US Army Corps of Engineers®
New Orleans District

Louisiana Coastal Area (LCA), Louisiana

Ecosystem Restoration Study

November 2004
Final
Volume 1:
LCA Study - Main Report

This Report Contains 4 Volumes

You are here

Volume 1:
LCA Study - Main Report

Volume 2:
Programmatic Environmental Impact Statement

Volume 3:
Public Comments and Responses

Volume 4:
Appendix A - Science and Technology Program
Appendix B - Historic and Projected Coastal Louisiana Land Changes: 1978-2050 (USGS)
Appendix C - Hydrodynamic and Ecological Modeling
Appendix D - Louisiana Gulf Shoreline Restoration Report

If you have any questions, or require additional information, please contact
Mr. Timothy Axtman; Project Manager, U.S. Army Corps of Engineers -
New Orleans District; P. O. Box 60267, New Orleans, LA 70160-0267,
(504) 862-1921, email: Timothy.J.Axtman@mvn02.usace.army.mil

Cover picture is a Live Oak tree on the eastern shoreline of Lake Salvador.
Picture provided by Lane Lefort of the U.S. Army Corps of Engineers, New Orleans District.

LOUISIANA COASTAL AREA (LCA), LOUISIANA

ECOSYSTEM RESTORATION STUDY

EXECUTIVE SUMMARY

PURPOSE

The accelerated loss of Louisiana's coastal wetlands has been ongoing since at least the early 1900s with commensurate deleterious effects on the ecosystem and possible future negative impacts to the economy of the region and the Nation. There have been several separate investigations of the problem and a number of projects constructed over the last 20 to 30 years that provide localized remedies. For example, the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) Program is an ongoing program comprised of relatively small projects to partially restore the coastal ecosystem. However, given the magnitude of Louisiana's coastal land losses and ecosystem degradation, it has become apparent that a systematic approach involving larger projects to restore natural geomorphic structures and processes, working in concert with smaller projects, will be required to effectively deal with a physical problem of such large proportions. Restoration strategies presented in the 1998 report entitled "Coast 2050: Toward a Sustainable Coastal Louisiana," which evolved into the Louisiana Coastal Area (LCA) 905(b) reconnaissance report, formed the basis for this broader-scale effort under the Louisiana Coastal Area Ecosystem Restoration Study (LCA Study).

The purpose of the LCA Study is to:

- Identify the most critical human and natural ecological needs of the coastal area;
- Present and evaluate conceptual alternatives for meeting the most critical needs;
- Identify the kinds of restoration features that could be implemented in the near-term (within 5 to 10 years) that address the most critical needs, and propose to address these needs through features that provide the highest return in net benefits per dollar of cost;
- Establish priorities among the identified near-term restoration features;
- Describe a process by which the identified priority near-term restoration features could be developed, approved, and implemented;
- Identify the key scientific uncertainties and engineering challenges facing the effort to protect and restore the ecosystem, and propose a strategy for resolving them;
- Identify, assess and, if appropriate, recommend feasibility studies that should be undertaken within the next 5 to 10 years to fully explore other potentially promising large-scale and long-term restoration concepts; and
- Present a strategy for addressing the long-term needs of coastal Louisiana restoration beyond the near-term focus of the Louisiana Coastal Area Ecosystem Restoration Plan (LCA Plan).

The goal of the LCA Plan is to reverse the current trend of degradation of the coastal ecosystem. The plan maximizes the use of restoration strategies that reintroduce historic flows of river water, nutrients, and sediment to coastal wetlands, and that maintain the structural integrity of the coastal ecosystem. Execution of the LCA Plan would make significant progress towards achieving and sustaining a coastal ecosystem that can support and protect the environment, economy, and culture of southern Louisiana and thus, contribute to the economy and well-being of the Nation. Benefits to and effects on existing infrastructure, including navigation, hurricane protection, flood control, land transportation works, agricultural lands, and oil and gas production and distribution facilities were considered in the formulation of coastal restoration plans.

Louisiana contains one of the largest expanses of coastal wetlands in the contiguous U.S., and accounts for 90 percent of the total coastal marsh loss occurring in the Nation. The coastal wetlands, built by the deltaic processes of the Mississippi River, contain an extraordinary diversity of habitats that range from narrow natural levee and beach ridges to expanses of forested swamps and freshwater, intermediate, brackish, and saline marshes. Taken as a whole, the unique habitats of upland areas and the Gulf of Mexico, with their hydrological connections to each other, and migratory routes of birds, fish, and other species, combine to place the coastal wetlands of Louisiana among the Nation’s most productive and important natural assets. In human terms, these coastal wetlands have been a center for culturally diverse social development.

Approximately 70 percent of all waterfowl that migrate through the U.S. use the Mississippi and Central flyways. With over 5 million birds wintering in Louisiana, the Louisiana coastal wetlands are a crucial habitat to these birds, as well as to neotropical migratory songbirds and other avian species who use them as crucial stopover habitat. Additionally, coastal Louisiana provides crucial nesting habitat for many species of water birds, such as the endangered brown pelican. These economic and habitat values, which are protected and supported by the coastal wetlands of Louisiana, are significant on a National level.

Louisiana's coastal wetlands and barrier island systems enhance protection of an internationally significant commercial-industrial complex from the destructive forces of storm-driven waves and tides. A complex of deep-draft ports includes the Port of South Louisiana, which handles more tonnage than any other port in the Nation, and the most active segment of the Nation’s Gulf Intracoastal Waterway (GIWW) (Waterborne Commerce Statistics Center (WCSC) 2002). In 2000, Louisiana led the Nation with production of 592 million barrels of oil and condensate (including the outer continental shelf (OCS)), valued at $17 billion, and was second in the Nation in natural gas production with $1.3 billion (excluding OCS and casing head gas) (Louisiana Department of Natural Resources (LDNR) 2003). In addition, nearly 34 percent of the Nation’s natural gas supply and over 29 percent of the Nation’s crude oil supply, moves through the state and is connected to nearly 50 percent of U.S. refining capacity (LDNR 2003b).

Additionally, coastal Louisiana is home to more than 2 million people, representing 46 percent of the state’s population. When investments in facilities, supporting service activities, and the urban infrastructure are totaled, the capital investment in the Louisiana coastal area totals approximately $100 billion. Excluding Alaska, Louisiana produced the Nation’s highest commercial marine fish landings (about $343 million) excluding mollusk landings such as clams, oysters, and scallops (National Marine Fisheries Service (NMFS) 2003). Recent data from the U.S. Fish and Wildlife Service (USFWS) show expenditures on recreational fishing (trips and equipment) in Louisiana to be nearly $703 million, and hunting expenditures were $446 million for 2001 (USFWS 2002).

Since the 1930s coastal Louisiana has lost over 1.2 million acres of land (485,830 ha) (Barras et al. 2003; Barras et al. 1994; and Dunbar et al. 1992). As recently as the 1970s, the loss rate for Louisiana's coastal wetlands was as high as 25,200 acres per year (10,202 ha/year). The rate of loss from 1990 to 2000 was about 15,300 acres per year (6,194 ha/year), much of which was due to the residual effects of past human activity (Barras et al. 2003). It was estimated in 2000 that coastal Louisiana would continue to lose land at a rate of approximately 6,600 acres per year (2,672 ha/year) over the next 50 years. It is estimated that an additional net loss of 328,000 acres (132,794 ha) may occur by 2050, which is almost 10 percent of Louisiana's remaining coastal wetlands (Barras et al. 2003). The cumulative effects of human and natural activities in the coastal area have severely degraded the deltaic processes and shifted the coastal area from a condition of net land building to one of net land loss.

While many studies have been conducted to identify the major contributing factors (e.g., Boesch et al. 1994; Turner 1997; Penland et al. 2000), most studies agree that land loss and the degradation of the coastal ecosystem are the result of both natural and human induced factors, producing conditions where wetland vegetation can no longer survive and wetlands are lost. Establishing the relative contribution of natural and human-induced factors is difficult. In many cases, the changes in hydrologic and ecologic processes manifest gradually over decades and in large areas, while other effects occur over single days and impact relatively localized areas. For barrier shorelines, complex interactions between storm events, longshore sediment supply, coastal structures, and inlet dynamics contribute to the erosion and migration of beaches, islands, and cheniers.

The measurable increase in coastal land loss in the mid to late 20th century can be linked to human activities that have fundamentally altered the deltaic processes of the coast and limited the ability to rebuild or sustain it. In the Chenier Plain, human activities have fundamentally altered the hydrology of the area, which has impacted the long-term sustainability of the coastal ecosystems. Because of the magnitude and variety of these human-induced changes, and their interaction with natural landscape processes, all of the factors contributing to coastal land loss and ecosystem degradation must be viewed together to fully understand how Louisiana's coastal ecosystem shifted from the historical condition of net land gain to the current condition of net land loss.

The past and continued loss of Louisiana's coastal wetlands will significantly affect the ecology, society, and economy of the region and the Nation. The continued decline of the natural ecosystem will result in a decrease in various functions and values associated with wetlands, including corresponding diminished biological productivity and increased risk to critical habitat of Federally-listed threatened and endangered species. The capacity of the coastal wetlands to buffer storm surges from tropical storm events will diminish, which will increase the risk of significant damage to oil, gas, transportation, water supply and other private and public infrastructure and agriculture lands and urban areas.

STUDY AREA

The study area, which includes the Louisiana coastal area from Mississippi to Texas, is comprised of two wetland-dominated ecosystems, the Deltaic Plain of the Mississippi River and the closely linked Chenier Plain, both of which are influenced by the Mississippi River. For planning purposes, the study area was divided into four subprovinces, with the Deltaic Plain comprising Subprovinces 1, 2, and 3, and the Chenier Plain comprising Subprovince 4 **(figure ES-1)**.

Today, the Deltaic Plain is a vast wetland area stretching from the eastern border of Louisiana to Freshwater Bayou. It is characterized by several large lakes and bays, natural levee ridges (up to 20 feet [6.1 meters] above sea level), and bottomland hardwood forests that gradually decrease in elevation to various wetland marshes. The Deltaic Plain contains numerous barrier islands and headlands, such as the Chandeleur Islands, Barataria Basin Barrier Islands, and Terrebonne Basin Barrier Islands. The Chenier Plain extends from the Teche/Vermilion bays to Louisiana's western border with Texas, and is characterized by several large lakes, marshes, cheniers, and coastal beaches.

Within the broadly delineated zones of marsh habitat types, a variety of other wetland habitats (with distinct surface features and vegetative communities) occur in association with the marshes. These include swamp and wetland forests, beach and barrier islands, upland, and other important habitats. There are also unique vegetative communities in the coastal area, such as floating marshes, tidal fresh marshes and maritime forests, that contribute to the extensive diversity of the coastal ecosystem and which are essential to the overall stability of the ecosystem.

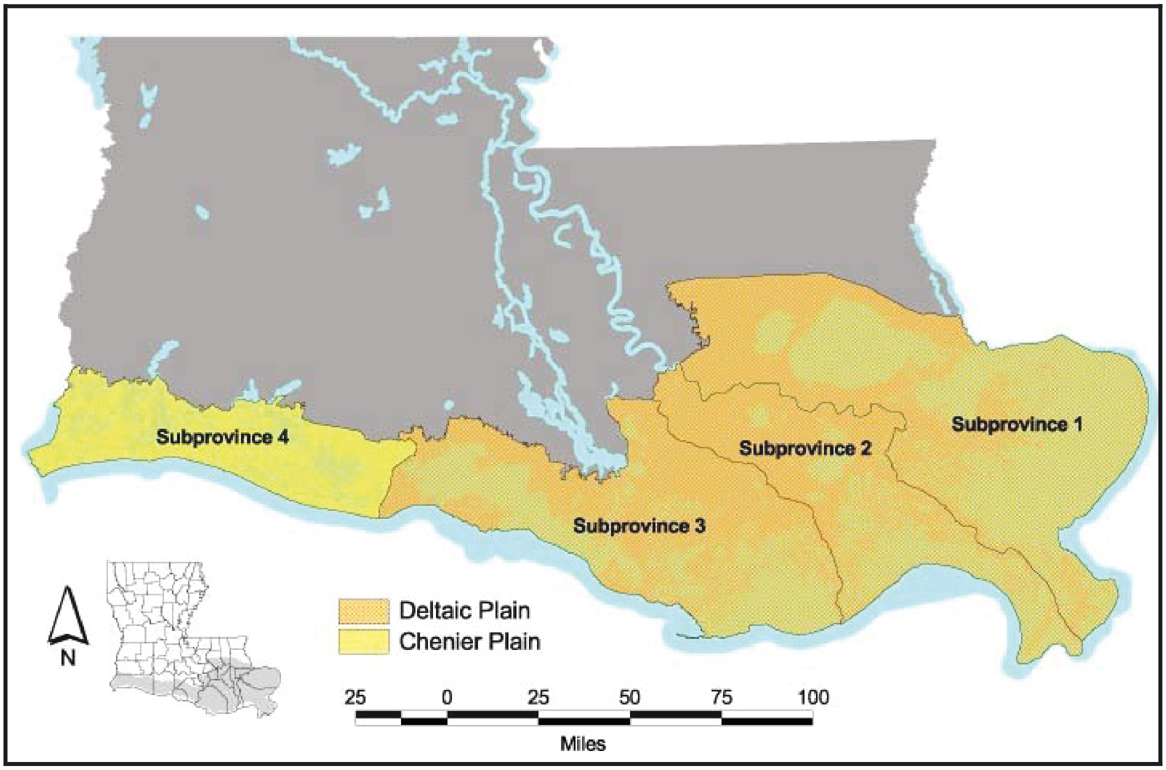


Figure ES-1. LCA Study Area and Subprovinces.

Project Delivery Team (PDT)

An interagency Project Delivery Team (PDT) was assembled to conduct the prerequisite studies and analyses and develop the alternative plans and report for the LCA Study. The team was composed of staff from the U.S. Army Corps of Engineers (USACE), State of Louisiana (the non-Federal sponsor), U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), U.S. Environmental Protection Agency (USEPA), U.S. Geological Survey (USGS), and National Resources Conservation Services (NRCS). To ensure that development of alternative restoration plans was based upon the best available science and engineering, the USACE and the State of Louisiana also enlisted the aid of over 120 scientists, engineers, and planners from across the Nation to provide advice and guidance, carry out complex modeling efforts, and review results.

Plan Formulation

The LCA Study planning process used by the PDT evolved over 2 years, ultimately resulting in the selection of a recommended near-term course of action. During this time, the PDT used an iterative decision making process to identify and evaluate the merits of individual restoration features, the effects of combining these features into different coast wide frameworks, and ultimately the ability of these frameworks to address the most critical ecological needs in the Louisiana coastal area. **Table ES-1** highlights the purpose, decision criteria, and results of the major iterations of the plan formulation process.

The most suitable LCA Plan is identified as the one that best meets the study objectives, is based upon identification of the most critical natural and human ecological needs, and proposes a program of highly cost effective features to address those needs. During program implementation, feasibility-level decision documents would be completed to fully analyze and justify specific features based upon standard planning guidance using National Environmental Restoration (NER) and National Economic Development (NED) analyses.

Planning Constraints

The development and evaluation of restoration alternatives within coastal Louisiana was constrained by several factors. Foremost among these factors was the fundamental premise that restoration of deltaic processes would be accomplished, in part, through reintroductions of riverine flows, but that natural and historical “channel switching” of the Mississippi River would not be allowed to occur. The availability of freshwater, primarily water transported down the Mississippi River, was considered a planning constraint because minimum levels or water flows are required to maintain navigation and flood control, and limit saltwater intrusion. The availability of sediment for restoration efforts was also considered a planning constraint for this study because there is not an unlimited, easily accessible, and low-cost source for restoration efforts.

Another significant category of constraints is the scientific and technological uncertainties inherent in large-scale aquatic ecosystem restoration projects. While many of these were known as the plan formulation process began, others became more evident as the formulation process was completed. A summary of the key scientific uncertainties and technological challenges as they are currently understood, along with proposed strategies to address these uncertainties and challenges, is presented below.

- **Type 1 - Physical, chemical, geological, and biological baseline condition uncertainties -** This general type of uncertainty is best resolved through continued improvement of tools and networks that would better establish baseline conditions and allow for more detailed and coast wide monitoring and assessment, which would better support program-level, as well as project-level, Adaptive Management;

- **Type 2 - Engineering concepts and operational method uncertainties -** This general type of uncertainty is best resolved through implementation of appropriately scaled demonstration projects and associated monitoring programs to gauge results;

- **Type 3 - Ecological processes, analytical tools, and ecosystem response uncertainties -** This general type of uncertainty is best resolved through research, monitoring, and assessment of ecological processes and ecosystem responses, and improving analytical tools, such as models; and

- **Type 4 - Socio-economic/political conditions and responses uncertainties -** This general type of uncertainty is best resolved through focused research and application of socioeconomic modeling and assessment methods to better establish socioeconomic linkages that will inform more complete NED/NER analysis.

Table ES-1. Major Iterations of Plan Formulation.

	Iteration We started with:	**Purpose** Our intent was to:	**Criteria** We made decisions based on:	**Result** The iteration ended with:
Phase 1	EOPs and Guiding Principles	Develop Planning Objectives and Planning Scales	• Professional judgment • Extensive CWPPRA experience • Scoping Comments	Planning Objectives Planning Scales
Phase 2	Coast 2050 Plan Section 905(b) Report	Assess broad scale strategies in 2050 Plan to identify Core Strategies for LCA Study effort	• Existing resources available in each of the four Subprovinces	LCA Core Strategies
Phase 3	LCA Core Strategies	Develop restoration features that would support LCA Core Strategies	• Planning Objectives • Creating features that would meet various Planning Scales • Developing features for all LCA Core Strategies	Restoration Features
Phase 4	Restoration Features	Combine Restoration Features into Subprovince Alternative Frameworks	• Need to combine Restoration Features into Alternative Frameworks that achieve different Planning Scales • Need to develop significantly different Restoration Features for all LCA Core Strategies	Subprovince Frameworks
	Subprovince Frameworks	Create, assess, and select Coast wide Restoration Frameworks	• Cost effectiveness (CE) • Incremental Cost Analysis (ICA)	Tentative Final Array of Coast wide Restoration Frameworks
Phase 5	Tentative Final Array of Coast wide Restoration Frameworks	Address completeness of Coast wide Restoration Frameworks in Tentative Final Array	• Public meeting and stakeholder comments • Re-verification of CE/ICA	Final Array
Phase 6	Final Array	Identify highly cost-effective Restoration Features within the Final Array that address most critical ecological needs	• Critical need sorting criteria • Critical need assessment criteria	LCA Plan

LCA Plan Recommendations

Based upon the best available science and engineering, professional judgment, and extensive experience in coastal restoration in Louisiana and beyond, the LCA Study identifies, evaluates, and recommends to decision makers an appropriate, coordinated, feasible solution to the identified critical water resource problems and opportunities in coastal Louisiana. This LCA Study report provides a complete presentation of the study process, results, and findings; indicates compliance with applicable statutes, executive orders, and policies; documents the Federal and non-Federal interest; and provides a sound and documented basis for decision makers at all levels to evaluate the request for the following LCA Plan components:

- Specific Congressional authorization for five near-term critical restoration features for which construction can begin within 5 to 10 years, with implementation subject to approval of feasibility-level decision documents by the Secretary of the Army (hereinafter referred to as "conditional authorization" in the Report and accompanying Programmatic Environmental Impact Statement);
- Programmatic Authorization of a Science and Technology Program;
- Programmatic Authorization of Science and Technology Program Demonstration Projects;
- Programmatic Authorization for the Beneficial Use of Dredged Material;
- Programmatic Authorization for Investigations of Modification of Existing Structures;
- Approval of investigations and preparation of necessary feasibility-level reports of 10 additional near-term critical restoration features to be used to present recommendations for potential future Congressional authorization (hereinafter referred to as "Congressional authorization"); and
- Approval of investigations for assessing six potentially promising large-scale and long-term restoration concepts.

Near-Term Critical Restoration Features for Conditional Authorization

The LCA Plan includes five near-term critical restoration features, which are recommended for specific authorization for implementation subject to approval of feasibility-level decision documents by the Secretary (conditional authorization). Implementation of these five restoration features would be subject to completion of NED/NER analyses, NEPA compliance requirements, and appropriate feasibility-level decision documentation. These feasibility-level decision documents would be developed utilizing current policies and guidelines to provide a sound basis for decision makers at all levels.

