In some cases such as dry flood proofing by the use of ring walls, a nonstructural measure can approximate a structural solution when expanded to protect a large contiguous complex (college campus, industry, or commercial area). When judiciously applied, nonstructural measures can result in reductions in inundation damages and losses of life to structure occupants.

6.17.2 *Opportunities*

The following opportunities were identified for the area:

- Hurricane storm damage reduction or remediation.
- Preservation of Fish and Wildlife.

Table 6.16-9.
EIFS Model Implementation Cost Inputs for the Inland Barrier Area

	Inland Barrier A	Inland Barrier B	Inland Barrier C	Inland Barrier D	Inland Barrier E	Inland Barrier F	Inland Barrier G	Inland Barrier H
Region of Influence (ROI)	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County
Change in Local Expenditures	$3,559,900,000	$5,039,300,000	$6,176,800,000	$3,329,500,000	$5,076,000,000	$1,257,100,000	$1,809,000,000	$2,583,000,000

Table 6.16-10.
EIFS Model Implementation Cost Inputs for the Inland Barrier Area

	Inland Barrier I	Inland Barrier J	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural	40-foot Nonstructural
Region of Influence (ROI)	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County
Change in Local Expenditures	$1,295,300,000	$1,954,800,000	$7,478,172,000	RFS	RFS	RFS

Based of the given implementation cost inputs the outputs are as followed:

Table 6.16-11.
EIFS Model Implementation Cost Outputs for the Inland Barrier Area

	Inland Barrier A	Inland Barrier B	Inland Barrier C	Inland Barrier D	Inland Barrier E	Inland Barrier F	Inland Barrier G
Direct Sales Volume	$3,559,900,000	$5,039,300,000	$6,176,800,000	$3,329,500,000	$5,076,000,000	$1,257,100,000	$1,809,000,000
Induced Sales Volume	$3,931,528,000	$5,565,951,000	$6,898,170,000	$3,643,528,000	$5,611,826,000	$1,554,878,000	$2,232,026,000
Total Sales Volume	$7,491,428,000	$10,605,251,000	$13,074,970,000	$6,973,028,000	$10,687,826,000	$2,811,978,000	$4,041,026,000
Direct Income	$810,567,613	$1,145,905,330	$1,395,933,868	$761,797,617	$1,153,673,815	$263,984,202	$379,177,804
Induced Income	$888,978,600	$1,256,935,279	$1,548,098,737	$828,016,097	$1,266,645,886	$326,762,954	$468,272,881
Total Income	$1,699,546,214	$2,402,840,609	$2,944,032,605	$1,589,813,714	$2,420,319,700	$590,747,156	$847,450,685
Direct Employment	21,916	31,000	38,093	20,453	31,233	7,895	11,332
Induced Employment	24,269	34,331	42,659	22,439	34,622	9,778	14,004
Total Employment	46,184	65,330	80,752	42,892	65,855	17,673	25,336
Local Population	0	0	0	0	0	0	0

Table 6.16-12.
EIFS Model Implementation Cost Outputs for the Inland Barrier Area

	Inland Barrier H	Inland Barrier I	Inland Barrier J	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural	40-foot Nonstructural
Direct Sales Volume	$2,583,000,000	$1,295,300,000	$1,954,800,000	$7,478,172,000	RFS	RFS	RFS
Induced Sales Volume	$3,194,170,000	$1,602,628,000	$2,414,276,000	$8,149,059,000	RFS	RFS	RFS
Total Sales Volume	$5,777,170,000	$2,897,928,000	$4,369,076,000	$15,627,232,000	RFS	RFS	RFS
Direct Income	$542,328,539	$272,070,199	$410,040,067	$1,711,127,000	RFS	RFS	RFS
Induced Income	$671,166,769	$336,870,453	$506,850,715	$1,852,321,000	RFS	RFS	RFS
Total Income	$1,213,495,308	$608,940,652	$916,890,782	$3,563,448,000	RFS	RFS	RFS
Direct Employment	16,219	8,138	12,258	45,830	RFS	RFS	RFS
Induced Employment	20,083	10,082	15,161	50,063	RFS	RFS	RFS
Total Employment	36,302	18,219	27,419	95,892	RFS	RFS	RFS
Local Population	0	0	0	0	RFS	RFS	RFS

Table 6.16-13.
EIFS Model Operation and Maintenance Cost Inputs for the Inland Barrier Area

	Inland Barrier A	Inland Barrier B	Inland Barrier C	Inland Barrier D	Inland Barrier E	Inland Barrier F	Inland Barrier G	Inland Barrier H
Region of Influence (ROI)	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County
Change in Local Expenditures	$867,581,000	$1,256,365,000	$1,556,235,000	$864,754,000	$1,257,707,000	$333,305,000	$482,518,000	$696,444,000

Table 6.16-14.
EIFS Model Operation and Maintenance Cost Inputs for the Inland Barrier Area

	Inland Barrier I	Inland Barrier J	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural	40-foot Nonstructural
Region of Influence (ROI)	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County	Jackson, Harrison & Hancock County
Change in Local Expenditures	$338,857,000	$522,460,000	$4,474,000	RFS	RFS	RFS

Based of the given implementation cost inputs the outputs are as followed:

Table 6.16-15.
EIFS Model Operation and Maintenance Cost Outputs for the Inland Barrier Area

	Inland Barrier A	Inland Barrier B	Inland Barrier C	Inland Barrier D	Inland Barrier E	Inland Barrier F	Inland Barrier G
Direct Sales Volume	$867,581,000	$1,256,365,000	$1,556,235,000	$864,754,000	$1,257,707,000	$333,305,000	$482,518,000
Induced Sales Volume	$949,794,000	$1,380,545,000	$1,732,946,000	$946,260,000	$1,382,223,000	$414,466,000	$597,786,000
Total Sales Volume	$1,817,375,000	$2,636,910,000	$3,289,181,000	$1,811,014,000	$2,639,930,000	$747,770,000	$1,080,304,000
Direct Income	$198,984,000	$287,002,000	$352,854,000	$198,385,000	$287,286,000	$70,275,000	$101,450,000
Induced Income	$216,353,000	$313,205,000	$390,161,000	$215,605,000	$313,561,000	$87,422,000	$125,767,000
Total Income	$415,337,000	$600,207,000	$743,015,000	$413,990,000	$600,846,000	$157,697,000	$227,218,000
Direct Employment	5,339	7,728	9,601	5,321	7,737	2,105	3,036
Induced Employment	5,860	8,514	10,721	5,838	8,525	2,620	3,765
Total Employment	11,199	16,242	20,321	11,158	16,262	4,725	6,801
Local Population	0	0	0	0	0	0	0

Table 6.16-16.
EIFS Model Operation and Maintenance Cost Outputs for the Inland Barrier Area

	Inland Barrier H	Inland Barrier I	Inland Barrier J	ABFE Nonstructural	20-foot Nonstructural	30-foot Nonstructural	40-foot Nonstructural
Direct Sales Volume	$696,444,000	$338,857,000	$522,460,000	$4,474,000	RFS	RFS	RFS
Induced Sales Volume	$864,109,000	$421,406,000	$647,713,000	$5,206,000	RFS	RFS	RFS
Total Sales Volume	$1,560,553,000	$760,262,000	$1,170,173,000	$9,680,000	RFS	RFS	RFS
Direct Income	$146,594,000	$71,450,000	$109,905,000	$960,000	RFS	RFS	RFS
Induced Income	$181,986,000	$88,891,000	$136,336,000	$1,113,000	RFS	RFS	RFS
Total Income	$328,581,000	$160,341,000	$246,241,000	$2,073,000	RFS	RFS	RFS
Direct Employment	4,388	2,140	3,289	27	RFS	RFS	RFS
Induced Employment	5,450	2,664	4,082	32	RFS	RFS	RFS
Total Employment	9,839	4,804	7,371	59	RFS	RFS	RFS
Local Population	0	0	0	0	RFS	RFS	RFS

6.17.3 Assumptions

The following assumptions were used in this analysis.

- The FY 2008 discount rate of 4-7/8 percent was used in estimating average annual benefits and costs.
- Price levels are FY-08, unless otherwise stated.
- A 100-year period of analysis (2012 to 2111) was used to calculate average annual benefits and costs.

6.17.4 Types of Nonstructural Measures

The nonstructural measures described below can be grouped into several general categories including:

- Flood Preparedness
- Floodplain Management, Floodplain Zoning and Flood Insurance
- Building codes
- Land Use Regulation and Zoning
- Development Impact Fees, TDR, TPR, and Redirection
- Land Taxation policies and development
- Flood proofing (elevation of structure in place, wet/dry proof, etc.)
- Permanent evacuations (acquisitions)
- Relocations of public buildings

Corps of Engineers documents and regulations as well as the technical papers and bulletins of other Federal and state agencies that address flooding from storms and hurricanes contain lists of possible nonstructural measures. Generally speaking, each of these identified measures can be applied either singly or in combination with other nonstructural or structural measures to attain project goals and planning objectives. In an effort to simplify the formulation of nonstructural plans, the NSFPC went through an initial screening process to determine which plans were feasible for detailed evaluation. The screening process used by the NSFPC for each of these types of measures can be found in the Nonstructural Appendix.

6.17.5 Historic Conditions

The Mississippi Gulf Coast is no stranger to large storm surge events. On August 17, 1969, Hurricane Camille impacted the area in a similar fashion to Hurricane Katrina. Hurricane Camille made landfall at Bay St. Louis, Mississippi only a few miles way from Hurricane Katrina's landfall path. The total surge area ranged from lower Plaquemines Parish in Louisiana to Perdido Pass, Alabama. Maximum surge from Hurricane Camille on the Mississippi coast ranged from 21.7-feet above m.s.l. in planning unit one, to 24.2-feet above m.s.l. in planning unit two, and 15.8-feet above m.s.l. in planning unit 3.

Damage to the Mississippi Coast from Hurricane Camille was extensive. Federal relief expenditures topped 100 million dollars at 1970 prices, over 600 million dollars at today's prices after accounting for inflation. The magnitude of this number is astounding considering that many of the relief programs that exist today did not exist for Hurricane Camille. Chapter IV of this appendix describes in detail damage statics caused by Hurricane Camille surge inundation.

6.17.6 Existing Conditions

On August 29, 2005, Hurricane Katrina made land fall in Hancock County, Mississippi just east of the Pearl River. By virtually all accounts, it was the single largest disaster in U.S. history. Storm surge from Hurricane Katrina was the largest that has ever hit the continental United States. The surge inundated approximately 484 square miles of southern Mississippi. The relief expenditures in Mississippi alone have totaled in the billions of dollars. Figure 6.17-1 shows the inundation footprint of Hurricane Katrina.

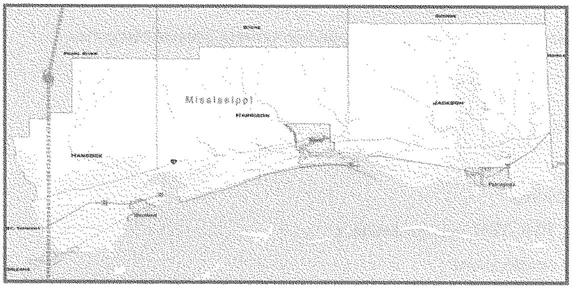


Figure 6.17-1. Hurricane Katrina Path and Extent of Hurricane Katrina Surge in Planning Units One, Two, and Three

The three planning units suffered tremendous devastation from Hurricane Katrina's surge. The PDT estimates that 32,446 structures were significantly destroyed (at least fifty-percent or more), with another 15,000 to 25,000 suffering moderate to minimal inundation damage. Of the structures sustaining significant destruction, 9,555 were in planning unit one, 16,528, in planning unit two, and 6,363 in planning unit three. Of those significant loss structures, approximately 19,000 claims were paid out by the Federal Emergency Management Agency's (FEMA's) National Flood Insurance Program (NFIP) totally over $2.3 Billion dollars, with the average claim around $137,000. Currently, no accurate data exists for uninsured losses, but estimates range in the billions of dollars. Table 6.17-1 displays the significantly damaged structures by planning unit and by structure category. Chapter IV of this appendix describes in greater detail the coast wide damage caused by Hurricane Katrina surge inundation.

Table 6.17-1.
Structures Damaged 50% or More by Planning Unit and by Category

	Planning Unit One	Planning Unit Two	Planning Unit Three	Total
Commercial	1,267	1,794	378	**3,439**
Residential	8,099	14,500	5,780	**28,379**
Municipal	127	89	136	**352**
Mobile Home	62	145	69	**276**
Total	**9,555**	**16,528**	**6,363**	**32,446**

Source: Field inventory conducted by the Corps PDT.

6.17.7 Without-Project Conditions

This section summarizes the coast wide future without-project conditions used as the basis for the evaluation of nonstructural measures. Future without-project conditions are defined as the characteristics of the area over the period of analysis should no federal project be implemented. The coast wide future without-project conditions are described in greater detail in Chapter IV of this appendix.

Given the vast devastation caused by hurricane Katrina, the projection of the future without-project conditions contains significant uncertainty. In an attempt to reduce this uncertainty, scenario testing was implemented. Scenario testing is where multiple future scenarios are created in order to evaluate what would happen if observed variables or assumptions do not happen as projected, and attempts to answer the 'what if' questions that arise when making forecasting assumptions and predictions. Table 6.17-2 summarizes the six future-without project scenarios created for the MsCIP Comprehensive Plan. As described in chapter IV, Future without-project scenarios one and two are for testing the sensitivity of effects of the increment between a no relative sea level rise scenario and the expected relative sea level rise scenario. Therefore, only future without-project scenarios three, four, five, and six were used to evaluate the nonstructural measures.

Table 6.17-2.
Overview of Future Scenarios

Future Scenario	Redevelopment Type	Relative Sea Level Rise	Description
Future Scenario 1	Residential	None	Rebuild structures as existed pre-Hurricane Katrina with no relative sea level rise over the period of analysis. This future scenario applies to all three planning units.
Future Scenario 2	Mixed Residential & Commercial	None	Rebuild structures as existed pre-Hurricane Katrina except at water front where condo/casino rebuild will occur. Also, no relative sea level rise over the period of analysis. This future scenario applies only to planning units one and two. Planning unit three would not allow commercial type redevelopment based on local ordinances.
Future Scenario 3	Residential	Expected (up to 2.4-feet depending on location)	Rebuild structures as existed pre-Hurricane Katrina with up to 2.4-feet relative sea level rise over the period of analysis. This future scenario applies to all three planning units.
Future Scenario 4	Mixed Residential & Commercial	Expected (up to 2.4-feet depending on location)	Rebuild structures as existed pre-Hurricane Katrina except at water front where condo/casino rebuild will occur. Also, a up to 2.4-feet relative sea level rise over the period of analysis. This future scenario applies only to planning units one and two. Planning unit three would not allow commercial type redevelopment based on local ordinances.
Future Scenario 5	Residential	High Rate (up to 3.4-feet depending on location)	Rebuild structures as existed pre-Hurricane Katrina with up to 3.4-feet of relative sea level rise over the period of analysis. This future scenario applies to all three planning units.
Future Scenario 6	Mixed Residential & Commercial	High Rate (Up to 3.4-feet depending on location)	Rebuild structures as existed pre-Hurricane Katrina except at water front where condo/casino rebuild will occur. Also, up to 3.4-feet of relative sea level rise over the period of analysis This future scenario applies only to planning units one and two. Planning unit three would not allow commercial type redevelopment based on local ordinances.

Future Scenarios One and Two are included only to evaluate the effects of relative sea level rise. These Future scenarios will not be used in the evaluation of potential measures. Futures Three, Four, Five, and Six will be the future scenarios by which potential measures will be evaluated depending on the planning unit.

Tables 6.17-3, 6.17-4, and 6.17-5 summarize the structure inventory for future without-project scenarios three and five.

Table 6.17-3.
Futures Without-Project Scenarios Three and Five Inventory
Parcels by Planning Unit and by Structure Category

Structure Categories	Planning Unit One	Planning Unit Two	Planning Unit Three	Total
Residential	17,907	49,121	49,688	**116,716**
Mobile Homes	498	2,497	3,553	**6,548**
Commercial	3,255	5,618	4,266	**13,139**
Municipal	653	351	763	**1,767**
Vacant Land	22,843	29,984	29,779	**82,606**
Total	**45,156**	**87,571**	**88,049**	**220,776**

Table 6.17-4.
Futures Without Project Scenarios Three and Five Inventory Cumulative Structures for All Three Planning Units by Structure Category and One-foot Elevation

Estimated First Floor Elevation (NAVD88)	Residential	Mobile Homes	Commercial	Municipal	Total
1-foot	19	1	2	1	**23**
2-foot	115	1	16	4	**136**
3-foot	411	2	42	18	**473**
4-foot	1,015	2	88	34	**1,139**
5-foot	2,566	20	143	52	**2,781**
6-foot	3,117	77	196	68	**3,458**
7-foot	3,975	129	270	87	**4,461**
8-foot	5,111	183	350	108	**5,752**
9-foot	6,475	226	463	130	**7,294**
10-foot	8,012	270	576	163	**9,021**
11-foot	10,381	321	730	194	**11,626**
12-foot	14,068	396	1,064	256	**15,784**
13-foot	18,411	507	1,537	352	**20,807**
14-foot	22,416	617	2,128	465	**25,626**
15-foot	31,139	779	3,424	629	**35,971**
16-foot	34,210	878	3,829	692	**39,609**
17-foot	37,925	1,006	4,125	774	**43,830**
18-foot	42,793	1,144	4,771	865	**49,573**
19-foot	47,914	1,368	5,650	942	**55,874**
20-foot	56,895	1,606	7,244	1,089	**66,834**
21-foot	60,673	1,784	7,809	1,154	**71,420**
22-foot	64,417	1,960	8,158	1,221	**75,756**
23-foot	71,143	2,174	8,893	1,293	**83,503**
24-foot	75,711	2,331	9,295	1,345	**88,682**
25-foot	79,957	2,473	9,633	1,392	**93,455**
26-foot	83,944	2,648	9,901	1,428	**97,921**
27-foot	86,948	2,788	10,144	1,463	**101,343**
28-foot	89,743	2,887	10,405	1,487	**104,522**
29-foot	92,130	2,986	10,634	1,502	**107,252**

Table 6.17-4.
Futures Without Project Scenarios Three and Five Inventory Cumulative Structures for All Three Planning Units by Structure Category and One-foot Elevation (continued)

Estimated First Floor Elevation (NAVD88)	Residential	Mobile Homes	Commercial	Municipal	Total
30-foot	94,042	3,057	10,873	1,521	**109,493**
31-foot	95,586	3,158	11,114	1,535	**111,393**
32-foot	96,621	3,242	11,324	1,545	**112,732**
33-foot	97,531	3,300	11,450	1,555	**113,836**
34-foot	98,165	3,364	11,559	1,572	**114,660**
35-foot	98,669	3,429	11,623	1,584	**115,305**
36-foot	99,075	3,481	11,651	1,590	**115,797**
37-foot	99,498	3,532	11,682	1,598	**116,310**
38-foot	99,952	3,589	11,711	1,600	**116,852**
39-foot	100,478	3,644	11,747	1,605	**117,474**
40-foot	116,716	6,548	13,139	1,767	**138,170**

Table 6.17-5.
Futures Without-Project Scenarios Three and Five Inventory Structure and Content Values by Category and Planning Unit

	Planning Unit One	Planning Unit Two	Planning Unit Three	Total
Structure Values				
Residential	$2,415,885,807	$4,449,184,443	$3,200,940,955	**$10,066,011,205**
Mobile Homes	$8,518,174	$48,312,941	$52,053,731	**$108,884,846**
Commercial	$611,355,705	$4,526,104,161	$2,048,940,654	**$7,186,400,520**
Municipal	$335,220,287	$261,009,884	$303,986,556	**$900,216,727**
Structure Value Subtotal	**$3,370,979,973**	**$9,284,611,429**	**$5,605,921,896**	**$18,261,513,298**
Content Values				
Residential	$2,415,885,807	$4,449,184,443	$3,200,940,955	**$10,066,011,205**
Mobile Homes	$12,606,898	71503152.68	77039521.88	**$161,149,573**
Commercial	$1,213,472.28	$2,388,618,644	$428,362,111	**$2,818,194,227**
Municipal	$135,597,922	$102,609,763	$102,022,049	**$340,229,734**
Content Value Subtotal	**$2,565,304,099**	**$7,011,916,003**	**$3,808,364,637**	**$13,385,584,739**
Total	**$5,936,284,072**	**$16,296,527,432**	**$9,414,286,533**	**$31,647,098,037**

Tables 6.17-6, 6.17-7, and 6.17-8 summarize the structure inventory for future without-project scenarios four and six.

Table 6.17-6.
Futures Without-Project Scenarios Four and Six
Inventory Parcels by Planning Unit and by Structure Category

Structure Categories	Planning Unit One	Planning Unit Two	Planning Unit Three	Total
Residential	17,757	2,497	49,688	**69,942**
Mobile Homes	498	48,636	3,553	**52,687**
Commercial	3,408	6,101	4,266	**13,775**
Municipal	651	381	763	**1,795**
Vacant Land	22,842	29,956	29,779	**82,577**
Total	**45,156**	**87,571**	**88,049**	**220,776**

Table 6.17-7.
Futures Without-Project Scenarios Four and Six Inventory Cumulative Structures for All Three Planning Units by Structure Category and One-foot Elevation

Elevation (NAVD88)	Residential	Mobile Homes	Commercial	Municipal	Total
1-foot	19	1	3	1	**24**
2-foot	111	1	17	4	**133**
3-foot	403	2	43	18	**466**
4-foot	1,003	2	89	34	**1,128**
5-foot	2,543	20	144	52	**2,759**
6-foot	3,080	77	197	68	**3,422**
7-foot	3,932	129	271	87	**4,419**
8-foot	5,055	183	351	108	**5,697**
9-foot	6,408	226	464	130	**7,228**
10-foot	7,934	270	577	163	**8,944**
11-foot	10,291	321	730	194	**11,536**
12-foot	13,954	396	1,069	256	**15,675**
13-foot	18,266	507	1,546	352	**20,671**
14-foot	22,220	617	2,147	465	**25,449**
15-foot	30,880	779	3,468	630	**35,757**
16-foot	33,923	878	3,930	692	**39,423**
17-foot	37,611	1,006	4,272	775	**43,664**
18-foot	42,439	1,144	4,949	866	**49,398**
19-foot	47,513	1,368	5,840	943	**55,664**
20-foot	56,412	1,606	7,398	1,089	**66,505**
21-foot	60,178	1,784	7,975	1,153	**71,090**
22-foot	63,910	1,960	8,365	1,220	**75,455**
23-foot	70,535	2,174	9,137	1,292	**83,138**
24-foot	75,091	2,331	9,590	1,344	**88,356**
25-foot	79,328	2,473	9,986	1,391	**93,178**
26-foot	83,308	2,648	10,301	1,427	**97,684**

Table 6.17-7.
Futures Without-Project Scenarios Four and Six Inventory Cumulative Structures for All Three Planning Units by Structure Category and One-foot Elevation (continued)

Elevation (NAVD88)	Residential	Mobile Homes	Commercial	Municipal	Total
27-foot	86,314	2,788	10,584	1,462	**101,148**
28-foot	89,112	2,887	10,878	1,486	**104,363**
29-foot	91,498	2,986	11,147	1,501	**107,132**
30-foot	93,409	3,057	11,406	1,520	**109,392**
31-foot	94,952	3,158	11,677	1,534	**111,321**
32-foot	95,986	3,242	11,902	1,544	**112,674**
33-foot	96,897	3,300	12,053	1,554	**113,804**
34-foot	97,531	3,364	12,178	1,571	**114,644**
35-foot	98,035	3,429	12,247	1,583	**115,294**
36-foot	98,441	3,481	12,278	1,589	**115,789**
37-foot	98,864	3,532	12,315	1,597	**116,308**
38-foot	99,318	3,589	12,345	1,599	**116,851**
39-foot	99,844	3,644	12,381	1,604	**117,473**
40-foot	116,081	6,548	13,775	1,795	**138,199**

Table 6.17-8.
Future Without-Project Scenarios Four and Six Inventory Structure and Content Values by Category and Planning Unit

	Planning Unit One	Planning Unit Two	Planning Unit Three	Total
	Structure Values			
Residential	$2,390,977,748	$4,402,477,082	$3,200,940,955	**$9,994,395,785**
Mobile Homes	$8,518,168	$48,312,740	$52,053,731	**$108,884,639**
Commercial	$1,500,399,292	$4,233,140,761	$2,048,940,654	**$7,782,480,707**
Municipal	$334,734,608	$261,025,195	$303,986,556	**$899,746,359**
Structure Value Subtotal	**$4,234,629,816**	**$8,944,955,778**	**$5,605,921,896**	**$18,785,507,490**
	Content Values			
Residential	$2,390,977,748	$4,402,477,082	$3,200,940,955	**$9,994,395,785**
Mobile Homes	$12,606,888.64	$71,502,855.20	$77,039,521.88	**$161,149,266**
Commercial	$1,473,899,310	$2,498,045,931	$428,362,111	**$4,400,307,352**
Municipal	$135,240,760	$102,280,080	$102,022,049	**$339,542,889**
Content Value Subtotal	$4,012,724,707	$7,074,305,948	$3,808,364,637	**$14,895,395,292**
Total	**$8,247,354,523**	**$16,019,261,726**	**$9,414,286,533**	**$33,680,902,782**

Equivalent annual damages for future without-project scenarios three, four, five, and six were estimated using the HEC-FDA program and based on the structure inventories described in the previous tables. Table 6.17-9 summarizes the equivalent annual damages for those scenarios. More detail can be found in chapter IV.

Table 6.17-9.
Equivalent Annual Without-Project Damages by Planning Unit and Future Scenario

Without-Project Damages	Future 3 Damages	Future 4 Damages	Future 5 Damages	Future 6 Damages
Planning Unit One	$218,050,000	$222,220,000	$237,310,000	$241,520,000
Planning Unit Two	$103,280,000	$107,120,000	$115,470,000	$119,760,000
Planning Unit Three	$104,700,000	$104,700,000	$122,420,000	$122,420,000
Total	**$426,040,000**	**$434,040,000**	**$475,200,000**	**$483,700,000**

1/ Damages are rounded to the nearest thousand.
2/ Futures Two, Four, and Six do not apply to planning unit three, therefore total damages are the same as future scenarios one, three, and five.

6.17.8 Equivalent Annual Damages Reduced and Residual Damages

Equivalent annual damages reduced are calculated as the difference between the damages under the future without-project scenarios three and five and the damages incurred with the measure in place. The HEC-FDA model was run for each measure to determine the damages reduced as compared to the without-project scenario.

In order to provide the HEC-FDA model with accurate information about the economic characteristics of each measure, separate inventories were created for each of the nonstructural measures. The inventories are the same as the without project inventory except that footprints of the acquisitions were deleted from the inventory and floodproofed structures (structures to be elevated in place) were given a higher elevation. The structure inventories for each of the HEC-FDA measure runs are as follows:

- NS-Measure A Acquisition and Floodproofing to Advisory Base Flood Elevation (ABFE) Level

This measure includes the acquisition of 33,198 structures and vacant parcels and the flood proofing (raise structure in place) of 25,419 structures to the ABFE elevation that is applicable for the planning sub-unit. This elevation was determined to be approximately the ABFE level of protection and is defined as still water elevation, plus wave run-up, plus an estimate for waves (depth divided by two), and is the minimum implementation elevation that a nonstructural measure do to the requirements of the National Flood Insurance Program (NFIP).The formulation process for this measure was conducted by the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and is detailed in the nonstructural appendix. Figure 6.17-2 shows the areas included in this plan. Figures 6.17-3, 6.17-4, and 6.17-5 show the same areas by planning unit.