Initial analysis indicates that these features address the most critical ecological needs of the Louisiana coastal area in locations where delaying action would result in a "loss of opportunity" to achieve restoration and/or much greater restoration costs. All of these features, based on preliminary estimates, appear to be cost effective and provide significant value to address critical natural and human ecological needs. These five critical near-term features present a range of effects essential for success in restoring the Louisiana coast. The benefits provided by these features include: the sustainable reintroduction of riverine resources; rebuilding wetlands in areas at high risk for future loss; the preservation and maintenance of critical coastal geomorphic structure; the preservation of critical areas within the coastal ecosystem; and, the opportunity to begin to identify and evaluate potential long-term solutions. Based on a body of work both preceding and including this study effort, the PDT produced an estimate of average annual costs and benefits for these five features. This information shows that average annual environmental output for this authorized feature package would be on the order of 22,000 habitat units [#] at an average annualized cost of $2,700 per unit provided.

The ecologic model output for land building estimates that the plan would offset approximately 62.5 percent of the 462,000 acres projected to be lost within the coast under the no action alternative. The estimated land building for Subprovince 1 exceed projected no action losses. In Subprovinces 2 & 3 the models estimated that the LCA plan prevented almost 50 percent of the expected losses in each basin. These estimates do not include any projects in Subprovince 4.

The LCA Plan presents significant capacity for the prevention of future wetland loss with a smaller component of wetland building capacity. Although the LCA Plan acts significantly to reduce future loss of ecosystem structure and function, overall levels of environmental outputs will remain significantly reduced compared to historical conditions. This is especially true in Subprovince 4 where limited actions are recommended in the LCA Plan.

Upon completion of the feasibility-level decision documents for the restoration features included in this component, the projects will be forwarded to the Secretary of the Army for implementation approval and subsequent inclusion in the USACE annual budget cycle. The five features are:

- Mississippi River Gulf Outlet (MRGO) environmental restoration features
- Small diversion at Hope Canal[*]
- Barataria Basin barrier shoreline restoration (Caminada Headland and Shell Island reaches)
- Small Bayou Lafourche reintroduction*
- Medium diversion with dedicated dredging at Myrtle Grove*

Science and Technology Program

While the LCA Plan is based upon the best available science and technology and takes advantage of more than 20 to 30 years of experience gained from previous Louisiana coastal restoration efforts, such as CWPPRA, there remain scientific and technical uncertainties associated with some of the proposed Louisiana coastal area restoration efforts (see section 3.1

[#] For Habitat Units: See Glossary
[*] Diversion/Re-introduction sizes:
Small diversion: 1,000 cfs – 5,000 cfs; Medium diversion: 5,001 cfs – 15,000 cfs;
Large diversion: > 15,000 cfs

for a detailed discussion of uncertainties). The USACE and the non-Federal sponsor have developed a Science and Technology Program (S&T Program) to provide a strategy, organizational structure, and processes to facilitate integration of science and technology into the decision-making processes for Program Management, the Program Execution Team, and the Science and Technology Plan (S&T Plan). Programmatic authorization and implementation of this S&T Program would ensure that the best available science and technology are available for use in the planning, design, construction, and operation of the LCA Plan components, as well as other coastal restoration projects and programs, such as CWPPRA. There are five primary elements in the LCA S&T Program, and each element has a different emphasis and requirement. These elements include: (1) Science Information Needs, (2) Data Acquisition and Monitoring, (3) Data and Information Management, (4) Modeling and Adaptive Management, and (5) Research. (Additional information on the structure and purpose of the S&T Program is provided in appendix A, SCIENCE AND TECHNOLOGY PROGRAM.) The S&T Program is designed to encourage creativity and scientific collaboration in responding to the needs of the restoration program. Scientific and technological uncertainties would also be addressed through the identification, development and implementation of appropriate demonstration projects.

Science and Technology Program Demonstration Projects

The purpose of the recommended LCA S&T Program Demonstration Projects is to resolve critical areas of scientific, technical, or engineering uncertainty while providing meaningful restoration benefits whenever possible. The types of uncertainty that are best resolved through implementation of appropriately scaled demonstration projects are the "Type 2" uncertainties presented in section 3.1. After design, construction, monitoring, and assessment of individual demonstration projects, the LCA program will leverage "lessons learned" to improve the planning, design, and implementation of other LCA restoration projects.

Demonstration projects may be necessary to address uncertainties that would be identified in the course of individual project implementation or during the course of studies of large-scale and long-term restoration concepts. Nominated demonstration projects would be subject to review and approval of individual project feasibility-level decision documents by the Secretary of the Army. In addition to standard feasibility-level decision document information, the demonstration project feasibility-level documents would address:

- Major scientific or technological uncertainties to be resolved; and
- A monitoring and assessment plan to ensure that the demonstration project would provide results, and that contributes to overall LCA program effectiveness.

It is proposed that demonstration projects developed by the S&T program be funded as a construction item at an amount not to exceed $100 million over 10 years, including a maximum cost of $25 million per project. Five initial candidate demonstration projects were developed by the PDT , but these may be modified or replaced by demonstration projects of higher priority as determined by the S&T Director. In order to support continued development of the LCA plan through AEAM, it is possible that additional and/or different demonstration projects will be needed. The PDT identified the following five candidate demonstration projects:

- Marsh restoration and/or creation using non-native sediment
- Marsh restoration using long-distance conveyance of sediment
- Canal restoration using different methods
- Shoreline erosion prevention using different methods
- Barrier island restoration using offshore and riverine sources of sediment

Programmatic Authorization for the Beneficial Use of Dredged Material

The USACE, Mississippi Valley Division, New Orleans District (the District) has the largest annual channel operations and maintenance (O&M) program in the USACE, with an annual average of 70 million cubic yards (mcy) (53.6 million cubic meters) of material dredged. At this time, approximately 14.5 mcy (11.1 million cubic meters) of this material is used beneficially in the surrounding environment with funding from either the O&M program itself or the Continuing Authorities Program (CAP) defined by the WRDA 1992 Section 204 for beneficial use of dredged material. The amount of material generated by O&M operations, the volume of material recovered for beneficial use in existing operations, and the potential total volume of material that can be reused varies considerably from year to year, based on the type of dredging operations being performed and their environmental setting. The LCA Plan's effectiveness would be enhanced by a programmatic authorization for expanding the beneficial use of dredged material. The proposed beneficial use program would allow the District to take greater advantage of existing sediment resources made available by maintenance activities to achieve restoration objectives. Annualized, there is reasonable potential to use an additional 30 mcy (23 million cubic meters) of material beneficially if funding were made available. (A portion of the average annual material total of 70 mcy (53.6 million cubic meters) is not available for beneficial use because it is re-suspended from upstream maintenance). Other limitations within particular areas include threatened and endangered species operating restrictions; cultural resource site operating restrictions; and unfavorable maritime working conditions. The following projects are a small subset of the many areas with significant opportunity for additional beneficial use:

- The MRGO, LA, project;
- The bay reach of the Barataria Bay Waterway, LA project;
- The [lower] MR&T project, Head of Passes and Southwest Pass;
- The Atchafalaya River and Bayous Chene, Boeuf, and Black, LA, project;
- The inland reach of the Calcasieu River and Pass, LA, project; and
- The Houma Navigation Canal.

The LCA Plan recommends authorization of $100 million in programmatic authority for the additional funding needed for beneficial use of dredged material generated by existing programs. Past Section 204 projects have demonstrated an incremental cost of $1.00 per cubic yard (cy) for beneficial placement. Additionally, these projects have demonstrated approximately 0.00025 acre created per cy. Based on the requested funds and a 10-year period of implementation, it is expected that the LCA beneficial use of dredged material could attain 21,000 acres (8,502 ha) of newly created wetlands. This recommended beneficial use program represents a significant opportunity to contribute to the accomplishment of the LCA objectives.

Programmatic authorization for the beneficial use of dredged material would allow the application of funds appropriated through LCA under guidelines similar to those of the Continuing Authorities Program defined by Section 204 of the Water Resources Development Act (WRDA) of 1992. Implementation would proceed with a more detailed analysis of the potential beneficial use disposal sites, a process that would be repeated annually within the O&M "Base Plan" cycle.

Programmatic Authorization for Investigations of Modifications of Existing Structures

Coastal Louisiana is a dynamic environment that requires continual adaptation of restoration plans. With this recognition, opportunities for modifying or rehabilitating existing structures and/or their operation management plans to contribute to the ecosystem restoration objectives may be required in the future. Initiation of investigations of modifications to existing structures requires advanced budgeting. Standard budgeting may limit responsiveness to recommendations made within the LCA Plan. As a result, the LCA Plan seeks programmatic authorization to initiate studies of existing structures using funds within the LCA appropriations, not to exceed $10 million.

Near-term Critical Restoration Features Recommended for Study and Future Congressional Authorization

The following component of the LCA Plan is not proposed for immediate construction authorization, but it is included in the plan for study and preparation of design and decision documents. These projects would then be submitted to Congress for construction authorization in future Water Resource Development Acts. Based on an analysis of the current plan implementation schedule, the recommended features would have feasibility-level decision documents or Feasibility Reports completed and ready to submit to Congress through FY 2013. Plan implementation would begin with basin-by-basin studies evaluating hydrodynamic and ecological responses of the critical restoration features that have been recommended for Congressional authorization. The projected outputs for these features would be evaluated by Cost Effectiveness / Incremental Cost Analysis (CE/ICA) to determine the cost-effective alternatives for implementation. This CE/ICA analysis would support the feasibility-level decision documents submitted for Congressional authorization.

The LCA Plan recommends 10 additional critical near-term restoration features throughout coastal Louisiana for further studies, in anticipation that such features may be subsequently recommended for future Congressional authorization. Proposed restoration features employ a variety of restoration strategies, such as freshwater and sediment diversions; interior shoreline protection; barrier island and barrier headland protection; and use of dredged material for marsh restoration. The USACE and the non-Federal sponsor concur that each of the identified restoration opportunities could begin construction within the next 10 years. The 10 restoration features recommended for study and future Congressional authorization in the LCA Plan are:

- Multi-purpose operation of the Houma Navigation Canal Lock;
- Terrebonne Basin barrier shoreline restoration;
- Maintain land bridge between Caillou Lake and Gulf of Mexico;
- Small diversion at Convent/Blind River;
- Increase Amite River Diversion Canal influence by gapping banks;
- Medium diversion at White's Ditch;
- Gulf shoreline stabilization at Point Au Fer Island;
- Convey Atchafalaya River water to northern Terrebonne marshes – via a small diversion in the Avoca Island levee, repairing eroding banks of the GIWW, and enlarging constrictions in the GIWW, and enlarging constrictions in the GIWW below Gibson and Houma, and Grand Bayou conveyance channel construction/enlargement;
- Modification of Caernarvon diversion; and
- Modification of Davis Pond diversion.

Large-Scale and Long-Term Concepts Requiring Detailed Study

Several candidate large-scale and long-term concepts for potential incorporation into the LCA Plan were identified during plan formulation. These restoration concepts exhibited significant potential to contribute to achieving restoration objectives in 1) the subprovince within which they would be located, 2) adjacent subprovince(s), and/or 3) substantial portions of Louisiana's coastal ecosystem. Accordingly, the corresponding benefits and costs for these potential plan features should be further analyzed and confirmed to determine how best to incorporate them, if at all, with other plan features. Upon completion of detailed feasibility studies as part of the LCA Plan, recommendations for action would be documented and proposed for Congressional authorization.

The LCA Plan recommends the initiation of six feasibility studies of large-scale and long-term restoration concepts which, based on scope and/or complexity, would require more time and further study prior to implementation. The large-scale and long-term study initiatives identified in the plan include:

- Mississippi River Hydrodynamic Study
- Mississippi River Delta Management Study
- Third Delta Study
- Chenier Plain Freshwater and Sediment Management and Allocation Reassessment Study
- Acadiana Bays Estuarine Restoration Feasibility Study
- Upper Atchafalaya Basin Study (this study would include evaluation of alternative operational schemes of Old River Control Structure and will be funded under MR&T)

Summary of Tentatively Selected Plan Recommendations

The proposed LCA Plan would facilitate the implementation of critical restoration features, essential science and technology demonstration projects, increased beneficial use of dredged material, and modification of selected existing projects to support coastal restoration objectives. The S&T Program would provide for acquisition of data and development of analytic tools to further resolve scientific uncertainties and support program implementation. The remaining recommended plan components would provide the basis for continued restoration within an established framework.

The cost of the five Near-Term Critical Restoration Features recommended for specific Congressional authorization, with implementation subject to Secretary of the Army review and approval of feasibility-level decision documents, (referred to as "conditionally authorized" elsewhere in the report) is estimated at $864,065,000. The total cost of the Science and Technology Program, the Demonstration Projects, the Program for the Beneficial Use of Dredged Material, and Investigations of Modifications of Existing Structures is estimated at $310,000,000. The combined total cost of the previously stated components of the LCA Plan is estimated at $1,174,065,000. The total cost of Other Near-Term Critical Restoration Features and Studies Requiring Future Congressional Construction Authorization, and Large-Scale and Long-Term Concepts Detailed Studies is estimated to be $821,916,000. The total cost of the LCA Plan is estimated to be $1,995,981,000. These costs can be found in table ES-2. Currently, the annual operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) costs are estimated at $7,883,000. OMRR&R costs are the responsibility of the non-Federal sponsor. These costs can be found in table MR 6-5.

Table ES-2. LCA Restoration Plan Cost Estimates

Item		Cost ($)	
MRGO environmental restoration features		$	80,000,000
Small diversion at Hope Canal		$	10,645,000
Barataria Basin Barrier shoreline restoration		$	181,000,000
Small Bayou Lafourche reintroduction		$	75,280,000
Medium diversion with dedicated dredging at Myrtle Grove		$	142,920,000
	SUBTOTAL	$	489,845,000
LERRD		$	178,619,000
First Cost	SUBTOTAL	$	668,464,000
Feasibility-Level Decision Documents		$	54,673,000
Preconstruction, Engineering, and Design (PED)		$	36,252,000
Engineering and Design (E&D)		$	29,018,000
Supervision and Administration (S&A)		$	68,973,000
Project Monitoring		$	6,685,000
Conditionally Authorized Cost	SUBTOTAL	**$**	**864,065,000**
Science & Technology Program Cost (10 year Program)		**$**	**100,000,000**
Demonstration Program Cost (10 year Program)*		**$**	**100,000,000**
Beneficial Use of Dredged Material Program*		**$**	**100,000,000**
Investigations of Modifications of Existing Structures		**$**	**10,000,000**
Total Authorized LCA Plan Cost		**$**	**1,174,065,000**
Multi-purpose operation of Houma Navigation Canal (HNC) Lock [#]		$	-
Terrebonne Basin Barrier shoreline restoration		$	84,850,000
Maintain Land Bridge between Caillou Lake and Gulf of Mexico		$	41,000,000
Small diversion at Convent / Blind River.		$	28,564,000
Increase Amite River Diversion Canal influence by gapping banks		$	2,855,000
Medium diversion at White’s Ditch		$	35,200,000
Stabilize Gulf shoreline at Point Au Fer Island		$	32,000,000
Convey Atchafalaya River Water to Northern Terrebonne marshes		$	132,200,000
Modification of Caernarvon diversion		$	1,800,000
Modification of Davis Pond diversion		$	1,800,000
	SUBTOTAL	$	360,269,000
LERRD		$	208,100,000
First Cost	SUBTOTAL	$	568,369,000
Feasibility Level Decision Documents		$	47,529,000
Preconstruction, Engineering, and Design (PED)		$	36,027,000
Engineering & Design (E&D)		$	45,635,000
Supervision & Administration (S&A)		$	58,673,000
Project Monitoring		$	5,683,000
Approved Projects Requiring Future Congressional Authorization for Construction		**$**	**761,916,000**
Mississippi River Hydrodynamic Study		$	10,250,000
Mississippi River Delta Management Study		$	15,350,000
Third Delta Study		$	15,290,000
Chenier Plain Freshwater and Sediment Management and Allocation Reassessment Study		$	12,000,000
Acadiana Bays Estuarine Restoration Feasibility Study		$	7,110,000
Upper Atchafalaya Basin Study^		$	-
Large-scale and Long Term Studies Cost	SUBTOTAL	**$**	**60,000,000**
Total LCA Restoration Plan Cost		**$**	**1,995,981,000**

*Program total costs include any estimated Real Estate costs for these activities
[#] Feature of the Mississippi River and Tributaries, Morganza Louisiana to the Gulf of Mexico Hurricane Protection project

Areas of Controversy

The following list is a summary of the major areas of controversy. The complete list of areas of controversy can be found in Section 5.0.

1. Conflict concerning the operation of the MRGO.

2. Public concern that litigation from parties negatively impacted by restoration projects will make restoration prohibitively expensive.

3. Concern about the priority of certain restoration projects.

   - Demand by Terrebonne and Barataria Basins residents for the immediate restoration of the Barataria-Terrebonne Estuary before other regions of the coastal ecosystem.
   - Public support for the construction of restoration projects in areas that will maximize the benefits to society, culture, and the regional economy.
   - Public concern for additional salinity controls in the Chenier Plain and inclusion of additional restoration features for this subprovince in the implemented LCA Plan.

4. Concern about the necessity for sediment and water quality testing for each restoration feature.

5. Conflicts may result when balancing economic interests with coastal restoration, especially when multiple stakeholders share common coastal resources.

   - Public concern that diversions will over-freshen receiving basins and concern that diversions could create algae blooms in interior bays and lakes.
   - Concern with changing the existing operational scheme of the Old River Control Structure in regulating river flows in the Mississippi and Atchafalaya Rivers.
   - Concern that LCA Plan restoration features in Subprovince 3 would result in excessive amounts of water and sediment into the area.
   - Real property rights issues including public access, mineral rights, and the perception that Federal monies would be spent to restore private properties.
   - Concern with impediments to navigation and proposed re-routing of the Mississippi River and the Atchafalaya River Navigation channels.
   - The effect of coastal restoration on flood control projects.

6. Concern with inaction and perceived lack of urgency with respect to restoration.

   - Public support for comprehensive, long-term restoration efforts beyond near-term restoration efforts.
   - Public demand for the immediate construction of restoration actions versus requirements for conducting additional study of restoration problems.

Management of Plan Implementation

Execution of the LCA Plan will require a concerted and collaborative effort between the USACE, the State of Louisiana, and other state and Federal agencies. For this reason, an LCA specific management plan was developed. This plan centers Program Management at the Division level, with Program Execution at the District level. The management plan maximizes concurrent and supporting efforts between the Program Managers, the USACE Washington Headquarters, and the Assistant Secretary of the Army for Civil Works. Program management and execution are conducted in full partnership with the non-Federal sponsor and in collaboration with other Federal and state resource agencies. Collaboration among other Federal agencies and the program is ensured through the involvement of a Federal Task Force comprised of members equivalent in authority and responsibility to the Secretary of the Army.

Key to the success of the program is the infusion of the best available science and engineering for the purposes of development and implementation of restoration plans. For this reason a supporting S&T Program and S&T Office is proposed to work hand in hand with the Program Management and Program Execution Teams throughout plan implementation. Since the coastal ecosystem is dynamic and the state of the science is evolving, a system of advancing science and "learn while building" will be instituted. The key to success is the implementation of AEAM principles into the program management.

A robust and vigorous consistency review conducted by the Program Execution Team will be done in order to protect public investment, leverage restoration opportunities of other projects and programs, and to ensure that future public and private actions do not detract from coast restoration.

This page intentionally left blank.

LOUISIANA COASTAL AREA (LCA), LOUISIANA
ECOSYSTEM RESTORATION STUDY
MAIN REPORT
TABLE OF CONTENTS

Number Title Page

Number Title Page

Number Title Page

Number Title Page

LIST OF FIGURES

LIST OF TABLES

This page intentionally left blank.

1.0 INTRODUCTION

1.1 STUDY BACKGROUND

The Louisiana coastal plain contains one of the largest expanses of coastal wetlands in the contiguous United States (U.S.), and accounts for 90 percent of the total coastal marsh loss in the Nation. The coastal wetlands, built by the deltaic processes of the Mississippi River, contain an extraordinary diversity of coastal habitats that range from narrow natural levee and beach ridges to expanses of forested swamps and freshwater, intermediate, brackish, and saline marshes. Taken as a whole, the unique habitats, with their hydrological connections to each other, upland areas, the Gulf of Mexico, and migratory routes of birds, fish, and other species, combine to place the coastal wetlands of Louisiana among the Nation's most productive and important natural assets. In human terms, these coastal wetlands have been a center for culturally diverse social development.

Approximately 70 percent of all waterfowl that migrate through the U.S. use the Mississippi and Central flyways. With more than 5 million birds wintering in Louisiana, the Louisiana coastal wetlands are crucial habitat to these birds, as well as to neotropical migratory songbirds and other avian species who use them as crucial stopover habitat. Additionally, coastal Louisiana provides crucial nesting habitat for many species of water birds, such as the endangered brown pelican. These economic and habitat values, which are protected and supported by the coastal wetlands of Louisiana, are significant on a National level.

Louisiana's coastal wetlands and barrier island systems enhance protection of an internationally significant commercial-industrial complex from the destructive forces of storm-driven waves and tides. A complex of deep-draft ports includes the Port of South Louisiana, which handles more tonnage than any other port in the Nation, and the most active segment of the Nation's Gulf Intracoastal Waterway (GIWW) (Waterborne Commerce Statistics Center (WCSC) 2002). In 2000, Louisiana led the Nation with production of 592 million barrels of oil and condensate (including the outer continental shelf (OCS)), valued at $17 billion, and was second in the Nation in natural gas production with $1.3 billion (excluding OCS and casing head gas) (Louisiana Department of Natural Resources [LDNR] 2003a). In addition, nearly 34 percent of the Nation's natural gas supply and over 29 percent of the Nation's crude oil supply moves through the state and is connected to nearly 50 percent of U.S. refining capacity (LDNR 2003a).

Additionally, coastal Louisiana is home to over 2 million people, representing 46 percent of the state's population. When investments in facilities, supporting service activities, and the urban infrastructure are totaled, the capital investment in the Louisiana coastal area adds up to approximately $100 billion. Excluding Alaska, Louisiana produced the Nation's highest commercial marine fish landings (about $343 million) excluding mollusk landings such as clams, oysters, and scallops (National Marine Fisheries Service (NMFS) 2003). Recent data from the U.S. Fish and Wildlife Service (USFWS) show expenditures on recreational fishing (trip and equipment) in Louisiana to be nearly $703 million, and hunting expenditures were valued at $446 million in 2001 (USFWS 2002).

Louisiana's coastal wetlands were built by deltaic processes involving the transport of enormous volumes of sediment and water by the Mississippi River. This sediment was eroded from the lands of the vast Mississippi River Basin in the interior of North America. For the last several thousand years, the dominance of the land building or deltaic processes resulted in a net increase of more than four million acres of coastal wetlands. In addition, there was the creation of an extensive skeleton of higher natural levee ridges along the past and present Mississippi River channels, distributaries, and bayous in the Deltaic Plain and beach ridges of the Chenier Plain. The landscape created by these deltaic processes gave rise to one of the most productive ecosystems on Earth.

Today, most of the Mississippi River's fresh water, with its nutrients and sediment, flows directly into the Gulf of Mexico, largely bypassing the coastal wetlands. Deprived of land-building sediment, the wetlands are damaged by saltwater intrusion and other causative factors associated with sea level change and land subsidence, and will eventually convert to open water. Deprived of the nutrients, the plants that define the surface of the coastal wetlands die off. Once the coastal wetlands are denuded of vegetation, the fragile substrate is left exposed to the erosive forces of waves and currents, especially during tropical storm events.

Since the 1930s coastal Louisiana has lost more than 1.2 million acres (485,830 ha) (Barras et al. 2003; Barras et al. 1994; and Dunbar et al. 1992). As recently as the 1970s, the loss rate for Louisiana's coastal wetlands was as high as 25,200 acres per year (10,202 ha per year). The rate of loss from 1990 to 2000 was about 15,300 acres per year (6,194 ha per year), mainly due to the residual effects of past human activity (Barras et al. 2003). It was estimated in 2000 that coastal Louisiana would continue to lose land at a rate of approximately 6,600 acres per year (2,672 ha per year) over the next 50 years. It is estimated that an additional net loss of 328,000 acres (132,794 ha) may occur by 2050, which is almost 10 percent of Louisiana's remaining coastal wetlands (Barras et al. 2003). The cumulative effects of human and natural activities in the coastal area have severely degraded the deltaic processes and shifted the coastal area from a condition of net land building to one of net land loss.

In 1990, passage of the Coastal Wetlands Planning, Protection and Restoration Act, (PL-101-646, Title III, CWPPRA), provided authorization and funding for the Louisiana Coastal Wetlands Conservation and Restoration Task Force to begin actions to curtail wetland losses. In 1998, after extensive studies and construction of a number of coastal restoration projects accomplished under CWPPRA, the State of Louisiana, and the Federal agencies charged with restoring and protecting the remainder of Louisiana's valuable coastal wetlands developed the "Coast 2050: Toward a Sustainable Coastal Louisiana" report, known as the Coast 2050 Plan. The underlying principles of the Coast 2050 Plan are to restore or mimic the natural processes that built and maintained coastal Louisiana. This plan proposed ecosystem restoration strategies that would result in efforts larger in scale than any that had been implemented in the past.

The Coast 2050 Plan was the basis for the May 1999 report, entitled Section 905(b) ([Water Resource Development Act] (WRDA) 1986) Analysis Louisiana Coastal Area, Louisiana --Ecosystem Restoration. This reconnaissance-level effort evaluated the Coast 2050 Plan as a whole and expressed a Federal interest in proceeding to the feasibility phase. In 2000, it was envisioned that a series of feasibility reports would be prepared over a 10-year period.

The first feasibility efforts focused on the Barataria Basin and involved marsh creation and barrier shoreline restoration. However, early in fiscal year (FY) 2002, it was recognized that it would be more efficient to develop a comprehensive coastal restoration effort that could be submitted to Congress as a blueprint for future restoration efforts. As a result, the USACE and the State of Louisiana initiated the Louisiana Coastal Area (LCA) Comprehensive Coastwide Ecosystem Restoration Study. In FY 2004, recognition of Federal and state funding constraints and scientific and engineering uncertainties pertaining to some of the restoration features under consideration led to the determination that the coastal area ecosystem restoration effort should begin with the development and implementation of a restoration plan that identifies highly cost-effective restoration features that address the most critical needs of coastal Louisiana, as well as large-scale and long-term restoration concepts.

1.2 STUDY AUTHORITY

This LCA Ecosystem Restoration Study (LCA Study) is authorized through resolutions of the U.S. House of Representatives and Senate Committees on Public Works, 19 April 1967 and 19 October 1967. These resolutions contain the following language:

> "RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE UNITED STATES SENATE, That the Board of Engineers for Rivers and Harbors created under Section 3 of the River and Harbor Act approved June 13, 1902, be, and is hereby requested to review the reports of the Chief of Engineers on the Mermentau River and Tributaries and Gulf Intracoastal Waterway and connecting waters, Louisiana, published as Senate Document Numbered 231, Seventy-ninth Congress, on the Bayou Teche, Teche-Vermilion Waterway and Vermilion River, Louisiana, published as Senate Document Numbered 93, Seventy-seventh Congress, on the Calcasieu River salt water barrier, Louisiana, published as House Document Numbered 582, Eighty-seventh Congress, and on Bayous Terrebonne, Petit Caillou, Grand Caillou, Dularge, and connecting channels, Louisiana, and the Atchafalaya River, Morgan City to the Gulf of Mexico, published as House Document Numbered 583, Eighty-seventh Congress, and other pertinent reports including that on Bayou Lafourche and Lafourche-Jump Waterway, Louisiana, published as House Document Numbered 112, Eighty-sixth Congress, with a view to determining the advisability of improvements or modifications to existing improvements in the coastal area of Louisiana in the interest of hurricane protection, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and related water resource purposes."

Attachment 1 includes summaries of other pertinent coastal restoration and related water resources authorizations that may be useful for implementing coastal restoration.

1.3 STUDY PURPOSE AND SCOPE

The purpose of the LCA Study is to:

- Identify the most critical human and natural ecological needs of the coastal area;

- Present and evaluate conceptual alternatives for meeting the most critical needs;
- Identify the kinds of restoration features that could be implemented in the near-term (within 5 to 10 years) that address the most critical needs, and propose to address these needs through features that provide the highest return in net benefits per dollar of cost;
- Establish priorities among the identified near-term restoration features;
- Describe a process by which the identified priority near-term restoration features could be developed, approved, and implemented;
- Identify the key scientific uncertainties and engineering challenges facing the effort to protect and restore the ecosystem, and propose a strategy for resolving them;
- Identify, assess and, if appropriate, recommend feasibility studies that should be undertaken within the next 5 to 10 years to fully explore other potentially promising large-scale restoration concepts; and
- Present a strategy for addressing the long-term needs of coastal Louisiana restoration beyond the near-term focus of the Louisiana Coastal Area Ecosystem Restoration Plan (LCA Plan).

The goal of the LCA Plan is to reverse the current trend of degradation of the coastal ecosystem. The plan emphasizes the use of restoration strategies that: reintroduce historical flows of river water, nutrients, and sediment to coastal wetlands: restore coastal hydrology to minimize saltwater intrusion; and maintain the structural integrity of the coastal ecosystem. Execution of the LCA Plan would make significant progress towards achieving and sustaining a coastal ecosystem that can support and protect the environment, economy, and culture of southern Louisiana and thus contribute to the economy and well being of the Nation. Benefits to and effects on existing infrastructure, including navigation, hurricane protection, flood control, land transportation works, agricultural lands, and oil and gas production and distribution facilities were strongly considered in the formulation of coastal restoration plans.

The LCA Plan is based upon the extensive experience gained through the on-going CWPPRA implementation effort, best available science and engineering, professional judgment, and other extensive experience in coastal restoration in Louisiana and beyond. The LCA Plan identifies, evaluates, and recommends to decision makers an appropriate, coordinated, and feasible course of action to address the identified critical water resource problems and restoration opportunities in coastal Louisiana. This report provides a complete presentation of the study process, results, and findings; indicates compliance with applicable statutes, executive orders, and policies; documents the Federal and non-Federal interest; and provides a sound and documented basis for decision makers at all levels to evaluate the request for:

- Specific authorization for implementation of five near-term critical restoration features for which construction can begin within 5 to 10 years, subject to approval of feasibility-level decision documents by the Secretary of the Army (hereinafter referred to as "conditional authorization" in the Main Report and accompanying Final Environmental Impact Statement);
- Programmatic Authorization of a Science and Technology Program;

- Programmatic Authorization of Science and Technology Program Demonstration Projects;
- Programmatic Authorization for the Beneficial Use of Dredged Material;
- Programmatic Authorization for Investigations of Modification of Existing Structures;
- Approval of 10 additional near-term critical restoration features and authorization for investigations to prepare necessary feasibility-level reports to be used to present recommendations for potential future Congressional authorizations (hereinafter referred to as "Congressional authorization"); and
- Approval of investigations for assessing six potentially promising large-scale and long-term restoration concepts.

The approval of the LCA Plan would initiate development of a series of feasibility-level decision documents that would provide detailed project justification, design, and implementation data. These future feasibility-level decision documents would support requests for project construction and would provide the basis for the implementation of the plan documented in this study report.

1.4 STUDY AREA DESCRIPTION

The study area, which includes Louisiana's coastal area from Mississippi to Texas, is comprised of two wetland-dominated ecosystems, the Deltaic Plain of the Mississippi River and the closely linked Chenier Plain, both of which are influenced by the Mississippi River. For planning purposes, the study area was divided into four subprovinces, with the Deltaic Plain comprising Subprovinces 1, 2, and 3, and the Chenier Plain comprising Subprovince 4 **(figure MR 1-1)**.

Louisiana parishes included in the study area are: Ascension, Assumption, Calcasieu, Cameron, Iberia, Jefferson, Lafourche, Livingston, Orleans, Plaquemines, St. Bernard, St. Charles, St. James, St. John the Baptist, St. Martin, St. Mary, St. Tammany, Tangipahoa, Terrebonne, and Vermilion **(figure MR 1-2)**. Subprovince 1 covers portions of Livingston, Tangipahoa, St. Tammany, St. Bernard, Orleans, St. Charles, St. John the Baptist, St. James, Ascension, Plaquemines, and Jefferson Parishes. Subprovince 2 covers all or part of Ascension, Plaquemines, Jefferson, Lafourche, St. Charles, St. James, St. John the Baptist, and Assumption Parishes. Subprovince 3 contains all or part of Lafourche, Terrebonne, Assumption, Iberville, St. Martin, Iberia, St. Mary, and Vermilion Parishes. Subprovince 4 contains all or part of Vermilion, Cameron, and Calcasieu Parishes.

Today, the Deltaic Plain is a vast wetland area stretching from the eastern border of Louisiana to Freshwater Bayou. It is characterized by several large lakes and bays, natural levee ridges (up to 20 feet [6.1 meters] above sea level), and bottomland hardwood forests that gradually decrease in elevation to various wetland marshes. The Deltaic Plain contains numerous barrier islands and headlands, such as the Chandeleur Islands, Barataria Basin Barrier Islands, and Terrebonne Basin Barrier Islands. The Chenier Plain extends from the Teche/Vermilion bays to Louisiana's western border with Texas, and is characterized by several large lakes, marshes, cheniers, and coastal beaches.

Within the broadly delineated zones of marsh habitat types, a variety of other wetland habitats (with distinct surface features and vegetative communities) occur in association with the marshes. These include swamp and wetland forests, beach and barrier islands, upland, and other important habitats. There are also unique vegetative communities in the coastal area, such as floating marshes and maritime forests, that contribute to the extensive diversity of the coastal ecosystem and which are essential to the overall stability of the ecosystem.

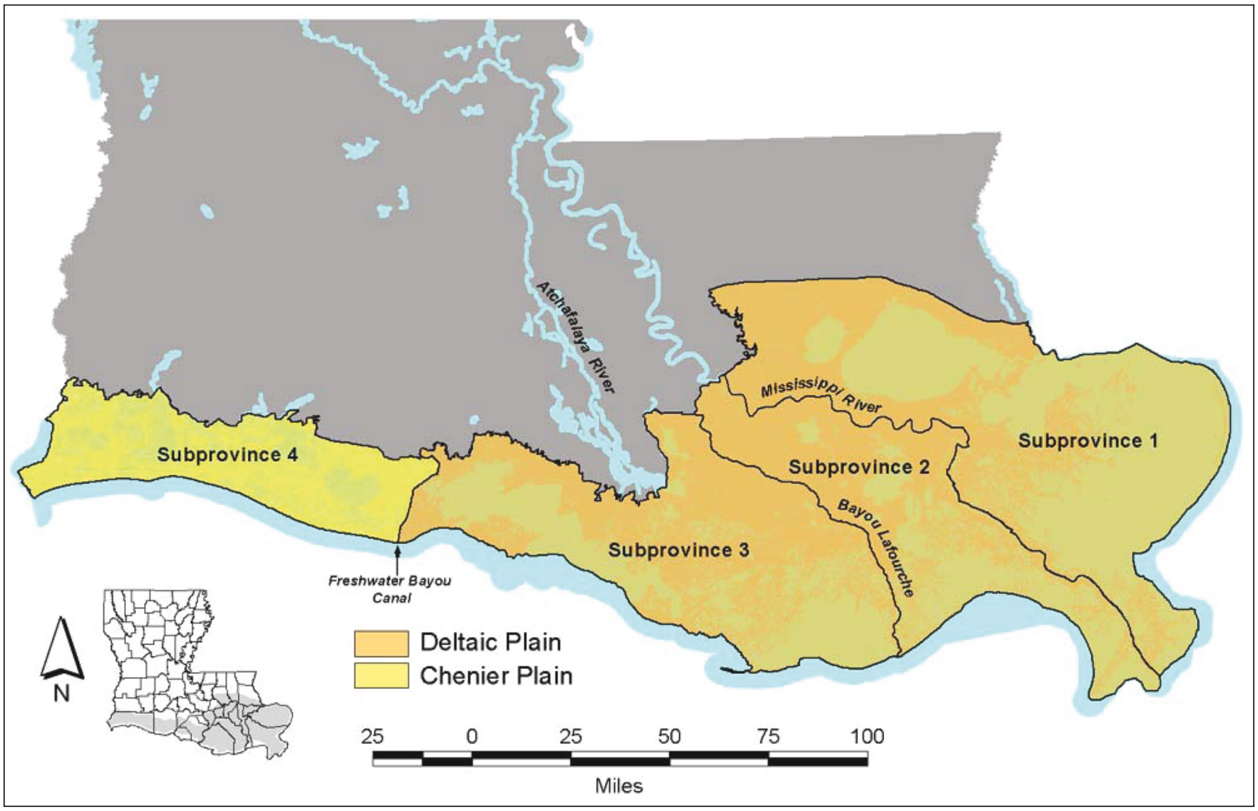


Figure MR 1-1. LCA Study Area and Subprovinces.

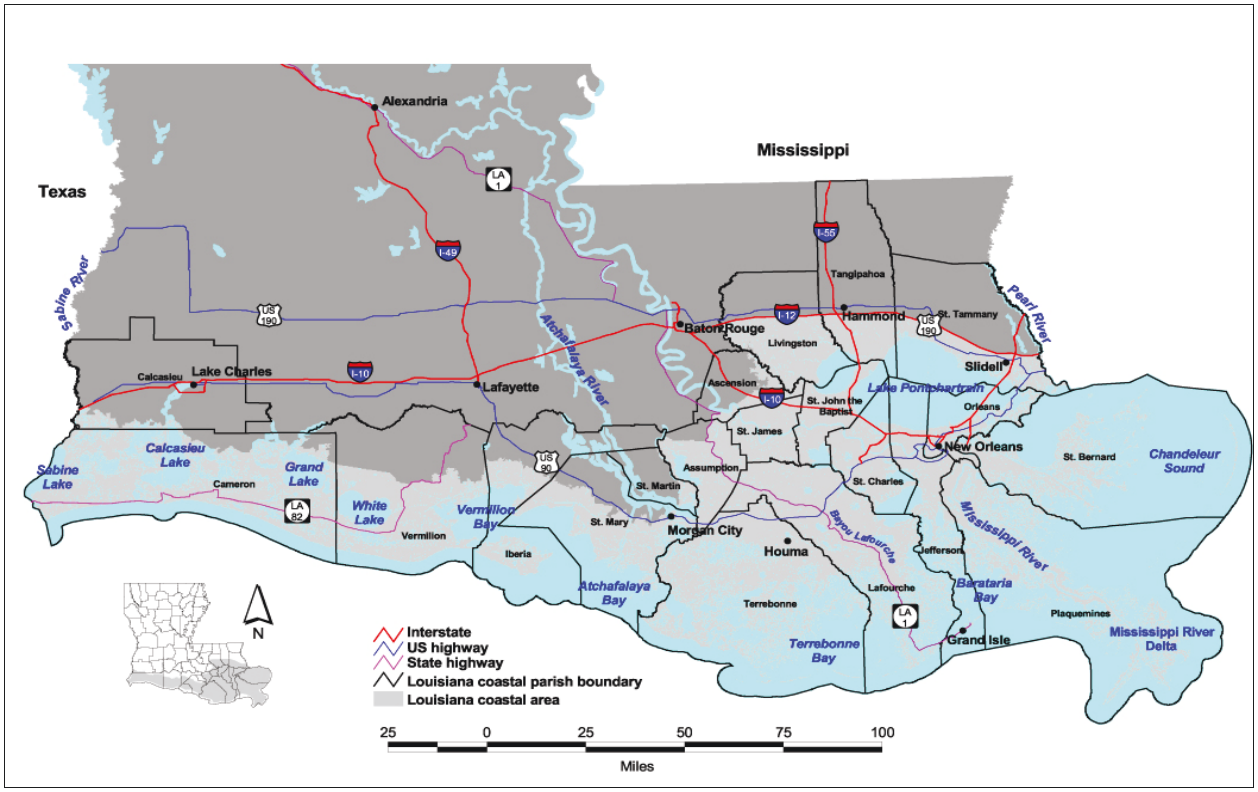


Figure MR 1-2. LCA Study Area Parishes, Major Water Bodies, and Highways.

1.5 COASTAL SYSTEM PROCESSES

1.5.1 Deltaic Cycle

The geologic development of coastal Louisiana and the resulting coastal landscape were dependent upon shifting Mississippi River courses and are influenced by the orderly progression of events related to the "deltaic cycle." The deltaic cycle is a dynamic and episodic process alternating between periods of “delta-building” with seaward advancement (progradation) of deltas and the subsequent landward retreat (degradation). As deltas are abandoned, the seaward edges are reworked into barrier headlands and barrier islands. Subsequently, the wetland complex behind the headlands and islands, without a significant and continuous source of sediment and nutrients, eventually succumbs to subsidence and becomes submerged by marine waters. The Mississippi River has changed its course several times during the last 7,000 year. Each time the Mississippi River has built a major delta it has eventually abandoned that river course in favor of a shorter, more direct route to the Gulf of Mexico. The Deltaic Plain is composed of six major delta complexes: two prograding and four degrading (**figure MR 1-3**).