- NS Measure B: Acquisition and Floodproofing to elevation 20.0-feet NAVD88

Requires Further Study

- NS Measure C: Acquisition and Floodproofing to elevation 30.0-feet NAVD88

Requires Further Study

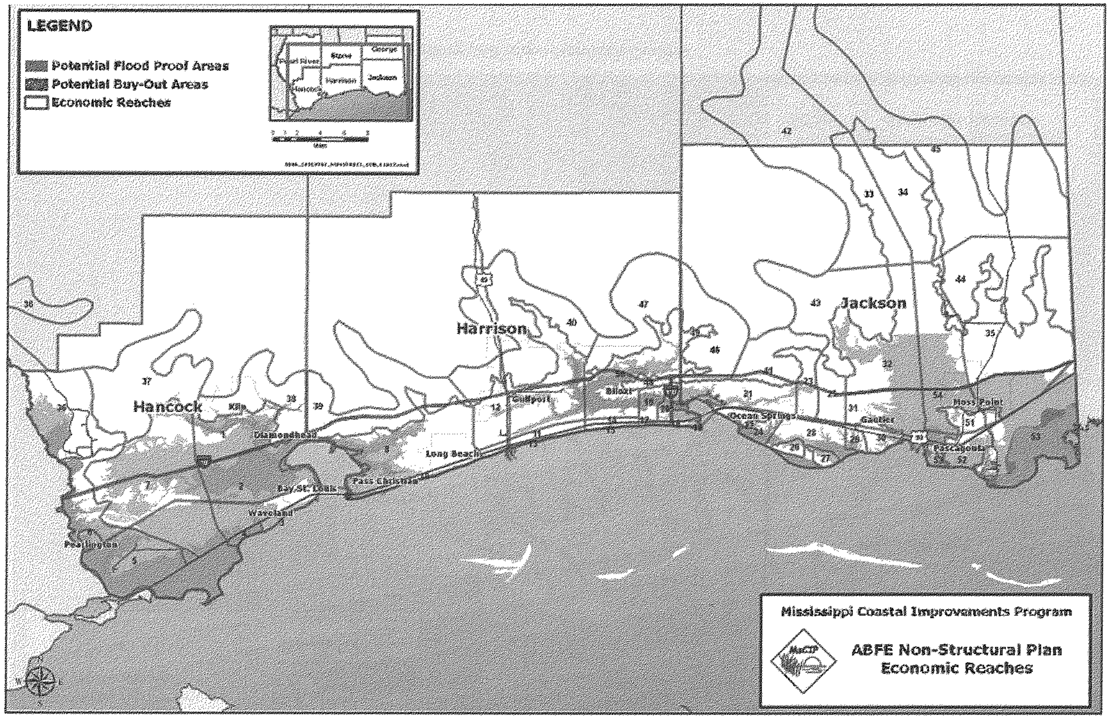


Figure 6.17-2. Nonstructural ABFE measure footprint

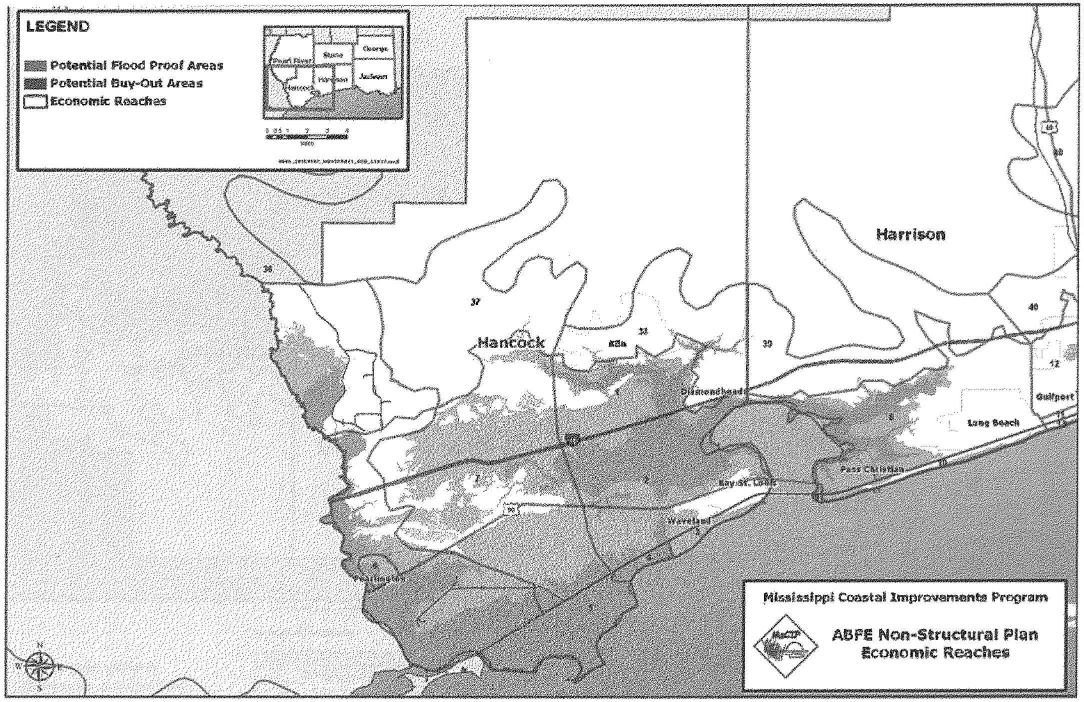


Figure 6.17-3. Nonstructural ABFE measure for planning unit one – Hancock County

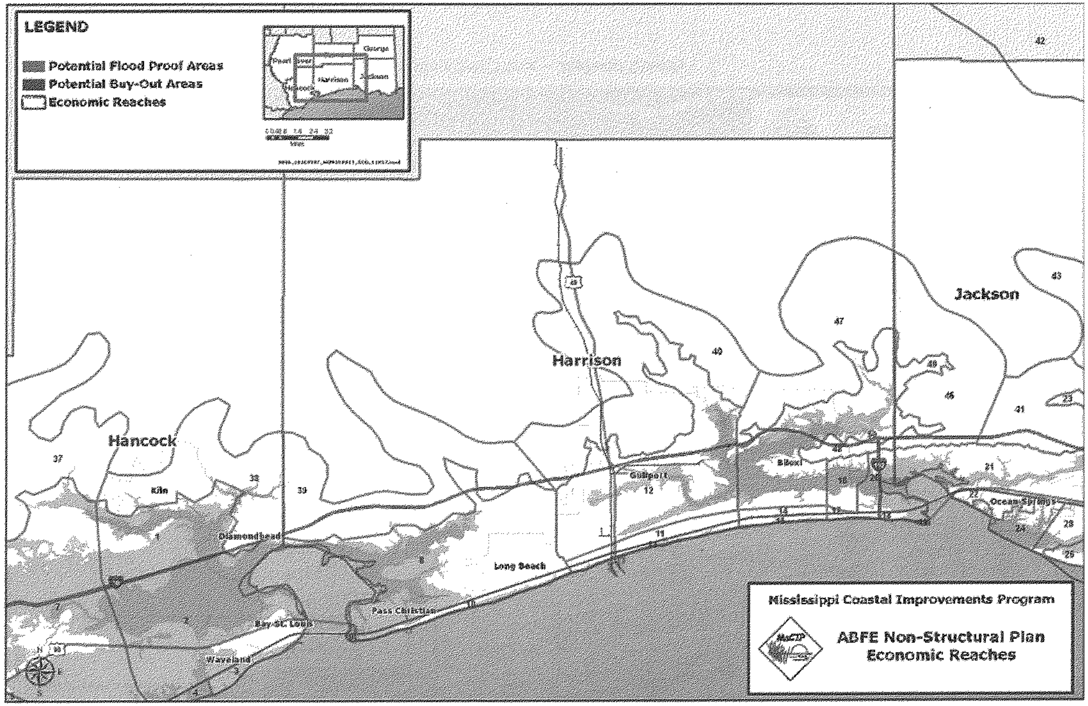


Figure 6.17-4. Nonstructural ABFE measure for Planning Unit Two – Harrison County

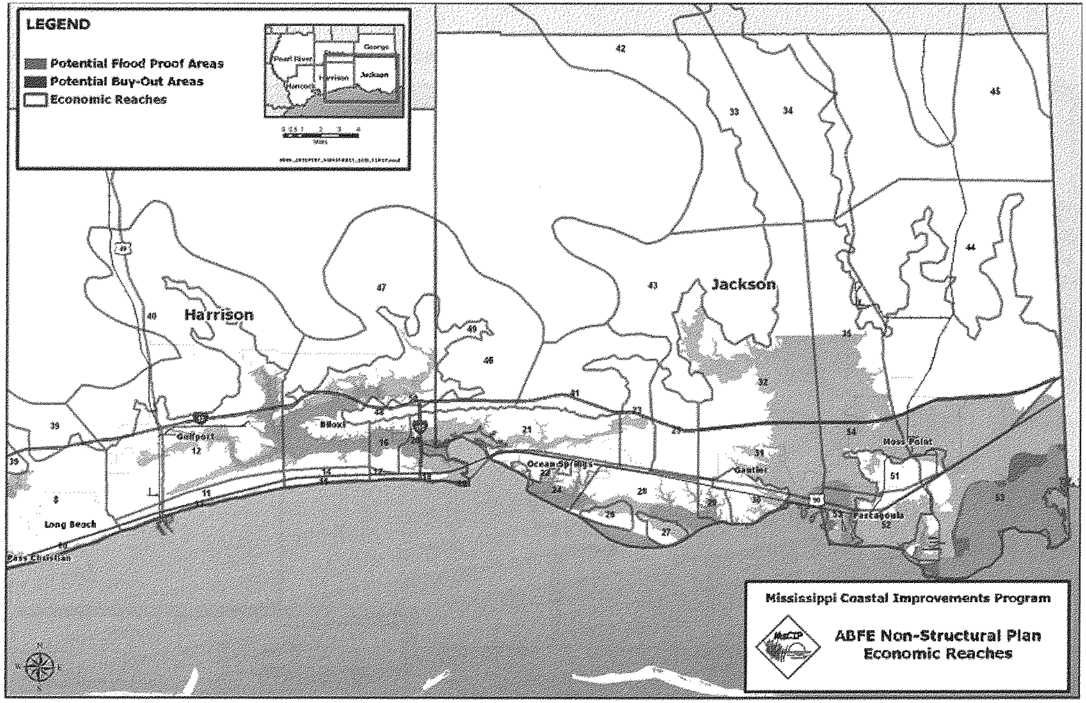


Figure 6.17-5. Nonstructural ABFE Measure for Planning Unit Three – Jackson County

- NS Measure D: Acquisition and Floodproofing to elevation 40.0-feet NAVD88

Requires Further Study

Residual damage is the equivalent annual damages that still remain even when a project is in place. Residual damage is calculated as the future without-project equivalent annual damages minus the damages reduced of the various measures. The purpose of residual damage is to calculate and communicate the portions of damages that will not be reduced by the implementation of a plan or "what damages are left on the table."

6.17.9. Summary of Damages

Table 6.17-10 summarizes the without-project damages, damages reduced, and residual damages by measure for scenarios three and five.

Table 6.17-10.
Summary of Damages by Potential Measure for Future Scenarios Three and Five

Measures	Equivalent Annual Damages Future 3 ($)	Equivalent Annual Damage Reduction Future 3 ($)	Residual Damage Future 3 ($)	Equivalent Annual Damages Future 5 ($)	Equivalent Annual Damage Reduction Future 5 ($)	Residual Damage Future 5 ($)
(No Action)	$0	$0	$0	$0	$0	$0
Measure A ABFE Nonstructural	$426,040,000	$280,705,000	$145,335,000	$475,200,000	$307,305,000	$167,895,000
Measure B 20FT Nonstructural	RFS	RFS	RFS	RFS	RFS	RFS
Measure C 30FT Nonstructural	RFS	RFS	RFS	RFS	RFS	RFS
Measure D 40FT Nonstructural	RFS	RFS	RFS	RFS	RFS	RFS

Damages are rounded to the nearest thousand dollars
RFS – Requires Further Study

Table 6.17-11 summarizes the without-project damages, damages reduced, and residual damages by measure for scenarios four and six.

Table 6.17-11.
Summary of Damages by Potential Measure for Future Scenarios Four and Six

Measures	Equivalent Annual Damages Future 4 ($)	Equivalent Annual Damage Reduction Future 4 ($)	Residual Damage Future 4 ($)	Equivalent Annual Damages Future 6 ($)	Equivalent Annual Damage Reduction Future 6 ($)	Residual Damage Future 6 ($)
(No Action)	$0	$0	$0	$0	$0	$0
Measure A ABFE Nonstructural	$434,040,000	$286,706,000	$147,334,000	$483,700,000	$311,333,000	$172,367,000
Measure B 20FT Nonstructural	RFS	RFS	RFS	RFS	RFS	RFS
Measure C 30FT Nonstructural	RFS	RFS	RFS	RFS	RFS	RFS
Measure D 40FT Nonstructural	RFS	RFS	RFS	RFS	RFS	RFS

Damages are rounded to the nearest thousand dollars.
RFS – Requires Further Study

6.17.10 Summary of Costs

Table 6.17-12 summarizes the costs by measure.

Table 6.17-12.
Summary of Costs by Nonstructural Measure

Measures	Total Cost to Implement (First Cost) ($)	Average Annual Implementation Cost ($)	Average Annual O&M ($)	IDC[1] ($)	Total Average Annual Costs ($)
(No Action)	$0	$0	$0	$0	$0
Measure A ABFE Nonstructural	$16,782,494	$825,216,000	$400,000	N/A	$825,616,000
Measure B 20FT Nonstructural	RFS[2]	RFS	RFS	N/A	RFS
Measure C 30FT Nonstructural	RFS	RFS	RFS	N/A	RFS
Measure D 40FT Nonstructural	RFS	RFS	RFS	N/A	RFS

1/ Due to the massive scale and extended time frame of implementation of the coast wide nonstructural plans, IDC is not able to be calculated at this time. 2/ RFS – Requires Further Study.

6.17.11 Alternative Land Use

Each of the nonstructural measures contains some portion of the plan that consists of the acquisition of structures and parcels. Should any of the plans be implemented, the land contained in the footprint could never be used again for habitable use. However, there are alternative uses of land for these areas such as recreational areas, ecotourism areas, or environmental restoration. Each of these alternative uses of the acquisition area land would have associated benefits and costs. Further study would be required to determine the most cost effective use of the acquisition lands.

6.17.12 Other Social and Economic Benefits

In addition to the direct structure damage reduction benefits and the alternative use of land, acquisition of structures would have other social and economic benefits. These benefits include the reduction of risk to health and human safety, reduction of evacuation and subsistence costs (travel and stay to evacuate, non-profit assistance such as food, etc.), reduction of emergency costs following storm events (debris removal, temporary housing, etc.), reduction of residential reoccupation costs, reduction of commercial clean-up costs, and future infrastructure savings to the tax base for roads and utilities. For example, the bullets below are from the Louisiana Coastal Master Plan[4] estimates for damages in these categories. These numbers are based on Louisiana data and do not apply for Coastal Mississippi, but provide a sense of the potential costs savings that could be reduced.

- Combined federal, state, parish and municipality spending average of $1,450 for inundated residential structures and $3,850 for inundated non-residential structures,
- Evacuation and subsistence costs of up to $21,284 per household at risk,
- Reoccupation costs of up to $7,133 per inundated residential structure,
- Commercial clean-up and restoration costs of up to $16, 245 per inundated commercial structure.

Although these benefits can be shown on a per structure basis, significant economies of scale can be achieved with the acquisition of clusters of structures including streets, neighborhoods, and communities. Due to timing constraints of the study, quantifiable dollar amounts for these benefit categories could not be identified, but would be estimated as part of implementation or further study. Careful coordination between the Corps and local stakeholders would be required prior to implementation in order to optimize the economic efficiencies that could be gained from acquisition of parcels.

6.17.13 Summary of Regional Economic Development Benefits

The purpose of this section is to show the economic impact of the proposed measure on business (sale volumes), income, employment, and population of the local area. Each of the measures would affect the local area of the three coastal counties of Mississippi. The first cost expenditures for the ABFE nonstructural measure are estimated to be $15,394,143,000, with an additional $8,134,000 for the total present worth of the operation and maintenance (O&M) expenditures assuming a 100-year period of analysis and an FY 08 discount rate of 4.875-percent. The 20FT elevation, 30FT elevation, and 40FT elevation coast wide nonstructural plans require further study to determine regional impacts. The following tables, 6.17-13 through 6.17-16, summarize the EIFS model inputs and outputs for the coast wide nonstructural plan.

[4] Louisiana Coastal Master Plan Appendix F: Economic Analysis.

Table 6.17-13.
EIFS Model Construction Costs Inputs for the Nonstructural Measures

	ABFE Nonstructural	20-Foot Nonstructural	30-Foot Nonstructural	40-Foot Nonstructural
Region of Influence (ROI)	Hancock, Harrison, and Jackson Counties	Hancock, Harrison, and Jackson Counties	Hancock, Harrison, and Jackson Counties	Hancock, Harrison, and Jackson Counties
Change in Local Expenditures	$16,782,494,000	RFS	RFS	RFS

RFS – Requires Further Study

Based of the given inputs the outputs are as followed:

Table 6.17-14.
EIFS Model Construction Costs Outputs for the Nonstructural Measures

	ABFE Nonstructural	20-Foot Nonstructural	30-Foot Nonstructural	40-Foot Nonstructural
Direct Sales Volume	$16,782,494,204	RFS	RFS	RFS
Induced Sales Volume	$18,593,365,860	RFS	RFS	RFS
Total Sales Volume	$35,375,860,065	RFS	RFS	RFS
Direct Income	$3,668,506,993	RFS	RFS	RFS
Induced Income	$4,041,514,947	RFS	RFS	RFS
Total Income	$7,710,021,941	RFS	RFS	RFS
Direct Employment	100,952	RFS	RFS	RFS
Induced Employment	112,040	RFS	RFS	RFS
Total Employment	212,992	RFS	RFS	RFS
Local Population	0	RFS	RFS	RFS

RFS – Requires Further Study

Table 6.17-15.
EIFS Model O&M Costs Inputs for the Nonstructural Measures

	ABFE Nonstructural	20-Foot Nonstructural	30-Foot Nonstructural	40-Foot Nonstructural
Region of Influence (ROI)	Hancock, Harrison, and Jackson Counties	Hancock, Harrison, and Jackson Counties	Hancock, Harrison, and Jackson Counties	Hancock, Harrison, and Jackson Counties
Change in Local Expenditures	$8,134,000	RFS	RFS	RFS

RFS – Requires Further Study

Based of the given inputs the outputs are as followed:

Table 6.17-16.
EIFS Model O&M Costs Outputs for the Nonstructural Measures

	ABFE Nonstructural	20-Foot Nonstructural	30-Foot Nonstructural	40-Foot Nonstructural
Direct Sales Volume	$8,134,000	RFS	RFS	RFS
Induced Sales Volume	$9,261,000	RFS	RFS	RFS
Total Sales Volume	$17,395,000	RFS	RFS	RFS
Direct Income	$1,718,000	RFS	RFS	RFS
Induced Income	$1,950,000	RFS	RFS	RFS
Total Income	$3,668,000	RFS	RFS	RFS
Direct Employment	49	RFS	RFS	RFS
Induced Employment	56	RFS	RFS	RFS
Total Employment	105	RFS	RFS	RFS
Local Population	0	RFS	RFS	RFS

RFS – Requires Further Study

6.18 Forrest Heights Levee, City of Gulfport, Harrison County

6.18.1 General

The culturally historical Forest Heights residential community in the City of Gulfport, Harrison County, Mississippi, has frequently been inundated by flood waters due to storm surges from the Mississippi Sound and from inland flooding along the lower Turkey Creek. Water reached a depth of 2-8 ft over the entire community during Hurricane Katrina inundation. The Forest Heights levee is proposed to be constructed as a pilot project for the MsCIP comprehensive plan. The levee will address the combination of storm surge protection, inland flooding protection, and evacuation. The levee is intended to be constructed to a height such that the levee might be certified under the National Flood Insurance Program. A preliminary engineering analysis suggests a levee built to approximately elevation 21 feet NAVD '88 would satisfy or exceed certification elevation criteria.

Engineering performance and economic evaluations of protection options were done using the Hydrologic Engineering Center's (HEC) Flood Damage Analysis (FDA) computer application HEC-FDA. HEC-FDA modeling was done using variations in with-project conditions compared to the future without-project conditions for the Turkey Creek study. Details regarding the methodology are presented in the Economic Appendix. Additional evaluation to determine the precise levee height will be performed during final engineering and design based upon analyzing the risk and uncertainty associated with the coincident occurrence of inland flooding and storm surge impacts.

6.18.2 Location

The Forrest Heights community is located in an area known as North Gulfport within the City of Gulfport on the Mississippi Gulf Coast. The location of the levee at Forrest Heights is shown below in Figures 6.18-1. The community lies along the lower Turkey Creek floodplain, which has a tendency to frequently exceed its stream channel capacity and flood adjacent low-lying areas.

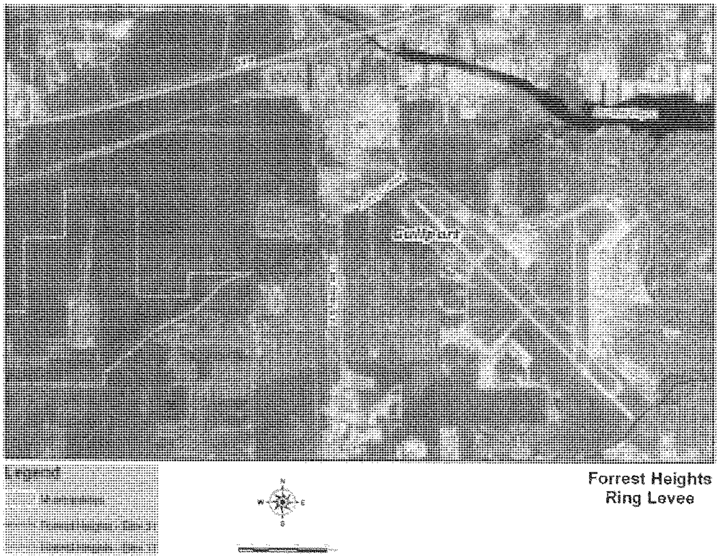


Figure 6.18-1. Forrest Heights Ring Levee Location

6.18.3 Assumptions

- The New Orleans District Corps of Engineers fresh water depth-damage relationships for residential and non-residential property were considered appropriate and accurate for the properties in this area,
- 50-year period of analysis,
- FY 2008 Federal discount rate of 4.875-percent,
- All values are equivalent to October 2007 dollars.

6.18.4 Existing Conditions

The community of Forrest Heights lies on the bank of Turkey Creek about 2.6 miles from the mouth at Bernard Bayou. Ground elevations over most of the residential area are between elevations 10-14 ft NAVD88. Drainage is mostly along streets and through natural drainage ways to the Turkey Creek. Impacts from flooding and hurricanes have been devastating. Hurricane Katrina in August, 2005 resulted in significant flood damages to residences in the Forrest Heights community. A levee with top width of 6 ft was constructed around the community to elevation 16.5 ft NGVD with side slopes of 1 vertical to 1.5 horizontal in 1969, prior to Hurricane Camille. It has not had adequate maintenance and is a state of disrepair. It is scheduled to be restored to as-built condition by January of 2009. However, the restored levee will not be sufficient to meet the present day standard for certification according to the existing FEMA flood profiles in the vicinity. It is assumed that the as-built condition of this restored levee will be the existing condition for this report.

6.18.5 Without-Project Conditions

The without-project condition is the most likely case to occur during the 50-year period when a project could be in place. Because the Forrest Heights area has been developed since the 1800's, all of the usable land within the community is presently developed and rebuilt since Hurricane Katrina. Damages considered in the analysis were inundation damages and emergency cost damages that would occur from future storm events. Inundation damages and damages reduced were estimated using the Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA) computer software program. Three future without-project scenarios were identified for the Forrest Heights area: existing relative sea level rise, moderate relative sea level rise and high relative sea level rise.

6.18.5.1 Coastal Hydraulic Data

This section describes the development of the existing relative sea level rise scenario. High water marks taken by FEMA after Hurricane Katrina in 2005 as well as the 4-ft(blue), 8-ft(dark green), 12-ft(green), 16-ft(brown), 20-ft(orange), and 20-ft(pink) ground contour lines and Hurricane Katrina inundation limits are shown below in Figure 6.18-2. The data indicates the water was as high as 18-20 ft NAVD88 near the site, totally inundating the entire area.

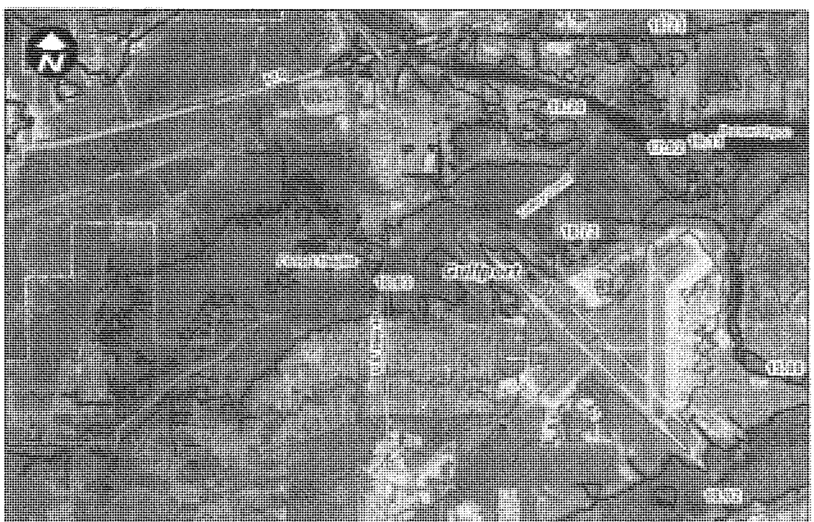


Figure 6.18-2. Hurricane Katrina Inundation and High Water, Forrest Heights

Stage-Frequency data for a suite of severe storms using Joint Probability Method (JPM) and hydrodynamic modeling were developed by the Engineer Research and Development Center (ERDC) for 80 locations along the study area. These data were combined with historical coastal tide gage frequencies for smaller storms to establish stage-frequency curves at 54 economic reaches in the study area. An expanded description of the procedure is presented in Section 2.13 of the Engineering Appendix. Points near Forrest Heights, at which data from hydrodynamic modeling was saved, are displayed in Table 6.18-1.

Table 6.18-1.
Surge Stage-Probability and Uncertainty

Annual Probability	Stage (Ft. NAVD88)	Standard Deviation (Feet)
0.04	8.8	0.6
0.02	11.6	1
0.01	13.7	1.5
0.002	17.2	2.5
0.001	18.3	2.9

It should be noted that the frequency curve reflects only that flooding resulting from storm surge in the gulf. The Forrest Heights community is also subject to riverine flooding by Turkey Creek. The preliminary FEMA Harrison County Flood Insurance Study (FIS) dated November 2007 provides computed Turkey Creek flood profiles which appear to have been adjusted for the effects of coincident surge in Back Bay of Biloxi. Table 6.18-2 shows relevant discharge and stage information from the FIS for Turkey Creek at Ohio Avenue, the southern entrance to the Forrest Heights community. In comparison to the preliminary FEMA Flood Insurance Study dated November 2007, which is based on contemporary (post-Katrina) FEMA contractor hydrodynamic modeling, the ERDC frequency curve, which is based on surge alone, suggests a lower stage associated with the annual one in one hundred chance (0.01 exceedance probability) event.

Table 6.18-2.
Turkey Creek Flood Stages At Ohio Avenue, Harrison County FIS.

Exceedance Probability	Discharge (cfs)	Stage (ft. NAVD '88)
0.1	2600	12
0.02	3650	14.2
0.01	5500	15.5
0.002	7950	18.3

Hydraulic data was developed for use in the Hydrologic Engineering Center's Flood Damage Analysis (HEC-FDA) program. The HEC-FDA program uses risk-based analysis methods for evaluating flood damage and flood damage reduction alternatives. The program relies on hydrologic, hydraulic, and economic data input. Uncertainties in these data are input and used by the model for computing annual damages. Version 1.2.3b dated August 2007 was used. As described in chapter 2 of this appendix, this is a customized version of the current official release version 1.2 dated March 2000. This section describes the model's hydrologic and hydraulic input as applied to the Forrest Heights community.

Forrest Heights is subject to both riverine and surge flooding. For this reason, a discharge-frequency curve and a stage-discharge relationship (also known as a 'rating curve') were developed for input into the HEC-FDA model. The discharge-frequency curve was computed in FDA using synthetic statistics using the 0.5-, 0.1-, and 0.01 annual exceedance probability discharges from the preliminary Harrison County FIS (see Table 3.3.6-2). The version of FDA used extends the stage frequency curve to the 0.999 and 0.0001 annual exceedance values. Uncertainty about the discharge-frequency curve was computed by the FDA program assuming an equivalent period of record. Sensitivity analysis of discharge uncertainty with respect to the equivalent period of record was conducted. Interpretation of the standard error and apparent period of record of the underlying hydrologic information used to develop the FIS discharge values versus discharge uncertainty computed by the FDA program suggested that an equivalent period of record of 20 years provided a reasonable preliminary estimate of uncertainty of discharge in the un-gaged stream. The resultant discharge-frequency curve and curves at the 5% and 95% confidence limits are shown below in Figure 6.18-3 and the values are shown in Table 6.18-3. These relationships are representative in the vicinity of Ohio Avenue.