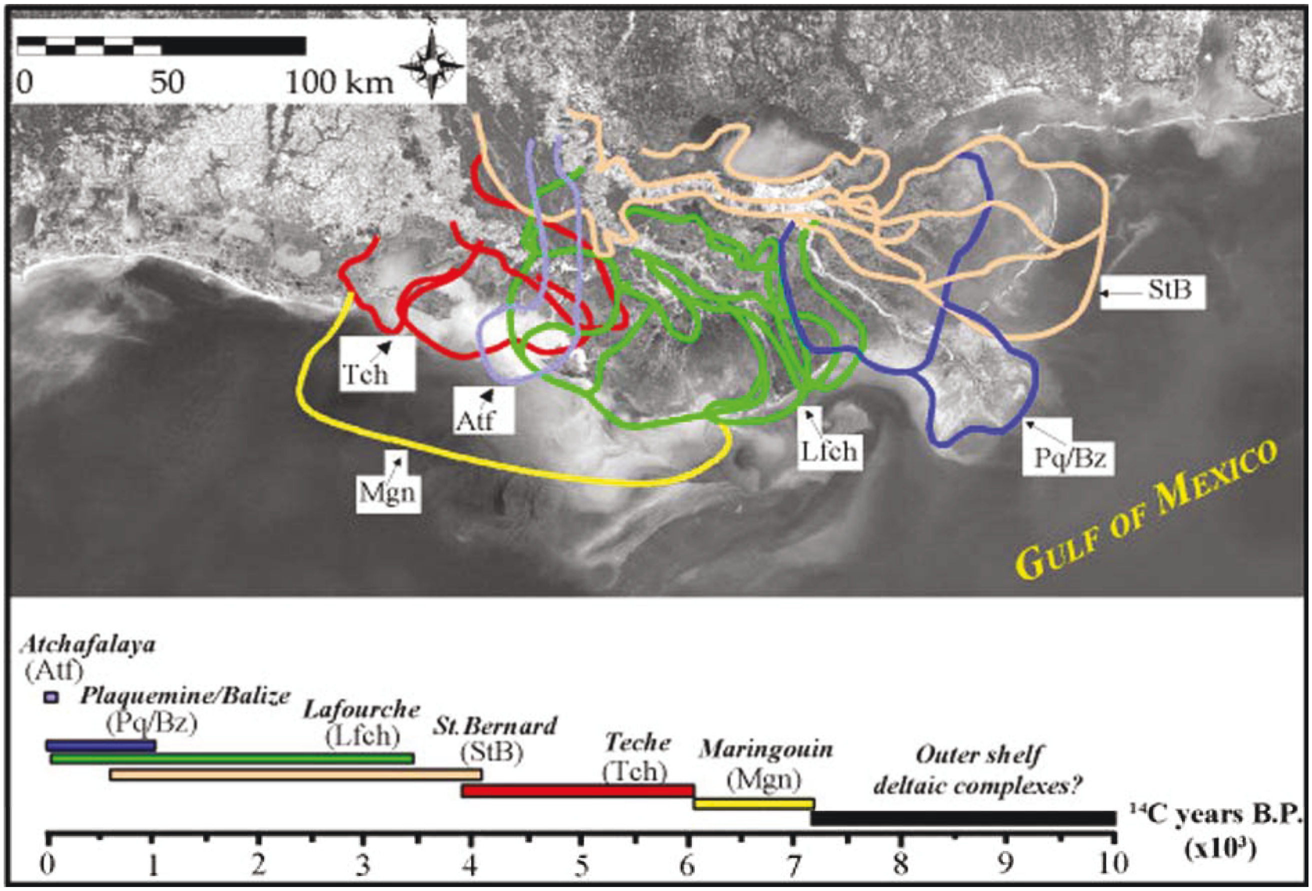


Figure MR 1-3. The Mississippi River Deltaic Plain with locations of major delta complexes. The Atchafalaya and Modern Delta complexes are active and the Teche, Lafourche, and St. Bernard complexes are inactive (*modified from Frazier 1967*)**.**

1.5.2 Delta Advancement

The Deltaic Plain wetland ecosystem developed as a result of delta-building processes, during which sea level conditions were relatively stable. The deltaic cycle is initiated when a stream or river, such as the Mississippi River, enters an open water body, such as a coastal lake or bay, which slows the velocity of the river's flow, thus limiting the river's ability to transport sediment. Consequently, most of the larger-grained sediment carried by the river drops out of the water column and falls to the bottom. Over time, the river deposits enough sediment to create land, which then becomes colonized by wetland plants. The organic deposition from additional river-borne sediment and decomposing wetland vegetation are the primary factors behind the land-building process. In this fashion, large expanses of wetlands, or deltas, form and extend seaward between the distributaries, or "fingers" of the delta, as long as the river continues to supply freshwater, nutrients, and land-building sediment.

Delta building is currently occurring in only two locations along the Louisiana coast. One location is the active Mississippi Delta, where a bird foot pattern of land extends out into the deep water of the Gulf of Mexico. The other location is the Atchafalaya Delta (**figure MR 1-4**) where, since about 1973, a delta has formed at the mouths of the Wax Lake Outlet and the Lower Atchafalaya River.

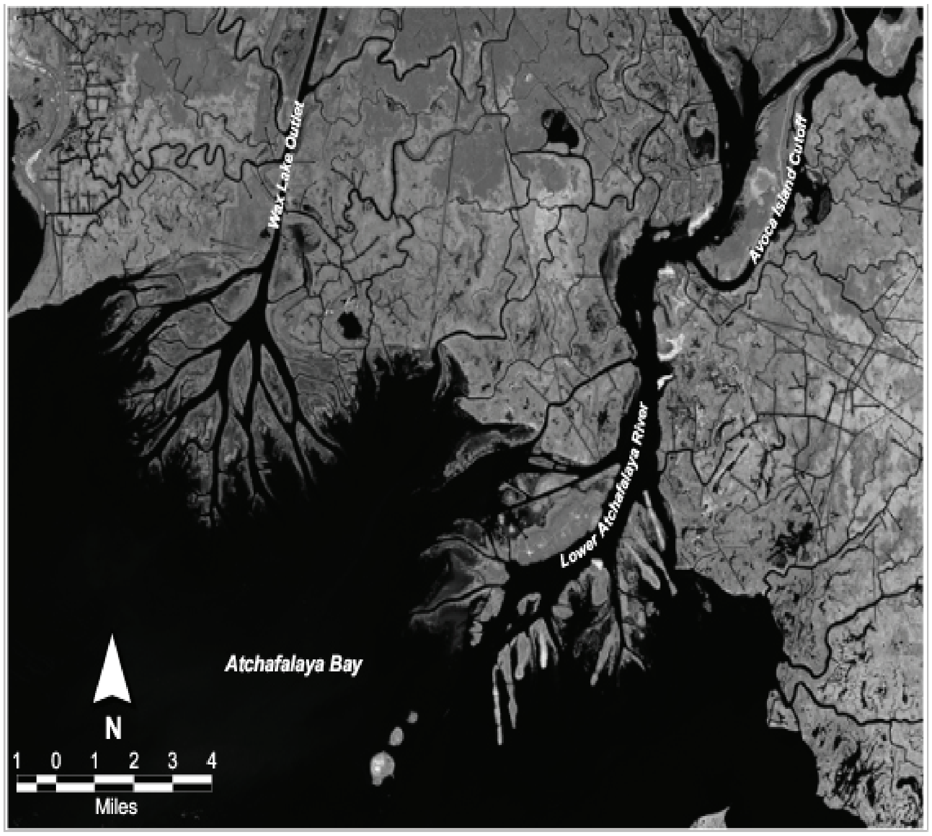


Figure MR 1-4. Delta Advancement at Wax Lake Outlet and the Lower Atchafalaya River.

Land building and nourishment within the Mississippi River Delta complex also occurred when floodwaters would overflow the riverbanks, or when river water would exit the main channel and travel through natural outlets, or distributaries, of the main river. In addition, floodwaters would periodically burst through weak points in the natural levees along the riverbank to create crevasses. Oftentimes, these floods deposited enormous amounts of sediment and were integral to land-building processes in the Deltaic Plain. Historical records indicate that major flooding events have created crevasses at 20 locations along the river in the Deltaic Plain (**figure MR 1-5**).

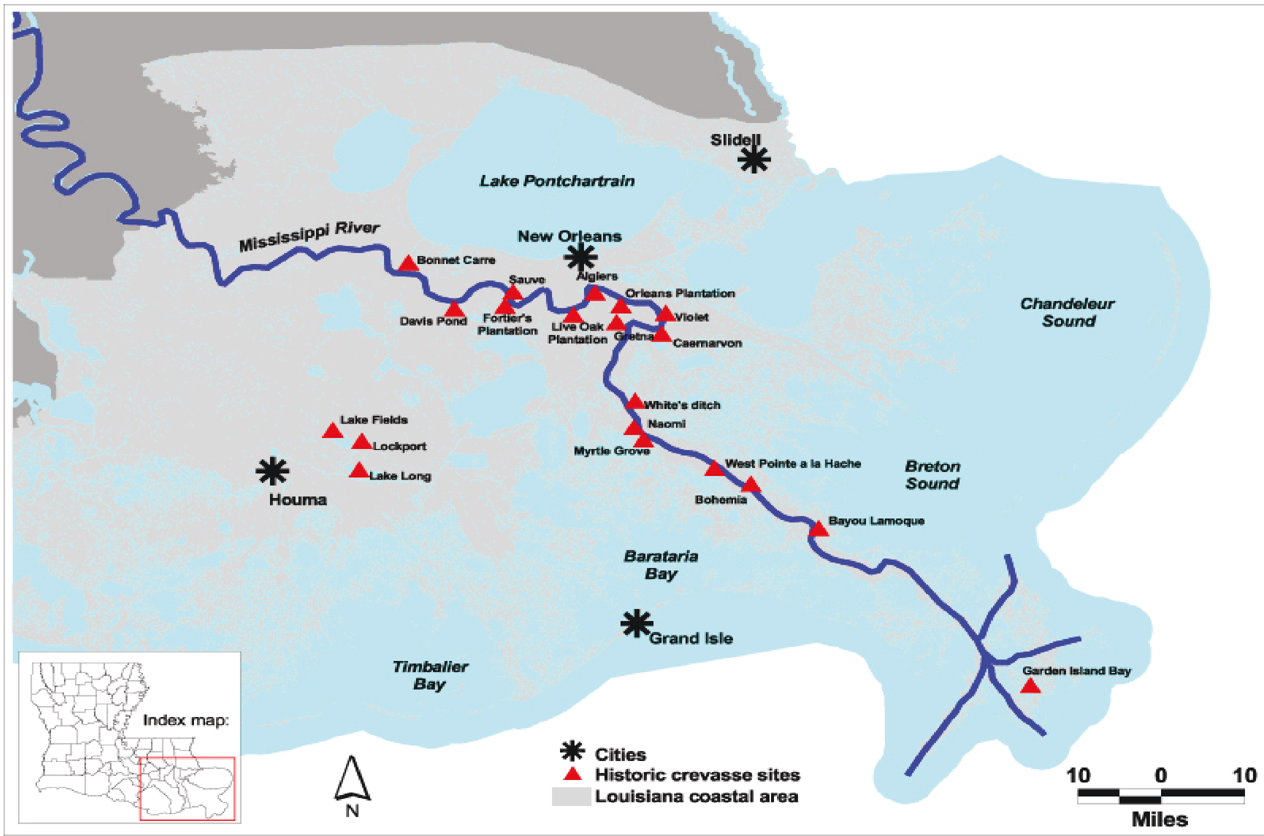


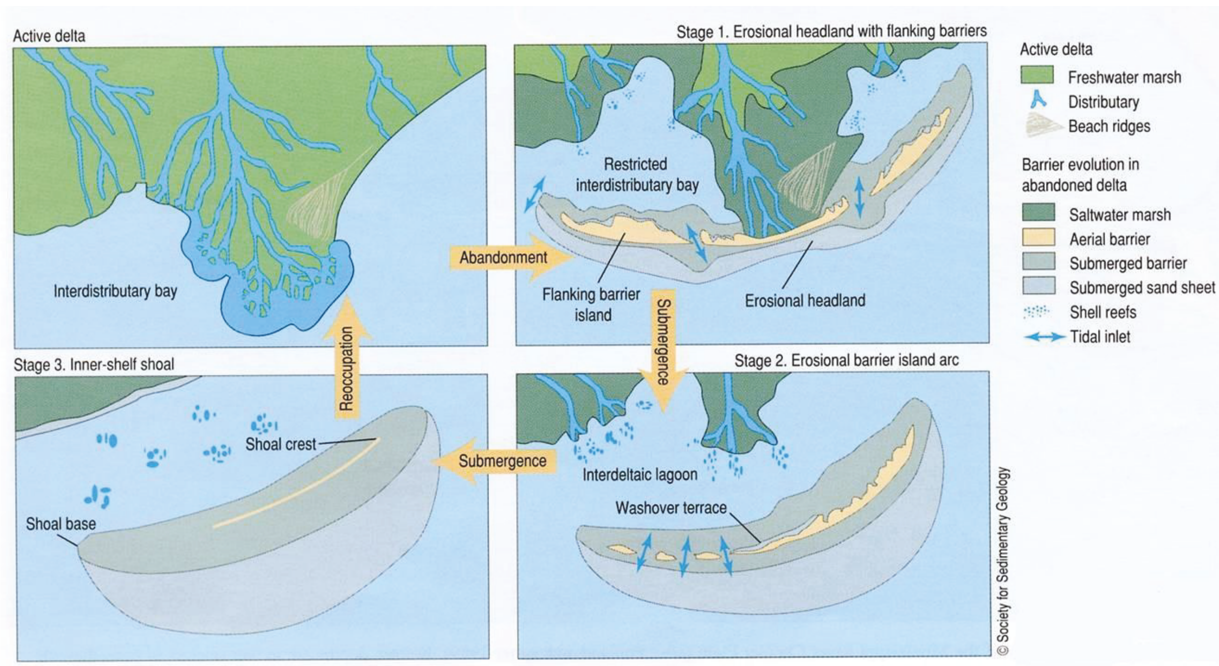
Figure MR 1-5. Locations of Historical Crevasses Along the Mississippi River and Bayou Lafourche in the Deltaic Plain *(adapted from Colten 2001).*

1.5.3 Delta Abandonment

As a delta grows and extends into the Gulf of Mexico, the river stage gradually heightens. Eventually, the river breaks through a weak point in its bank and/or shifts its main water flow into a distributary, thus providing a shorter route for the river to travel to the gulf. About every 1,000 years, the Mississippi River altered its path to the gulf, sometimes flowing down the western portion of the current Deltaic Plain and sometimes down the eastern portion. Whenever the river changed course, the location of active delta building also changed. Areas that no longer received sufficient volumes of freshwater laden with sediment and nutrients began to succumb to subsidence, while those areas that received the majority of river water input began a new phase of delta building. These meandering changes in the course of the Mississippi River and accompanying shifts in centers of sediment deposition are responsible for the distribution of deltaic sediment along the entire Louisiana coast and into Texas.

Once the Mississippi River altered its course and began to form a new delta, tidal influences and a lack of sediment and nutrient inputs slowly degraded the previously active delta location. Over time, the interior wetlands were submerged and marine influences reworked the gulfward edge of the delta into a series of barrier headlands. As the shoreline facing the Gulf of Mexico matured, and as the marshes behind the shoreline broke-up and eventually disappeared, the barrier headlands transitioned into barrier islands (**figure MR 1-6**). As the marsh degraded further, open bays formed behind the barrier islands. Eventually, complete submergence and marine reworking of the islands created sand-rich marine shoals detached from the coastline, such as today's Ship Shoal, which is located on the mid-central Louisiana coastal shelf.

Delta development and degradation occurred simultaneously, with some portions of the Louisiana coast experiencing land gain, while other areas experienced land loss. However, the net effect of this process was the creation of land across the Deltaic Plain. The dynamic nature of these geologic and hydrologic processes provided for an extremely diverse and highly productive wetland ecosystem in the coastal area.



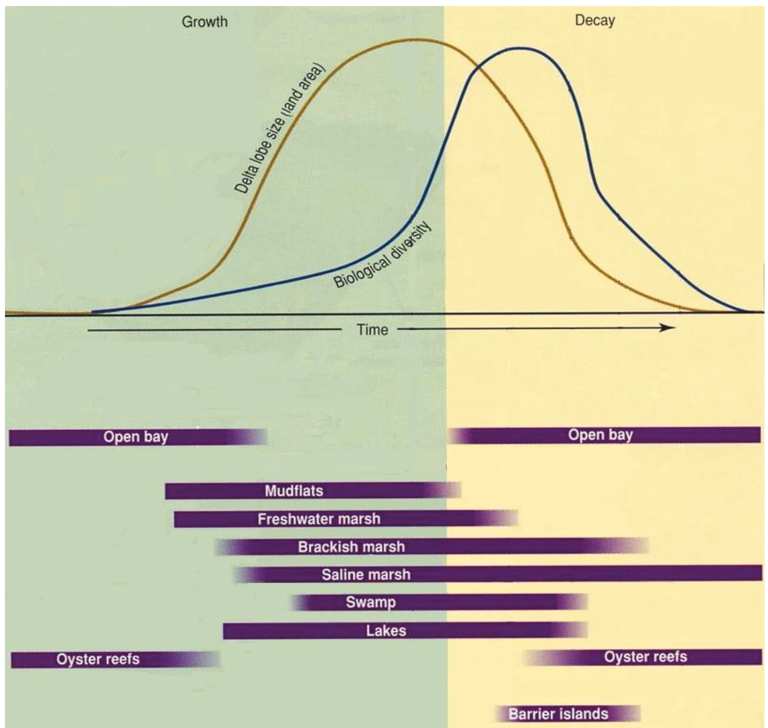
This model summarizes the genesis and evolution of transgressive depositional systems in the Mississippi River Deltaic Plain (Penland and Boyd 1981).

Figure MR 1-6. Three-Stage Geomorphic Model.

1.5.4 Delta Geomorphology and Ecologic Evolution

The distribution and abundance of wetland habitats in the Deltaic Plain has been, and continues to be, in constant flux — a function of the differing salinity gradients that occur during the land building and degradation phases of the deltaic processes. During the delta-building phase, freshwater predominates and creates vast expanses of freshwater marsh and swamp. In the delta degradation phase, marine (saltwater) influences take hold and convert freshwater wetlands into intermediate, brackish, and saline marsh.

The deltaic cycle of land building and land loss is paralleled by cycles of biological diversity and biological productivity. However, these cycles peak slightly after the land building phase of the deltaic cycle and are highest during the early degradation phase **(figure MR 1-7)**. In the degradation phase, the marshes become fragmented by natural channels, ponds, lakes, and bays, and have an increasing amount of "edge" habitat (land-water interface). Biological diversity and primary plant and fishery productivity are the highest in this phase, and generally speaking, the more "edge" habitats an ecosystem exhibits, the higher the biological productivity and diversity of the ecosystem. Thus, the highest diversity and productivity of the wetland ecosystems typically occur at the same time freshwater wetlands are transitioning into intermediate, brackish, and saline marshes, and when these transitional marshes are degrading and disappearing. Today, many of Louisiana's coastal wetlands are in the degradation phase of the deltaic cycle and are therefore sources of high biological productivity and diversity. However, as coastal marshes continue to degrade and convert to open water, it is likely that biological productivity and diversity will decline.



Habitat and diversity peak in the early to middle stage of the decay phase (adapted from Gagliano and Van Beek 1975; Neill and Deegan 1986).

Figure MR 1-7. Graphical Depiction of the Growth and Decay of a Delta Lobe.

1.5.5 The Chenier Plain

The Chenier Plain wetland ecosystem developed primarily as a result of the interplay of three coastal plain rivers (Sabine, Calcasieu, and Mermentau Rivers), the intermittent mudstream from Mississippi River outlets, and the Gulf of Mexico. During periods of active delta building in the Deltaic Plain, Gulf currents transport fine-grained sediments (clay and silt) that do not immediately fall to the bottom, thus forming a "mudstream." Twenty-five percent or more of transported sediment in the river escape deposition in the immediate area of delta building. The dominant longshore drift along the Louisiana coast is from east to west. When delta formation occurs in shallow waters of a bay or the inner continental shelf along the western reaches of the

Deltaic Plain, longshore currents carry the fine-grained sediment west in a mudstream towards the Chenier Plain (**figure MR 1-8**). On the other hand, when delta building extends to the edge of the continental shelf or beyond and/or takes place in the eastern reaches of the Deltaic Plain, the mudstream flows offshore into the deep waters of the Gulf and has little effect on the shoreline (**figure MR 1-9**).