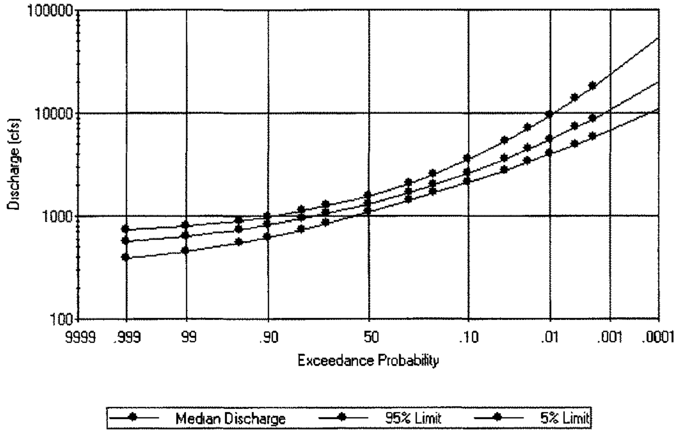


Figure 6.18-3. Computed Discharge-Frequency Curve, Turkey Creek at Ohio Avenue

Table 6.18-3.
Discharge-Frequency, Turkey Creek at Ohio Avenue

Exceedance Probability	Discharge (cfs)	Confidence Limit Curves Discharge (cfs)			
		95%	75%	25%	5%
0.9990	563	383	458	660	720
0.9900	634	447	525	733	795
0.9500	735	542	622	839	904
0.9000	811	614	696	918	986
0.8000	932	731	814	1,044	1,118
0.7000	1,045	840	924	1,165	1,245
0.5000	1,300	1,081	1,167	1,443	1,548
0.3000	1,678	1,412	1,511	1,882	2,051
0.2000	1,995	1,669	1,785	2,274	2,522
0.1000	2,601	2,118	2,281	3,066	3,515
0.0400	3,563	2,770	3,027	4,411	5,296
0.0200	4,449	3,330	3,684	5,716	7,104
0.0100	5,500	3,961	4,439	7,334	9,428
0.0040	7,211	4,935	5,625	10,093	13,561
0.0020	8,771	5,778	6,671	12,723	17,655
0.0001	19,704	11,042	13,464	33,224	52,792

The stage-discharge curve was developed by fitting an equation of the form $H = CQ^a$ (H = water surface elevation; Q is discharge; C and a determined by regression) through the Turkey Creek stage at cross section F as shown on the Turkey Creek Flood Profile, Plate 83P, of the preliminary FIS. The profile plate shows this location to have been adjusted for coincident probability of surge. The equation thus developed was used to extend the rating curve through a broader range of discharges than represented on the flood profiles. Uncertainty about the rating curve was assumed to be 1.5 feet at the 10-year and higher discharges based on FIS hydraulic modeling techniques and assuming a poor historic hydrologic data record (Turkey Creek is ungaged). The rating curve is shown in Figure 6.18-4.

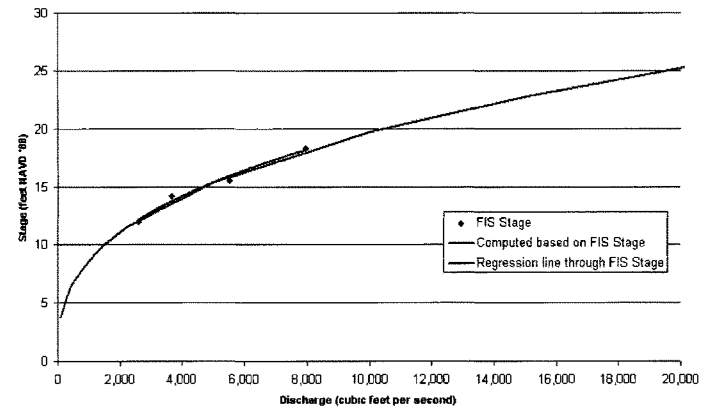


Figure 6.18-4. Computed Rating Curve, Turkey Creek at Ohio Avenue.

6.18.5.2 Summary of Without-Project Damages

Equivalent annual without-project damages for the Forrest Heights area were estimated using HEC-FDA program and evaluated for three future relative sea level rise scenarios; existing (Future 1), moderate (Future 3), and high (Future 5) relative sea level rise. The existing relative sea level rise condition, as described in the previous section, incorporates relative sea level rise to the base year, 2012, and does not project future relative sea level rise. The moderate and high relative sea level rise functions were used in the program by adding 0.9-feet for the moderate rate and 1.3-feet for the high rate to the existing relative sea level rise curves. Table 6.18-4 summarizes the without-project damages expected for the Forrest Heights area.

Table 6.18-4.
Without-Project Damages for the Forrest Heights Area by Future Scenario

Future Scenario 1	Future Scenario 3	Future Scenario 5
Existing Relative Sea Level Rise	Moderate Relative Sea Level Rise	High Relative Sea Level Rise
$107,550	$127,010	$141,290

6.18.6 List of Measures

- **Measure A - Elevation 17 ft NAVD88**

This option consists of an earthen dike around the Forrest Heights community as shown on the following Figure 6.18-5, along with the levee culvert/interior pump/detention location. The earth dike will be trapezoidal in shape with a 12-foot top width with one foot vertical to three foot horizontal slopes on both sides (1H:3V). For this option the two existing roadway entrances will be ramped over the restored levee. The total length of the levee will be approximately 7900 feet.

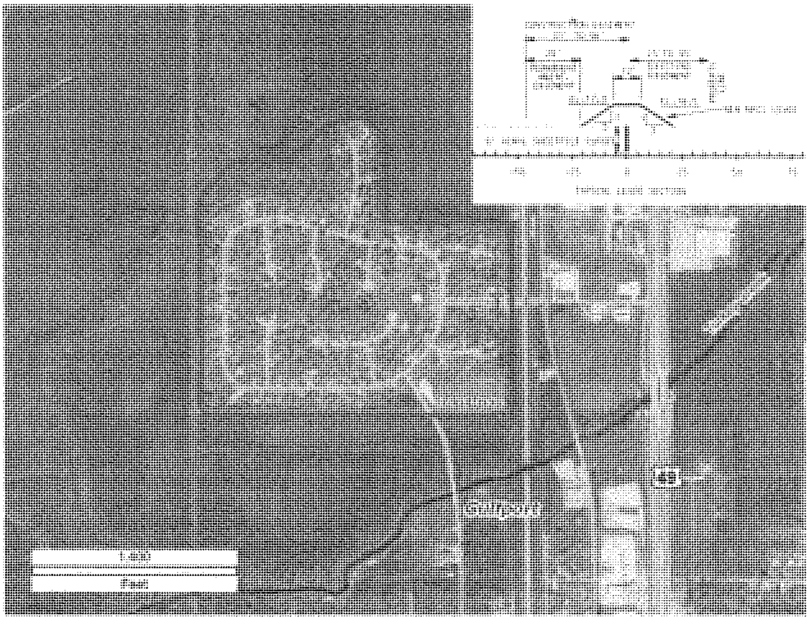


Figure 6.18-5. 17-ft Elevation Levee Alignment with Culvert and Pump/Detention Basin Locations

Levees reduce the storage capacity and overbank flow conveyance of the adjacent floodplain. The reductions in overbank flow area could induce higher water levels upstream. An HECRAS model was used to evaluate the potential for induced damages and solutions. The modeling indicates that selective clearing and snagging would prevent increases in water surface elevations upstream that would occur due the placement of the levees in the floodplain.

The selective clearing and snagging would extend for approximately 4.5 miles from the mouth of Turkey Creek at Bernard Bayou to the upstream limits as shown in Figure 6.18-6. Selective clearing and snagging would remove obstructions such as debris dams and excessive sedimentation that hinders the flow through the Turkey Creek channel. While the selective clearing and snagging component of the plan does not eliminate flooding along Turkey Creek, the plan does reduce flood damages along the creek and at the upper end of the canals at 28th Street. The main purpose of the selective clearing and snagging is to make sure that induced damages do not occur due to the construction of the levee.

The selective clearing and snagging work will follow Stream Obstruction Removal Guidelines established by the American Fisheries Society. Only debris, snags and sediment that obstruct the flow will be removed. Material to be removed includes: 1) fine sediment accumulations that obstruct flows and alter flow patterns; 2) Debris blockages that currently or in the near future cause obstructed flow and altered flow patterns; and 3) Rooted trees that obstruct flow or need to be cleared for equipment access. Access areas that are cleared will be reestablished at the conclusion of the selective clearing and snagging activities. Some access points, however, may remain for the non-Federal sponsor to use for maintenance activity of the completed project. The existing bank alignment along the entire reach will not be changed, including the downstream reaches of Turkey Creek along the meander bends. Specific reaches to be cleared and snagged will be identified by an interdisciplinary team prior to construction.

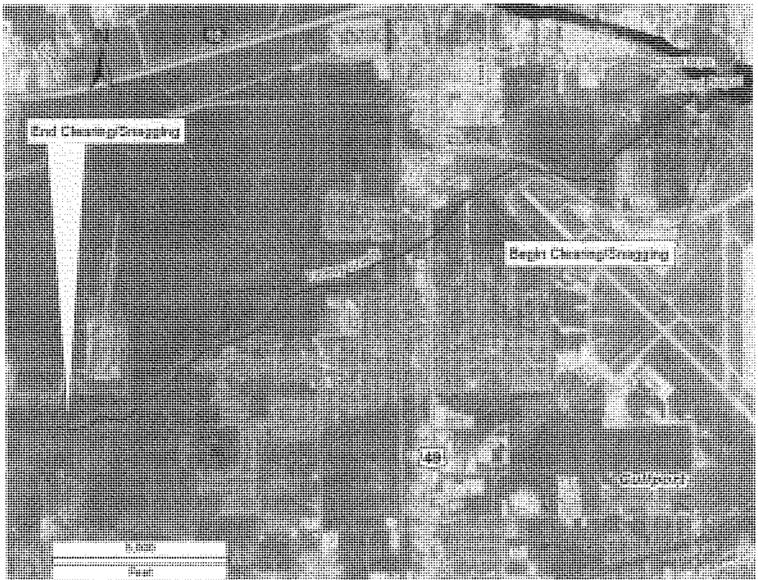


Figure 6.18-6. Channel Clearing and Snagging Limits

Damage and failure by overtopping of levees could be caused by storm surges greater than the levee crest. Overtopping failures are caused by the high velocity of flow on the top and back side of the levee. Although significant wave attack on the seaward side of some of the New Orleans levees occurred during Hurricane Katrina, the duration of the wave attack was for such a short time that major damage did not occur from wave action. The erosion shown below in Figure 6.18-7 was caused by approximately 1-2 ft of overtopping crest depth.

Source: ERDC, Steven Hughes

Figure 6.18-7. Crown Scour from Hurricane Katrina at Mississippi River Gulf Outlet (MRGO) Levee in St. Bernard Parish, New Orleans, LA

An overtopping reach of the levee with a revetment at the detention/culvert location would be included in the levee design to prevent overtopping failure. The levee would be protected by gabions on filter cloth as shown in Figure 6.18-8, extending across a drainage ditch which carries water to nearby culverts and which would also serve to dissipate some of the supercritical flow energy during overtopping conditions.

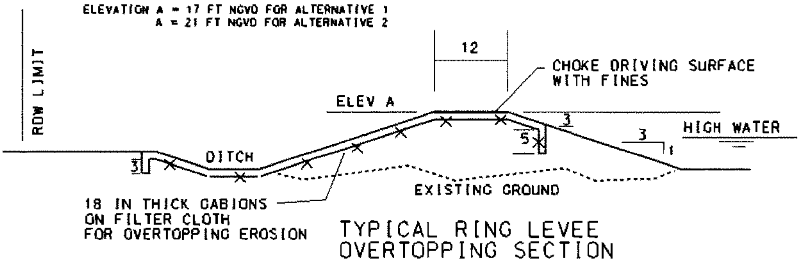


Figure 6.18-8. Typical Levee Overtopping Section

- **Option B - Elevation 21 ft NAVD88**

This option consists of an earthen levee around the entire community of Forrest Heights. The alignment of the levee is generally the same as Option A, above, with the required northern levee portion that would enclose the community within the levee as shown in Figure 6.18-3. The only difference between the description of this option and preceding description of Option A is the height of the levee and the length of the levee culverts. Other features and methods of analysis are the same.

6.18.7 With-Project Conditions

Equivalent annual damages reduced are those damages that are estimated to be reduced with a ring levee measure in place. Table 6.18-5 summarizes the equivalent annual damages reduced and table 6.18-6 summarizes residual damage.

Table 6.18-5.
Summary of Equivalent Annual Damages Reduced

Measure	Damages Reduced Future 1	Damages Reduced Future 3	Damages Reduced Future 5
No Action	$0	$0	$0
Measure A 17FT Levee	$8,860	$10,210	$11.580
Measure B 21FT Levee	$74,340	$89,340	$100,540

Table 6.18-6.
Summary of Equivalent Annual Residual Damages

Measure	Damages Reduced Future 1	Damages Reduced Future 3	Damages Reduced Future 5
No Action	$0	$0	$0
Measure A 17FT Levee	$98,690	$116,800	$129,710
Measure B 21FT Levee	$33,210	$37,670	$40,750

6.18.8 Summary of Costs

The rough order magnitude (ROM) costs for construction and for operations and maintenance are comparative-Level "Parametric Type" estimates and are based on Historical Data, Recent Pricing, and Estimator's Judgment. Quantities listed within the estimates represent Major Elements of the Project Scope and were furnished by the Project Delivery Team. Price Level of Estimate is April 07. Estimates excludes project Escalation and HTRW Cost. Table 6.18-7 summarizes the costs for the levee measures.

Table 6.18-7.
Summary of Costs by Measure for Forrest Heights

Measures	Total Cost to Implement (First Cost) ($)	IDC ($)	Total Initial Cost ($)	Average Annual Implementation Cost ($)	Average Annual O&M ($)	Total Average Annual Costs ($)
(No Action)	$0	$0	$0	$0	$0	$0
Measure A 17FT Levee	$6,100,000	$135,000	$6,235,000	$335,000	$42,000	$377,000
Measure B 21FT Levee	$11,400,000	$252,000	$11,652,000	$626,000	$114,000	$740,000

The implementation costs include 1/ supervision and administration (30 account), 2/ planning, engineering & design (31 account) and 3/ appropriate contingencies. See the Cost Appendix for more detail on the implementation cost breakdowns Numbers are rounded to the nearest thousand.

6.18.9 Regional Economic Development (RED) Benefits Socioeconomic Impacts using the Economic Impact Forecast System

The purpose of this analysis is to determine the economic impact of the proposed project alternatives on business (sales volumes), income, employment, and population of the local area. Each of the alternatives would affect the local area of Hancock County, Mississippi. The expenditures for the alternatives are estimated to be $6,100,000 for Alternative 1 and $11,400,000 for the Alternative 2. Moreover, the Annual Operation and Maintenance (O&M) expenditures are estimated to be $700,000 for Alternative 1 and $1,400,000 for Alternative 2 (assuming a 50 year period of analysis and an interest rate of 5.375-percent). Tables 6.18-8 through 6.18-11 summarize the EIFS model inputs and outputs for the cost effective measures at Admiral Island.

Table 6.18-8.
EIFS Model Implementation Inputs for the Forrest Heights Area

	No Action	17FT Levee	21FT Levee
Region of Influence (ROI)	Harrison County	Harrison County	Harrison County
Change in Local Expenditures	$0	$6,100,000	$11,400,000

Based of the given inputs the outputs are as follows:

Table 6.18-9.
EIFS Model Implementation Outputs for the Forrest Heights Area

	No Action	17FT Levee	21FT Levee
Direct Sales Volume	$0	$6,100,000	$11,400,000
Induced Sales Volume	$0	$7,625,000	$14,250,000
Total Sales Volume	$0	$13,725,000	$25,650,000
Direct Income	$0	$1,291,220	$2,413,099
Induced Income	$0	$1,614,025	$3,016,374
Total Income	$0	$2,905,244	$5,429,473
Direct Employment	0	39	72
Induced Employment	0	48	91
Total Employment	0	87	163
Local Population	0	0	0

Table 6.18-10.
EIFS Model O&M Inputs for the Forrest Heights Area

	No Action	17FT Levee	21FT Levee
Region of Influence (ROI)	Hancock County	Harrison County	Harrison County
Change in Local Expenditures	$0	$782,000	$2,122,000

Based of the given inputs the outputs are as followed:

Table 6.18-11.
EIFS Model O&M Outputs for the Forrest Heights Area

	No Action	17FT Levee	21FT Levee
Direct Sales Volume	$0	$782,000	$2,122,000
Induced Sales Volume	$0	$977,500	$2,652,500
Total Sales Volume	$0	$1,759,500	$4,774,500
Direct Income	$0	$165,530	$449,175
Induced Income	$0	$206,913	$561,469
Total Income	$0	$372,443	$1,010,644
Direct Employment	0	5	13
Induced Employment	0	6	17
Total Employment	0	11	30
Local Population	0	0	0

CHAPTER VII. SENSITIVITY ANALYSIS

7.1 Period of Analysis Sensitivity

This section describes the sensitivity of the period of analysis on the evaluation of equivalent annual damage reduction and average annual costs for the various measures. There are two significant drivers inherit in the period of analysis that will be addressed in this section. The first is the effect of relative sea level rise depending on a 50-year or a 100-year horizon and the other is the concept of the time value of money and amortization.

In order to describe the effects of these variables, two specific sites were chosen; Pearlington and Gautier areas. These areas were specifically chosen because they reside in the western and eastern planning units of the state, planning units one and three respectively, and because they have been formulated for the comparison of structural and nonstructural measures. Measures for each area were evaluated using the 100-year and 50-year periods of analysis. The measures included a ring levee at 20-feet NAVD88, a ring levee at 30-feet NAVD88, an ABFE level nonstructural plan (acquisitions and elevate-in-place), a nonstructural plan to a 20-foot NAVD88 elevation, and a nonstructural plan with a 30-feet NAVD88 elevation. These elevations were chosen to develop a cost and benefit curve, and were not assigned a particular event frequency. At some point, the curve would be used to determine the elevation for various frequency events. The evaluation of these measures to determine cost-effectiveness is located in Chapter VI of this appendix.

7.1.1 Effects of the Period of Analysis on Damages

The Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA) program was used to calculate equivalent annual without-project damages and equivalent annual damages reduced for the various measures. The HECFDA model calculates equivalent annual damages for a base year and a most likely future year, and then linearly interpolates damages and damages reduced between the years. Figure 7.1-1 depicts this process. The process is the same for a 50-year period of analysis except that the most likely future would be 2061.

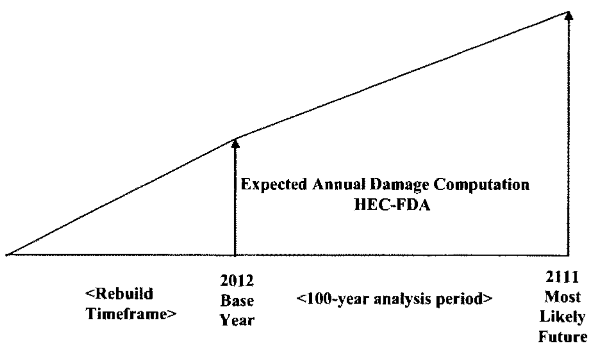


Figure 7.1-1. Calculation of Equivalent annual damages

There are six future without-project scenario conditions that were created for the MsCIP Comprehensive Plan. They are a combination of two different types of redevelopment scenarios with three types of relative sea level rise scenarios. Table 7.1-1 summarizes the six scenarios, which are described in greater detail in Chapter V of this appendix.

Table 7.1-1.
Overview of Future Scenarios

Future Scenario	Redevelopment Type	Relative Sea Level Rise 100-Years	Description
Future Scenario 1	Residential	Historical Only	Rebuild structures as existed pre-Hurricane Katrina with no relative sea level rise over the period of analysis. This future scenario applies to all three planning units.
Future Scenario 2	Mixed Residential & Commercial	Historical Only	Rebuild structures as existed pre-Hurricane Katrina except at water front where condo/casino rebuild will occur. Also, no relative sea level rise over the period of analysis. This future scenario applies only to planning units one and two. Planning unit three would not allow commercial type redevelopment based on local ordinances.
Future Scenario 3	Residential	Expected	Rebuild structures as existed pre-Hurricane Katrina with up to 2.4-feet relative sea level rise over the period of analysis. This future scenario applies to all three planning units.
Future Scenario 4	Mixed Residential & Commercial	Expected	Rebuild structures as existed pre-Hurricane Katrina except at water front where condo/casino rebuild will occur. Also, a up to 2.4-feet relative sea level rise over the period of analysis. This future scenario applies only to planning units one and two. Planning unit three would not allow commercial type redevelopment based on local ordinances.
Future Scenario 5	Residential	High Rate	Rebuild structures as existed pre-Hurricane Katrina with up to 3.4-feet of relative sea level rise over the period of analysis. This future scenario applies to all three planning units.
Future Scenario 6	Mixed Residential & Commercial	High Rate	Rebuild structures as existed pre-Hurricane Katrina except at water front where condo/casino rebuild will occur. Also, up to3.4-feet of relative sea level rise over the period of analysis. This future scenario applies only to planning units one and two. Planning unit three would not allow commercial type redevelopment based on local ordinances.

Future Scenarios One and Two are included only to evaluate the effects of relative sea level rise. These Future scenarios will not be used in the evaluation of potential measures. Futures Three, Four, Five, and Six will be the future scenarios by which potential measures will be evaluated depending on the planning unit.

The Pearlington and Gautier areas were on evaluated against future scenarios one, three, and five due to the geographic characteristics, historical development patterns, and political climate of the areas. SAM Engineering Division developed exceedance probability functions for each of the fifty-four planning sub-units; Pearlington is denoted as planning sub-unit six and Gautier as planning sub-unit thirty. The exceedance probability functions were developed by using an approach that combined historical Corps gage data and modeling conducted by the Engineer Research and Development Center (ERDC). The engineering appendix contains more information about the exceedance probability functions.

The exceedance probability function for the base year is the observed/modeled value, and the most like future year is the base year exceedance probability function plus some measure of relative sea level rise depending on the period of analysis. Future without-project scenario one is the full redevelopment of the area back to pre-Hurricane Katrina levels with no addition for future relative sea level rise. Future without-project scenario three is the same redevelopment scenario as future one with an expected rate of relative sea level rise applied to the most likely future year (2111), and future without-project scenario five is the same redevelopment with a high rate of relative sea level rise included. Table 7.1-2 summarizes the future without-project scenario three and five conditions.

Table 7.1-2.
Details of Future Without-Project Scenarios One, Three, and Five 100-Year and 50-Year Periods of Analysis

Measure	Redevelopment Type	Approximate 100-Year Relative Sea Level Rise	Approximate 50-Year Relative Sea Level Rise
Pearlington Area (Planning sub-unit six)			
Future Scenario One	Redevelopment back to pre-Hurricane Katrina Levels	0.0-feet	0.0-feet
Future Scenario Three	Redevelopment back to pre-Hurricane Katrina Levels	1.8-feet	0.9-feet
Future Scenario Five	Redevelopment back to pre-Hurricane Katrina Levels	3.2-feet	1.3-feet
Gautier Area (Planning sub-unit 30)			
Future Scenario One	Redevelopment back to pre-Hurricane Katrina Levels	0.0-feet	0.0-feet
Future Scenario Three	Redevelopment back to pre-Hurricane Katrina Levels	2.4-feet	1.5-feet
Future Scenario Five	Redevelopment back to pre-Hurricane Katrina Levels	3.8-feet	2.0-feet

By comparing the change in equivalent annual damages, damages reduced, and residual damages for future without-project scenario one under the 100-year and 50-year periods of analysis, the effects of the time value of money can be isolated. This is true because future scenario one has no change in relative sea level rise whether it is being evaluated at 100-years or at 50-years. Thus, the only difference between future scenario one for the 100-year and 50-year is the change in the capital recovery factor. The Capital recovery factor is a ratio that is applied to total present worth damages in order to estimate the average annual value of a number. For damages, it is calculated as:

Average Annual damages = Total Present Worth of Damages x Capital Recovery Factor

Total Present Worth = $\sum_n$ (Cost / (1+ i) ^n)

Capital Recovery Factor (CRF) = i / (1-(1+i) ^-n)

Where:

i = discount rate

n = period of analysis

The capital recovery factor is calculated by the HEC-FDA program based on the user input discount rate (4.875-percent) and the period of analysis (100-years or 50-years). The HEC-FDA program was run for periods of analysis for future without-project scenario one. Without-project damages for the Pearlington area were $11,569,000 and $12,640,000 for the 100-year and 50-year analysis respectively, and without project damages for the Gautier area for future scenario one are

$4,920,000 and $5,376,000 for the 100-year and 50-year period of analysis respectively. This represents a 9.26-percent difference for the Pearlington area and a 9.27-percent difference for the Gautier area for equivalent annual without-project damages. Thus, the effects of a 50-year period of analysis are higher equivalent annual damages than would be expected under the 100-year period of analysis. The same higher effect can be seen for the equivalent annual damages reduced and the equivalent annual residual damages. Tables 7.1-3 and 7.1-4 show the comparison of the damages reduced and the residual damages for future without-project scenario one for the two periods of analysis.

Table 7.1-3.
Equivalent Annual Damage Reduction Comparison of 50-Year Compared to 100-Year Future Without-Project Scenario One Pearlington and Gautier Area Measures

Measure	100-Year Equivalent annual damages ($)	50-Year Equivalent annual damages ($)	Percent Difference 50-Yr to 100-Yr (%)
	Pearlington Area Measures		
Ring Levee 20FT	$11,241,000	$12,282,000	9.26%
Ring Levee 30FT	$11,560,000	$12,630,000	9.26%
ABFE Nonstructural	$10,998,000	$12,016,000	9.26%
	Gautier Area Measures		
Ring Levee 20FT	$4,378,000	$4,784,000	9.27%
Ring Levee 30FT	$4,897,000	$5,350,000	9.26%
ABFE Nonstructural	$3,104,000	$3,391,000	9.25%

Damages are rounded to the nearest thousand.

Table 7.1-4.
Equivalent Annual Residual Damage Comparison of 50-Year Compared to 100-Year Future Without-Project Scenario One Pearlington and Gautier Area Measures

Measure	100-Year Equivalent Annual Residual Damages ($)	50-Year Equivalent Annual Residual Damages ($)	Percent Difference 50-Yr to 100-Yr (%)
	Pearlington Area Measures		
Ring Levee 20FT	$328,000	$358,000	9.15%
Ring Levee 30FT	$9,000	$10,000	11.11%
ABFE Nonstructural	$571,000	$624,000	9.28%
	Gautier Area Measures		
Ring Levee 20FT	$542,000	$592,000	9.23%
Ring Levee 30FT	$23,000	$26,000	13.04%
ABFE Nonstructural	$1,816,000	$1,985,000	9.31%

Damages are rounded to the nearest thousand.

Future without-project scenarios three and five are different from future without-project scenario one in that they account for some rate of relative sea level rise over the period of analysis. As previously displayed in table 7.1-2, the 50-year period of analysis would constitute a smaller rate of relative sea level rise than the 100-year period of analysis. This smaller rate, given all other things equal, would mean that the equivalent annual without-project damages, equivalent annual damages reduced, and the equivalent annual residual damages for the 50-year period of analysis would be lower than the 100-year period of analysis. However, the time value of money effect that was described for future scenario one also comes into play for future scenarios three and five, resulting in and upward effect. Thus, there is a simultaneous push upward (time value of money) and downward (relative sea level rise) from these two variables when comparing the equivalent annual damages under a 50-year to the 100-year period of analysis. This can be seen in the effects of the change in equivalent annual without-project damages for future scenarios three and five are displayed in table 7.1-5. For the Pearlington area, the change to equivalent annual without-project damages is 3.24 and -4.01(negative 4.01)-percent for future without-project scenario conditions three and five respectively. The changes for the Gautier are 1.90 and -7.65 (negative 7.65)-percent for future scenarios three and five respectively. The effects of the change in scenario three are dominated by the time value of money factor, causing and increase in equivalent annual damages; where scenario five is dominated by a reduction in relative sea level rise (the difference in a 100-year estimate compared to a 50-year estimate), thus causing a lowering effect.

Table 7.1-5.
Equivalent Annual Without-Project Damage Comparison of 50-Year Compared to 100-Year Future Without-Project Scenarios Three and Five Pearlington and Gautier Area Measures

Measure	100-Year Equivalent annual damages ($)	50-Year Equivalent annual damages ($)	Percent Difference 50-Yr to 100-Yr (%)
Pearlington Area Measures			
Future Scenario Three Without Project Damages	$12,885,000	$13,303,000	3.24%
Future Scenario Five Without Project Damages	$14,205,000	$13,635,000	-4.01%
Gautier Area Measures			
Future Scenario Three Without Project Damages	$5,831,000	$5,942,000	1.90%
Future Scenario Five Without Project Damages	$6,702,000	$6,189,000	-7.65%

Damages are rounded to the nearest thousand.

Table 7.1-6 displays the equivalent annual damage reduction for the 100-year and 50-year periods of analysis for future without-project scenario three and table 7-1.7 for future without-project scenario five. Residual damages, damages that remain even if the measure were to be implemented, are shown in table 7.1-8 for future-without project scenario three and table 7.1-9 for future without-project scenario five.

Table 7.1-6.
Equivalent Annual Damage Reduction Comparison of 50-Year Compared to 100-Year Future Without-Project Scenario Three Pearlington and Gautier Area Measures

Measure	100-Year Equivalent annual damages ($)	50-Year Equivalent annual damages ($)	Percent Difference 50-Yr to 100-Yr (%)
Pearlington Area Measures			
Ring Levee 20FT	$11,894,000	$12,918,000	8.61%
Ring Levee 30FT	$12,267,000	$13,292,000	8.35%
ABFE Nonstructural	$12,260,000	$12,652,000	3.20%
Gautier Area Measures			
Ring Levee 20FT	$5,166,000	$5,279,000	2.19%
Ring Levee 30FT	$5,800,000	$5,912,000	1.93%
ABFE Nonstructural	$3,623,000	$3,713,000	-5.27%

Damages are rounded to the nearest thousand.

Table 7.1-7.
Equivalent Annual Damage Reduction Comparison of 50-Year Compared to 100-Year Future Without-Project Scenario Five Pearlington and Gautier Area Measures

Measure	100-Year Equivalent annual damages ($)	50-Year Equivalent annual damages ($)	Percent Difference 50-Yr to 100-Yr (%)
Pearlington Area Measures			
Ring Levee 20FT	$13,088,000	$13,236,000	1.13%
Ring Levee 30FT	$13,228,000	$13,623,000	2.99%
ABFE Nonstructural	$13,520,000	$12,970,000	-4.07%
Gautier Area Measures			
Ring Levee 20FT	$5,923,000	$5,492,000	-7.28%
Ring Levee 30FT	$6,663,000	$6,156,000	-7.61%
ABFE Nonstructural	$3,984,000	$3,844,000	-3.51%

Damages are rounded to the nearest thousand.

Table 7.1-8.
Equivalent Annual Residual Damage Comparison of 50-Year Compared to 100-Year Future Without-Project Three Pearlington and Gautier Area Measures

Measure	100-Year Equivalent Annual Residual Damages ($)	50-Year Equivalent Annual Residual Damages ($)	Percent Difference 50-Yr to 100-Yr (%)
Pearlington Area Measures			
Ring Levee 20FT	$991,000	$385,000	-61.15%
Ring Levee 30FT	$618,000	$11,000	-98.22%
ABFE Nonstructural	$625,000	$651,000	4.16%
Gautier Area Measures			
Ring Levee 20FT	$665,000	$663,000	-0.30%
Ring Levee 30FT	$31,000	$30,000	-3.24%
ABFE Nonstructural	$2,208,000	$2,229,000	0.95%

Damages are rounded to the nearest thousand.

Table 7.1-9.
Equivalent Annual Residual Damage Comparison of 50-Year Compared to 100-Year Future Without-Project Five Pearlington and Gautier Area Measures

Measure	100-Year Equivalent Annual Residual Damages ($)	50-Year Equivalent Annual Residual Damages ($)	Percent Difference 50-Yr to 100-Yr (%)
Pearlington Area Measures			
Ring Levee 20FT	$1,117,000	$399,000	-64.28%
Ring Levee 30FT	$977,000	$12,000	-98.77%
ABFE Nonstructural	$685,000	$665,000	-2.92%
Gautier Area Measures			
Ring Levee 20FT	$779,000	$697,000	-10.53%
Ring Levee 30FT	$39,000	$33,000	-15.38%
ABFE Nonstructural	$2,718,000	$2,345,000	-13.72%

Damages are rounded to the nearest thousand.

The results of the sensitivity of the period of analysis on future without project scenarios three and five vary by location and plan. As previously noted, this is due to the upward effect of the time value of money and the lowering effect that results from a lesser relate of relative sea level rise for the 50-year period of analysis. The only conclusive evidence that can be deduced from this exercise is that there will be higher residual damages under the 100-year period of analysis as compared to the 50-year period of analysis, and, in some cases, the difference in residual damages are very large.

It is important to note that the 20-feet NAVD88 and 30-feet NAVD88 elevations were fixed point elevations for cost and benefit evaluation purposes only, and not directly tied to a particular frequency event. When implemented to a particular frequency event, an elevation would have to be selected to provide for that level of protection. By using a 50-year period of analysis, the selection of an elevation for a particular event level would be lower than the selection for the same event level under the 100-year period of analysis due to the difference in relative sea level rise. Thus, if you were to pick the elevation for the 1-percent event under the 50-year period of analysis and relative sea level rise were more like the 100-year period of analysis, the risk of overtopping and increased level of residual damages could be significant.

7.1.2 Effects of the Time Value of Money

7.1.2.1 Average Annual Implementation Cost

Traditionally, the Corps of Engineers reports costs on an average annual basis. Average annual costs are calculated by multiplying the total present worth of costs times the capital recovery factor.

Average Annual Implementation Costs = Total Present Worth of Costs x Capital Recovery Factor

Total Present Worth = Cost / (1+ i) ^n))

Capital Recovery Factor (CRF) = i / (1-(1+i) ^-n)

Where:

i = interest rate

n = period of analysis

Typically, costs are associated to the years they would be expended in should the project be constructed. Those expenditures are then brought back, or present worthed, to the same fiscal year (FY) as the benefits in order for a direct and accurate comparison. At this point in the analysis of the potential measures, the timing of expenditures have not yet been identified; therefore the total implementation cost act as the total present worth of the implementation costs and will be multiplied by the capital recovery factor to get the average annual implementation cost values.

A simple case example is to imagine that a project costs one dollar to implement, or the present worth of the project is one dollar. This is the same whether you chose a 50-year period of analysis or a 100-year period of analysis, thus the changing variable is the capital recovery factor. The capital recovery factors for a 100-year and 50-year period of analysis are 0.049171225 and 0.053722282 respectively. Using the average annual cost equation expressed above the average annual costs of the one dollar project is:

100-Year

$1 x 0.049171225 = $0.049

50-Year

$1 x 0.053722282 = $0.053

This simple comparison shows that the difference in cost for a 100-year period of analysis compared to a 50-year period of analysis is that the 50-year average annual cost is 9.26-percent higher. This result would be expected since the costs are attributed to a shorter period. The everyday example of this is a person saving to buy something. If you save monthly over two years compared to one year, you will have to save less every month to achieve the same goal. Table 7.1-10 shows this effect on the measures for the Pearlington area and the Gautier area. **Note:** Future without-project scenarios have no bearing on the implementation cost of the various measures.

Table 7.1-10.
Average Annual Implementation Cost Comparison of 50-Year Compared to 100-Year Pearlington and Gautier Area Measures

Measure	100-Year Average Annual Costs ($)	50-Year Average Annual Costs ($)	Percent Difference 50-Yr to 100-Yr (%)
Pearlington Area Measures			
Ring Levee 20FT	$4,754,857	$5,194,945	9.26%
Ring Levee 30FT	$5,620,271	$6,140,457	9.26%
ABFE Nonstructural	$19,073,518	$20,838,873	9.26%
Gautier Area Measures			
Ring Levee 20FT	$16,629,708	$18,168,876	9.26%
Ring Levee 30FT	$21,620,587	$23,621,687	9.26%
ABFE Nonstructural	$9,362,201	$10,228,723	9.26%

7.1.2.2 Interest During Construction

Interest during construction is an added economic cost because it is the opportunity cost of having construction monies tied up until the measure becomes fully operational. Since, at this point in the analysis, the length of construction for these measures have not been identified, interest during construction was not calculated for the analyzed Pearlington and Gautier area measures and is not included in the total average annual costs. Further study would be required in order to calculate interest during construction on each of the measures. However, since interest during construction is a function of the discount rate and the period of time it takes to construct the project, it will have no bearing on whether a 100-year or 50-year period of analysis is used, i.e. interest during construction would be the same regardless of the period of analysis.

Average annual operation and maintenance costs for the structural ring levee measures was calculated as two-percent of the contract cost for the structure. This number was provided by MOBILE DISTRICT (SAM) Engineering Division and would not be impacted under a 100-year or 50-year period of analysis. Average annual operation and maintenance costs for nonstructural measures were provided but the Corps of Engineers Nonstructural Flood Proofing Committee (NSFPC) and were based on factors that are not directly affected by the period of analysis.

7.2 First Floor Elevation Uncertainty Sensitivity

The HEC-FDA program is a Monte Carlo based program that allows and compensates for the uncertainty pertaining to multiple structure characteristic inputs. The main uncertainty variables are those pertaining to the exceedance probability function, structure value, content value, and first floor elevation. Initial sensitivity runs on these variables determined that the first floor elevation uncertainty is the most sensitive to change. For that reason, the first floor elevation was chosen for this sensitivity analysis.

In a typical feasibility level study, the first floor elevation of each structure is determined by a survey crew in the field. For the MsCIP Comprehensive Plan Report, the survey of over 130,000 structures was not feasible from a time, labor, and funding perspective. Therefore, a sampling technique was used to estimate the first floor elevation of each structure using a combination of LIDAR data and field estimation of the finished floor above ground elevation. The uncertainty pertaining to the estimated first floor elevation was found to be 3.52-feet for one standard deviation. This was attained by surveying a two-percent sample, approximately 3,000 structures, using the typical feasibility level survey method and then comparing it to the estimates attained from the LIDAR plus finished floor estimates. Chapter IV describes the inventory sampling process and first floor elevation estimates in greater detail.

Given the nature of sensitivity and the magnitude of the uncertainty pertaining to the first floor elevation, a sensitivity analysis was conducted to determine the extent of influence this variable had on the equivalent annual damages that were estimated for the entire study area. The sensitivity analysis was conducted for the equivalent annual without-project damages for all six future without-project scenarios. Details on those scenarios can be found above in table 7.1.1 or in chapter V of this appendix.

The intent of this sensitivity analysis was to compare the first floor elevation uncertainty in the MsCIP Comprehensive data to the uncertainty expressed in previous Corps studies using more accurate and traditional surveying methods. In order to determine a typical uncertainty that is associated with the standard survey of ach structure, previous Mobile District reports were utilized. Uncertainty pertaining to the first floor elevation used for previous feasibility studies ranged from 0.3-feet and 0.9-feet for one standard deviation. For this sensitivity analysis, the mean of these values (0.6-feet) was used. The future without-project conditions for each of the six scenarios were run with both the 3.52-feet of uncertainty and the 0.6-feet of uncertainty and compared to determine the sensitivity. The following tables show the results of the first floor elevation sensitivity analysis on equivalent annual damages and damages reduced for the Pearlington and Gautier area measures.

Table 7.2-1.
First Floor Uncertainty Sensitivity on Equivalent Annual Without-Project Damages
Pearlington and Gautier Area Measures

Measure	3.52FT Uncertainty Equivalent annual damages ($)	0.6FT Uncertainty Equivalent annual damages ($)	Percent Difference (%)
Pearlington Area Measures			
Future Scenario One Without Project Damages	$11,569,000	$6,950,000	-39.93%
Future Scenario Three Without Project Damages	$12,885,000	$8,856,000	-31.27%
Future Scenario Five Without Project Damages	$14,205,000	$9,586,000	-32.52%
Gautier Area Measures			
Future Scenario One Without Project Damages	$4,920,000	$2,992,000	-39.19%
Future Scenario Three Without Project Damages	$5,831,000	$3,686,000	-36.79%
Future Scenario Five Without Project Damages	$6,702,000	$4,288,000	-36.02%

Damages are rounded to the nearest thousand.

Table 7.2-2.
First Floor Uncertainty Sensitivity on Equivalent annual damages Reduced Future Without Project Scenario One Pearlington and Gautier Area Measures

Measure	3.52FT Uncertainty Equivalent annual damages Reduced ($)	0.6FT Uncertainty Equivalent annual damages Reduced ($)	Percent Difference (%)
Pearlington Area Measures			
Ring Levee 20FT	$11,241,000	$6,611,000	-41.19%
Ring Levee 30FT	$11,560,000	$6,941,000	-39.96%
ABFE Nonstructural	$10,998,000	$6,501,000	-40.89%
Gautier Area Measures			
Ring Levee 20FT	$4,378,000	$2,410,000	-44.95%
Ring Levee 30FT	$4,897,000	$2,968,000	-39.39%
ABFE Nonstructural	$3,104,000	$1,917,000	-38.24%

Damages are rounded to the nearest thousand.

Table 7.2-3.
First Floor Uncertainty Sensitivity on Equivalent annual damages Reduced Future Without Project Scenario Three Pearlington and Gautier Area Measures

Measure	3.52FT Uncertainty Equivalent annual damages Reduced ($)	0.6FT Uncertainty Equivalent annual damages Reduced ($)	Percent Difference (%)
Pearlington Area Measures			
Ring Levee 20FT	$11,894,000	$8,421,000	-29.20%
Ring Levee 30FT	$12,267,000	$8,843,000	-27.91%
ABFE Nonstructural	$12,260,000	$8,315,000	-32.18%
Gautier Area Measures			
Ring Levee 20FT	$5,166,000	$2,975,000	-42.41%
Ring Levee 30FT	$5,800,000	$3,654,000	-37.00%
ABFE Nonstructural	$3,623,000	$2,405,000	-33.62%

Damages are rounded to the nearest thousand.

Table 7.2-4.
First Floor Uncertainty Sensitivity on Equivalent annual damages Reduced Future Without Project Scenario Five Pearlington and Gautier Area Measures

Measure	3.52FT Uncertainty Equivalent annual damages Reduced ($)	0.6FT Uncertainty Equivalent annual damages Reduced ($)	Percent Difference (%)
Pearlington Area Measures			
Ring Levee 20FT	$13,088,000	$9,115,000	-30.36%
Ring Levee 30FT	$13,228,000	$9,571,000	-27.65%
ABFE Nonstructural	$13,520,000	$9,047,000	-33.08%
Gautier Area Measures			
Ring Levee 20FT	$5,923,000	$3,451,000	-41.74%
Ring Levee 30FT	$6,663,000	$4,247,000	-36.26%
ABFE Nonstructural	$3,984,000	$2,809,000	-29.49%

Damages are rounded to the nearest thousand.

CHAPTER VIII. RECOMMENDED PLAN FEATURES

The recommended system wide plan features for the MsCIP Comprehensive plan, explained in more detail in the Main Report, have multiple levels. Some of the features will be recommended as work for entities other than the Corps of Engineers, some will be recommended for further construction, and some will be recommended for implementation. The list of measures in this appendix which are recommended for further study include the ring levee and nonstructural measures at the Pearlington, Ocean Springs, Gautier, Gulf Park Estates, Belle Fontaine, and Pascagoula/Moss Point areas, as well as further inquiry into the coast wide 20-foot, 30-foot, and 40-foot elevation nonstructural measures. Among the list of recommended plan features for construction that were analyzed in this appendix include barrier island restoration, beach and dune placement, ecosystem restoration at the Admiral Island, Turkey Creek, Bayou Cumbest, Dantzler, and Franklin Creek areas, the 21-foot elevation levee at the Forrest Heights area, and the acquisition of parcels within high risk areas.

For planning and screening purposes, the analysis in this appendix used a 100-year period of analysis for measures that were determined to be complex in nature such as the barrier island restoration or measures that had a high risk of residual damages due to relative sea level rise such as flood risk management measures. Other measures that were not as complex in nature, such as the beach and dune placement and the ecosystem restoration measures were evaluated at the traditional 50-year period of analysis used in Corps of Engineers studies. In order to show consistency among the plans recommended for construction, those measures that were initially screened at a 100-year period of analysis have been converted to a 50-year period of analysis for costs and benefits and are summarized in table 8-1. The costs in table 8-1 represent Rough Order Magnitude (ROM) utilized for screening. Detailed Micro-Computer Aided Cost Estimating System (MCACES) costs can be found in the cost estimating appendix.

Table 8-1.
Summaries of Benefits and Costs for Measures Recommended for Implementation[1]

	Equivalent annual damages Reduced Future 3 (Annual $)	Recreation (Annual $)	Environmental Impacts	Changes in Sales Volume ($)	Changes in Income ($)	Changes in Employment	Total First Cost with IDC[2] ($)	Average Annual Cost (Annual $)
Barrier Island Restoration	$18,028,000	$466,000	$43,618,000 Fishery Losses Avoided	$798,984,000	$167,850,000	4,920	$551,134,800	$29,608,000
Beach and Dune Placement	Moderate Reduction	N/A	736 Functional Habitat Index (FHI) Score	$33,413,200	$7,307,000	208	$25,192,300	$1,353,000
Acquisition in High Risk Areas	$22,000,000 to $33,000,000	Potential Recreational Opportunities	Potential Restoration Opportunities	$3,238,602,000	$706,330,000	19,452	$459,442,100	$24,682,000
Forrest Heights 21-FT Ring Levee	$89,000	N/A	3.6 Acres Impacted	$30,425,000	$6,440,000	193	$14,482,500	$778,000
Admiral Island Ecosystem Rest.	Increased Surge Storage	N/A	60 Average Annual Functional Units (AAFU)	$49,750,000	$ 11,996,000	301	$22,997,000	$1,235,000
Turkey Creek Ecosystem Rest.	Increased Surge Storage	N/A	1,565 Average Annual Functional Units (AAFU)	$15,237,000	$3,226,000	97	$7,206,300	$387,000
Bayou Cumbest Ecosystem Rest.	Increased Surge Storage	N/A	188 Average Annual Functional Units (AAFU)	$54,073,000	$ 10,546,000	306	$26,917,800	$1,446,000
Dantzler Ecosystem Rest.	Increased Surge Storage	N/A	1,244 Average Annual Functional Units (AAFU)	$ 5,054,000	$ 986,000	29	$2,331,800	$125,000
Franklin Creek Ecosystem	Increased Surge Storage	N/A	516 Average Annual Functional Units (AAFU)	$3,890,000	$ 759,000	22	$1,960,500	$105,000

1/ These measures were analyzed for economic benefits and do not represent the entire recommended plan features for implementation. See the main report for more detail.
2/ Implementation costs are based on ROM cost estimates and an FY 08 price level and do not include escalation. See the engineering appendix for more details on the costs.
3/ Average annual damages reduced and costs are based on a 50-year period of analysis and an FY 08 discount rate of 4.875-percent. Dollar values are rounded to the nearest thousand.

ADDENDUM A – HEC-FDA DEPTH DAMAGE FUNCTIONS

CHAPTER A-I. OVERVIEW

Damages for assets and contents were calculated using the Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA) model. Damage of an structure and its contents are estimated as a function of stage, first floor elevation, depth of water in asset, percent of damage at each depth, and the value of the structure and its contents (see equation below). This function derives the stage damage in terms of dollar value damage for the structure and its contents. At each stage, the stage damage for all assets and their contents are aggregated to determine a total damage for each stage. The HEC-FDA model, described in detail in the Economic Appendix, applies a Monte Carlo simulation to the aggregated stage damage to determine Equivalent Annual Damages (EAD). The purpose of this addendum is to detail the depth-damage relationships (percent of damage at each depth) that were used in the HEC-FDA model runs, 2/ why they were used, 3/ how they were developed, and 4/ the uncertainty that is included within the relationships.

Stage Damage ($) = Stage – First Floor Elevation = water depth in structure = % damage x asset/content value

Depth-damage relationships are a mathematical function that describes the extent of damage to an structure and its contents for each foot of water that is deposited into the structure by a storm event. The general premise is that the entire structure and its contents are not damaged by just one foot of water within it, but increase as the water depth within the structure rises. Typically, depth-damage relationships are developed using a combination of observed data that is collected after a storm event and by expert elicitation. Depth-damage relationships take into account multiple variables such as whether the water is fresh water or salt water, the duration the water remains in the asset, the materials that the structure is constructed of, and whether a person or business occupies the asset.

A-1.1 Selection of Depth-Damage Relationships

The depth-damage relationships for assets and contents that were used in the HEC-FDA model runs for the Mississippi Coastal Improvement Program (MsCIP) Comprehensive Plan include generic relationships developed by the Institute for Water Resources and depth-damage relationships developed for the U.S. Army Corps of Engineers, New Orleans District. According to ER 1105-2-100, E-19q. (2), depth-damage relationships for feasibility studies should be developed either based on site-specific data or from comparable floodplain data. For this analysis, site-specific data was not readily available for use given the scope, complexity, and timing constraints pertaining to the MsCIP Comprehensive Plan Report; therefore, comparable floodplain data was used.

For residential structures, generic relationships for residential one-story and two-story assets and their contents are from The Corps of Engineers *Economic Guidance Memorandum (EGM) 01-03, Generic Depth Damage Relationships*. These relationships were developed for nation-wide applicability in flood damage reduction studies for assets without basements.

The depth-damage relationships used in association with commercial, municipal, and mobile home assets and their contents are those that were develop for the Lower Atchafalaya and Morganza Feasibility Studies. These relationships are saltwater short-term duration relationships, meaning that the period of inundation (the time that water is in the asset) is approximately twenty-four hours. The

Lower Atchafalaya and Morganza short-duration relationships were specifically chosen because of the vast similarities between structures in Louisiana and the Mississippi Gulf Coast. These similarities include building code requirements, quality of material and labor used for construction, size, and design, and other attributes that make the Lower Atchafalaya and Morganza short-duration relationships a perfect match for the MsCIP Comprehensive Plan Report. These curves are further described in section 1.4 of this addendum.

A-1.2 Uncertainty

A statistical definition of uncertainty is the 'estimated amount or percentage by which an observed or calculated value may differ from the true value.' Since depth-damage relationships are developed through data sampling and/or by using expert opinion, some amount of uncertainty naturally exists. To account for this uncertainty, each structure and content curve contains uncertainty bounds. For residential assets and their contents, a bell-curve distribution was used in which the mean and the standard deviation were input into the HEC-FDA model, and then the model accounted for two standard deviations of error, or approximately a ninety-five percent confidence level. For commercial and municipal assets and contents, an upper and lower bound surrounds a mean value.

The HEC-FDA model uses Monte Carlo simulation to randomly sample damage percentages at each stage. The random sampling allows for multiple values to be analyzed for depth-damage relationship. For example, one-foot of water depth within a Mobile Home asset, see Table A1-3 below, can equate to structure damage ranging from 42.5-percent to 53.6-percent to the Mobile Home. The Monte Carlo simulation used by the HEC-FDA model will select values within this range and determine a 'typical' damage for that one-foot water depth. Thus, the model incorporates the uncertainty of the depth-damage relationship in this process.

A-1.3 Residential Damage Relationships

Residential assets and their contents were divided into and analyzed as one-story, two-story, and mobile homes as per EGM 01-03. These residential relationships were developed based primarily on the findings of the Flood Damage Data Collection Program. According to EGM 01-03, "Proper planning and evaluation of flood damage reduction projects require knowledge of actual damage caused to various types of properties. The primary purpose of the Flood Damage Data Collection Program is to meet that requirement by providing Corps district offices with standardized relationships for estimating flood damage and other costs flooding that occurred in various parts of the United States in 1996, 1997, and 1998. Damage estimates are based on comprehensive accounting of losses from flood victims' records. The standardized functions represent a substantive improvement over other generalized depth-damage functions such as the Flood Insurance Administration (FIA) Rate Reviews." The residential depth-damage relationships for structure and content are shown in Tables 1, 2, and 3.

Table A1-1.
Residential One-Story Damage Relationship

Residential One-Story				
	Structure		Content	
Depth	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**
-2	0%	0.0%	0%	0.0%
-1	2.5%	2.7%	2.4%	2.1%
0	13.4%	2.0%	8.1%	1.5%
1	23.3%	1.6%	13.3%	1.2%
2	32.1%	1.6%	17.9%	1.2%
3	40.1%	1.8%	22.0%	1.4%
4	47.1%	1.9%	25.7%	1.5%
5	53.2%	2.0%	28.8%	1.6%
6	58.6%	2.1%	31.5%	1.6%
7	63.2%	2.2%	33.8%	1.7%
8	67.2%	2.3%	35.7%	1.8%
9	70.5%	2.4%	37.2%	1.9%
10	73.2%	2.7%	38.4%	2.1%
11	75.4%	3.0%	39.2%	2.3%
12	77.2%	3.3%	39.7%	2.6%
13	78.5%	3.7%	40.0%	2.9%
14	79.5%	4.1%	40.0%	3.2%
15	80.2%	4.5%	40.0%	3.5%
16	80.7%	4.9%	40.0%	3.8%

[1] Source: EGM 01-01, 4 December, 2000

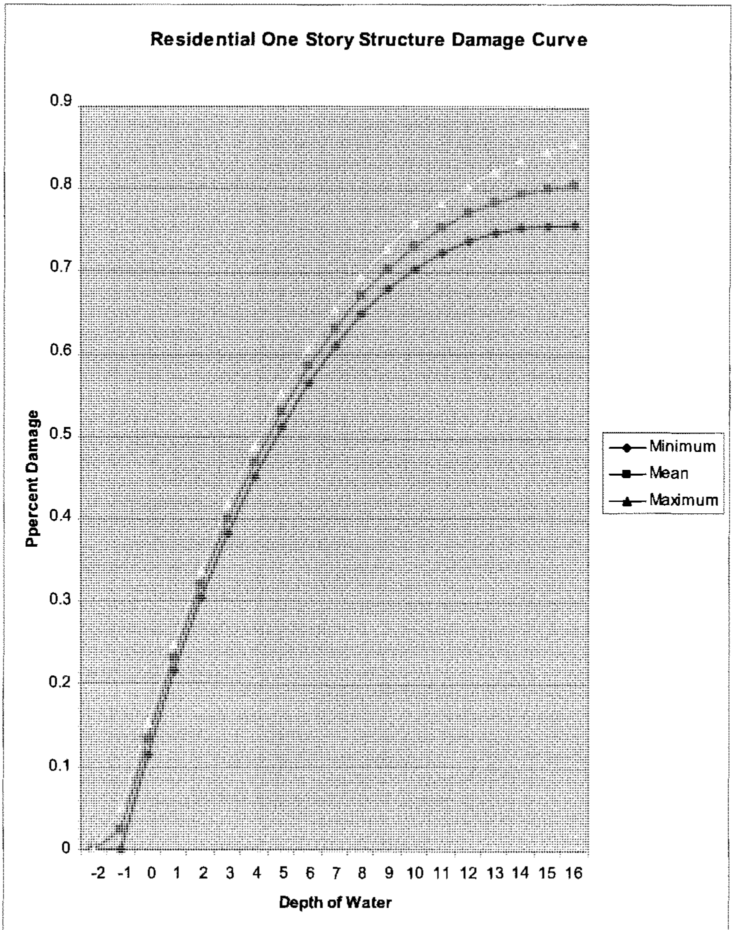


Figure A-1. Residential One-Story Structure Damage Relationship

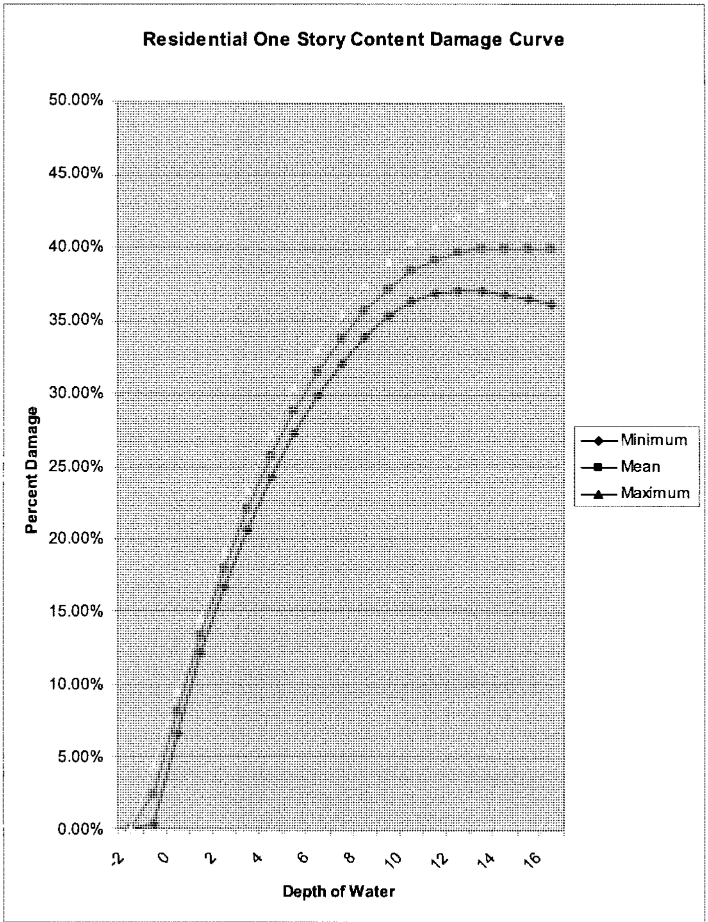


Figure A-2. Residential One-Story Content Damage Relationship

Table A1-2.
Residential Two-Story Damage Relationship

Residential Two-Story				
	Structure		Content	
Depth	Mean	Standard Deviation	Mean	Standard Deviation
-2	0%	0.0%	0%	0.0%
-1	3.0%	4.1%	1.0%	3.5%
0	9.3%	3.4%	5.0%	2.9%
1	15.2%	3.0%	8.7%	2.6%
2	20.9%	2.8%	12.2%	2.5%
3	26.3%	2.9%	15.5%	2.5%
4	31.4%	3.2%	18.5%	2.7%
5	36.2%	3.4%	21.3%	3.0%
6	40.7%	3.7%	23.9%	3.2%
7	44.9%	3.9%	26.3%	3.3%
8	48.8%	4.0%	28.4%	3.4%
9	52.4%	4.1%	30.3%	3.5%
10	55.7%	4.2%	32.0%	3.5%
11	58.7%	4.2%	33.4%	3.5%
12	61.4%	4.2%	34.7%	3.5%
13	63.8%	4.2%	35.6%	3.5%
14	65.9%	4.3%	36.4%	3.6%
15	67.7%	4.6%	36.9%	3.8%
16	89.2%	5.0%	37.2%	4.2%