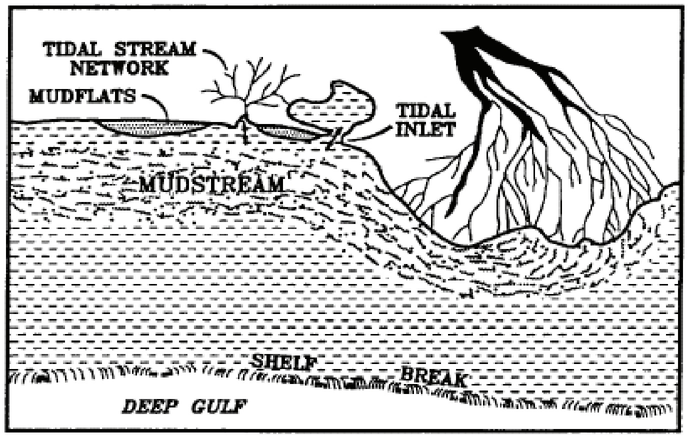


Figure MR 1-8. The Shallow Water Mudstream of the Mississippi River.
(*After Gagliano and van Beek 1993).*

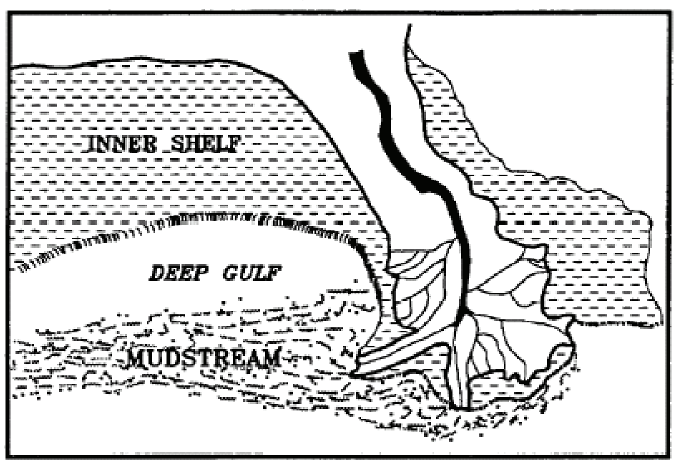


Figure MR 1-9. The Deep Water Mudstream of the Mississippi River.
(*After Gagliano and van Beek 1993).*

Fine-grained sediment transported in the mudstream to the Chenier Plain may be brought into coastal estuaries and marshes along the gulf shoreline by tidal processes and storms and may be deposited along the shore to form mudflats (Gagliano and van Beek 1993). Similar to the Deltaic Plain, the newly formed land is colonized by wetland vegetation, which further promotes the land-building process. Wave action and occasional storm events also deposit sand and shells onto the newly built land.

As the Mississippi River changed course and active delta building switched to the eastern Deltaic Plain or extended to the edge of the continental shelf or beyond, the mudstream ceased to carry sediment to the Chenier Plain and the gulf shore became subject to erosion. Historically, periods of erosion winnowed out fine-grained materials, leaving the deposits of sand and shell to form the gulf beaches. Beach deposits were subsequently shaped by waves and coastal currents to form elevated ridge systems. Once the mudstream returned and land building continued seaward, these elevated ridges were stranded inland where deciduous vegetation growth (e.g., live oak trees) occurred. These inland ridges, which parallel the gulf shoreline, are called "cheniers" (**figure MR 1-10**). The relict shell beach ridges and cheniers blocked drainage and saltwater inflows from the Gulf of Mexico, resulting in the development of large freshwater basins on the landward side of the ridges. On the seaward side, a zone of brackish to saline marshes developed as a result of tidal influences from the gulf.

Image displaying a chenier, which is an elevated ridge that parallels the gulf shoreline. Covered with live oaks and other deciduous vegetation, the cheniers are distinct geomorphic features resulting from the land-building processes in the Chenier Plain.
Figure MR 1-10. A Typical Chenier in the Chenier Plain.

Since 1973, delta-building processes at the mouth of the Atchafalaya River have initiated a new interval of land building via the formation of extensive mudflats along the eastern part of the Chenier Plain.

1.5.6 Factors Controlling Coastal Wetlands Sustainability

For the past 7,000 years, many factors have influenced the sustainability of habitats and ecosystems in coastal Louisiana. Nevertheless, land loss and coastal disturbances attributed to natural factors such as land subsidence, sea level change, storm events, and herbivory were offset by the land building and nourishment processes of the deltaic cycle. Over time, the trend had been one where more land was created than was lost, and much of the coastal ecosystems were sustained with freshwater, sediment, and nutrients. More recently, human settlement and economic development along the Mississippi River, its major tributaries, and in the coastal area, have led to the building of levees, upstream reservoirs, channel dredging, bank stabilization, and other activities. These activities have altered historic hydrology and inputs of land-building sediment and nutrients and have resulted in a situation where more land is being lost than is being created. Without significant intervention, much of coastal Louisiana does not have the necessary ingredients (freshwater, sediment, and nutrients) to sustain the coastal ecosystems.

1.6 PRIOR STUDIES, REPORTS, AND EXISTING WATER PROJECTS

This section describes the coastal restoration efforts by the Federal Government and the State of Louisiana over the past three decades, which have culminated in development of this LCA Plan, as well as studies, reports (past and present), and existing water resources projects, that are most relevant to ecosystem restoration in coastal Louisiana.

1.6.1 History of Coastal Restoration Efforts

Over the past 3 decades, both the Federal Government and the State of Louisiana have established policies and programs that are intended to halt and reverse the loss of Louisiana's coastal wetlands and to restore and enhance their functionality.

Awareness of Louisiana's coastal land loss problem resulted in part from the publication of the 1972 report "Environmental Atlas and Multi-Use Management Plan for South-Central Louisiana." That report provided an initial assessment of the extent and magnitude of Louisiana's land loss problem. Coastal resource management in Louisiana also accelerated once Louisiana adopted and began participating in the Federal Coastal Zone Management program in 1978. Shortly thereafter, the state developed its first coastal zone management plan. One of the primary objectives of this plan was to ensure that future development activities within the coastal area would be accomplished with the greatest benefit and the least amount of environmental damage.

In 1989, the constitution of the State of Louisiana was amended with enactment and voter approval of Act 6, LA. R.S. 49:213 *et seq*., also known as the Louisiana Coastal Wetlands Conservation, Restoration and Management Act. Act 6 empowered the LDNR as the lead state agency for the development, implementation, operation, maintenance, and monitoring of coastal restoration projects. Chief among its many functions, LDNR has the lead for the development and implementation of state-sponsored coastal restoration projects. In addition, LDNR acts as the state's designated liaison for the Coastal Impact Assistance Program (CIAP), which was authorized by Congress in 2001 to provide a one-time appropriation of $150 million to assist states in mitigating impacts from OCS oil and gas production. In 2001, Louisiana received a one-time allocation from the CIAP of $26.4 million, which was used to fund various state and local coastal activities and projects including: monitoring, assessment, research, and planning; habitat, water quality, and wetland restoration; coastline erosion control; and control of invasive non-native plant and animal species.

Act 6 also created the Wetlands Conservation and Restoration Fund (WCRF), which dedicates a portion of the state's revenues from severance taxes on mineral production (e.g., oil and gas) to finance coastal restoration activities and projects. Currently, the WCRF provides approximately $25 million per year to support coastal restoration activities and projects. Finally, Act 6 requires the state to prepare and annually update a "Coastal Wetlands Conservation and Restoration Plan." This plan provides location-specific authorizations for the funding of coastal restoration projects from the WCRF.

While the Federal Government has been concerned with and involved in Louisiana's coastal land loss problem for decades, enactment of the CWPPRA in 1990 marked the first Federal statutory mandate for restoration of Louisiana's coastal wetlands. The initial priority of the CWPPRA Task Force, composed of five Federal agencies (U.S. Environmental Protection Agency (USEPA), USFWS, USACE, National Marine Fisheries Service (NMFS), and National Resources Conservation Service (NRCS)), and the State of Louisiana, was to prepare a comprehensive restoration plan that would coordinate and integrate coastal wetlands restoration projects to ensure the long-term conservation of coastal wetlands of Louisiana. The plan was adopted in 1993. The task force was also required to prepare and adopt an annual Project Priority List. As of January 2004, 13 priority lists have been approved; there are 127 active projects approved, of which 61 have been completed. These projects include gulf and inland shoreline protection, sediment and freshwater diversions, terracing, vegetative plantings, marsh creation, hydrologic restoration, marsh management, and barrier island restoration. CWPPRA provides $5 million annually for coastal restoration planning and roughly $50 million each year for the construction of coastal protection and restoration projects.

Another important Federal partnership in coastal Louisiana is the Barataria Terrebonne National Estuary Program (BTNEP). Established in 1990 as part of the USEPA's National Estuary Program, the BTNEP is a partnership for the study of natural and man-made causes of environmental degradation in the Barataria-Terrebonne watershed and for protection of the watershed from further degradation.

While the coastal restoration programs and projects previously described reduced coastal land loss and enhanced the health and functionality of portions of Louisiana's coastal ecosystem, Federal and state agencies, leading scientists, and other stakeholders realized that these efforts were not sufficient to address the magnitude of the land loss problem and to ensure a sustainable coastal ecosystem. In 1998, Federal and state agencies, local governments, academia, numerous non-governmental groups, and private citizens reached consensus on the Coast 2050 Plan, a conceptual plan for restoration of the Louisiana coast. As previously described, the Coast 2050 Plan was a direct outgrowth of lessons learned from implementation of restoration projects through CWPPRA, reflected a growing recognition that a more comprehensive "systemic" approach was needed, and was the basis for the May 1999 905(b) reconnaissance report. The 905(b) report was the precursor to the LCA Ecosystem Restoration Study.

In addition to coastal restoration efforts undertaken through CWPPRA, other Federal and state coastal restoration efforts over the years have resulted in the construction of 39 state projects, 30 Federal projects, and 224 state vegetative plantings (LDNR 2003). One of the more significant contributions to the restoration of coastal wetlands has been a result of the North American Wetlands Conservation Act (NAWCA), administered by the USFWS. The 1999 and 2001 biennial NAWCA report presented to Congress cites 30,558 acres (1,2372 ha) of restoration and 40,348 acres (16,335 ha) where ecosystem function has been improved in coastal Louisiana wetlands.

Non-governmental organizations have also participated in various coastal restoration projects. For example, Ducks Unlimited recently constructed approximately 26 linear miles (42 kilometers) of terraces in eroded marsh areas in Cameron Parish, located in the Chenier Plain, in partnership with a number of state and private sector partners. These terraces are very similar to some of the ones identified as priority projects under CWPPRA. Other examples of public and private parties involved in wetlands preservation or restoration activities in coastal Louisiana include Coastal America, Corporate Wetlands Restoration Partnership, Gulf Coast Joint Venture, Audubon Society, National Fish and Wildlife Foundation, The Nature Conservancy, and the National Wildlife Federation.

1.6.2 Prior Studies, Reports, and Existing Water Projects

A number of studies and reports on water resources development in the study area have been prepared by the USACE, other Federal, state, and local agencies, research institutes, and individuals. Previous studies established an extensive database for the LCA Study. Historical trends and existing conditions were identified to provide insight into future conditions, help isolate the problems, and identify the most critical areas. The following studies, reports, and projects in the coastal area are the most relevant to ecosystem restoration. A more thorough listing of prior studies, reports, and water resources projects can be found in attachment 2 to this report.

1.6.2.1 The Mississippi River and Tributaries (MR&T) Project

The Mississippi River and Tributaries (MR&T) Project is a comprehensive project for flood control on the lower Mississippi River below Cape Girardeau, Missouri. The project was authorized as a result of the 1927 flood of the lower Mississippi River, which resulted in the failure of existing levees and extensive flooding of populated areas. The four major elements of the MR&T Project are: 1) levees for containing flood flows; 2) floodways for the passage of excess flows past critical reaches of the Mississippi River; 3) channel improvement and stabilization to provide an efficient navigation alignment, increase the flood carrying capacity of the river, and protect the levee system; and 4) tributary basin improvements for major drainage and for flood control, such as dams and reservoirs, pumping plants, auxiliary channels, etc. (**figure MR 1-11**). The MR&T system controls and confines the river system before it reaches the coastal area. Several major outlets to the main stem of the river, which are described below, exist for the purposes of flood control during flood stages. The effects of channel and backwater storage are not accounted for in the flow volumes through the Atchafalaya Floodway and Atchafalaya River presented in **figure MR 1-11**.

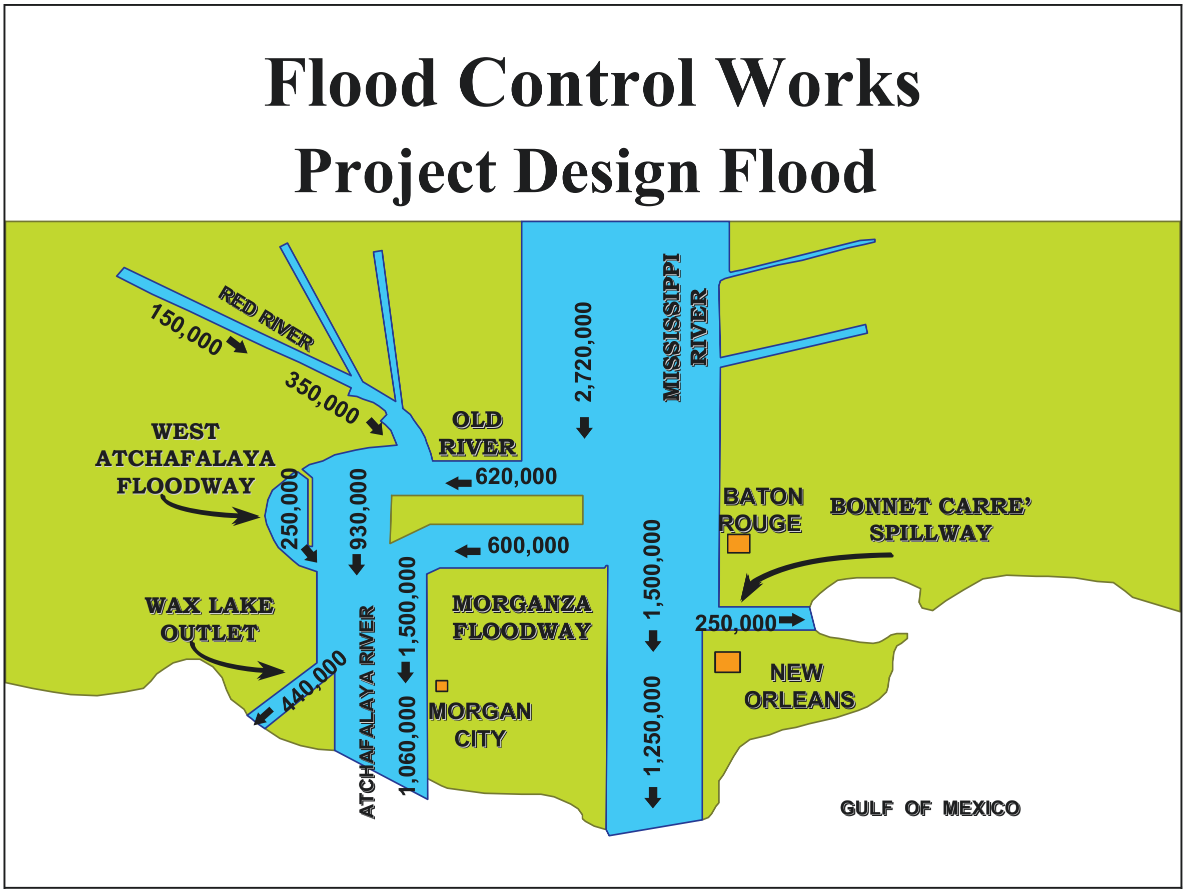


Figure MR 1–11. MR&T Scenario During Maximum Flood Projected Flood Conditions.

The Atchafalaya Basin

At the latitude of the Old River Control Complex, the MR&T Project flood totals 3 million cubic feet per second (cfs) (90,000 cubic meters per second [cms]) consisting of the sum of the Red River and Mississippi River flood flows. The Atchafalaya Basin is designed to convey up to one half of the project flood flows or 1.5 million cfs (45,000 cms). During daily operations, the Old River Control structures are regulated to maintain a 70/30 distribution between the Mississippi/Atchafalaya Rivers. In authorizing the Old River Control Complex (Flood Control Act of 1954), Congress directed that the system distribution should be maintained at the same distribution that existed in 1950 which was 70/30. During a project flood, the Old River Control Complex would divert up to 620,000 cfs (18,600 cms) from the Mississippi River to the Atchafalaya from the Morganza and West Atchafalaya Floodways.

The Morganza Floodway (located to the east of the Atchafalaya River) and the West Atchafalaya Floodway (located to the west of the river) are two floodways that can convey flood waters into the Atchafalaya Basin during severe floods. The West Atchafalaya Floodway is controlled by a fuse plug levee at the Red River, which would overtop or be blown in the event of the project flood, thereby allowing an additional 250,000 cfs (7,500 cms) to enter the basin. The Morganza Floodway is controlled by a structure at the Mississippi River that can allow another 600,000 cfs (18,000 cms) to enter the basin in the event of the project flood.

The basin has two outlets at the southern end, which empty into Atchafalaya Bay and then the Gulf of Mexico. One outlet is the Lower Atchafalaya River, a natural outlet, while the other is a manmade outlet, the Wax Lake Outlet, which was constructed in 1941 to facilitate better conveyance of flood flows.

Bonnet Carré Spillway

The Bonnet Carré Spillway is located at the site of an old crevasse, and contains a control structure at the Mississippi River. The facility is designed to convey a maximum of 250,000 cfs (7,500 cms) of floodwater to Lake Pontchartrain to relieve flood conditions downstream,

Caernarvon and Davis Pond Freshwater Diversion Projects

The "Freshwater Diversion to the Barataria and Breton Sound Basins" report (USACE, 1983), and subsequent technical appendices (USACE 1984), recommended diverting Mississippi River water into Breton Sound Basin near Caernarvon and into Barataria Basin near Davis Pond to increase habitat quality and improve fish and wildlife resources. The Caernarvon Freshwater Diversion was completed in 1991 with a design discharge of 8,000 cfs (240 cms). Since its construction, the Caernarvon structure has been operated as a salinity control measure, with freshwater introductions ranging between 1,000 cfs (30 cms) to 10,000 cfs (300 cms). The Davis Pond Freshwater Diversion was completed in 2002 with a maximum design capacity of 10,650 cfs (319 cms). It is noted that a third freshwater diversion project with a maximum capacity of 30,000 cfs (900 cms) at Bonnet Carré was included in the 1983 report, but the project has not been constructed due to environmental concerns by non-Federal interests.

1.6.2.2 The Gulf Intracoastal Waterway (GIWW)

The GIWW was authorized and construction was begun in the 1920s. It traces the U.S. coast along the Gulf of Mexico from Apalachee Bay near St. Marks, Florida to the Mexican border at Brownsville, Texas. From its intersection with the Mississippi River, the waterway extends eastward for approximately 376 miles (605 kilometers) and westward for approximately 690 miles (1,111 kilometers). In addition to the main stem, the GIWW includes a major alternate channel, 64 miles (103 kilometers) long, which connects Morgan City, Louisiana, to Port Allen, Louisiana. Project dimensions for the main stem channel and the alternate route are 12 feet (3.7 meters) deep and 125 feet (38.1 meters) wide, except for the reach between the Mississippi River and Mobile Bay, which is 150 feet (45.7 meters) wide. Today, portions of the GIWW are deeper and wider than the original construction dimensions. Numerous side channels and tributaries intersect both the eastern and western main stem channel, providing access to inland areas, coastal harbors, and the Gulf of Mexico.

1.6.2.3 Mississippi River Gulf Outlet (MRGO)

The Rivers and Harbors Act of 1956 (PL 84-455) authorized construction of the Mississippi River - Gulf Outlet (MRGO), a deep draft navigation channel that was completed and put into service in the 1960s. The MRGO provides deep draft navigation access to the New

Orleans tidewater port area located along the upper reaches of the MRGO and the Inner Harbor Navigation Canal (IHNC), close to the junction of the GIWW with the Mississippi River. Today, the surface dimensions of the channel have increased beyond those of the original construction, and in some areas, the width of the channel has appreciably widened as a result of erosion. The authorized channel width for the project is 500 feet (152 meters), but the channel is more than 2,000 feet (610 meters) wide at some locations.

The USACE is currently investigating the feasibility of continued operation of the MRGO Navigation Project because of the increased cost of channel maintenance and decreased channel use at maximum depths. The reevaluation study is tentatively scheduled for completion in FY 2005.

1.6.2.4 Morganza to the Gulf

In March 2002, a feasibility report and programmatic environmental impact statement (PEIS) entitled "Mississippi River & Tributaries - Morganza, Louisiana to the Gulf of Mexico -- Hurricane Protection" was prepared by the USACE (USACE 2002). It is noted that there is an addendum 1 to the report dated April 2003 and an addendum 2 dated March 2004. It is further noted that the Chief's Report (which the proposed authorizing language references) is dated August 9, 2002. The Chief's report was also supplemented in 2003. The recommended plan proposed a series of flood protection measures and included the following:

- The construction of approximately 72 miles (116 kilometers) of levee south of Houma;
- The construction of nine gated structures in various waterways and three floodgates in the GIWW;
- The construction of a lock structure and floodgate complex for the Houma Navigation Canal (HNC); and
- The construction and operation of new and replacement fish and wildlife structures in selected locations to maintain tidal exchange.