[1] Source: EGM 01-01, 4 December, 2000

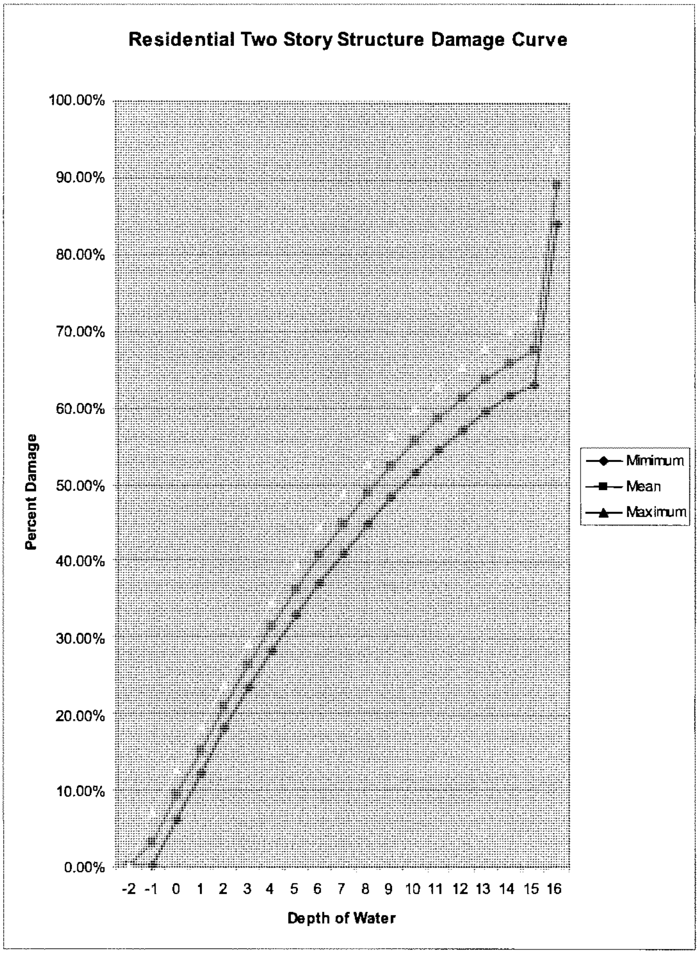


Figure A-3. Residential Two-Story Structure Damage Relationship

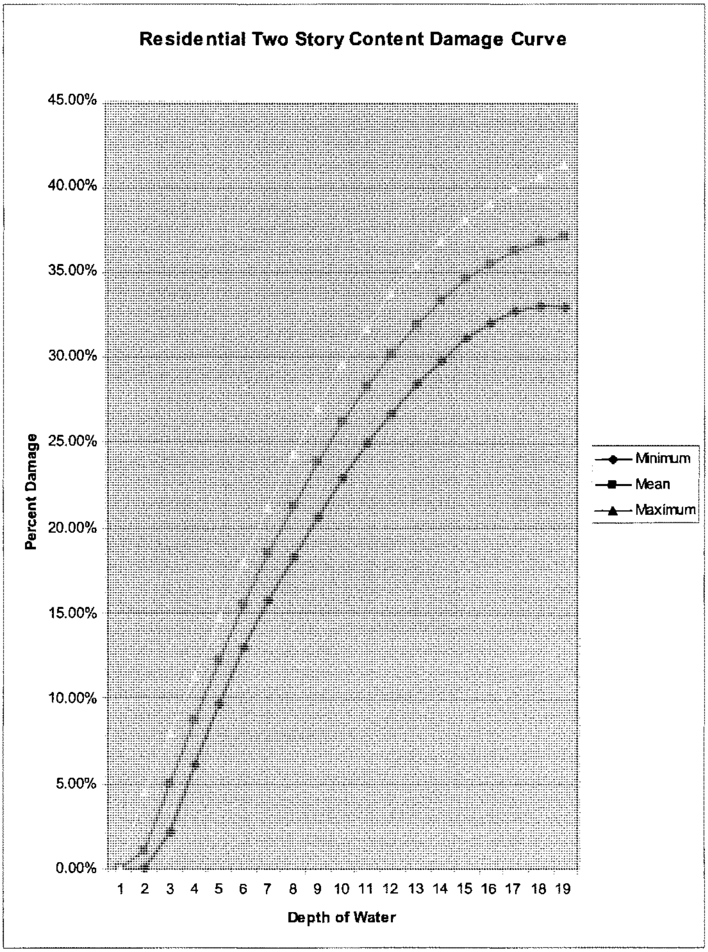


Figure A-4. Residential Two-Story Content Damage Relationship

Table A1-3.
Residential Mobile Home Damage Relationship

Residential: Mobile Homes						
	Structure			Content		
Depth	**Mean**	**Minimum**	**Maximum**	**Mean**	**Minimum**	**Maximum**
-1	6.4%	6.1%	7.7%	0.0%	0.0%	0.0%
-0.5	7.3%	6.9%	8.8%	0.0%	0.0%	0.0%
0	9.9%	9.4%	11.9%	0.0%	0.0%	0.0%
0.5	43.4%	41.2%	52.1%	36.7%	13.7%	48.0%
1	44.7%	42.5%	53.6%	45.4%	32.2%	53.7%
1.5	45.9%	43.6%	55.1%	48.8%	43.1%	53.7%
2	46.6%	44.3%	55.9%	64.3%	60.0%	73.3%
3	46.8%	44.5%	56.2%	71.2%	65.7%	73.9%
4	51.0%	48.5%	61.2%	82.2%	79.6%	84.5%
5	66.9%	63.5%	80.2%	92.1%	89.2%	94.7%
6	66.9%	63.5%	80.2%	92.3%	89.4%	94.9%
7	67.3%	64.0%	80.8%	95.7%	92.7%	100%
8	67.3%	64.0%	80.8%	95.7%	92.7%	100%
9	67.3%	64.0%	80.8%	95.7%	92.7%	100%
10	67.3%	64.0%	80.8%	95.7%	92.7%	100%
11	67.3%	64.0%	80.8%	95.7%	92.7%	100%
12	67.3%	64.0%	80.8%	95.7%	92.7%	100%
13	67.3%	64.0%	80.8%	95.7%	92.7%	100%
14	67.3%	64.0%	80.8%	95.7%	92.7%	100%
15	67.3%	64.0%	80.8%	95.7%	92.7%	100%

[1] Morganza to the Gulf, Louisiana Feasibility Studies, July 1997.

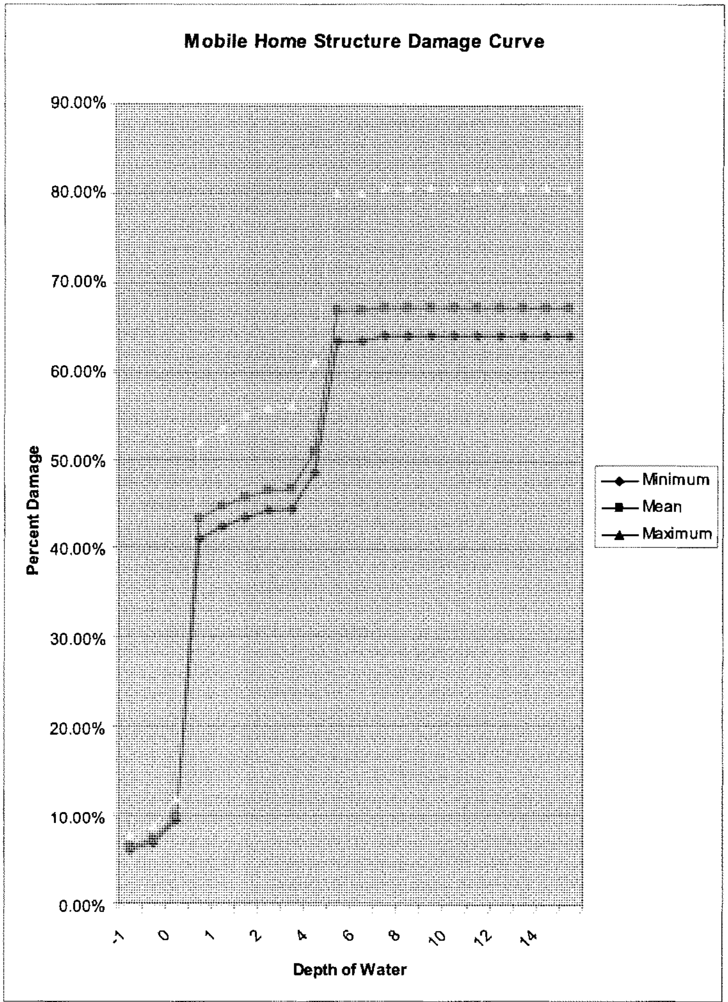


Figure A-5. Mobile Home Structure Damage Relationship

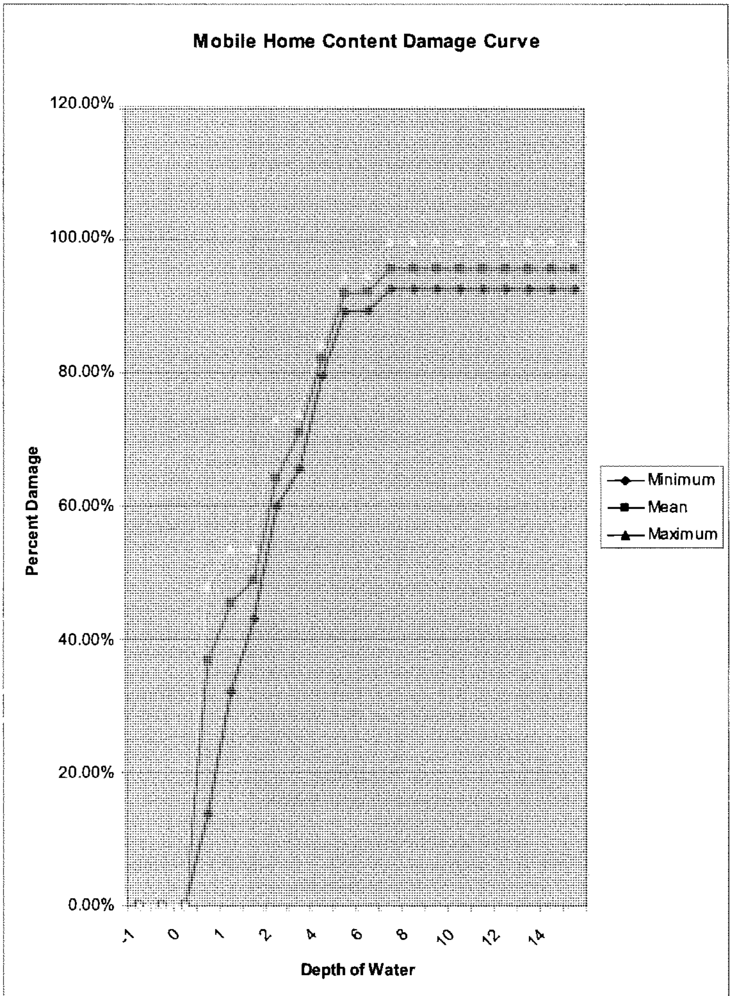


Figure A-6. Mobile Home Content Damage Relationship

A-1.4 Commercial Damage Relationships

Commercial and mobile home structure and content relationships are from the July 1997 final Report entitled Depth-Damaged Relationships for Assets, Contents, and Vehicles and Content-To-Asset Value Ratios (CSVR) in Support of the Lower Atchafalaya Reevaluation and Morganza to the Gulf, Louisiana Feasibility Studies prepared for New Orleans District Corps of Engineers. These relationships are based on field surveys, interviews, and expert panel opinions. Interviews with commercial operators yielded owner/operator estimates of damage that would occur to assets and contents at various flooding levels. Expert panel opinions were based on the "Expert Opinion" method described in the Handbook of Forecasting Techniques (IWR Contract Report 75-7, December 1975) and the Handbook of Forecasting Techniques, Part II, Description of 31 Techniques (Supplement of IWR Contract Report 75-7, August 1977). The panel was asked to determine depth-damage relationships for typical assets in the Lower Atchafalaya and Morganza study areas. The depth-damage relationship is the expected amount of damage either in dollars, or as a percentage of total value for each foot of flooding above or below the first floor of a asset. Commercial structure types were categorized as metal frame, masonry bearing walls, and wood or steel frame walls. However, commercial content categories were divided into the following types: (1) eating and recreation, (2) groceries and gas stations, (3) multi-family residences, (4) repair and home use, (5) retail and personal services, (6) professional business, (7) public, semi-public, and (8) warehouse and contractor services. The commercial depth-damage relationships for structure and content are shown in Tables 4 to 11.

Table A1-4.
Commercial Eating and Recreation Damage Relationship

Commercial: Eating and Recreation						
	Structure Type: Masonry Bearing Walls			Content		
Depth	Mean	Minimum	Maximum	Mean	Minimum	Maximum
-1	0%	0%	0%	0.0%	0.0%	0.0%
-0.5	0%	0%	0%	0.0%	0.0%	0.0%
0	1.8%	1.6%	2.1%	0.0%	0.0%	0.0%
0.5	13.2%	12.3%	15.9%	18.7%	16.8%	22.4%
1	13.2%	12.3%	15.9%	25.0%	22.5%	30.1%
1.5	18.9%	17.0%	22.7%	46.8%	42.1%	56.1%
2	19.1%	17.2%	23.5%	50.2%	45.2%	60.3%
3	24.7%	21.7%	29.6%	80.3%	72.3%	96.4%
4	29.0%	24.6%	36.2%	95.8%	86.2%	100%
5	32.5%	27.6%	40.6%	98.2%	88.4%	100%
6	32.5%	27.6%	40.6%	99.1%	89.2%	100%
7	32.5%	27.6%	40.6%	100%	90.0%	100%
8	35.1%	29.8%	43.9%	100%	90.0%	100%
9	46.5%	39.5%	58.1%	100%	90.0%	100%
10	53.3%	45.3%	66.6%	100%	90.0%	100%
11	57.7%	45.3%	66.6%	100%	90.0%	100%
12	57.7%	49.0%	72.1%	100%	90.0%	100%
13	57.7%	49.0%	72.1%	100%	90.0%	100%
14	57.7%	49.0%	72.1%	100%	90.0%	100%
15	57.7%	49.0%	72.1%	100%	90.0%	100%

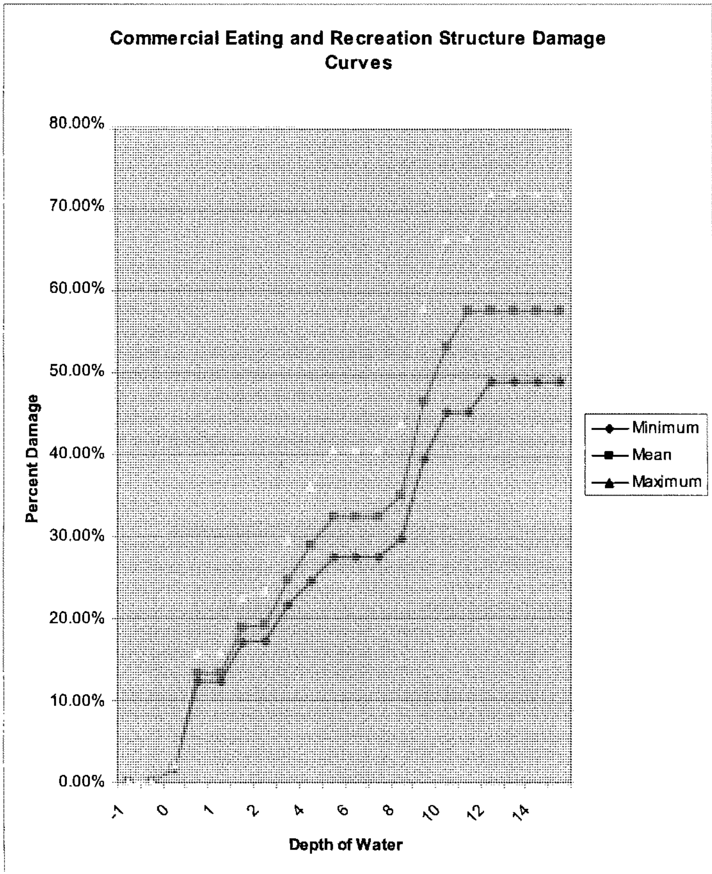
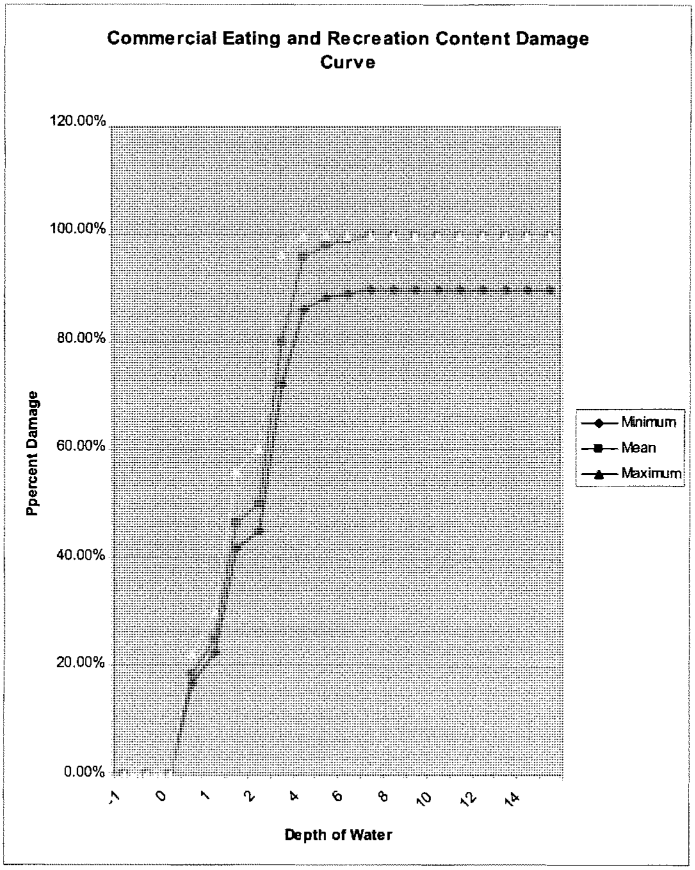


Figure A-7. Eating and Recreation Structure Damage Relationship



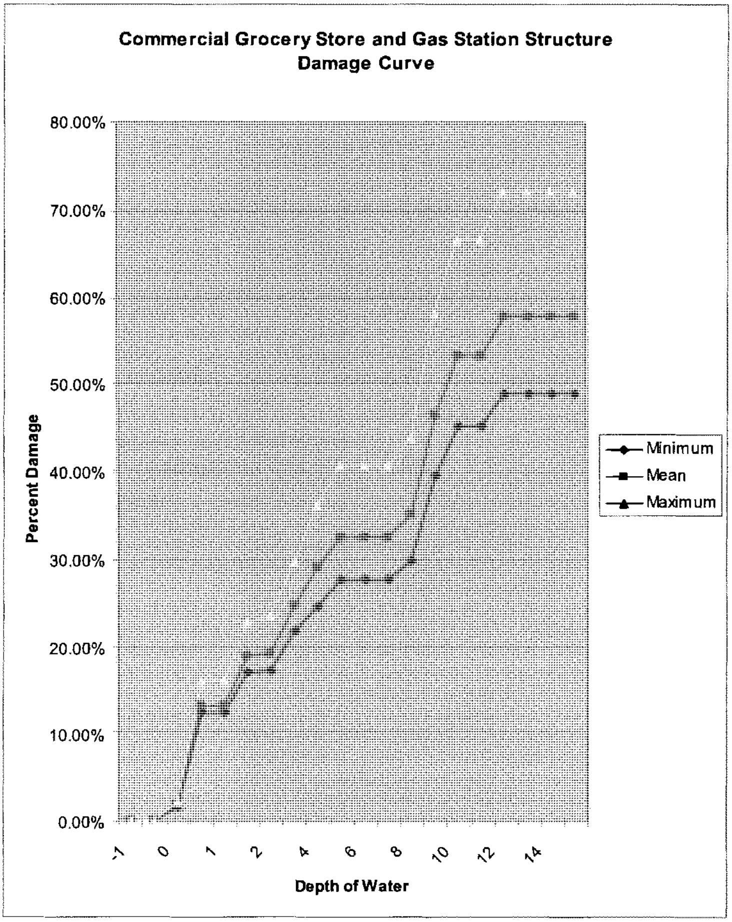
1

2 **Figure A-8. Eating and Recreation Content Damage Relationship**

Table A1-5.
Commercial Grocery and Gas Station Damage Relationship

Commercial: Gas Station and Grocery Store						
	Structure Type Masonry Bearing Walls			Content		
Depth	**Mean**	**Minimum**	**Maximum**	**Mean**	**Minimum**	**Maximum**
-1	0%	0%	0%	0.0%	0.0%	0.0%
-0.5	0%	0%	0%	0.0%	0.0%	0.0%
0	1.8%	1.6%	2.1%	0.0%	0.0%	0.0%
0.5	13.2%	12.3%	15.9%	18.7%	16.8%	22.4%
1	13.2%	12.3%	15.9%	25.0%	22.5%	30.1%
1.5	18.9%	17.0%	22.7%	46.8%	42.1%	56.1%
2	19.1%	17.2%	23.5%	50.2%	45.2%	60.3%
3	24.7%	21.7%	29.6%	80.3%	72.3%	96.4%
4	29.0%	24.6%	36.2%	95.8%	86.2%	100%
5	32.5%	27.6%	40.6%	98.2%	88.4%	100%
6	32.5%	27.6%	40.6%	99.1%	89.2%	100%
7	32.5%	27.6%	40.6%	100%	90.0%	100%
8	35.1%	29.8%	43.9%	100%	90.0%	100%
9	46.5%	39.5%	58.1%	100%	90.0%	100%
10	53.3%	45.3%	66.6%	100%	90.0%	100%
11	53.3%	45.3%	66.6%	100%	90.0%	100%
12	57.7%	49.0%	72.1%	100%	90.0%	100%
13	57.7%	49.0%	72.1%	100%	90.0%	100%
14	57.7%	49.0%	72.1%	100%	90.0%	100%
15	57.7%	49.0%	72.1%	100%	90.0%	100%

[1] Morganza to the Gulf, Louisiana Feasibility Studies, July 1997.



1

2 **Figure A-9. Grocery Store and Gas Station Structure Damage Relationship**

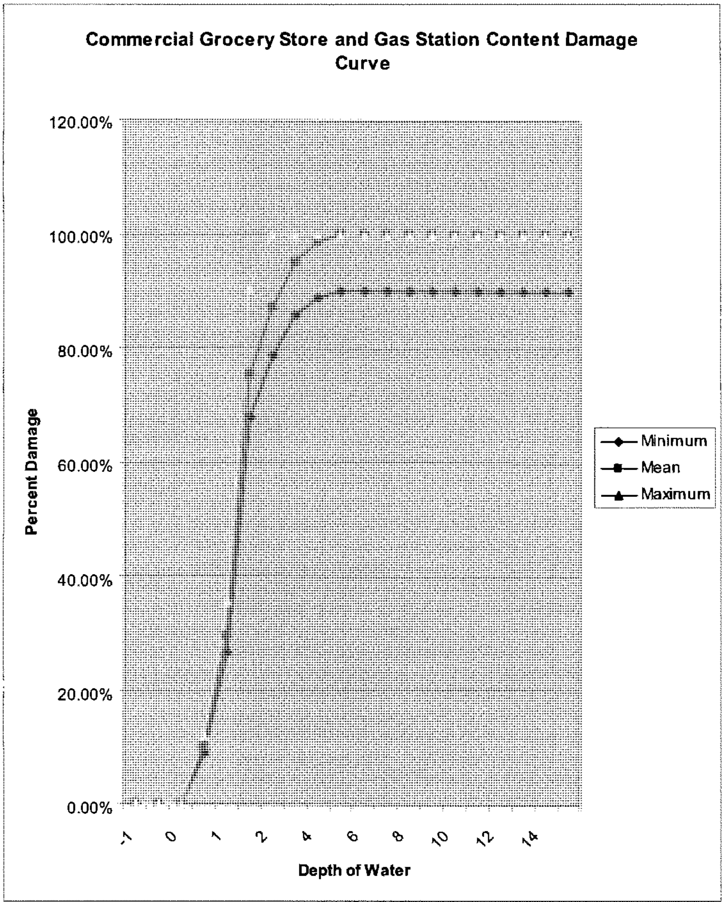


Figure A-10. Grocery Store and Gas Station Content Damage Relationship

Table A1-6.
Municipal Damage Relationship

Municipal Structures						
	Structure Type Masonry Bearing Walls			Content		
Depth	Mean	Minimum	Maximum	Mean	Minimum	Maximum
-1	0%	0%	0%	0.0%	0.0%	0.0%
-0.5	0%	0%	0%	0.0%	0.0%	0.0%
0	1.8%	1.6%	2.1%	0.0%	0.0%	0.0%
0.5	13.2%	12.3%	15.9%	40.0%	36.0%	50.0%
1	13.2%	12.3%	15.9%	72.0%	64.8%	90%
1.5	18.9%	17.0%	22.7%	72.0%	64.8%	90%
2	19.1%	17.2%	23.5%	72.0%	64.8%	90%
3	24.7%	21.7%	29.6%	99.7%	89.7%	100%
4	29.0%	24.6%	36.2%	100%	90%	100%
5	32.5%	27.6%	40.6%	100%	90%	100%
6	32.5%	27.6%	40.6%	100%	90%	100%
7	32.5%	27.6%	40.6%	100%	90%	100%
8	35.1%	29.8%	43.9%	100%	90%	100%
9	46.5%	39.5%	58.1%	100%	90%	100%
10	53.3%	45.3%	66.6%	100%	90%	100%
11	53.3%	45.3%	66.6%	100%	90%	100%
12	57.7%	49.0%	72.1%	100%	90%	100%
13	57.7%	49.0%	72.1%	100%	90%	100%
14	57.7%	49.0%	72.1%	100%	90%	100%
15	57.7%	49.0%	72.1%	100%	90%	100%

[1] Morganza to the Gulf, Louisiana Feasibility Studies, July 1997.