The area to be protected by the levee system is a former major delta from a previous course of the Mississippi River. As in other locations in south Louisiana, urban and agricultural development has occurred along the banks of the remnant ridges of the delta. Therefore, conveyance of freshwater via the Mississippi River through these remnant channels is not practical. However, the close proximity of the area to the Atchafalaya Basin offers other options of freshwater distribution. The GIWW is linked to the Atchafalaya Basin and conveys water eastward to the area. The HNC intercepts these flows before they reach the area of need and conveys them efficiently to the Gulf of Mexico. If authorized, and with the levee system and water control structures in place, the Atchafalaya River flows can be managed and distributed across the area. The proposed Morganza to the Gulf levees and water control structures would convey Atchafalaya River water eastward and would support the efforts proposed within the LCA Plan, thus helping solve the saltwater intrusion problem in the Houma area.

1.6.2.5 Donaldsonville, Louisiana to the Gulf of Mexico Feasibility Study

In February 2002 the USACE, New Orleans District signed a Feasibility Cost Sharing Agreement with the Lafourche Basin Levee District and the Louisiana Department of Transportation and Development. This agreement continued investigations under the authority of a U.S. House of Representatives Transportation and Infrastructure Committee resolution adopted May 6, 1998. The focus for initial action is within the jurisdictional boundaries of the Lafourche Basin Levee District, which covers portions of the parishes of Ascension, Assumption, Lafourche, St. Charles, St. James, and St. John the Baptist. The study area has been declared a Federal Disaster Area four times since 1985 after flooding events. The basin is subject to heavy rainfall, tidal surges from the Gulf of Mexico, and hurricane flooding.

The purpose of the study is to investigate the feasibility of constructing a hurricane protection levee from Larose, Louisiana, that connects to the authorized West Bank Hurricane Protection Levee Project to investigate possible solutions to improve interior drainage within the Lac des Allemands drainage basin and to investigate restoring and/or protecting the natural and human environment to create a sustainable ecosystem in the Lac des Allemands drainage basin. The investigations are ongoing and scheduled for completion of the feasibility phase in June 2006.

1.6.2.6 Third Delta

In June 1999, a report entitled The Third Delta Conveyance Channel Project was completed by S. M. Gagliano and J. L. van Beek. The primary concept of the “Third Delta Conveyance Channel” is to reestablish the natural processes of Mississippi River land building on a large scale as a fundamental approach to achieving sustainable restoration in coastal Louisiana. The report discusses reintroduction of Mississippi River water and sediment in a manner that mimics natural processes. The implementation of a Third Delta would likely target wetlands in western Barataria Basin and eastern Terrebonne Basin. The LDNR is currently undertaking a reconnaissance-level study to evaluate the feasibility of constructing the Third Delta as proposed, and also to define and evaluate alternatives to the original concept that may also achieve the desired results. This study is projected to be completed by the end of FY 2005.

1.6.2.7 Cooperative River Basin Studies

Cooperative River Basin Studies have also been published by the NRCS. These contain current (as of publication date) and historic descriptions of basins and provide detailed management alternatives of hydrologic units within these basins. The published coastal reports include:

- Lafourche-Terrebonne, 1986
- East Central Barataria, 1989
- Calcasieu-Sabine, 1994
- Mermentau, 1997
- Teche-Vermilion, 1999

1.6.2.8 Watershed Reports

Watershed Reports have also been published by the NRCS. These contain current and historic descriptions of watersheds and provide detailed management alternatives of hydrologic units within these watersheds. The completed coastal projects include:

- Bayou Folse Watershed, Lafourche Parish, completed 1977
- Bell City Watershed, Calcasieu, Cameron and Jefferson Davis Parishes, completed 1994
- Cameron Creole Watershed, Cameron Parish, completed 1994
- English Bayou Watershed, Calcasieu and Jefferson Davis Parishes, completed 1974
- Lake Verret Watershed, Iberville, Ascension and Assumption Parishes, completed 1994
- Seventh Ward Canal Watershed, Vermilion Parish, completed 1971
- West Fork of Bayou Lacassine Watershed, Jefferson Davis and Calcasieu Parishes, completed 1977

Watershed reports authorized, but not yet complete, in coastal areas include:

- Bayou Penchant-Lake Penchant, approved 1987
- West Fork Bayou L'Ours, approved 1987
- Bayou Tigre Watershed, Iberia and Vermilion Parishes, planning authorized 2002
- Hebert Canal Watershed, Vermilion Parish, planning authorized 2002
- Sabine-Black Bayou Watershed, planning authorized 1995

2.0 PROBLEM IDENTIFICATION

2.1 CAUSES OF COASTAL LAND LOSS AND ECOSYSTEM DEGRADATION

In preparation for subsequent discussions of existing and future without-project conditions, a summary of the major factors that contribute to coastal land loss and ecosystem degradation in Louisiana is necessary. While many studies have been conducted to identify the major contributing factors (e.g., Boesch et al. 1994; Turner 1997; Penland et al. 2000a), most studies agree that land loss and the degradation of the coastal ecosystem are the result of both natural and human induced factors, which interact to produce conditions where wetland vegetation can no longer survive and where wetlands are lost. Establishing the relative contribution of natural and human-induced factors is difficult. In many cases, the changes in hydrologic and ecologic processes manifest gradually over decades and in large areas, while other effects occur over single days and impact relatively localized areas. For barrier shorelines, complex interactions among storm events, longshore sediment supply, coastal structures, and inlet dynamics contribute to the erosion and migration of beaches, islands, and cheniers.

The measurable increase in coastal land loss in the mid- to late- 20th century can be linked to human activities that have fundamentally altered the deltaic processes of the coast and limited their ability to rebuild and sustain it. In the Chenier Plain, human activities have fundamentally altered the hydrology of the area, which has impacted the long-term sustainability of the coastal ecosystems. Because of the magnitude and variety of these human-induced changes, and their interaction with natural landscape processes, all of the factors contributing to coastal land loss and ecosystem degradation must be viewed together to fully understand how Louisiana's coastal ecosystem shifted from the historical condition of net land gain to the current condition of accelerated net land loss.

2.1.1 Natural Causes Influencing Coastal Land Loss and Ecosystem Degradation

The following discussion identifies those predominantly natural factors of coastal land loss and ecosystem degradation. However, these factors are intrinsically linked with human factors of land loss and ecosystem degradation due to man's overwhelming influence over the natural system. Geologic faulting, compaction of muddy and organic sediment, river floods, global sea level change, wave erosion, and tropical storm events have shaped the coastal Louisiana landscape for thousands of years (Kulp 2000; Reed 1995). Over millennia, sea level change and subsidence were offset by delta building in the Deltaic Plain and mudstream accretion in the Chenier Plain. Erosion of barrier shorelines and disruption of fragile organic marshes by tropical storm events resulted in land loss, but also contributed to habitat and wildlife diversity. There is little direct evidence that any of these natural processes changed in the mid to late 20th century. The following is a brief summary of the natural factors contributing to land loss.

2.1.1.1 Barrier island degradation

Barrier islands are important elements of the geomorphic framework of the estuary. Barrier islands separate the gulf from the back-barrier estuarine environment helping to maintain the salinity gradients important to estuarine species. As islands erode and are breached, marine forces are allowed to affect the interior boundaries of the estuaries, thereby accelerating land loss. Barrier islands also serve as valuable storm buffers protecting communities, industry, and associated infrastructure from storm surges.

Barrier island degradation is a natural process and represents the latter phase of the deltaic process, as described in section 1 INTRODUCTION. Marine influences, particularly those associated with tropical storm events, gradually erode and rework the structure of the islands until they eventually disappear. While the acreage amounts associated with the loss of barrier islands may not contribute appreciably to the total acreage of land loss in the study area, their disappearance can result in significant and profound impacts on coastal land loss and ecosystem sustainability. Barrier islands serve as natural storm protective buffers and provide protection and limit erosion of Louisiana’s coastal wetlands, bays, and estuaries, by reducing wave energies at the margins of coastal wetlands. In addition, barrier islands limit storm surge heights and retard saltwater intrusion. The historic rates of land loss for Louisiana's barrier islands are varied, and can average as high as 50 acres per year (20.3 ha per year), over several decades. Hurricane events can push the rate of land loss to surpass 300 acres per year (122 ha per year). For example, the Isles Dernieres have decreased in acreage from approximately 9,000 acres (3,645 ha) in the late 1880s to approximately 1,000 acres (405 ha) by 2000 (see appendix D LOUISIANA GULF SHORELINE RESTORATION REPORT).

2.1.1.2 Tropical storm events

Tropical storm events can directly and indirectly contribute to coastal land loss through a variety of ways: erosion from increased wave energies, removal and/or scouring of vegetation from storm surges, and saltwater intrusion into interior wetlands carried by storm surges. These destructive processes can result in the loss and degradation of large areas of coastal habitats in a relatively short period of time (days and weeks versus years). Since 1893, approximately 135 tropical storms and hurricanes have struck or indirectly impacted Louisiana’s coastline. On average, since 1871, a tropical storm or hurricane affects Louisiana every 1.2 years.

2.1.1.3 Eustatic sea level change

Eustatic sea level change is the global change of the oceanic water level. Data indicate that concentrations of greenhouse gases (e.g., carbon dioxide), and global temperatures have increased during the 20th century. As a result, eustatic sea levels are expected to rise in the future at a higher rate than observed during the 20th century. EPA (1995) estimated that global warming is likely to raise global sea levels 5.9 inches (15 cm) by the year 2050 and 13.4 inches by the year 2100 (34 cm). Other experts predict that the level of the world’s oceans could rise over 8 inches (20 cm) over the next 50 years.

2.1.1.4 Relative sea level change

Along the Louisiana coast, both changes in water level and changes in land elevation are occurring. Relative sea level change is the term applied to the difference between the change in eustatic sea level and the change in land elevation. Relative sea level change is also referred to as relative subsidence.

Land elevations decrease due to subsidence from compaction and consolidation of sediments, faulting, and groundwater depletion. Recent studies have shown that subsurface fluid (e.g., oil and gas) withdrawal may also be a contributor, but the magnitude of its contribution is not well understood (Morton et al. 2002). Land elevations increase due to sediment accretion from riverine and littoral sources and organic deposition from vegetation. For most of coastal Louisiana, sediment accretion is insufficient to offset subsidence, causing land elevations are decreasing.

Changes in land elevation vary spatially along coastal Louisiana. In areas where subsidence is high and riverine influence is minor or virtually nonexistent, such as in areas of western Barataria Basin and eastern Terrebonne Basin, wetland habitats sink and convert to open water. Estimated subsidence rates for the Deltaic Plain are between 0.5 to 4.3 ft/century (0.15 to 1.31 m/century) and between 0.25 to 2.0 ft century (0.08 to 0.61 m/century) for the Chenier Plain.

Factoring in changes in land elevation and water levels, the average rate of relative sea level change along coastal Louisiana is currently estimated to be between 3.4 to 3.9 ft/century (1.03 and 1.19 m/century).

2.1.2 Human Activities Influencing Coastal Land Loss and Ecosystem Degradation

Human activities that have direct impacts on wetland loss often have indirect impacts.

2.1.2.1 Flood control

Following European settlement in coastal Louisiana, humans began to modify the Mississippi River. Levees were built and maintained to limit flooding of populated areas and agricultural areas, and to support interests such as navigation. Levees serve two general purposes: 1) contain river flows and 2) protect against storm surges. There are approximately 2,250 miles (3,622 kilometers) of levees that have been constructed in coastal Louisiana to contain the Mississippi River and its distributaries and to protect agricultural and urban areas from flooding. Numerous water control structures have been constructed related specifically to agricultural activities in the coastal zone as well resulting occasionally in impoundment of water. Several hurricane protection levee projects are in various stages of design and construction, including Morganza to the Gulf and Donaldsonville to the Gulf projects. These projects would upgrade or build new levees in the coastal area. An additional effect of these flood protection actions has been the facilitation of development throughout the coastal zone. Although the development of designated wetland areas are currently regulated this does not completely prohibited development. Perhaps more importantly, historically there was no prohibition for such development.

An unintended consequence of the construction of the levee system has been to accelerate coastal land loss and reduce the sustainability of the coastal ecosystem by reducing riverine influences to many of the coastal wetlands. In most instances, wetland habitats have become isolated from the freshwater, sediment, and nutrients of the Mississippi River and its distributaries. With a reduced or absent hydrologic connection to the river, marine influences in the areas can predominate. In the short-term, this influence can result in greater habitat and wildlife diversity, as well as some land loss. In the long-term, coastal habitats can disappear without a renewed or enhanced connection to freshwater, sediment, and nutrients.

2.1.2.2 Navigation

There are 10 major navigation channels, both deep draft and shallow draft, within the Louisiana coastal area. While these channels support the local, regional, and National economies, they also serve as conduits for saltwater intrusion in some areas and barriers to the distribution of freshwater, sediment, and nutrients to wetland habitats in other areas. For example, jetties adjacent to the Empire Waterway, Belle Pass, Mermentau River Navigation Channel, and Calcasieu Ship Channel trap sediment on the east side creating an erosional shadow to the west due to disruption of the natural sediment transport system. The navigation channels, such as the GIWW, also subject inland areas to more dramatic tidal forces and wave action, thereby increasing erosion.

2.1.2.3 Oil and gas infrastructure

With the discovery of oil and gas deposits in coastal Louisiana during the early 1920s, a vast network of canals, pipelines, and production facilities have been created to service the industry. Today, an estimated 9,300 miles (14,973 kilometers) of oil and gas pipelines crisscross the coastal wetlands of Louisiana. In addition, there are approximately 50,000 oil and gas production facilities located in the Louisiana coastal area. Canals that stretch from the Gulf of Mexico inland to freshwater areas allow saltwater to penetrate much farther inland, particularly during droughts and storms, which has had severe effects on freshwater wetlands (Wang 1987 and 1988).

Dredged material banks, which are much higher than the natural marsh surface, and the many smaller canals dredged for oil and gas exploration, alter the flow of water across wetlands. This hydrological alteration changes important hydrogeomorphic, biogeochemical, and ecological processes, including chemical transformations, sediment transport, vegetation health, and migration of organisms. Because of the presence of dredged material banks, partially-impounded areas have fewer but longer periods of flooding and reduced water exchange when compared to unimpounded marshes (Swenson and Turner 1987). This results in increased waterlogging and frequently in plant death. Importantly, dredged material banks also block the movement of sediment resuspended in storms, which play a major role in sustaining land elevations (Reed et al. 1997). By altering salinity gradients and patterns of water and sediment flow through marshes, canal dredging, which mostly occurred between 1950 and 1980, not only directly changed land to open water, but also indirectly changed the processes essential to a healthy coastal ecosystem. Elevated dredged material embankments may provide important wildlife refugia during storm events and valuable habitat for neotropical migratory birds, and the value of this habitat should be considered as restoration of these areas occurs.

2.1.2.4 Hypoxia

Hypoxia is a major environmental problem affecting coastal Louisiana and the northern Gulf of Mexico. It is also a problem of National importance, which will require action throughout the Mississippi River Basin to solve. While hypoxia is not a cause of land loss in coastal Louisiana, it is highly relevant to the broader coastal Louisiana ecosystem.

Hypoxia in the northern gulf is caused primarily by excess nitrogen in combination with stratification of gulf waters (CENR, 2000). For the period 1985 to 2001, the bottom area of the hypoxic zone ranged from 2,730 to over 7,700 square miles (7,070 to 20,000 square kilometers) (**figure MR2-1**) (Rabalais et al. 1999). The reduced hypoxic zone during years 1988, 1989, and 2000 are anomalies due to severe drought (i.e., significantly reduced water flows from the Mississippi River and its distributaries into the gulf).

The January 2001, "Action Plan for Reducing, Mitigating, and Controlling Hypoxia in the Northern Gulf of Mexico" describes a National strategy to reduce the frequency, duration, size, and degree of oxygen depletion in the northern Gulf of Mexico. The Action Plan describes in general actions that are needed throughout the Mississippi River basin to address gulf hypoxia, including restoring de-nitrification and nitrogen retention in the coastal plain of Louisiana.

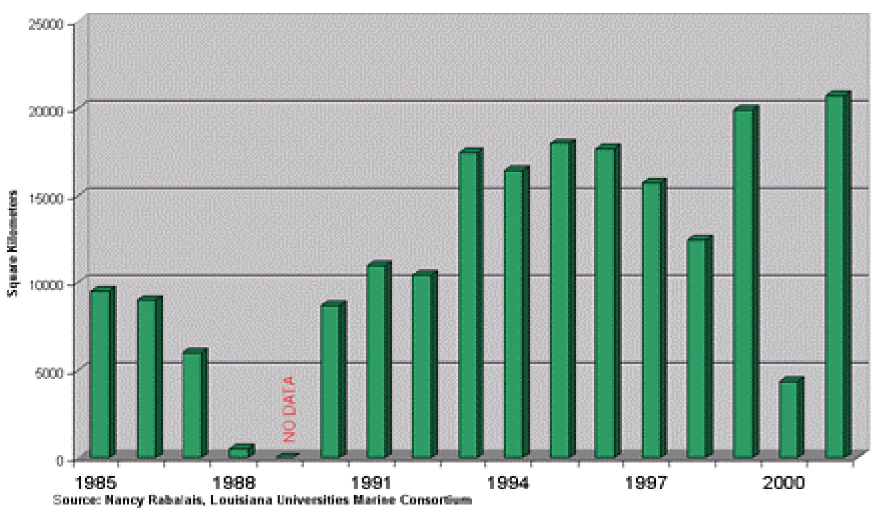


Figure MR2-1. Comparative Size of the Hypoxic Area from 1985 to 2001 (*source Nancy Rabalais, Louisiana Universities Marine Consortium*).

As described in section 1 INTRODUCTION, in the past, a portion of the Mississippi River's flow would occasionally divert into the coastal wetlands through crevasses or overbank flow. These flows into the wetlands would occur particularly during high river discharges when the maximum levels of sediment and nutrients were also being transported. These diversions would disperse a fraction of the sediment and nutrients into the wetlands, where the marsh vegetation would capture and incorporate them into the cycle of growth, thus reducing the total nutrient load reaching the gulf. Today, more nutrients pass though the study area and into the northern gulf as a result of the loss of wetlands (less wetlands to absorb the nutrients) and the significant reduction in hydrologic connectivity between the river and coastal wetlands (less ability to transport freshwater to wetlands that would absorb the nutrients).

2.1.2.5 Saltwater intrusion

Saltwater intrusion occurs when freshwater flows decrease in volume, allowing saltwater from the gulf, which is heavier than freshwater, to move inland or "upstream". Saltwater can then infiltrate fresh groundwater and surface water supplies, and damage freshwater ecosystems. The rate of saltwater intrusion depends on the amount of freshwater flows traveling downstream and the water depth in the wetlands, channels, and/or canals. Generally, high-inflow/low-salinity periods occur from late winter to late spring and low-inflow/high-salinity periods from late spring to fall. Saltwater intrusion is a principle factor in the conversion of freshwater habitats to saline habitats. Extreme salinity changes can stress fresh and intermediate marshes to the point where vegetation dies and the wetlands convert into open water (Flynn et al. 1995).

2.1.2.6 Sediment reduction/vertical accretion deficit

Vertical accretion of wetland soils depends on soil formation from sedimentary material of two types: mineral sand, silts, and clays brought in by river water, floodwaters, or winds; and living and dead organic matter produced locally by plants. In Louisiana, organic matter accumulation is frequently more important than mineral sediment input to vertical accretion (Nyman et al. 1990; Nyman and DeLaune 1991), except during initial phases of delta building (van Heerden and Roberts 1988). Accretion deficits in Louisiana coastal marshes are caused primarily by inadequate organic matter accumulation (Nyman et al. 1993). Any environmental change that lowers productivity or increases the rate of organic matter removal increases the vertical accretion deficit.

For those areas of active delta building, sediment from the Mississippi River and its distributaries is an essential ingredient in the land-building process. However, upstream reservoirs, changes in agricultural practices and land uses, and bank stabilization measures have reduced average sediment loads in the lower Mississippi River by approximately 67 percent since the 1950s (Kesel 1988).

2.2 EXISTING AND FUTURE WITHOUT-PROJECT CONDITIONS (NO ACTION)

The Louisiana coastal area is one of the most ecologically, economically, socially, and culturally diverse regions in America. The area includes extensive terrestrial, aquatic, and marine ecosystems, as well as adjacent agricultural, industrial, and urban centers. Forces that have shaped coastal Louisiana, both natural and human, have produced a delicate interdependency between man and the environment. Coastal Louisiana today can be characterized as a “working wetland” as life is closely linked to and depends on its resources. Louisiana’s economic and cultural future is inextricably linked to the long-term sustainability of its natural environment.

Existing conditions in the Louisiana coastal area, as described in this section, can be attributed largely to changes in the management of coastal resources and processes. These changes provide for water control and the prevention of major floods, which historically precluded large-scale human settlement and economic development along the gulf coast, the Mississippi River, and its major tributaries and distributaries. Changes also included the creation of navigation channels and waterways across the coastal area, which provide for large-scale waterborne transportation of both commodities and finished products, and an extensive network of oil and gas canals and infrastructure.

While these activities have provided enormous benefits to Louisiana and have helped to build the Nation, they have also resulted in unforeseen consequences, such as coastal land loss. Today, the rapid loss of Louisiana’s coastal wetlands and barrier islands has resulted in loss of environmental resources, population dislocation, and a growing threat to public safety and to billions of dollars worth of property and infrastructure. The future without-project conditions for the area, also known as "no action", forecast a continued trend of land loss and an associated decline in environmental and economic sustainability.

This section provides a description of the existing conditions and future without-project conditions for the Louisiana coastal area. Descriptions of existing conditions summarize physical, ecological, and socioeconomic conditions within the study area. Future without-project conditions describe what is assumed to be in place if none of the LCA Study alternative plans are implemented. Neither summary attempts to provide a comprehensive description of all resources or concerns; instead, both summaries focus on the most pertinent issues relevant to the implementation of a LCA Plan. A more detailed description of existing and future without-project conditions is contained in the final Programmatic Environmental Impact Statement (FPEIS).

2.2.1 Hydrology (Water and Sediment Transport)

2.2.1.1 <u>Existing conditions</u>

The Deltaic and Chenier Plains within the Louisiana coastal area contain all or part of 10 hydrologic regions including Pontchartrain, Pearl, Breton Sound, Barataria, Terrebonne, Atchafalaya, Teche/Vermilion, Mermentau, and Calcasieu/Sabine basins and the Mississippi River Delta (**figure MR2-2**). The basins within the Deltaic Plain are primarily influenced by the Mississippi River, while those in the Chenier Plain are not. As a result, the discussion of existing and future without-project hydrologic conditions addresses the Deltaic and Chenier Plains separately.

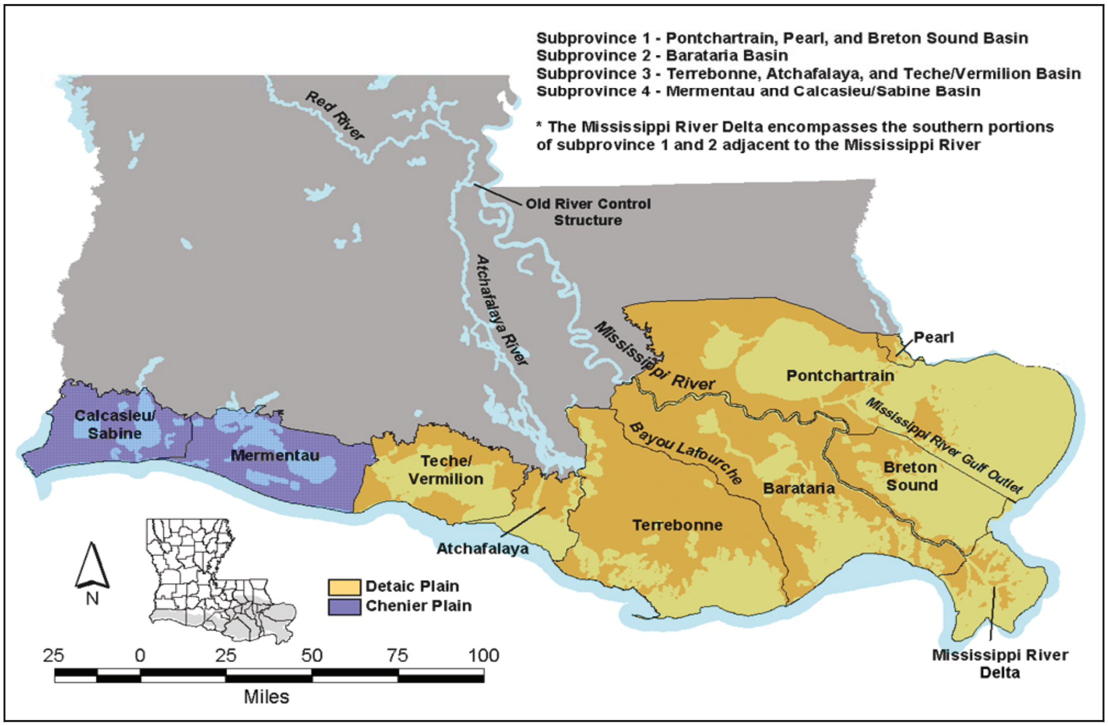


Figure MR2-2. Major Hydrologic Basins in the Louisiana Coastal Area.

2.2.1.1.1 *Deltaic Plain*

The Mississippi River Drainage Basin covers more than 1,245,000 square miles (3,224,553 square kilometers), and contains 41 percent of the contiguous United States and a portion of two Canadian provinces **(figure MR2-3)**. The Lower Mississippi Valley, which varies in width from 25 to 125 miles (40 to 201 kilometers), begins just below Cape Girardeau, Missouri and is roughly 600 miles in length. The Mississippi River has an annual average flow rate of 495,000 cubic feet per second (14,000 cms) and a freshwater discharge onto the continental shelf of 470,000,000 acre feet (580 cubic kilometers) per year. The river discharge into the Gulf of Mexico is distinctly seasonal, with highest flows occurring between March and May and lowest flows occurring during August and October.

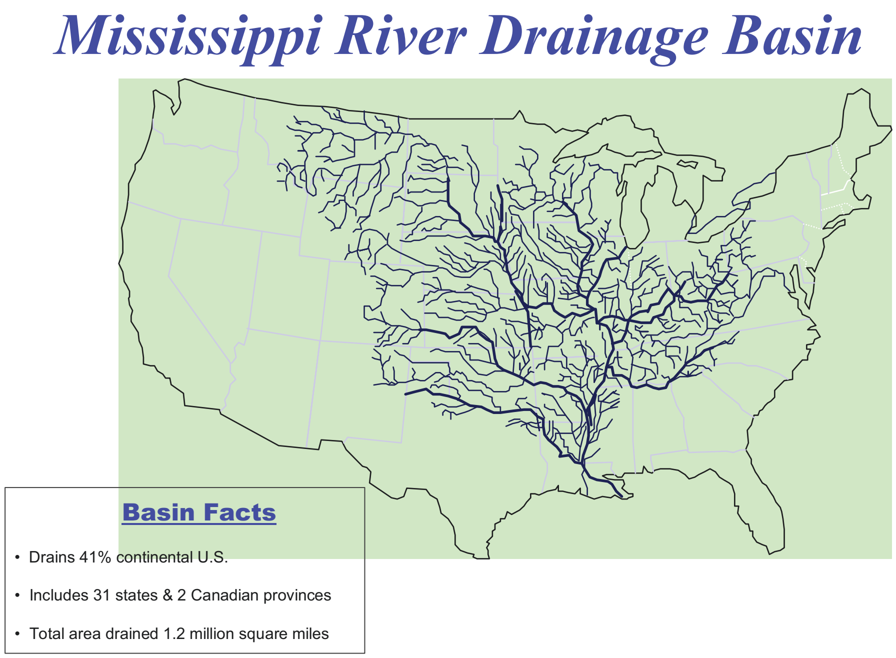


Figure MR2-3. Mississippi River Drainage Basin.

As described in section 1 INTRODUCTION, the Mississippi River and its distributaries historically provided immense volumes of land-building sediment and nutrients throughout Louisiana’s coastal areas. Levee activity along the Mississippi River in coastal Louisiana began as early as the 1700s. As the lower portions of the river were contained within the flood control levees, most of Louisiana’s coastal wetlands were deprived of the freshwater flows, sediment, and nutrients that had historically sustained them against natural factors of coastal land loss such as sea level change and subsidence.

By the early 1900s, human activities had a major influence on many of the key elements controlling the deltaic cycle. Flood protection levee systems completed in the early 1900s contained the flow of the Mississippi River, thereby reducing the number of overbank flooding events. Flood protection afforded to residents spurred a period of extensive development in the coastal area. Subsequent activities that altered the natural landscape and adversely impacted the natural hydrology included the dredging and maintenance of navigation and access canals, the construction of roads, levees, and oil and gas canals within wetlands, and drainage projects. As these and other activities impaired the deltaic cycle and disrupted the natural hydrology of the coastal ecosystems, extensive land building and sustenance of coastal wetlands diminished to the point where more land was being lost than was being created.

Today, Louisiana's Deltaic Plain is composed of two active deltas, the Mississippi River Delta, also known as the "birdfoot delta" (**figure MR2-4**), and the Wax Lake Outlet/Lower Atchafalaya River Delta. Delta formation is occurring in these two areas because of flood control management practices of the MR&T Project. Seventy percent of the combined flow of the Mississippi and Red Rivers at the latitude of the Old River Control Structure is diverted down the Mississippi River and into the northern Gulf of Mexico. The remaining 30 percent of the latitude flow is discharged into the gulf via the Atchafalaya Basin through Atchafalaya Bay, located to the west of the Mississippi River. These water flows provide sediment, freshwater, and nutrients that fuel land building and sustenance processes of the two active deltas.

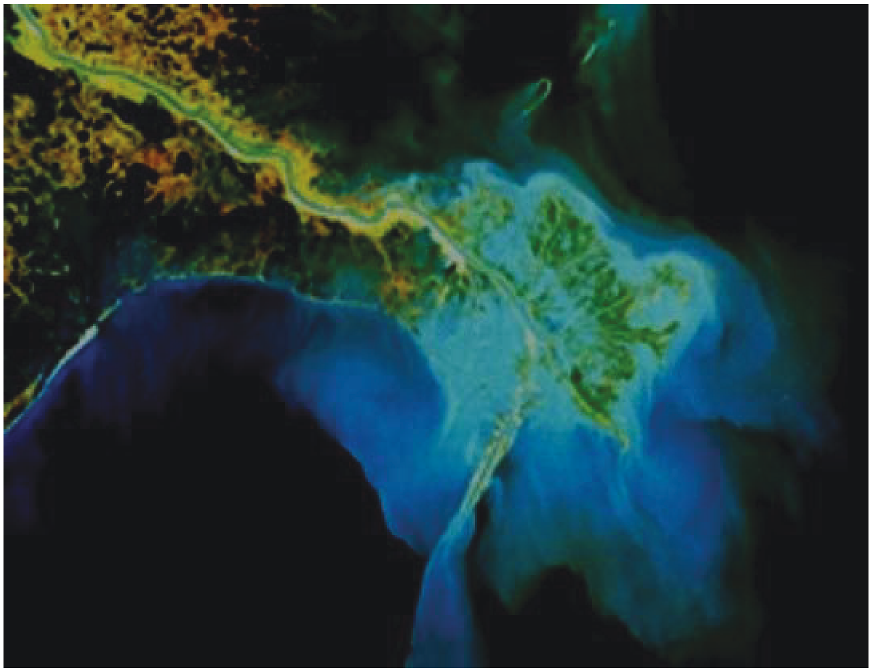


Figure MR2-4. Birdfoot Delta at the Mouth of the Mississippi River.

While the land-building phase of the deltaic cycle is occurring in the two active deltas, the remainder of the coastal area in the Deltaic Plain has transitioned into the abandonment phase. Some areas of the coast have been in the abandonment phase for hundreds of years, as evidenced by the presence of barrier headlands and islands, which are distinctive geomorphic features of the latter part of the degradation phase. Other areas of the Deltaic Plain, however, are being subjected to the natural processes that predominate in the abandonment phase (erosion, increased marine influences, habitat switching, and land loss) because they have been cut off from riverine influences (freshwater, sediment, and nutrients) by levees and other flood control projects. Many of these areas are located adjacent to the Mississippi River. The presence of navigation channels and oil and gas canals has also contributed to an increase in marine influences on coastal wetlands, which has facilitated their subsequent degradation and loss.

Bayou Lafourche provides an example of how the natural hydrology of a portion of the coastal area has been altered by natural and human factors. Bayou Lafourche, the geomorphic structure that separates Subprovince 2 from Subprovince 3, was formerly a main channel of the Mississippi River. By the 12th century, the river had switched course and initiated delta formation in another area of the Louisiana coastline. The remnant channel at Bayou Lafourche (now in a degrading portion of a delta lobe), in turn, reduced in size and flows to that of a minor distributary of the river. As discussed earlier, levee activity along the Mississippi River also occurred on river reaches at and near Bayou Lafourche. Review of Mississippi River Commission flow records indicates that by the mid to late 1800s, the bayou conveyed less than 2 percent of the Mississippi River during major flood flows. In 1904, a dam was placed across the distributary as a flood protection measure for Donaldsonville, Louisiana (Doyle 1972). While the dam fulfilled its authorized purpose to help prevent flooding in the city, its construction also severed what remained of the hydrologic connection between the Mississippi River and the wetlands in western Barataria Basin and eastern Terrebonne Basin. Today, these wetlands are experiencing the greatest, and most accelerated land loss as marine influences dominate the hydrology of the area. It is important to note that habitat degradation in the western Barataria Basin and eastern Terrebonne Basin would be occurring as a natural function of the degradation phase of the deltaic cycle. However, the virtual absence of riverine influence in these areas has accelerated the rate of degradation in the wetland habitats.

An important component of the hydrologic and deltaic process in the Deltaic Plain is the suspended sediment flowing down the Mississippi River. A combination of factors, such as dams, channel improvement features, and improved land use management practices upstream of the Louisiana coastal area, has decreased the available suspended sediment load within the system. While the retention of soil and reduction of bank erosion in the middle and upper portions of the Mississippi River Drainage Basin are considered as positive developments to people and industries upstream of Louisiana, the reduction of available sediment flowing down the Mississippi directly impacts the land-building and sustenance processes in the Deltaic Plain.

The following discussion describes the major hydrologic features in the various subprovinces of the Deltaic Plain, and identifies the more prominent water control and flood protection structures that affect the natural hydrology of each subprovince.

<u>Subprovince 1</u>

Subprovince 1 includes Breton Sound, Pontchartrain Basin, portions of the Pearl hydrologic basin, and the eastern portion of the lower Mississippi River Delta (**figure MR2-5**). The Pontchartrain Basin, the largest in the subprovince, is about 4,200 square miles (10,920 square kilometers) of estuarine habitat, and receives runoff from several smaller basins, including the Amite, Tickfaw, Tangipahoa, and Tchefuncte Basins. Lake Maurepas, Lake Pontchartrain, and Lake Borgne are the major lakes found in the basin. Pass Manchac connects Lake Maurepas with Lake Pontchartrain, while Chef Menteur Pass and the Rigolets connect Lake Pontchartrain with Lake Borgne and Mississippi Sound.

The Breton Sound Basin includes Lakes Lery and Big Mar, which are the largest water bodies in the northern part of the basin. Black Bay, California Bay, and Breton Sound are located in the southern part of the basin. Breton Sound is the largest water body in the subprovince. Currently, the Caernarvon Freshwater Diversion project introduces freshwater, sediment, and nutrients into the Lake Lery area of the upper Breton Sound marshes.

Major navigational channels include the MRGO, the GIWW, and the Mississippi River. The first two of these navigation channels introduce and/or compound marine influences in many of the coastal wetlands and water bodies within the subprovince.

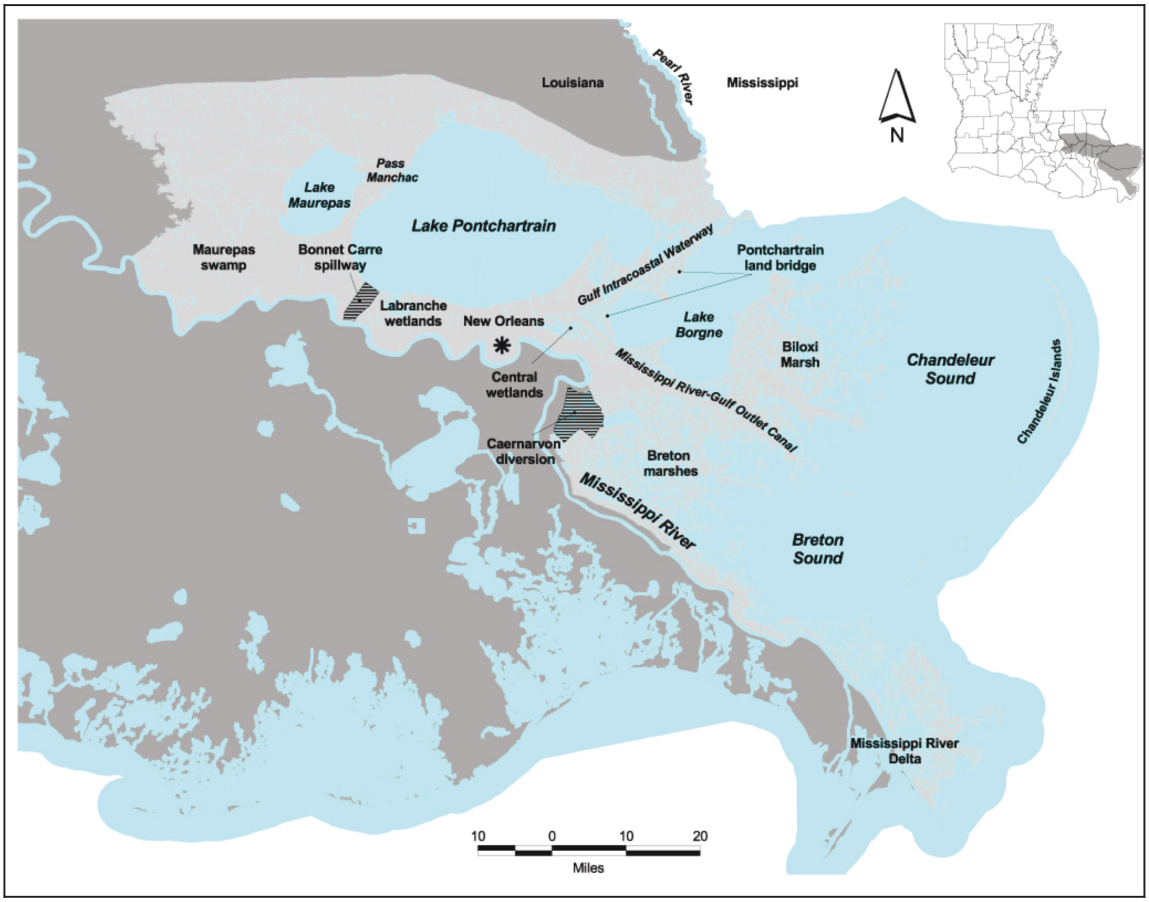


Figure MR2-5. Major Hydrologic Features of Subprovince 1.

Subprovince 2

Subprovince 2 is defined by the hydrologic boundary of the Barataria Basin, which is approximately 2,446 square miles (6,359 square kilometers), and the western portion of the lower Mississippi River Delta. The basin contains four major lakes; Lake Salvador, Lake Cataouatche, Little Lake, and Lac Des Allemands (**figure MR2-6**). The basin is separated from the gulf by a chain of barrier islands, which serve as a natural barrier to storm events and reduce marine influences on interior wetlands within the basin.

Currently, the Davis Pond Freshwater Diversion project directs Mississippi River water into the upper portion of the basin's wetlands. The primary purpose of the Davis Pond project has been to maintain salinity gradients in the central portion of the Barataria Basin. A majority of wetlands in the western portion of the basin are hydrologically isolated from riverine influences of the Mississippi River.

Major navigational channels in the subprovince include the Barataria Bay Waterway and the GIWW. Each of these navigation channels introduces and/or compounds marine influences in many of the interior coastal wetlands and water bodies within the subprovince.