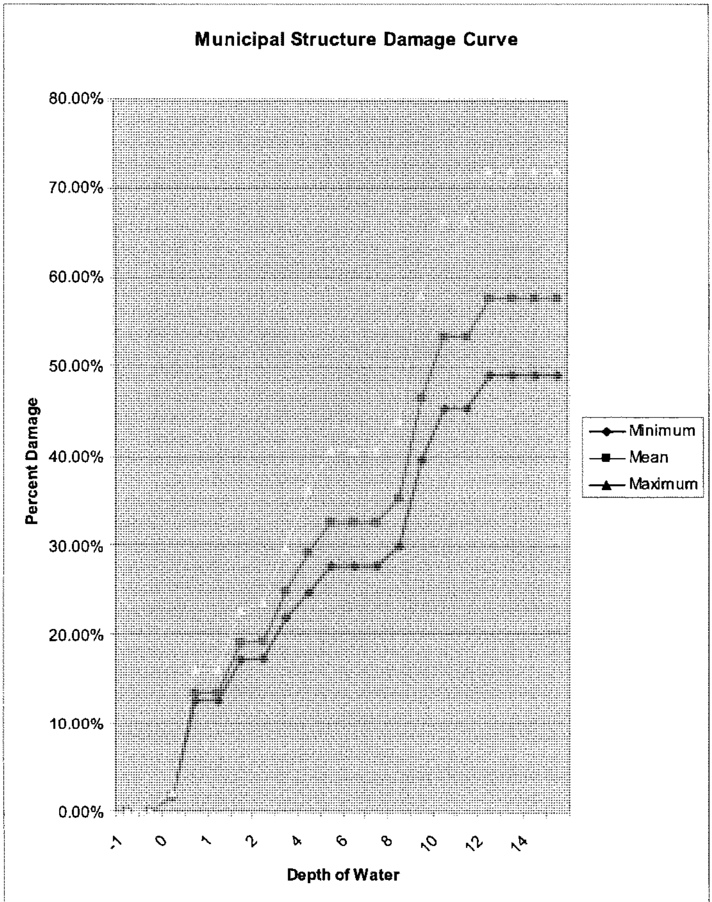


Figure A-11. Municipal Structure Damage Relationship

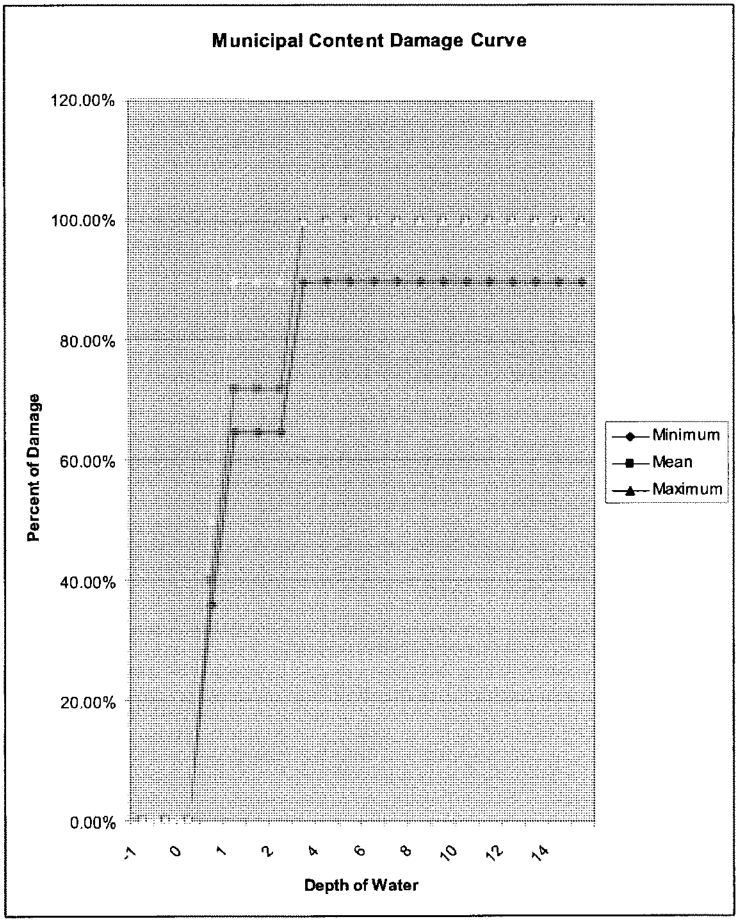


Figure A-12. Municipal Content Damage Relationship

Table A1-7.
Retail and Personal Services Damage Relationship

Commercial: Retail and Personal Services						
	Structure Type Masonry Bearing Walls			Content		
Depth	**Mean**	**Minimum**	**Maximum**	**Mean**	**Minimum**	**Maximum**
-1	0%	0%	0%	0.0%	0.0%	0.0%
-0.5	0%	0%	0%	0.0%	0.0%	0.0%
0	1.8%	1.6%	2.1%	0.0%	0.0%	0.0%
0.5	13.2%	12.3%	15.9%	12.0%	10.8%	14.4%
1	13.2%	12.3%	15.9%	25.3%	22.7%	30.3%
1.5	18.9%	17.0%	22.7%	36.6%	32.9%	43.9%
2	19.1%	17.2%	23.5%	60.5%	54.5%	72.6%
3	24.7%	21.7%	29.6%	75.4%	67.8%	90.5%
4	29.0%	24.6%	36.2%	85.1%	76.6%	100%
5	32.5%	27.6%	40.6%	94.5%	85.0%	100%
6	32.5%	27.6%	40.6%	100%	90.0%	100%
7	32.5%	27.6%	40.6%	100%	90.0%	100%
8	35.1%	29.8%	43.9%	100%	90.0%	100%
9	46.5%	39.5%	58.1%	100%	90.0%	100%
10	53.3%	45.3%	66.6%	100%	90.0%	100%
11	53.3%	45.3%	66.6%	100%	90.0%	100%
12	57.7%	49.0%	72.1%	100%	90.0%	100%
13	57.7%	49.0%	72.1%	100%	90.0%	100%
14	57.7%	49.0%	72.1%	100%	90.0%	100%
15	57.7%	49.0%	72.1%	100%	90.0%	100%

[1] Morganza to the Gulf, Louisiana Feasibility Studies, July 1997.

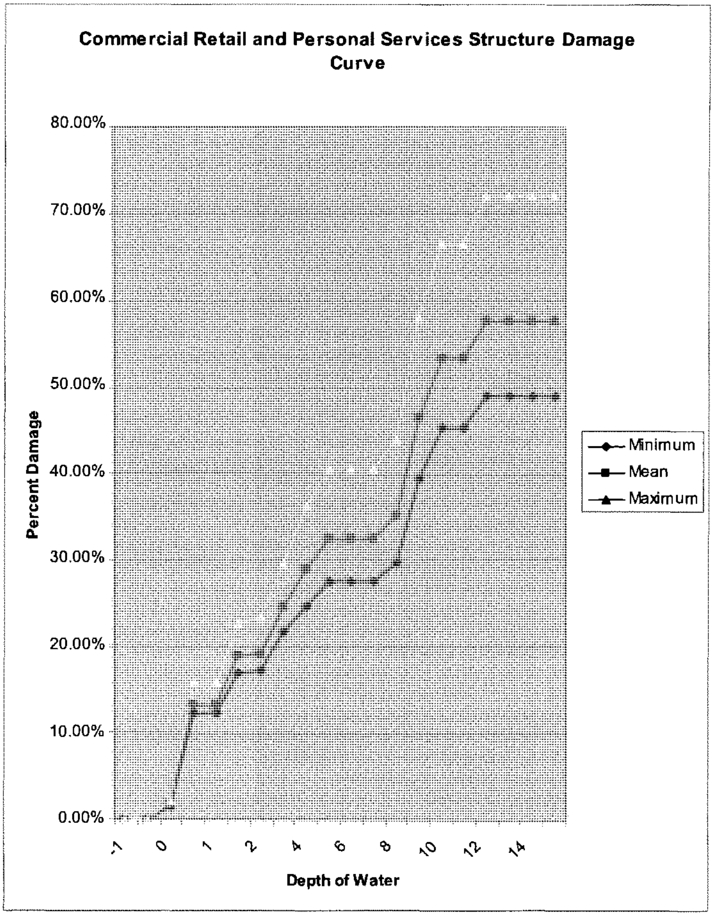


Figure A-13. Retail and Personal Services Structure Damage Relationship

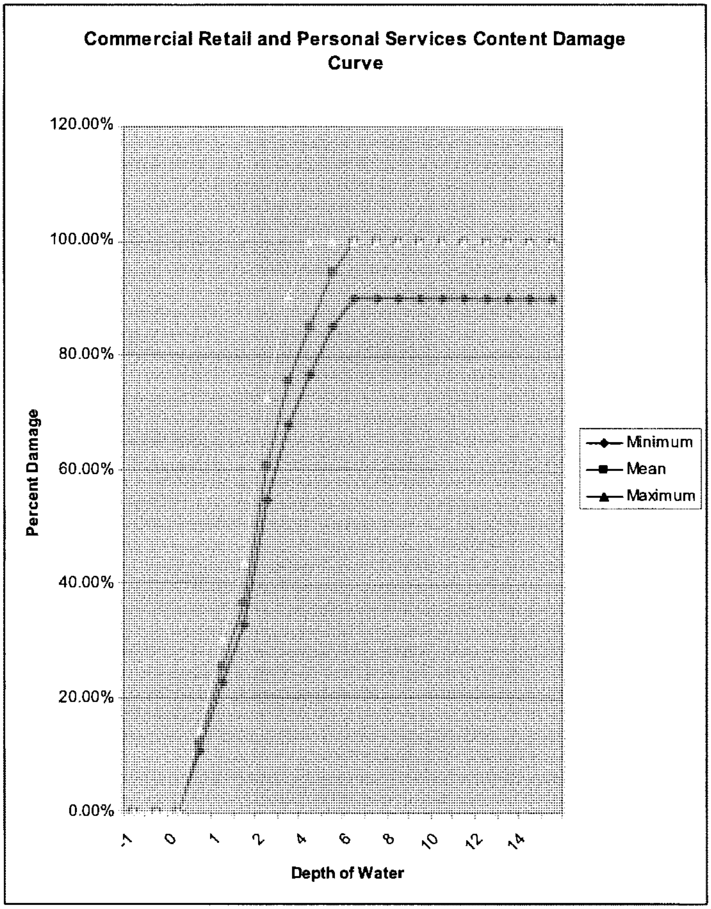


Figure A-14. Retail and Personal Services Content Damage Relationship

Table A1-8.
Multi-Family Damage Relationship

Municipal Structures						
	Structure Type Wood or Steel Frame			Content		
Depth	**Mean**	**Minimum**	**Maximum**	**Mean**	**Minimum**	**Maximum**
-1	0%	0%	0%	0.0%	0.0%	0.0%
-0.5	0%	0%	0%	0.0%	0.0%	0.0%
0	1.1%	1.0%	1.3%	0.0%	0.0%	0.0%
0.5	20.1%	18.7%	24.1%	7.9%	3.0%	10.3%
1	20.1%	18.7%	24.1%	15.3%	10.9%	18.1%
1.5	25.8%	18.7%	31.0%	18.8%	16.6%	20.5%
2	29.9%	23.2%	36.7%	23.5%	21.9%	26.7%
3	34.0%	26.9%	40.8%	39.7%	36.6%	41.2%
4	40.7%	29.9%	50.9%	45.3%	43.8%	46.5%
5	49.0%	34.6%	61.3%	47.2%	45.7%	48.5%
6	49.0%	41.7%	61.3%	47.2%	45.7%	48.5%
7	50.8%	41.7%	63.6%	47.2%	45.7%	50.3%
8	52.4%	43.2%	65.5%	47.2%	45.7%	50.3%
9	57.3%	44.5%	71.6%	47.2%	45.7%	50.3%
10	57.3%	48.7%	71.6%	55.1%	50.6%	72.1%
11	57.3%	48.7%	71.6%	66.0%	58.4%	72.1%
12	60.4%	51.3%	75.4%	86.9%	80.2%	90.2%
13	60.4%	51.3%	75.4%	92.5%	89.5%	95.1%
14	60.4%	51.3%	75.4%	94.4%	91.4%	97.1%
15	60.4%	51.3%	75.4%	94.4%	91.4%	97.1%

[1] Morganza to the Gulf, Louisiana Feasibility Studies, July 1997.

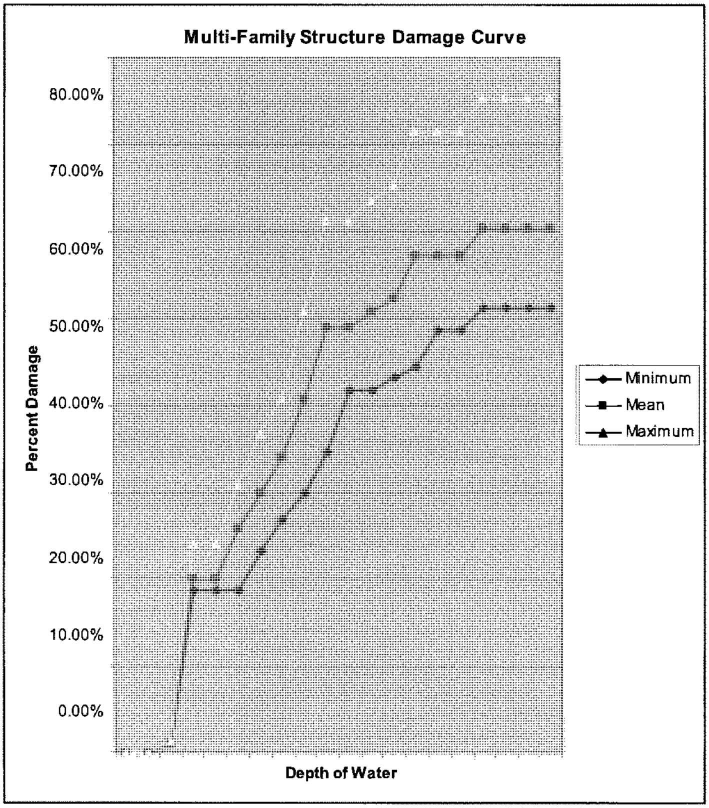


Figure A-15. Multi-Family Structure Damage Relationship

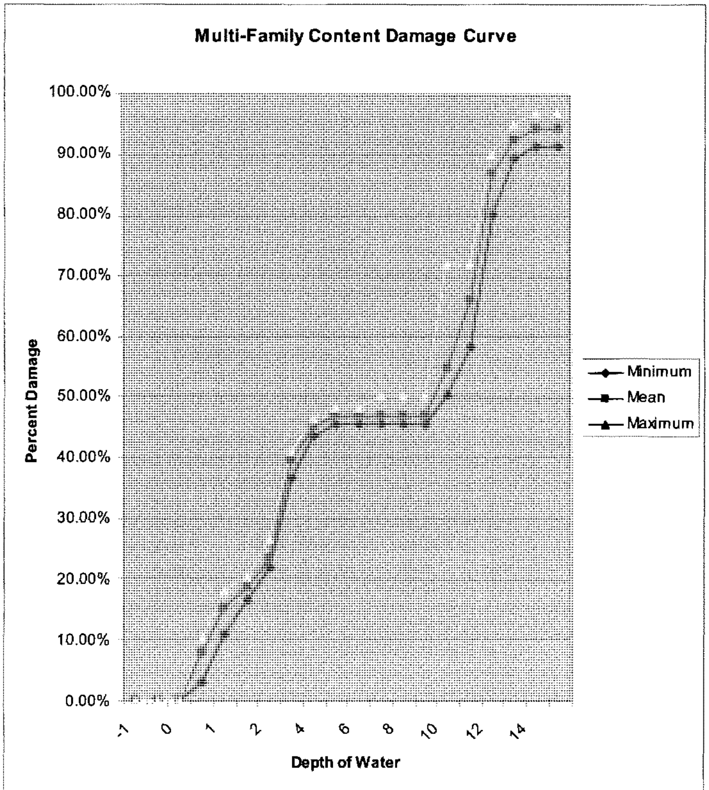


Figure A-16. Multi-Family Content Damage Relationship

Table A1-9.
Professional Businesses Damage Relationship

Professional Business Structures						
	Structure Type Wood or Steel Frame			Content		
Depth	**Mean**	**Minimum**	**Maximum**	**Mean**	**Minimum**	**Maximum**
-1	0%	0%	0%	0.0%	0.0%	0.0%
-0.5	0%	0%	0%	0.0%	0.0%	0.0%
0	1.1%	1.0%	1.3%	0.0%	0.0%	0.0%
0.5	20.1%	18.7%	24.1%	14.8%	13.3%	18.4%
1	20.1%	18.7%	24.1%	18.6%	16.7%	23.2%
1.5	25.8%	18.7%	31.0%	33.3%	30.0%	41.6%
2	29.9%	23.2%	36.7%	39.0%	35.1%	48.8%
3	34.0%	26.9%	40.8%	74.6%	67.1%	93.2%
4	40.7%	29.9%	50.9%	92.2%	83.0%	100%
5	49.0%	34.6%	61.3%	94.1%	84.7%	100%
6	49.0%	41.7%	61.3%	100%	90.0%	100%
7	50.8%	41.7%	63.6%	100%	90.0%	100%
8	52.4%	43.2%	65.5%	100%	90.0%	100%
9	57.3%	44.5%	71.6%	100%	90.0%	100%
10	57.3%	48.7%	71.6%	100%	90.0%	100%
11	57.3%	48.7%	71.6%	100%	90.0%	100%
12	60.4%	51.3%	75.4%	100%	90.0%	100%
13	60.4%	51.3%	75.4%	100%	90.0%	100%
14	60.4%	51.3%	75.4%	100%	90.0%	100%
15	60.4%	51.3%	75.4%	100%	90.0%	100%

[1] Morganza to the Gulf, Louisiana Feasibility Studies, July 1997.

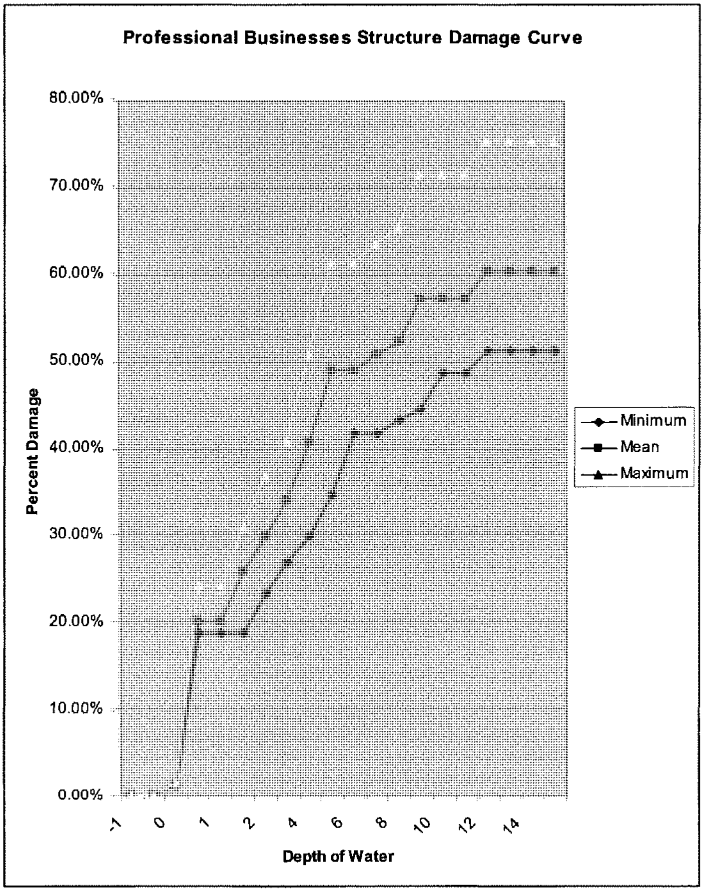


Figure A-17. Professional Businesses Structure Damage Relationship

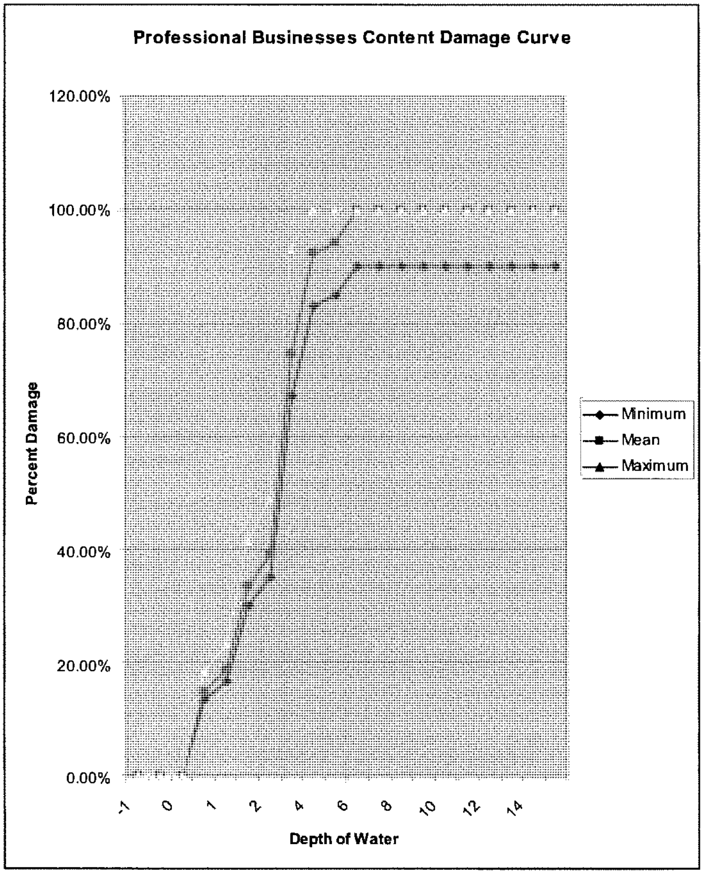


Figure A-18. Professional Businesses Content Damage Relationship

Table A1-10.
Commercial Repair and Home Damage Relationship

Commercial Repair and Home Use						
	Structure Type Wood or Steel			Content		
Depth	**Mean**	**Minimum**	**Maximum**	**Mean**	**Minimum**	**Maximum**
-1	0%	0%	0%	0.0%	0.0%	0.0%
-0.5	0%	0%	0%	0.0%	0.0%	0.0%
0	1.1%	1.0%	1.3%	0.0%	0.0%	0.0%
0.5	13.0%	12.1%	15.6%	14.6%	13.1%	17.5%
1	13.0%	12.1%	15.6%	20.6%	18.5%	24.7%
1.5	18.2%	16.4%	21.9%	31.8%	28.6%	38.2%
2	18.7%	16.9%	23.0%	32.8%	29.5%	39.3%
3	22.3%	19.6%	26.7%	66.0%	59.4%	79.2%
4	26.9%	22.8%	33.6%	67.4%	60.7%	80.9%
5	28.7%	24.4%	35.9%	68.8%	62.0%	82.6%
6	28.7%	24.4%	35.9%	76.9%	69.3%	92.3%
7	28.7%	24.4%	35.9%	79.9%	71.9%	95.9%
8	32.5%	27.6%	40.6%	79.9%	71.9%	95.9%
9	39.9%	34.0%	49.9%	79.9%	71.9%	95.9%
10	39.9%	34.0%	49.9%	79.9%	71.9%	95.9%
11	39.9%	34.0%	49.9%	79.9%	71.9%	95.9%
12	39.9%	34.0%	49.9%	79.9%	71.9%	95.9%
13	39.9%	34.0%	49.9%	79.9%	71.9%	95.9%
14	39.9%	34.0%	49.9%	79.9%	71.9%	95.9%
15	39.9%	34.0%	49.9%	79.9%	71.9%	95.9%

[1] Morganza to the Gulf, Louisiana Feasibility Studies, July 1997.

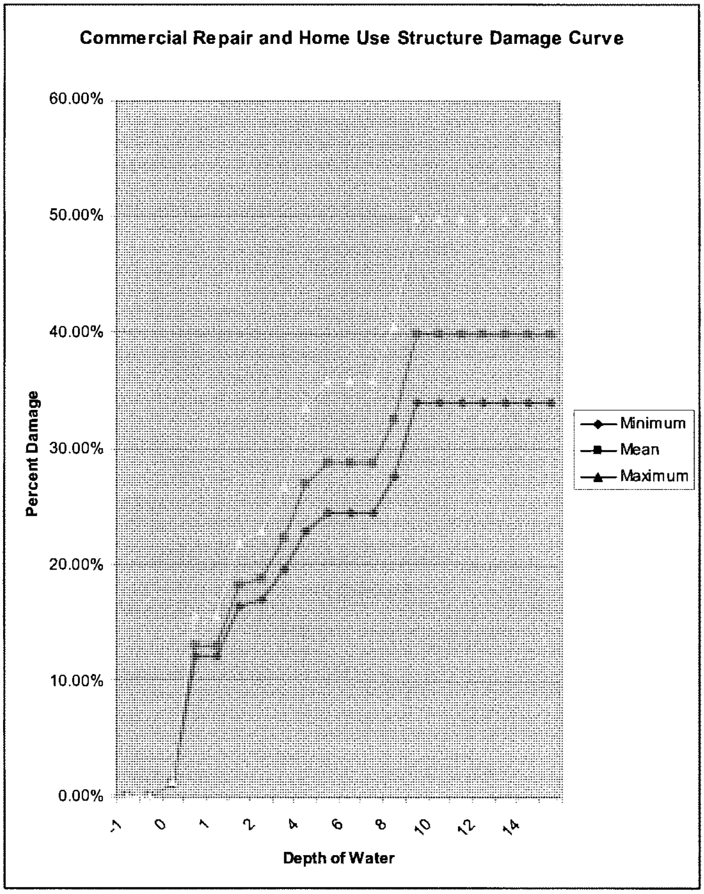


Figure A-19. Commercial Repair and Home Use Structure Damage Relationship

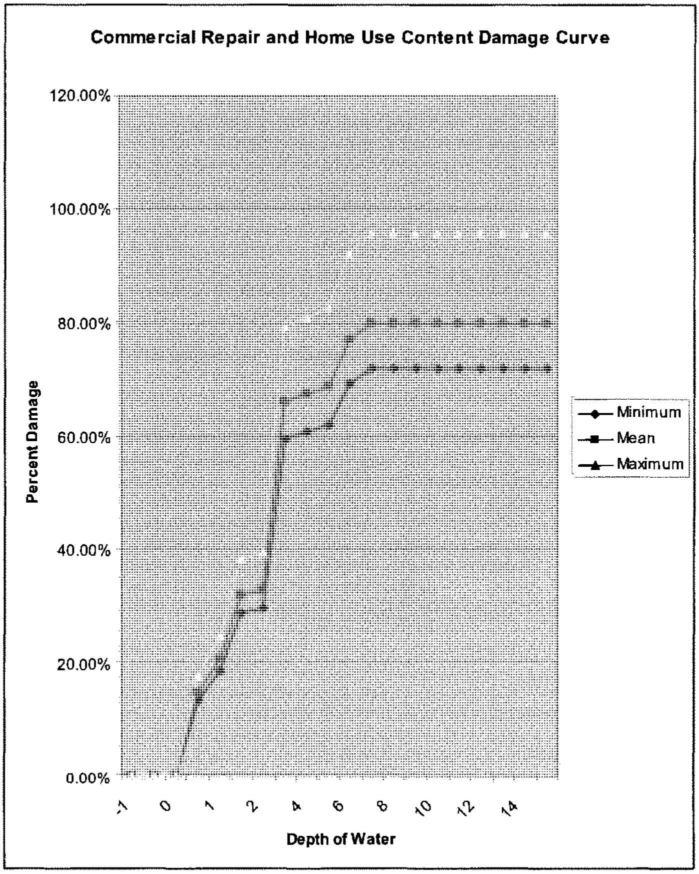


Figure A-20. Commercial Repair and Home Use Damage Relationship

Table A1-11.
Warehouse and Contractor Services Damage Relationship

Commercial Repair and Home Use						
	Structure Type Metal Frame			Content		
Depth	**Mean**	**Minimum**	**Maximum**	**Mean**	**Minimum**	**Maximum**
-1	0%	0%	0%	0.0%	0.0%	0.0%
-0.5	0%	0%	0%	0.0%	0.0%	0.0%
0	1.1%	1.0%	1.3%	0.0%	0.0%	0.0%
0.5	13.0%	12.1%	15.6%	8.5%	7.6%	10.2%
1	13.0%	12.1%	15.6%	12.6%	11.4%	15.2%
1.5	18.2%	16.4%	21.9%	16.8%	15.2%	20.2%
2	18.7%	16.9%	23.0%	21.1%	19.0%	25.4%
3	22.3%	19.6%	26.7%	27.9%	25.1%	33.5%
4	26.9%	22.8%	33.6%	32.5%	29.2%	39.0%
5	28.7%	24.4%	35.9%	40.9%	36.8%	49.1%
6	28.7%	24.4%	35.9%	48.5%	43.6%	58.2%
7	28.7%	24.4%	35.9%	56.1%	50.5%	67.3%
8	32.5%	27.6%	40.6%	63.7%	57.3%	76.4%
9	39.9%	34.0%	49.9%	71.3%	64.1%	85.5%
10	39.9%	34.0%	49.9%	76.1%	68.5%	91.3%
11	39.9%	34.0%	49.9%	76.1%	68.5%	91.3%
12	39.9%	34.0%	49.9%	76.1%	68.5%	91.3%
13	39.9%	34.0%	49.9%	76.1%	68.5%	91.3%
14	39.9%	34.0%	49.9%	76.1%	68.5%	91.3%
15	39.9%	34.0%	49.9%	76.1%	68.5%	91.3%

[1] Morganza to the Gulf, Louisiana Feasibility Studies, July 1997.

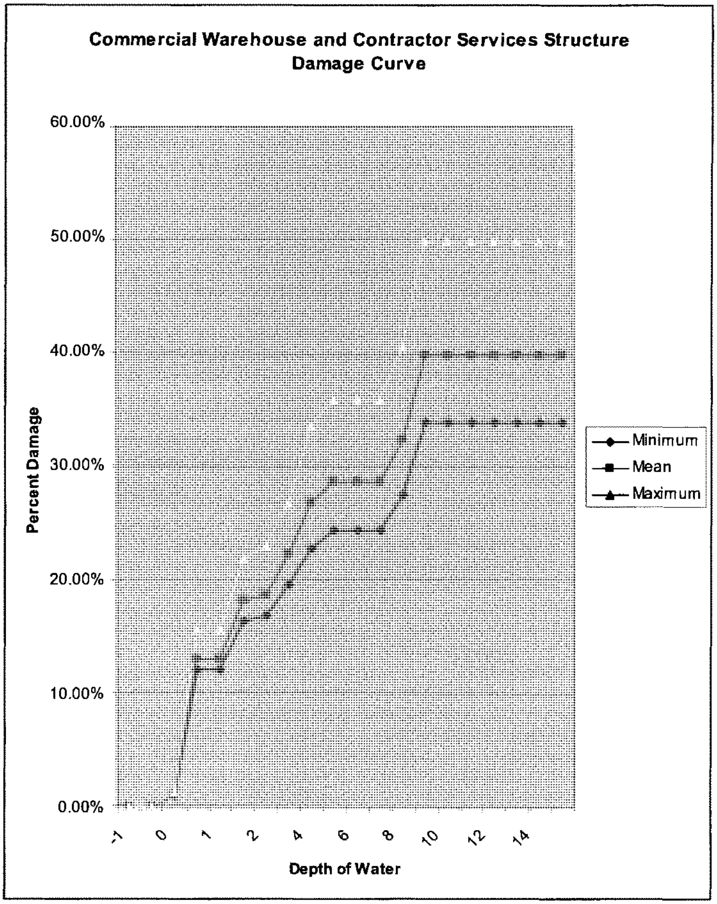


Figure A-21. Warehouse and Contractor Services Structure Damage Relationships

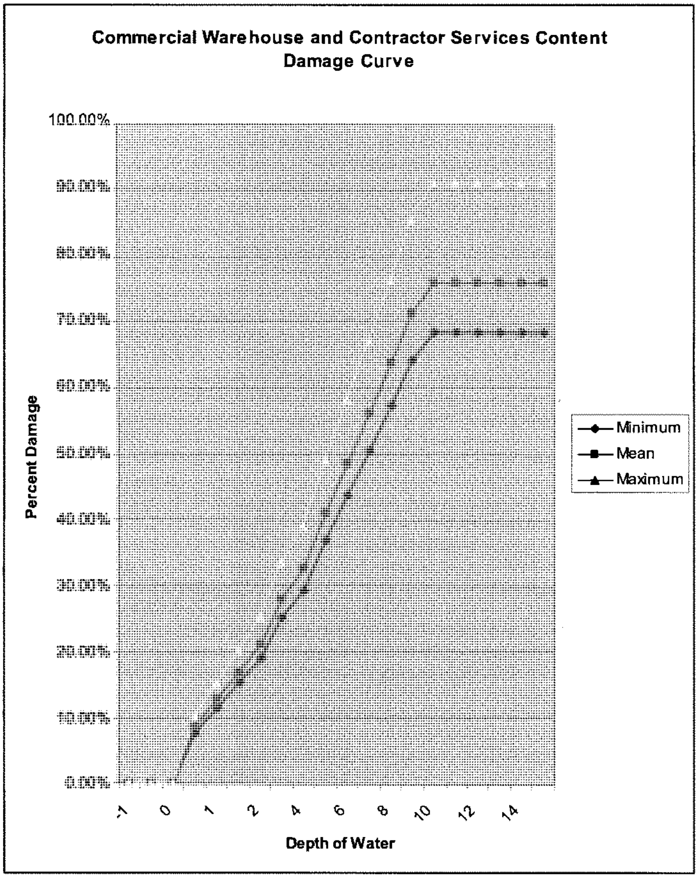


Figure A-22. Warehouse and Contractor Services Structure Damage Relationships

Moreover, each of the eight commercial content categories included a wide variety of business establishments as shown in the following list:

1/ Eating and Recreation: fast food restaurants, full-service restaurants, lounges, bowling alleys, movie theaters, etc.

2/ Groceries and Gas Stations: large and neighborhood groceries, bakeries, candy Stores, wine stores, liquor stores, drug stores, gas stations, convenience stores, and etc.

3/ Multi-Family Residences: garden apartments, high-rise apartments, condominiums, townhomes, motels, hotels, and etc.

4/ Professional Businesses: banks, real estates offices, legal offices, accounting firms, medical offices, veterinary offices, dentist offices, funeral homes, etc.

5/ Public and Semi Public: schools, civic associations, churches, government facilities, utility companies, etc.

6/ Repairs and Home Use: auto repair, watch repair, re-upholstery, home repair, and etc.

7/ Retail and Personal Services: department stores, furniture stores, clothing stores, shoe stores, barber shops, beauty salon, Laundromats, etc.

8/ Warehouse and Contractor Services: transit warehouse, distribution warehouse, storage warehouse, factory, manufacturers, plumbing services, heating and air condition services, carpeting services, etc.

ADDENDUM B – EXPERT ELICITATION ABSTRACT

Institute for Water Resources, U.S. Army Corps of Engineers

Version 1 dated June 19, 2009

COASTAL STORM DAMAGE RELATIONSHIPS BASED ON EXPERT OPINION ELICITATION

(DRAFT)

U. S. Army Corps of Engineers
USACE Institute for Water Resources
Humphreys Engineer Center, Casey Building
7701 Telegraph Road
Alexandria, VA 22315-3868

CHAPTER B-I. ABSTRACT

This report documents the results of the Coastal Storm Damage Workshop on June 5, 6, 2002 in Alexandria, Virginia where expert-opinion was elicited for economic consequence assessment of coastal storm damage. The objectives of this workshop were to discuss and recommend damage relationships needed for predicting structural damage from coastal storms as functions of hazard intensity levels, with associated uncertainties, resulting from erosion, waves, inundation, and their combined effects. Because information on the relationship between residential structural damage and storm parameters is limited, this workshop used expert-opinion as a means of gaining information on these relationships (see Aye 2001). This report describes the results of the workshop both in terms of damage relationships and future information needs identified by the experts at the workshop.

This workshop is part of longer-term research effort whose objective is to develop a peer-reviewed, step-by-step methodology for estimating coastal storm damages. The methodology will be incorporated as part of the inputs to a new hurricane and storm damage reduction estimation model being developed by IWR. The methodology will be able to stand alone for use in Corps' districts or by other national or local agencies including potential incorporation as an option in FEMA's HAZUS model.

CHAPTER B-II. INTRODUCTION

B-2.1 Program Overview

The objective of this research is to develop a peer-reviewed, step-by-step methodology for estimating damages from coastal storms to property and improvements. The methodology will also be incorporated as part of the inputs to a new hurricane and storm damage reduction estimation model being developed by the Institute for Water Resources (IWR). The methodology will be able to stand alone for use in Corps' districts or by other national or local agencies including potential incorporation as an option in FEMA's HAZUS model.

The objective will be achieved using a two-stage process to elicit opinions from experts to develop damage functions to estimate storm damages. The first stage of this process consisted of developing framework to quantitatively describe the damage done to a structure from storm hazards such as inundation, waves, erosion, and wind. Preliminary damage relationships (curves) were also developed. As a starting point for the first stage, the project core team from IWR proposed a "straw man" framework to be modified by a small group of experts. Inputs for this first stage included the models presently in use by Corps' offices (e.g. Wilmington and Jacksonville) and other agencies around the country, as well as a framework that is being developed for this purpose for the Corps' Wilmington District. Experts were chosen from within the Corps', from contractors and academics with experience in coastal storm damage, and from the Federal Emergency Management Authority. Although a focus was on the hurricane-prone southeastern U.S., the workshop also included expertise from the North Atlantic and California.

The second stage will involve additional data collection through a full review of the initial framework and relationships by a review team, by Corps' offices, and by the professional community at-large, and from damage data collected in post-storm surveys. Experts will then be convened in a formal expert elicitation to use this additional information to modify the preliminary depth-damage relationships and develop final estimates of likely economic damages from a coastal storm.

B-2.3 Needs and Existing Storm Damage Information

This study was prompted by a widely-perceived need for better information on coastal storm damage relationships. A December 2000 letter from the Assistant Secretary of the Army to the Wilmington District requested a "Corps-wide-survey of damage functions used for all types of structures and the rationale for using them, for hurricane and storm damage reduction projects". The expectation was that "better guidance can be provided to field offices on the conduct of economic analysis if we have the benefit of ... better tools to evaluate hurricane and storm damage projects". This research seeks to provide these better tools.

In investigating storm damage relationships, available sources of information can be divided into two general categories: 1) data on storm damages and on existing structures, and 2) models of the relationships between storm parameters and damage. Whereas the relationships between storm parameters and damage are the ultimate purpose of this investigation, the relationships need to be grounded in the data on actual storm damages. As background for the research and in preparation for the workshop, the project core team from IWR reviewed coastal damage methodologies from various sources including: Corps Districts in Jacksonville, Wilmington, New Orleans, Mobile, New York, Philadelphia; the HAZUS model - a natural hazard loss estimation methodology developed by the Federal Emergency Management Agency in partnership with the National Institute of Building Sciences; FEMA building performance studies; Federal Insurance claims data; USACE reports on Hurricane Fran and on Shoreline Protection and Beach Erosion Control; state data from Hurricane Opal (FL); the Heinz Center's Evaluation of Erosion Hazards, and various articles from the open literature (i.e. Budge 1991, King et al. 1991, Ulrich et al. 1994, Kato and Torii 2002, Tomalley et al. 2002).

B-2.4 Use of Expert Opinions

The primary reason for using expert opinions is provide "data" where little or no data exists about an issue or problem. It can also deal with uncertainty in selected technical issues related to a system of interest. Issues with significant uncertainty, issues that are controversial and/or contentious, issues that are complex, and/or issues that can have a significant effect on risk are most suited for expert-opinion elicitation. Here we used an informal, consensus-based elicitation process to promote creative thinking about potential frameworks and problem definition. The value of any expert-opinion elicitation comes from its initial intended uses as a heuristic tool, not a scientific tool, for exploring vague and unknowable issues that are otherwise inaccessible. It is not a substitute to scientific, rigorous research.

The identification of the need for the information developed during the elicitation process and its communication to experts are essential for the success of the elicitation. The need identification and communication should include the definition of the goal of the study and relevance of issues to this goal. Establishing this relevance would make the experts stakeholders and thereby increase their attention and sincerity levels. Relevance of each issue and/or question to the study needs to be established. This question-to-study relevance is essential to enhancing the reliability of collected data from the experts. Each question or issue needs to be relevant to each expert especially when dealing with subjects with diverse views.

The expert-opinion elicitation process can be defined as a formal, heuristic process of obtaining information or answers to specific questions about certain quantities, called issues, such as failure rates, unsatisfactory-performance consequences and expected service life. This process should not be used in lieu of rigorous reliability and risk analytical methods, but should be used to supplement them and to prepare for them. It should be preferably performed during a face-to-face meeting of members of an expert panel that is developed specifically for the issues under consideration. The meeting of the expert panel should be conducted after communicating to the experts in advance to the meeting background information, objectives, list of issues, and anticipated outcome from the meeting. The different components of the expert-opinion elicitation process are described in Aye (2001).

B-2.5 Recent USACE Expert-Opinion Elicitation Studies

Expert-opinion elicitation is a technique for using a panel of individuals with various areas of specialized knowledge for estimating parameters or addressing issues of interest based on their expertise. The March 2002 expert elicitation conducted by IWR on the Economic Consequence Assessment of Residential Flood Damage is a recent example of use of the technique. Expert-opinion elicitation has also been recently applied by the New Orleans District's study of the Lower Atchafalaya Basin and reevaluation of the Morganza to the Gulf of Mexico feasibility studies, by Vicksburg District's Pearl River study, and by the Sacramento District's Feather River flood damage study. Building contractors, insurance adjusters, home decorators, and other individuals with knowledge of construction, prices, and typical home furnishings were used to estimate depth-damage and content-to-structure value ratios. Details on some of these studies are provided in Aye (1999 and 2001).

B-2.6 Residential Damage Due to Coastal Storms

The scope of this study consists of structural damage to single-family homes from coastal storms. These economic consequences can be described by mathematical functions that relate storm parameters such as wave crest height or the depth of still water flooding to the percent of damage that occurs to structures. The percent damage to structure refers to the percent of the depreciated replacement costs of the structure that is damaged. Coastal storms damage structures through wave action, still water flooding, wave run-up, erosion, and wind. These hazard types are described briefly below.

Waves: Most of the energy delivered to the shore by the ocean originates from the wind acting on the ocean to produce waves. Wave characteristics are determined by the wind direction, wind speed, wind duration, how far the wind blows over water, and how far the wave travels before reaching land. Wave action can cause significant damage to coastal structures. Conventional wisdom is that if breaking waves strike at or above a building's first floor elevation, that structure will be severely damaged. This is the rationale for the National Flood Insurance Program's (NFIP) characterization of a highly vulnerable zone (V-zone) for damage from wave action. The ability to prevent wave damage is considered a major benefit of Corps' shore protection measures. Although FEMA demarks the V-zone as an area subject to breaking waves at least 3 feet high, recent, FEMA-sponsored tests indicate that 1.5-foot waves can break away walls. This research suggests that the V-zone might more appropriately extend to all areas subject to 1.5-foot high breaking waves.

Stillwater flooding: Storms can cause inundation of structures with still water either through overtopping of a dunes system (coastal flooding) or through flood waters coming from the bay side of a coastal island (bay-side flooding). Coastal flooding implies still-water level flooding of structures because of overtopping of a dune system or storm surge breaking through from the coastal side and inundating beach areas. A major benefit of Corps' shore protection measures may be reduced coastal flooding damages. Bayside flooding implies still water level flooding of structures, with flooding coming from the bayside. Natural or man-made structures may have prevented flooding from storm surge on the coastal side of an island, but high seas inundated structures from the bay or backside of an island. Structures on the bayside of islands are frequently constructed with a lower level of flood protection than structures across the island on the oceanfront. For example bayside houses may be built lower to the ground whereas oceanfront houses might be raised on piles. Damage from bayside flooding is generally not reduced through shore protection measures.

Erosion: On average, the nation's shorelines are receding at an annual rate of slightly more than one foot per year, although rates vary significantly across regions and across shoreline types. In addition to long-term erosion, erosion during a storm may destroy a dune and undermine shorefront structures. The extent of damage will depend on the amount of storm-induced erosion at the structure and structural characteristics such as foundation and piling embedment. Damages from storm-induced erosion can be significant, regardless of the long-term erosion rate or whether natural processes rebuild the dune in the months following a storm. Corps shore protection measures can provide significant reduction in damages attributable to erosion. Because erosion causes beaches to narrow over time, it is a major factor to consider in conducting a life cycle analysis of project benefits and costs.

Wave Run-up: Wave run-up is the upper level reached by a wave on a beach or coastal structure, relative to still-water level (Coastal Engineering Manual, 2002). Wave run-up applies pressure on a structure in both a vertical and horizontal direction and is a function of the water depth and the square of the water velocity. Wave run-up ceases to be a damage factor when breaking waves attack a structure.

Wind Damages: High winds associated with storms can cause significant damages to structures both on the coast and much further inland. High winds and associated flying projectiles can damage doors, windows or roofs. This damage to the integrity of the structure may combine with high winds to cause severe damage or structural failure. Such breaching also allows rainwater damage to the structure. Most of the damages from Hurricanes Andrew, Inky, and Hugo were caused by wind and wind-related rainwater as opposed to waves, flooding, wave run-up, or erosion. Because Corps' projects do not significantly affect the wind speed of storms, wind damage is not reduced through shore protection measures. Nonetheless, wind damage plays a significant role in life cycle cost analysis for Corps' storm damage reduction projects.

CHAPTER B-III. PARTICIPANTS

B-3.1 Requirements

The IWR project core team has the lead responsibility for achieving the project objectives, but relied on input from a larger, working group of experts to develop appropriate damage relationships. The working group represented Corps' Districts that had been active in shoreline protection projects and represented different geographic regions. In addition, it included outside experts from the Federal Emergency Management Agency, universities, and the private sector who had expertise in coastal storm damage assessment.

B-3.2 Participants

A list of the IWR project core team and working group for the workshop is below.

PROJECT CORE TEAM

Affiliation	**Name**	**Role**
IWR	Stuart Davis	Project Leader
IWR	Hal Cardwell	Project Leader
IWR	David Moser	IWR Program Manager

USACE-HQ	Lillian Almodovar	HQ Program Manager
BMA Engr/Un. of MD	Bilal Ayyub	Facilitator

WORKING GROUP

Affiliation	**Name**	**Role**
USACE/Wilmington	Bob Finch	In-house Technical Advisor (S.Atlantic)
USACE/Wilmington	Mike Wutkowski	In-house Technical Advisor (S.Atlantic)
USACE/Jacksonville	Dan Peck	In-house Technical Advisor (S.Atlantic)
USACE/Jacksonville	Tom Smith	In-house Technical Advisor (S.Atlantic)
USACE/SAD	Gerald Melton	In-house Technical Advisor (S.Atlantic)
USACE/New Orleans	Brian Maestri	In-house Technical Advisor (Gulf)
USACE/Los Angeles	Dan Sulzer	In-house Technical Advisor (W.Coast)
USACE/Los Angeles	Susie Ming	In-house Technical Advisor (W.Coast)
USACE-HQ	Harry Shoudy	In-house Technical Advisor
USACE-HQ	Charlie Chesnutt	In-house Technical Advisor
USACE-HQ	Jay Warren	In-house Technical Advisor
URS	Bill Coulbourne	Outside Technical Advisor (N.Atlantic)
URS	Mike Cannon	Outside Technical Advisor (N.Atlantic)
Consultant	Chris Jones	Outside Technical Advisor (S.Atlantic)
NC SeaGrant	Spencer Rogers	Outside Technical Advisor (S.Atlantic)
FEMA	Paul Tertell	Outside Technical Advisor

CHAPTER B-IV. WORKSHOP RESULTS

B-4.1 Straw man Coastal Storm Damage Framework

The starting point for discussions of coastal storm damage processes was a "straw man framework" for structural damage estimation that was put forth by the IWR project core team. The straw man framework assumes as known, the physical parameters of the area and of the storm. These parameters include surface water elevation, ground elevation, and shoreline type, wave heights, storm-induced erosion depth. Also assumed known are structural characteristics such as location, foundation type, height of lowest supporting beam of structures including their location. Long-term erosion is considered by progressively moving the shoreline landward, therefore increasing the storm-induced erosion and inundation potential from subsequent storms. Economic losses (damages) due to land lost are outside the scope. Wind damages are estimated outside of this framework; this estimate will be used to modify damage to structures from coastal flooding and erosion as appropriate. We also assume the surface water elevation accounts for bay-side flooding and dune breaches.

Inundation: Damage to both contents and structures from wave run-up, breaking waves, and still water flooding is assumed to be captured through the use of FIMA[5] V-zone curves for all areas that experience breaking waves of 1.5 ft above the lowest structural horizontal member of the structure. For areas that experience less than 1.5 feet of flooding, FIMA A-zone curves will be used for structure damage.

[5] The Federal Insurance and Mitigation Administration (FIMA – formerly the Federal Insurance Administration - FIA) developed and uses depth-damage curves to estimate actuarial premiums for flood insurance. FIMA has two sets of curves, A-zone curves for riverine and coastal areas without high wave velocity, and V-zone curves for coastal areas that are expected to experience wave action. FIMA defines the V-zone as those coastal areas expected to experience a 3-foot high breaking wave.

Storm-induced erosion: A curve relating damage to the depth of vertical erosion at the center of building will be developed for various foundation types. This curve will be applied for sandy beaches with small dunes (as defined by FEMA). An additional relationship for high dunes and sandy bluff shoreline types will describe storm-induced damages from near-vertical erosion scarps.

Combined Damage vectors: The total damage to a structure will be the sum of the inundation damages and the storm-induced erosion damages, with the total not to exceed the value of the structure.

B-4.2 Revised Framework

Discussion at the workshop produced consensus on a revised framework for structural damage estimation. Once the damage hazards were identified, the experts focused on determining the appropriate storm variable that would relate to damage for each hazard type. For example, depth of water above the walking surface for the lowest main floor was selected as the best variable to relate to still water flooding damages. This is the X-axis in a depth (or other variable) versus damage curve. The experts then agreed on the number of relationships that would have to be developed to properly predict damages to different foundation types (e.g. slab on grade or pile) or materials (wood, concrete, masonry) were appropriate for each damage hazard. Discussion then moved to different ways to combine the damages across hazards, and how to account for regional differences in shorelines, with a focus on estimating damages to bluffs. We describe the discussions and decisions in this section. Appendix A contains results in the form of quantified relationships (curves) for storm damages.

B-4.2.1 Inundation Damage

For damages from still water inundation the workshop determined that the appropriate storm variable to use was the "Depth of water above the walking surface of the lowest main floor". Although damages to the floors of a structure occur before the water depth reaches the walking surface, using the depth of water surface is an easier variable to use for data collection. **Structural damages that occur from inundation of the floors at slightly lower depths can be included by assigning positive values to damages when depth of water above the walking surface is negative.**

The workshop determined that damages from inundation also depend on the foundation type, on material, number of floors, and, for structures on piles, on the existence of ground-level enclosures. Separate relationship (although using the same X-axis) would need to be developed for each of the following cases:

- Wood frame with piles (with & without enclosures – small medium and full)
- Wood frame without piles
- Concrete & masonry with piles (with & without enclosure – small medium and full)
- Concrete & masonry without piles
- Number of floors (1, 1.5 and 2)

The workshop considered various existing data sources to quantify the relationships for inundation. These data sources included FIMA coastal A-zone curves, curves from New Orleans District for structures on piles and on piers, and curves issued by the Corps in 2000 based on post-flood surveys of actual damages in various parts of the United States.

B-4.2.2 Waves Damage

For damages due to breaking waves the workshop determined that the appropriate storm variable to use was the "difference between the top of wave (crest) and the bottom of the lowest horizontal member". The workshop considered using the walking floor elevation as the datum for comparison with the top of the wave height for consistency with the measure suggested for inundation. However the workshop decided that the framework would be clearer and more rigorous if it used the bottom of the lowest horizontal member as the reference point because it is at this point that waves can start to damage the structure. If practical considerations preclude measurements of the bottom of the lowest horizontal member, this value can be estimated based on the elevation of the walking surface.

The workshop determined that damages from inundation also depended on the foundation type for structures on piles and on the existence of ground-level enclosures. Separate relationships (although using the same X-axis) would need to be developed for each of the following cases:

- Structures on piles (with & without enclosures – small medium and full)
- Structures not on piles

B-4.2.3 Wave Run-up Damage

The workshop concluded that damages from wave run-up were attributable to the "Difference between the top of water and the bottom of the lowest horizontal member, and its velocity at the seaward face of the structure". The force applied by wave run-up could be described as directly dependent on the depth of the water and the square of the velocity. Forces would likely act in both a horizontal and vertical direction and be measured in lbs/linear foot. However the workshop participants did not feel that the there was enough known about the damage from wave run-up to determine an appropriate storm variable to use, and opted to delay development of a damage relationship as a long-term need.

B-4.2.4 Erosion Damage

For damages from storm-induced erosion, the workshop determined that the appropriate storm variable to use both for structures with shallow foundations and ones on piers was the "percent of footprint compromised." Shallow foundation structures were defined as structures that are on slabs or on piers. Houses on bluffs that experience erosion can be considered as structures with shallow foundations. When a shallow foundation experiences vertical erosion such that it loses support from the ground, the foundation is compromised. Six inches of vertical erosion or undermining has been conventionally considered to cause a loss of support. Whereas the workshop participants felt that this definition was relatively straightforward for shallow foundations, the selection of a variable for deep or pile-supported foundations was more contentious.

The distinction was made between a structure that was undermined by erosion and one that had its foundation "compromised". Whereas for structures on shallow foundations undermining (six vertical inches of erosion) is equivalent to compromised, pile structures can be extensively undermined with little or no damage. In these cases the entire footprint could experience vertical erosion of six inches yet no damage would occur because, although undermined, the erosion does not compromise the ability of the foundation to support the structure. Conversely, a compromised pile can be defined as one whose remaining embedment depth renders it ineffective against lateral forces such as wind and waves. Using, as the independent variable (X-axis) the "percent of footprint compromised" would allow correct categorization of damages done to a pile-support house that, because of erosion, might have its entire footprint in the surf zone (and hence undermined), but yet had minimal damage because its foundation was not compromised. The workshop noted that relating storm parameters to the percent of footprint compromised would be difficult and likely be regionally and structurally specific. Comment: This percent of footprint compromised is pretty useless to predict damage from a storm unless this can be predicted from the extent of vertical erosion at the structure. I don't think there will be any model that keeps track of all piles of a pile-founded structure. We will have to make assumptions about where piles are located and the extent of embedment.

Because the appropriate storm variable was defined so broadly, the workshop only called for two separate relationships to be developed for erosion damages: one for shallow foundation and one for deep foundations (piles). More relationships may need to be developed as definitions of "footprint compromised" are developed for specific regions and projects.

B-4.2.5 Combining Damages

Because a structure may be damaged by more than one of the four storm damage hazards identified by the workshop, a methodology must be developed for how to combine the damages. The Straw man Framework proposed a simple additive combination with a constraint that the total damages to a structure could not exceed its value. The can be expressed as %A + %B. A more commonly used rule for combining damages is to simply use the maximum percent damage from any hazard, or Max [%A, %B]. Whereas the first rule assumes that there is no common damage caused by different hazards, the latter rule assumes the other extreme - which no damage occurs that is not covered by the most damaging hazard. A third rule to consider would be the sum of the hazard percentages minus their product: %A + %B -%A%B. This framework was used in the Portland District and is akin to the probability of occurrence at least one of two independent events A and B.

The workshop concluded that the combination rule must be dependent on the types of hazard that cause damages. If both waves and inundation cause damage the workshop suggested the rule be to only use the damages caused by waves (this is consistent with FEMA's V-zone definition). If both erosion and inundation cause damage the proposed rule is to use the sum of the damages minus their product. Similarly, if both erosion and run-up cause damage the rule is to use the sum of the damages minus their product. For the case where both run-up and erosion cause damages, the workshop proposed two definitions, one for shallow foundation structures, where the rule is to use the maximum of the two damages, and one for pile foundation structures where the rule is to use the sum of the damages minus their product. We summarize these relationships below for the various cases of combination

Case 1 – Inundation + Waves	%W
Case 2 – Run-up + Waves	%W
Case 3 – Inundation + Run-up	will not occur
Case 4 – Inundation + Erosion	%I + %E - %I*%E
Case 5 – Run-up + Erosion	%R + %E - %R*%E
Case 6 – Waves + Erosion	Max %W, %E (shallow foundation)
	%W + %E - %W*%E (pile foundation)

These cases cover all likely combinations of hazards because a structure would not be subject to both moving water (run-up) at the same time as still-water inundation, and waves damages would subsume run-up as it does inundation damages. The workshop noted as a long term need, better information as to when to "switch" from the inundation damage curve to the wave damage curve. Similarly this could be one area of investigation when determining the run-up damage relationships.

Discussion at the workshop included concerns on how to calibrate damage relationships from multiple sources, and noted that the structure should permit direct data collection for the calibration

B-4.2.6 Coastlines with of Bluffs

Storm damages on coastlines with bluffs differ from those on a beach and dune coastline. Inundation is not an issue for bluffs, and neither are waves or run-up except as they promote erosion. Also, all foundations on bluffs can be treated as shallow foundations or slabs, because erosion from a bluff will undermine a deep pile foundation in the same way as a shallow foundation. Failure of a bluff can be from top to bottom or from bottom to top.

B-4.2.7 Long-term and Short-term Needs / Next Steps

The following table summarizes the long-term and short-term needs and future steps in this area:

Priority	Long-term and Short-term Needs / Next Steps
High	Methodology (including authority) for post storm data collection to determine flood conditions during event and erosion conditions at the end of an event.
High	Define/issue guidance for "Compromised" regional Differences
High	Beach profile translation
High	Contents
High	Land Loss/estimated value
High	Post storm data – wave crest water level elevations, lower limit (elevation) of wave damage.
High	Pre-storm building inventory
High	Collection of Existing loss information (including analysis of data from Fran)
Medium	Wave damage height threshold (1.5 ft vs 3 ft) – When do we abandon the inundation curve? How far inland is wave damage an issue?
Medium	RUN-UP RELATIONSHIPS - HOW TO QUANTIFY (WEST COAST)
Medium/Low	Sedimentation damage during inundation
Medium/Low	Duration of inundation
Low	Bluff Erosion processes
Low	Curves/response of engineered buildings, and other non residential structures
Low	Salt versus fresh water inundation damage

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CHAPTER B-VI. DAMAGE RELATIONSHIP DETAILS

The following figures contain the details of the damage relationships developed in the workshop. The "Proposed" curve represents the experts' median estimate of damages, whereas the upper and lower represent estimates of the range of the damages. Here, 75 percent of the time damages will be less than the "Upper" curve and 25 percent of the time damages will be lower than the "Lower" curve. For the inundation curves, the upper and lower bounds were set equivalent to the estimates used by New Orleans district for structures on piers (N.O. pier), and by the FIMA coastal A-zone curves, respectively. For damages from inundation, the workshop only developed curves for the selected cases noted below. The workshop assumed that estimates for inundation damages in structures with partial enclosures would flow from the curves developed here. Likewise all curves apply for single story houses.

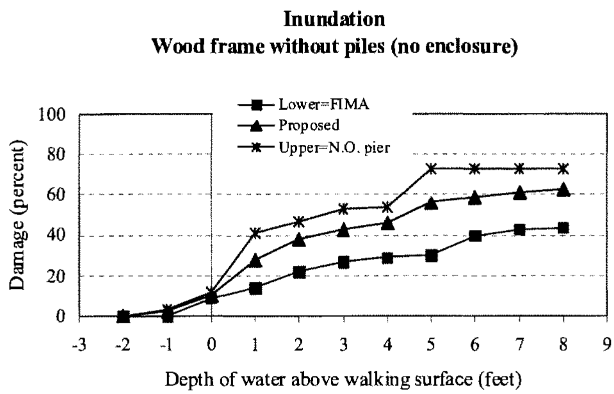


Figure B-1. Inundation Wood Frame without Piles (no enclosure)

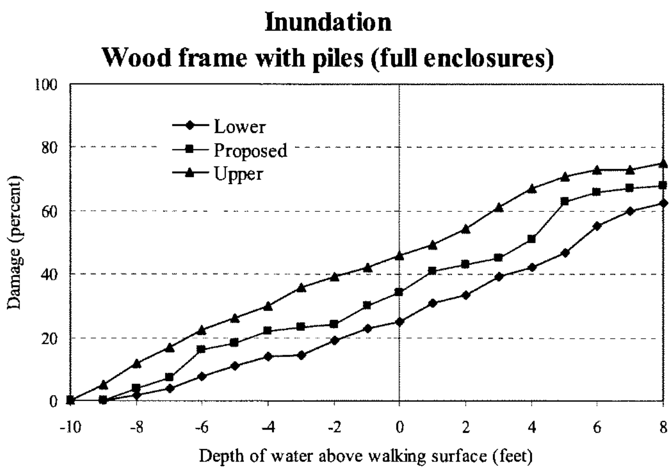


Figure B-2. Inundation Wood Frame with Piles (full enclosure)

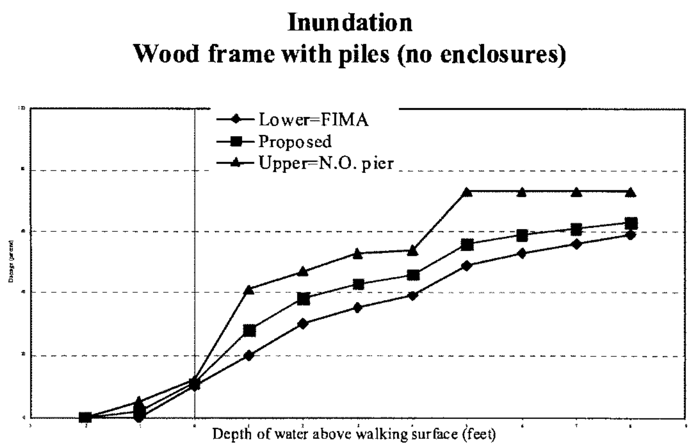


Figure B-3. Inundation Wood Frame with Piles (no enclosure)

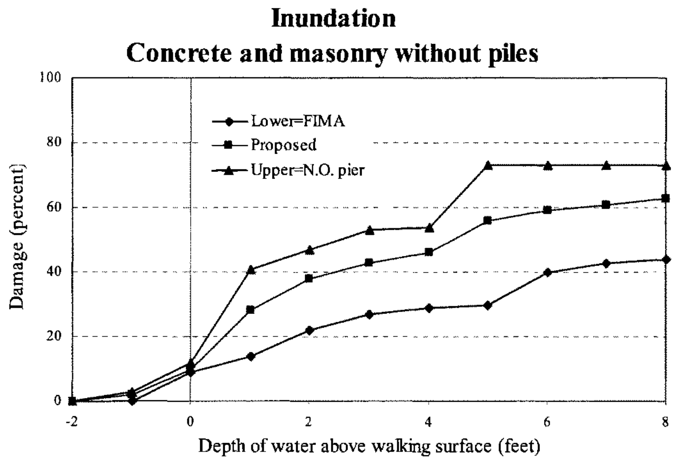


Figure B-4. Inundation Concrete and Masonry without Piles

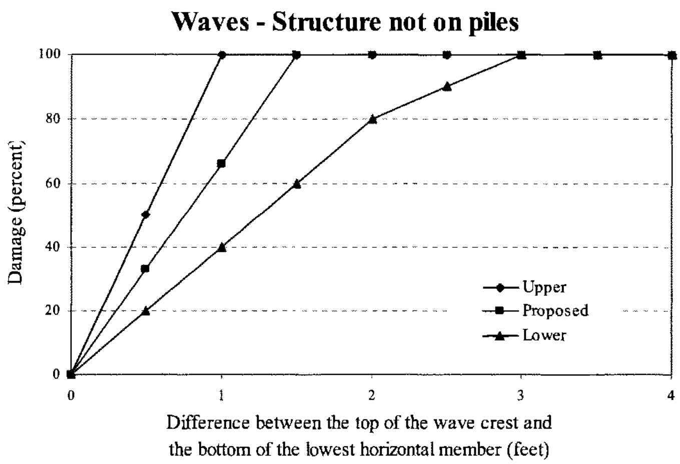


Figure B-5. Waves – Structure not on Piles

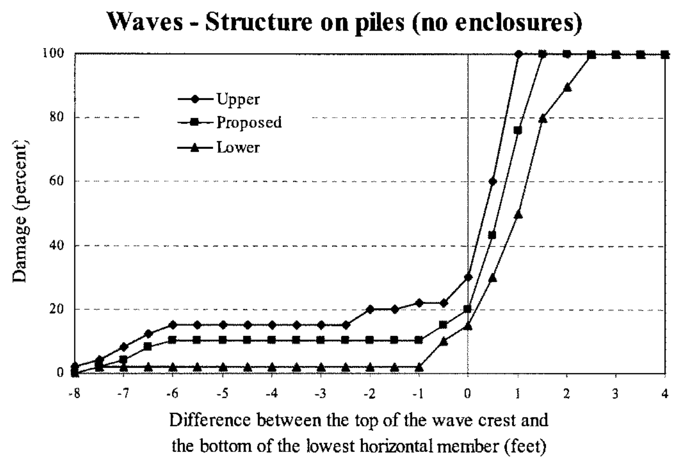


Figure B-6. Waves – Structure on Piles (no enclosure)

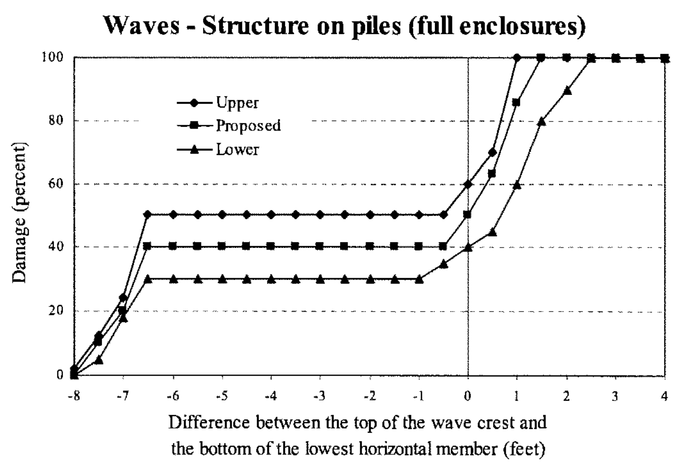


Figure B-7. Waves – Structure on Piles (full enclosure)

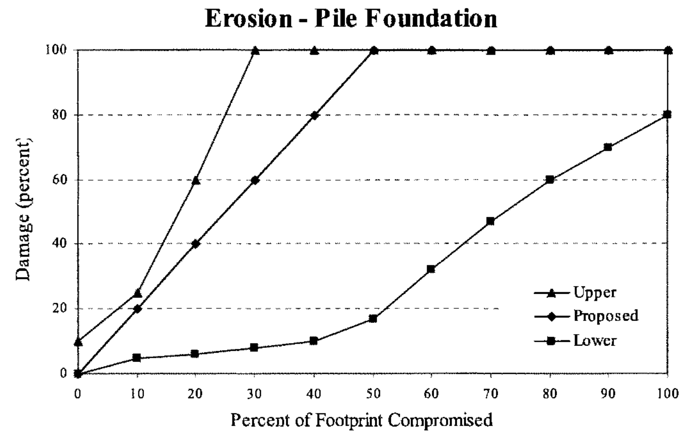


Figure B-8. Erosion – Pile Foundation

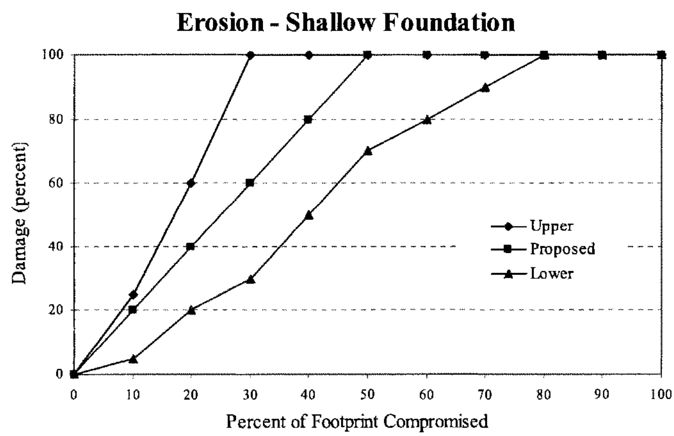


Figure B-9. Erosion – Shallow Foundation

ADDENDUM C – PARKING AND ACCESS

CHAPTER C-I. USER FEES, PUBLIC ACCESS AND PARKING

This addendum describes the public access, and parking for the length of the beach construction evaluated in the Mississippi Coastal Improvement Program (MsCIP) Comprehensive Report. This parking and access analysis was conducted in accordance with ER 1165-2-130 "Water Resource Policies and Authorities – Federal Participation in Shore Protection" dated 15 June 1989. The data provided in this addendum was collected through field verification.

According to ER 1165-2-130, "Unless the protection of privately-owned beaches is incidental to protection of public beaches (paragraph 9), they must be open to all visitors regardless of origin or home area, or provide protection to nearby public property to be eligible for Federal assistance. Items affecting public use are... 1/ parking, 2/ access, and 3/ user fees." Typically, these items serve a dual purpose of both identifying the basis for federal participation and to justify the recreation benefits of the proposed shoreline protection project. For the MsCIP Comprehensive Report, the shoreline protection measures (Line of Defense 2) have zero net recreational benefits, in other words, the future with project condition recreation benefits are the same as the future without project recreation benefits. Since there is no claim on recreation benefits, this analysis is not intended to show public availability for justifying benefits claimed, but merely to show whether or not there is sufficient availability to use that would warrant federal participation.

C-1.1 Parking

The coast of Mississippi is approximately 70 miles long and spans Hancock (planning unit 1), Harrison (planning unit 2) and Jackson Counties (planning unit 3), from west to east respectively. Within each county there is public parking and access to the beach. There are a total of 3,730 free parking spaces along the beach in the three-county study area.

The Coast of Hancock County is approximately 16 miles long. Beach Blvd spans 8 miles of the eastern portion of Hancock County's coast. Along Beach Blvd there are 592 free parking spaces, both in lots and along the street. The beach can be accessed without significant hindrance from virtually anywhere along South Beach Blvd.

The Coast of Harrison County is approximately 25 miles long. Highway 90 spans the entire coast of Harrison County. Along Highway 90 there are 2,788 free parking spaces, both in lots and along the street. The beach can be accessed without significant hindrance from virtually anywhere along Highway 90.

The Coast of Jackson County is approximately 29 miles long. There are a few roads which run along various portions of the coast. Some of these roads have parking either on the street or in lots. There are a total of 350 free parking spaces. In areas where there is both beach and road along the coast, the beach can be accessed without significant hindrance.

Data on the parking areas for each of the three counties are displayed separately in the tables below. Table C1-1 displays data for Hancock County. Table C1-2 displays data for Harrison County. Table C1-3 displays data for Jackson County. Each table begins with the parking area furthest west in the county that it represents and ends with the parking area furthest east in the same county. Following the tables are maps of the study area and images of some parking areas.

Table C1-1.
Hancock County Parking

	Location	Spaces	Parking Type	Distance from Previous Access Point	Distance from previous lot (miles)
1	Silver Slipper Casino	241	Free, Lot	Continuous	0.0
2	Lakeshore Rd	100	Free, Street	Continuous	0.1
3	State Park Rd 1	10	Free, Street	Continuous	1.7
4	State Park Rd 2	40	Free, Street	Continuous	0.1
5	Terrace Ave	51	Free, Lot	Continuous	2.8
6	Washington St	150	Free, Lot	Continuous	2.8

Table C1-2.
Harrison County Parking

	Location	Spaces	Parking Type	Distance from previous access point	Distance from previous lot (miles)
1	5th Ave	20	Free, Street	Continuous	0.0
2	Boisdore Ave	8	Free, Street	Continuous	0.3
3	Sherman Ave	12	Free, Street	Continuous	0.2
4	Brown Ave	3	Free, Street	Continuous	0.1
5	Magnolia Ave	5	Free, Street	Continuous	0.8
6	Clarence Ave	30	Free, Lot	Continuous	0.3
7	Church Ave	7	Free, Street	Continuous	0.3
8	Hiern Ave	150	Free, Lot	Continuous	0.3
9	Market St	12	Free, Street	Continuous	0.3
10	Seal Ave	12	Free, Street	Continuous	0.5
11	Donlin Ave	5	Free, Street	Continuous	0.2
12	Courtenay Ave	3	Free, Street	Continuous	0.4
13	Hackett Ln	7	Free, Street	Continuous	0.1
14	Menge Ave	5	Free, Street	Continuous	0.6
15	Espy Ave	18	Free, Street	Continuous	0.9
16	Shadow Lawn Ave	10	Free, Street	Continuous	0.3
17	Least Tern Dr	7	Free, Street	Continuous	0.1
18	Emerald Ave	20	Free, Street	Continuous	0.2
19	Hayden Ave	25	Free, Street	Continuous	0.2
20	Holiday Ave	5	Free, Street	Continuous	0.2
21	White Harbor Rd	7	Free, Street	Continuous	0.3
22	N Seashore Ave	10	Free, Street	Continuous	0.6
23	S Lang Ave	7	Free, Street	Continuous	0.2
24	Oak Gardens Ave	95	Free, Lot	Continuous	0.5
25	Shelter Rock Dr	27	Free, Lot	Continuous	0.3
26	Russell Ave	20	Free, Street	Continuous	0.2
27	Winter Ln	10	Free, Street	Continuous	0.1

Table C1-2.
Harrison County Parking (continued)

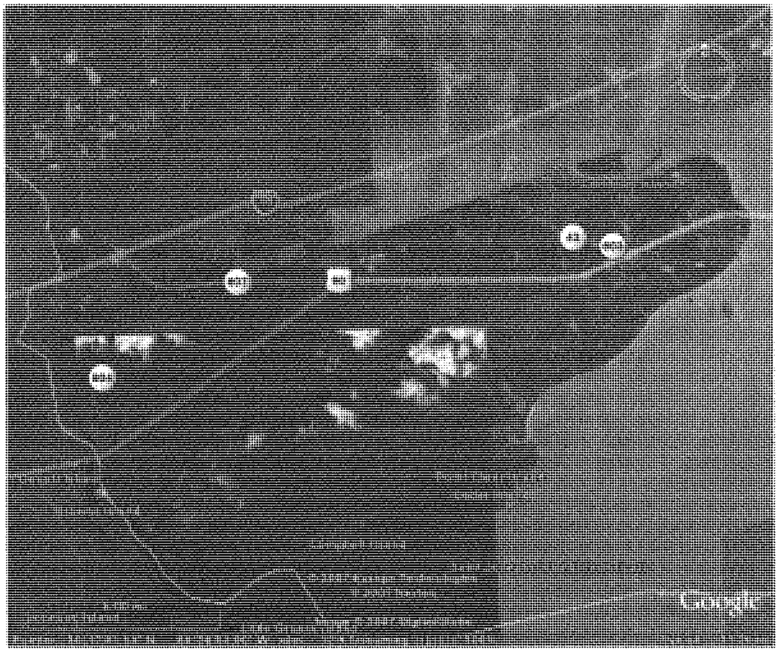
	Location	Spaces	Parking Type	Distance from previous access point	Distance from previous lot (miles)
28	Jeff Davis Ave	180	Free, Lot	Continuous	0.3
29	S Cleveland Ave	190	Free, Lot	Continuous	0.3
30	Gulfview Ave	7	Free, Street	Continuous	0.1
31	N Nicholson Ave	5	Free, Street	Continuous	0.3
32	Beach Park Pl	37	Free, Lot	Continuous	0.1
33	E Azalea Dr	5	Free, Street	Continuous	0.2
34	Richards Ave	5	Free, Street	Continuous	0.1
35	S Ocean Wave Ave	5	Free, Street	Continuous	0.2
36	Rich Ave	32	Free, Lot	Continuous	0.1
37	Ruth Ave	16	Free, Lot	Continuous	0.2
38	Maria Ave	10	Free, Street	Continuous	0.1
39	Fournier Ave	10	Free, Street	Continuous	0.1
40	Camp Ave	49	Free, Lot	Continuous	0.2
41	41st Ave	21	Free, Street	Continuous	0.3
42	38th Ave	45	Free, Street	Continuous	0.2
43	33rd Ave	200	Free, Lot	Continuous	0.2
44	20th Ave	150	Free, Lot	Continuous	1.0
45	Pratt Ave	42	Free, Lot	Continuous	0.4
46	Thornton Ave	35	Free, Lot	Continuous	0.1
47	Hill Pl	5	Free, Street	Continuous	0.2
48	Kelly Ave	10	Free, Street	Continuous	0.2
49	Bert Ave	30	Free, Street	Continuous	0.1
50	Evans Ln	7	Free, Street	Continuous	0.1
51	Gulf Ave	5	Free, Street	Continuous	0.1
52	Roberts Ave	5	Free, Street	Continuous	0.2
53	Alfonso Dr	5	Free, Street	Continuous	0.2
54	Midway Ave	5	Free, Street	Continuous	0.1
55	Oak Ave	5	Free, Street	Continuous	0.1
56	Oask Ave #2	65	Free, Lot	Continuous	0.2
57	Arkansas Ave	50	Free, Lot	Continuous	0.2
58	Texas Ave	5	Free, Street	Continuous	0.1
59	Courthouse Rd	100	Free, Lot	Continuous	0.1
60	Palmetto Ln	3	Free, Street	Continuous	0.1
61	Tegarden Rd	7	Free, Street	Continuous	0.4
62	Paradise Ave	20	Free, Street	Continuous	0.2
63	Oleander Dr	5	Free, Street	Continuous	0.1
64	E Cedar Dr	5	Free, Street	Continuous	0.1
65	Cowan Rd	5	Free, Street	Continuous	0.3
66	Anniston Ave	5	Free, Street	Continuous	0.6
67	Southern Cir	10	Free, Street	Continuous	0.1
68	Mockingbird Ln	5	Free, Street	Continuous	0.1

Table C1-2.
Harrison County Parking (continued)

	Location	Spaces	Parking Type	Distance from previous access point	Distance from previous lot (miles)
69	Gateway Dr	20	Free, Street	Continuous	0.7
70	Eisenhower Dr	35	Free, Street	Continuous	0.4
71	Edgewater Dr	5	Free, Street	Continuous	0.4
72	Grande View Dr	7	Free, Street	Continuous	0.1
73	Oakmont Pl	60	Free, Street	Continuous	0.2
74	Beauvoir Ave	3	Free, Street	Continuous	0.1
75	Sadler Beach Dr	10	Free, Street	Continuous	0.6
76	Sadler Beach Dr 2	25	Free, Street	Continuous	0.1
77	Camellia St	25	Free, Street	Continuous	0.2
78	Treasure Bay Casino	275	Free, Lot	Continuous	0.3
79	Rodenberg Ave	108	Free, Lot	Continuous	0.9
80	Saint Peter Ave	5	Free, Street	Continuous	0.8
81	Saint Francis St	15	Free, Street	Continuous	0.3
82	Saint Paul St	3	Free, Street	Continuous	0.2
83	Morrison Ave	30	Free, Lot	Continuous	0.3
84	Azalea Dr	18	Free, Lot	Continuous	0.2
85	Porter Ave	61	Free, Lot	Continuous	0.3
86	Main St	70	Free, Lot	Continuous	1.0
87	Holley St	15	Free, Street	Continuous	0.5
88	Oak St	20	Free, Lot	Continuous	0.5
89	Cedar St	32	Free, Lot	Continuous	0.3

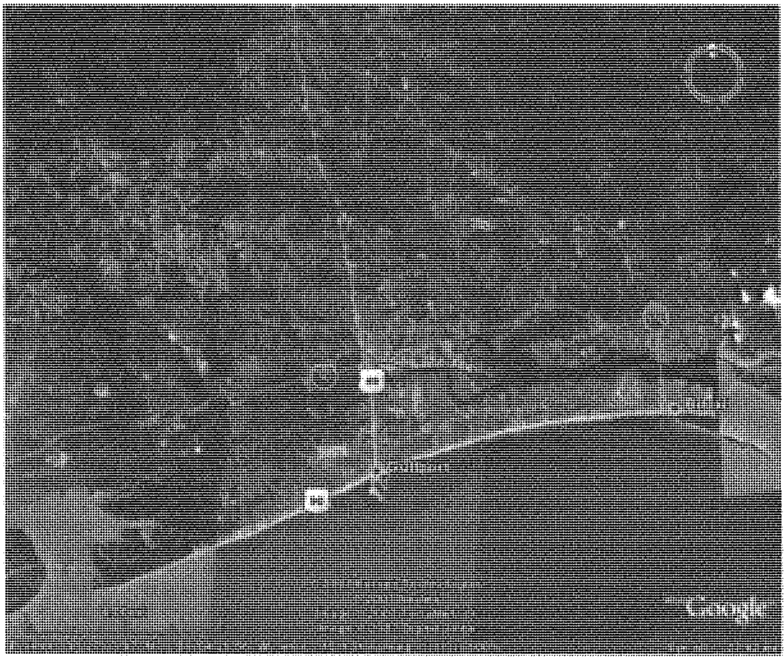
Table C1-3.
Jackson County Parking

	Location	Spaces	Parking Type	Distance from previous lot (miles)
1	Hillandale Ave	225	Free, Street	0.0
2	Shearwater Dr	25	Free, Street	1.7
3	Lake Mars Ave	25	Free, Lot	3.0



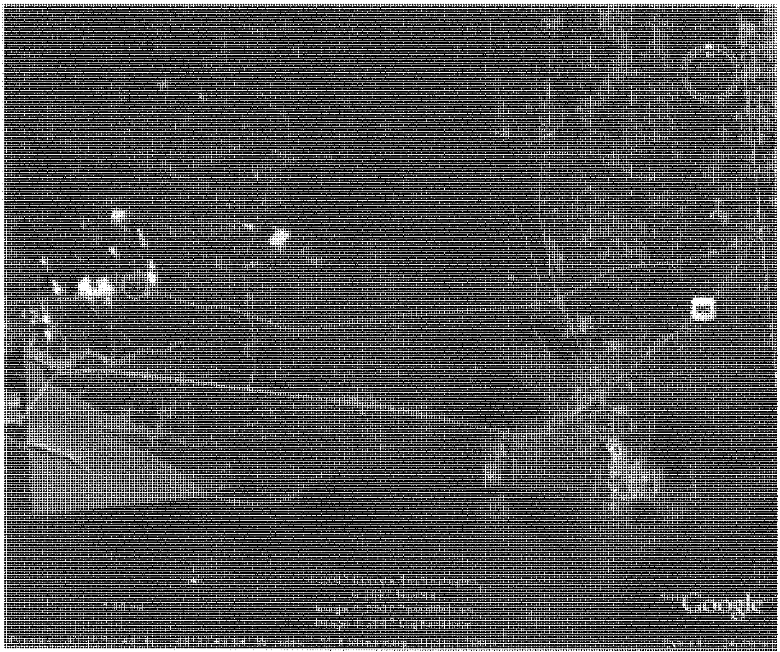
Source: Google Earth

Figure C1-1. Hancock County Map



Source: Google Earth

Figure C1-2. Harrison County Map



Source: Google Earth

Figure C1-3. Jackson County Map

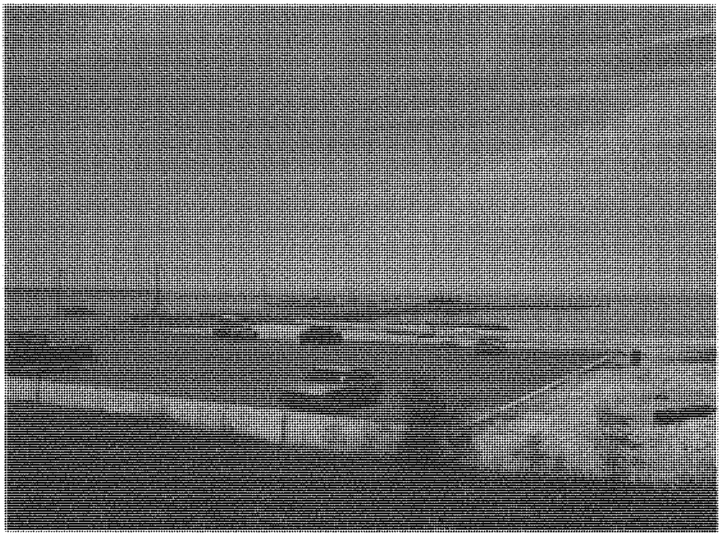


Figure C1-4. Hancock County Parking Lot

Figure C1-5. Example of Harrison County Parking Lot.

Figure C1-6. Example Jackson County Parking Lot.

C-1.2 Access

Sufficient access to the public beach exists throughout the three planning units. Under both future without-project and future with-project conditions, the three planning units have access points that run along the entire length of beach in either the form of a board walk or a step down directly from the seawall. These access points are all on the right-of-way for the major road that abuts the beaches including North and South Beach Boulevard in planning unit one and U.S. Highway 90 in planning unit two. Planning unit three contains a combination of direct step downs from the seawalls that run along various sections and walkovers for those sections of beach that require them. All of the access points are on public and are accessible to all visitors on an equal basis at no charge. Figures 1-7, 1-8, and 1-9 illustrate examples of access points to the public beaches in the three planning units.

C-1.3 User Fees

User fees are sometimes charged to the public at beaches in order to recoup the costs of maintaining the beach. Per ER 1165-2-130, "A reasonable beach fee, uniformly applied to all, for use in recovery of the local share of project costs is allowable. Normal charges made by concessionaires and municipalities for use of facilities such as bridges, parking areas, bathhouses, and umbrellas are not construed as a charge for the use of the Federal beach project, if they are commensurate with the value of the service they provide and return only a reasonable profit. Fees for such services must be applied uniformly to all concerned and not as a prerequisite to beach use." For the beaches in the three planning units in the MsCIP Comprehensive Plan, no fees are anticipated to be charged by the local community.

C-1.4 Conclusion

The results of the analysis indicate that the project meets the requirements of being open 'to all users on an equal basis', and there is sufficient parking and access for the entire length of shoreline protection projects within the three planning units in Mississippi to warrant federal participation. The analysis showed that there are 592 available parking spaces in Hancock County, 2,788 parking spaces in Harrison County, and 350 parking spaces in Jackson County. All spaces are located within a quarter mile of an access point and there is sufficient access to the public beaches either through boardwalk/seawall direct access (planning units one and two) or carefully located access points/crossovers (planning unit 3) along the entire length. User fees are not currently charged to anyone for use and are not anticipated should a project be constructed.

FOR CONTINUATION OF HOUSE DOCUMENT 111-95
COMPREHENSIVE PLAN REPORT ON THE MISSISSIPPI
COASTAL IMPROVEMENTS PROGRAM (MsCIP)
SEE PART 2