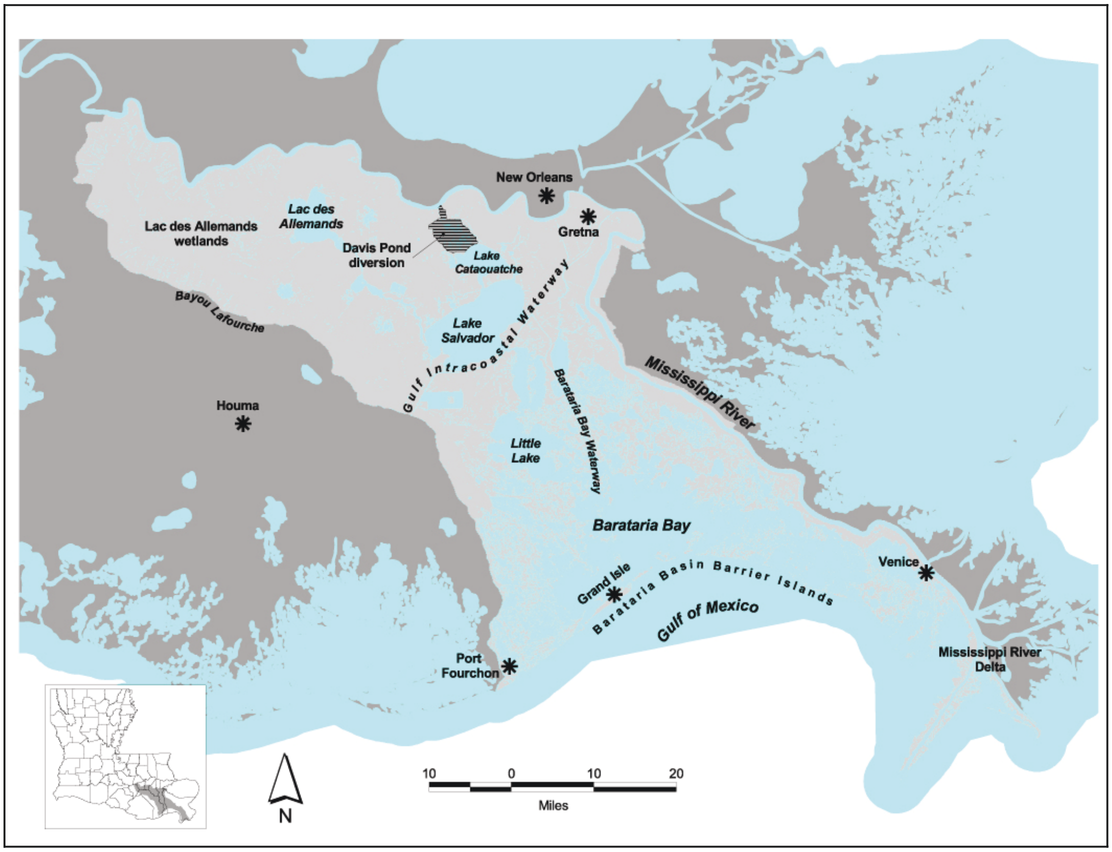


Figure MR2-6. Major Hydrologic Features of Subprovince 2.

<u>Subprovince 3</u>

Subprovince 3 consists of the Teche/Vermilion and Terrebonne Basins, and portions of the Atchafalaya Basin. The Teche/Vermilion Basin extends from Point Chevreuil to Freshwater Bayou Canal and includes East and West Cote Blanche Bays, Vermilion Bay, and the surrounding marshes (**figure MR2-7**). The Teche/Vermilion Basin has a drainage area of 3,040 square miles (7,904 square kilometers). The Atchafalaya Basin is part of the MR&T flood control system and has a drainage area of approximately 1,800 square miles (4,680 square kilometers). The Terrebonne Basin drainage area is approximately 1,455 square miles (3,783 square kilometers) in size.

The Atchafalaya River, a distributary of the Mississippi River, supports delta building and wetland creation at the Wax Lake Outlet and at the mouth of the Lower Atchafalaya River. In addition, the Lower Atchafalaya River nourishes the wetlands in the Teche/Vermilion Basin, located in the western portion of the subprovince. Wetland communities immediately adjacent to and west of the Lower Atchafalaya River are some of the healthiest wetlands in the Louisiana coastal area, fueled by the inputs of sediment and nutrients from the Atchafalaya River.

The wetland communities within the eastern portions of the Terrebonne Basin are hydrologically isolated. Wetlands in the southwestern portion of the Terrebonne Basin have some of the lowest loss rates in the state because they are nourished by the Atchafalaya River.

However, the wetland communities within the northwestern portion of Terrebonne Basin, including those located both north and south of the GIWW, have been, in part, separated from the influence of the Atchafalaya River. Instead, the hydrology of these areas is influenced by a widely variable pattern of Atchafalaya River backwater effect, rainfall runoff events, and marine processes.

It is important to note that a majority of the sediment and freshwater that supports the active deltas in the Lower Atchafalaya River Basin pass through the Upper Atchafalaya River Basin, which is not within the LCA Study area. In essence, the upper basin acts as a large conveyance system and reservoir for freshwater and sediment material that eventually fuels delta building at the Wax Lake Outlet and the mouth of the Lower Atchafalaya River. While delivery of sediment material is necessary to sustain and, if possible, augment land-building processes in the LCA Study area, the continued accumulation of sediment affects the hydrology of the upper basin, and adversely impacts its cypress tupelo swamps communities.

Barrier islands separating the coast from the gulf include the Timbalier and Isles Dernieres barrier systems. These systems provide protection to interior areas by reducing marine influences, such as wave action and saltwater intrusion.

Major navigation channels in the subprovince are the Atchafalaya River, Wax Lake Outlet, Houma Navigation Canal, GIWW, and Lower Atchafalaya River (south of Morgan City). Each of these navigation channels introduces and/or compounds marine influences in many of the interior coastal wetlands and water bodies within the subprovince.

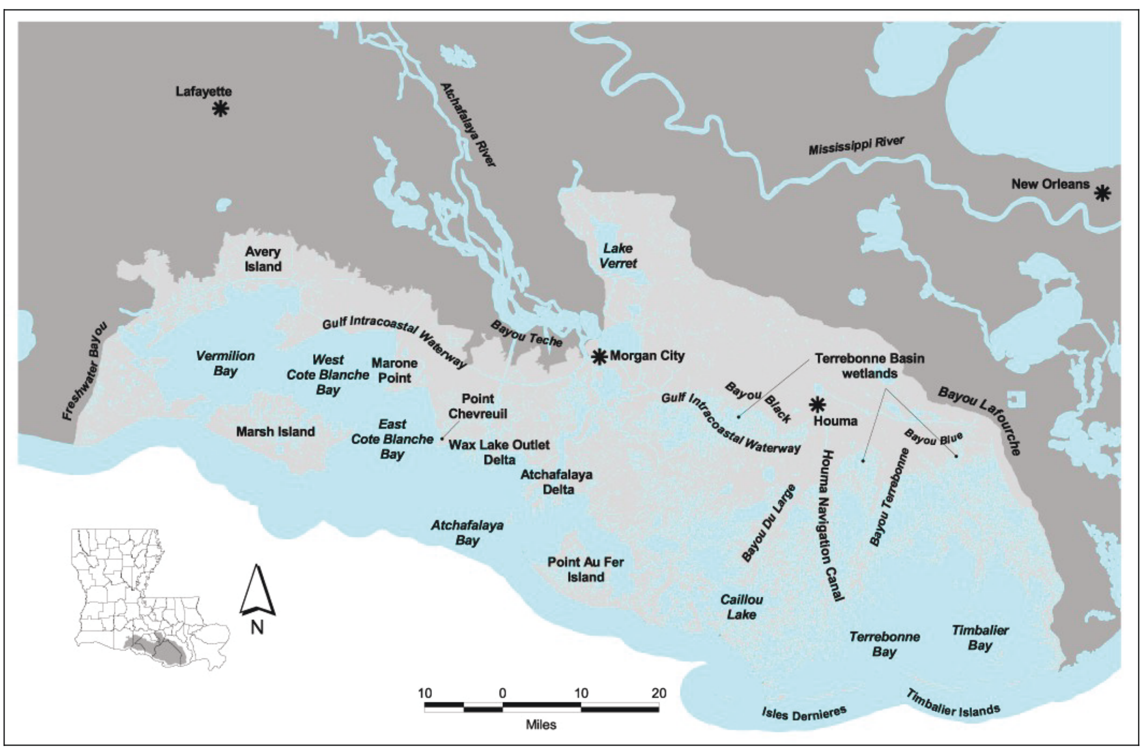


Figure MR2-7. Major Hydrologic Features of Subprovince 3.

2.2.1.1.2 *Chenier Plain*

Subprovince 4

In contrast to the Deltaic Plain, the Chenier Plain formed to the west of the Mississippi River, away from active deltaic growth. The Chenier Plain extends from Freshwater Bayou, Louisiana to Sabine Pass, Texas (**figure MR2-8**). As described in section 1 INTRODUCTION, Chenier Plain development is the result of the interplay of three coastal plain rivers, cycles of Mississippi River Delta development, and marine processes. Historically, cheniers acted as hydrologic barriers between the coastal salt marshes south of the cheniers and the inland fresh marshes and lakes to the north of the cheniers.

Two major hydrologic basins occur in the Chenier Plain, the Mermentau Basin and the Calcasieu/Sabine Basin. The Mermentau River is the primary freshwater supply for the Mermentau Basin, which has a drainage area of approximately 3,820 square miles (9,932 square kilometers). Hydrologic connectivity in some areas of the Chenier Plain, particularly within the Mermentau Basin, has been disrupted by several activities, including: the creation of dredge material banks from activities such as oil and gas canal dredging; the presence of east-west canals, such as the GIWW; and the operation of water control structures, such as the Calcasieu and Leland Bowman locks on the GIWW, the Freshwater Bayou Canal Lock, the Schooner Bayou Control Structure, and the Catfish Point Control Structure Grand Lake at the outlet for the Lower Mermentau River. These water control structures enable portions of the Mermentau Basin to be operated as a freshwater reservoir for agriculture, primarily rice and crawfish.

Other wetland communities have become "compartmentalized" and, in effect, hydrologically isolated through the creation of dredge material banks, roads and highways, and flood protection levees, all of which can restrict water flows into or out of the area. During extreme weather events, such as tropical storms, wetlands that are compartmentalized and/or subject to extremely slow drainage, can be particularly vulnerable to high precipitation levels, which can inundate wetlands with inches of water. In such cases, the typical result has been "ponding" of water over the wetlands. When properly managed, these may be important habitat for waterfowl. For example, the 16,000-acre (6478 ha) Pool of the Lacassine NWR and the 27,000-acre (10931 ha) Pool 3 on the Sabine NWR were created to maintain adequate freshwater habitat for migratory waterfowl. However, excessive ponding over an extended duration of time in certain types of wetland habitats can kill the vegetative communities and result in the eventual wetland loss (conversion to open water).

The Calcasieu/Sabine Basin is a shallow coastal wetland system with freshwater input at the north end, and a north-south circulation pattern through the Calcasieu and Sabine Lakes. Some east-west water movement occurs along the GIWW and interior marsh canals. In the Calcasieu drainage basin, the drainage area north of the point where the river crosses the GIWW is 3,235 square miles (8,411 square kilometers). The Calcasieu River flows through three small lakes before flowing into Calcasieu Lake near the coast. The Sabine drainage basin has a drainage area of 9,760 square miles (25,376 square kilometers). The headwaters start in northeastern Texas and the river runs about 150 miles (241 kilometers) before it meets the

Louisiana-Texas state line, then runs to the gulf. The Toledo Bend Reservoir and Sabine Lake are the major hydrologic features of the Sabine Basin.

The Sabine/Neches Waterway, Calcasieu River Navigation Channel, GIWW, Mermentau Ship Channel, and Freshwater Bayou Canal are navigational channels in the Chenier Plain that influence the hydrology within the subprovince, primarily by increasing marine influences (saltwater intrusion, wave energies) into freshwater and other interior marshes.

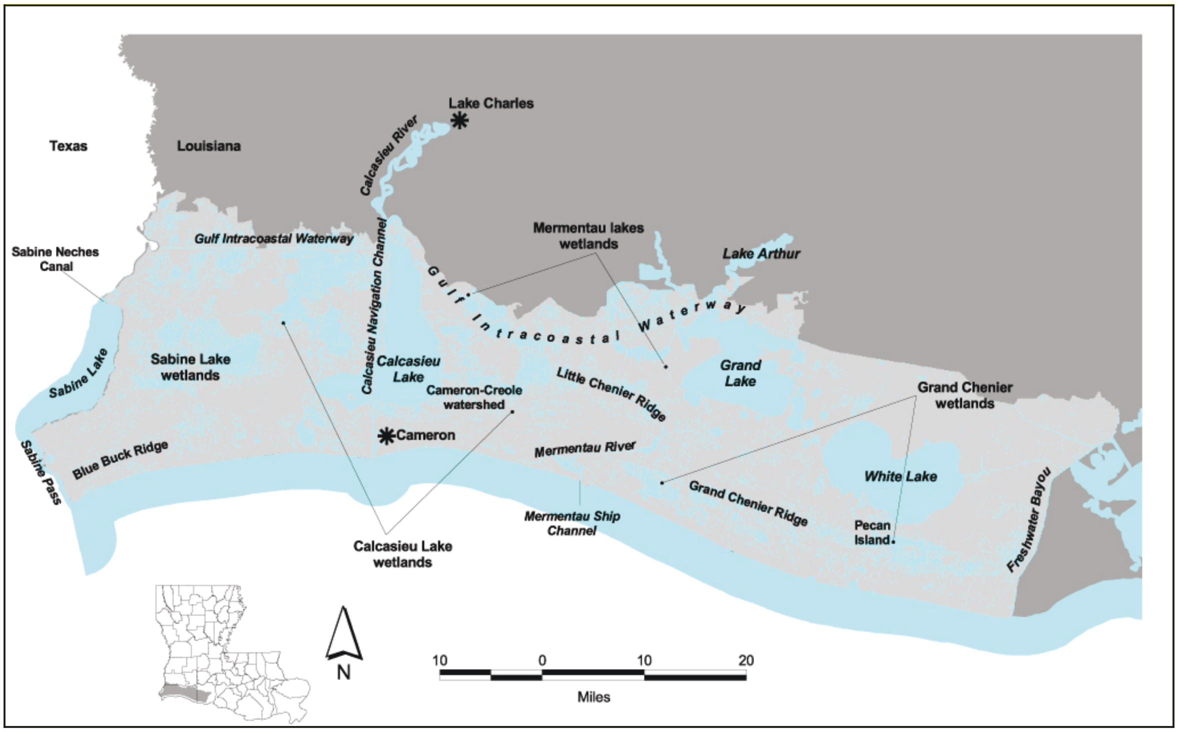


Figure MR2-8. Major Hydrologic Features of Subprovince 4.

2.2.1.2 Future without-project conditions

The following future without-project conditions assume no further restoration actions beyond the presently planned/approved construction or maintenance actions in the study area, including those contained in the CWPPRA and other programs described in section 1 INTRODUCTION.

Without action, riverine influences (e.g. freshwater, sediment, and nutrients) would continue to sustain land-building processes at the Mississippi River Delta and the Wax Lake Outlet/Lower Atchafalaya River Delta. In addition, wetland communities adjacent to and immediately to the west southeast of the Atchafalaya River would continue to be nourished and sustained by the river.

For much of the remaining Louisiana coastal area, however, marine processes would continue to increasingly dominate the hydrology of wetland communities. The projected loss of an additional 328,000 acres (132,794 ha) of coastal wetlands by 2050, including the degradation and loss of barrier islands and gulf shorelines, would exacerbate the problems of saltwater intrusion and erosion, especially during tropical storm events. Based on a USACE hurricane study for Morgan City and vicinity, a drop in storm surge of approximately 1 foot (0.3 meters) was observed for every 3 miles (4.8 kilometers) inland (USACE 1963). As the marshes continue to fragment and disappear, in the future, storm surges would travel farther inland and inundate interior wetlands with saline, gulf waters.

In addition, existing and newly constructed oil and gas canals and maintenance of navigation channels would continue to facilitate saltwater intrusion into interior coastal wetlands. Salinity gradients across the coast would migrate north and become more narrow and variable without additional inputs of freshwater from riverine sources to hold back gulf waters.

2.2.1.2.1 *Deltaic Plain*

A majority of the wetland communities in the Deltaic Plain would remain isolated from riverine influences. The most notable exceptions in Subprovinces 1 and 2 would be those wetlands nourished by the Davis Pond and Caernarvon Freshwater Diversion Projects. In these areas, salinity gradients would be maintained and the freshwater, sediment, and nutrients introduced through the diversions would continue to aid land-preservation processes. In Subprovince 3, those wetlands located immediately adjacent and to the west of the Lower Atchafalaya River would also receive enough river water to maintain salinity gradients and sustain land-building processes.

For other areas in the Deltaic Plain, including western Barataria Basin, eastern Terrebonne Basin, and areas adjacent to the Mississippi River, marine influences would continue to predominate in the future. Wetland communities in these areas, isolated from riverine influences, would succumb to a combination of natural factors that cause land loss such as sea level change, erosion from tidal processes (e.g. wave action), and subsidence.

2.2.1.2.2 *Chenier Plain*

Marine influences would continue to affect the hydrology of interior areas through navigation channels and through breaches of eroded gulf shorelines. The absence of additional salinity controls in the Calcasieu/Sabine Basin would allow continued saltwater intrusion within coastal wetland communities. In the Mermentau Basin, existing water management practices and infrastructure, such as the east/west Highway 82, would result in future ponding of water within coastal marshes.

2.2.2 Coastal Habitats and Productivity

2.2.2.1 Existing conditions

In addition to the Mississippi and Atchafalaya Rivers, the most prominent natural features in the Deltaic Plain are the abandoned Mississippi River courses and the ridges and levees that bordered them, large shallow lakes, extensive marshes, large bays, bayous, barrier headlands, and barrier islands. Natural levee ridges are now separated by vast expanses of freshwater, intermediate, brackish, and saline marshes, as well as by swamps, flotant marsh, maritime forests, salt domes, and tidal channels. Each of these coastal habitats contributes to the extensive diversity of the coastal ecosystem and is essential to its stability. Detailed descriptions of each of these habitat types are contained in the FPEIS.

As described in section 1 INTRODUCTION, the oscillating nature of the deltaic process drove spatial and distribution patterns of coastal ecosystems back and forth between ones dominated by riverine and marine influences. Accordingly, the hydrology in the coastal ecosystems, particularly in the Deltaic Plain, greatly influenced the types and productivity of vegetative communities. During the delta advancement phase, major inputs of freshwater led to the predominance of riverine influence over marine influence, and, as a result, the majority of coastal marsh in the growing delta was cypress/tupelo swamp and freshwater marsh. This scenario reflects the coastal habitat conditions in the two active deltas within the study area, the Mississippi River Delta and the Atchafalaya Delta.

During the abandonment of a delta, freshwater inputs decline and allow marine influences to predominate over riverine influence in coastal areas nearby and adjacent to the gulf. As marine influences take hold and salinity levels rise, distinct zones of coastal habitats develop with increasing distance inland from the coast, beginning with saline marshes, and transitioning into brackish, intermediate, and finally to freshwater marsh and swamp. It is during this time that vegetation community diversity, as well as plant and animal productivity (e.g. primary and secondary productivity), are at their highest. As a delta continues to degrade, subsidence and storms cause the conversion of low-lying vegetated areas to open water and the redistribution of marine sediment. These actions eventually lead to conditions that expedite interior marsh loss. As interior marshes disappear, and as marine influences and storms interact with the abandoned delta, the resulting geomorphic structures, or remnants of the delta, are the barrier headland, and eventually, the barrier islands. This scenario reflects the coastal habitat conditions in much of the remaining Deltaic Plain.

Approximately 80 percent of the Mississippi River Deltaic Plain is in some phase of abandonment because of loss of riverine influences, and much of the area is in advanced stages of wetland deterioration (U.S. Geological Survey [USGS]-National Wetlands Research Center [NWRC] 2004).

2.2.2.1.1 *Deltaic & Chenier Plains*

The Deltaic Plain is a vast wetland area characterized by large lakes and bays, natural levee ridges, and bottomland hardwood forests that gradually decrease in elevation to various wetland marshes. Numerous barrier islands and headlands are also present. The Chenier Plain is characterized by large lakes, wetlands, cheniers, and coastal beaches. Large freshwater basins occur on the landward side of the natural ridges and a zone of brackish to saline marshes occurs on the seaward side.

Because of the complexity and diversity of coastal habitats within the Deltaic and Chenier Plains, subdivision of the plains provides a subprovince level perspective of the vegetative communities. Therefore, the following discussion focuses on existing coastal habitats within each of the four previously described subprovinces.

Recent GIS analysis and classification by USGS-NWRC for the LCA Study provided a summary of coastal habitat types by subprovince. This information is provided in **table MR2-1**.

Table MR2-1. Existing Habitat and Vegetation.

	Existing Conditions[1] (Acres)			
	Subprovince 1	**Subprovince 2**	**Subprovince 3**	**Subprovince 4**
Wetland Forest/Swamp	293,100	236,100	358,300	10,500
Wetland Scrub[2]	26,800	16,000	48,000	16,900
Freshwater Marsh	70,700	161,400	290,500	338,000
Intermediate Marsh	136,400	76,800	167,700	278,000
Brackish Marsh	154,000	63,600	194,700	135,300
Saline Marsh	126,500	123,200	140,900	32,800
Open Water	2,192,700	714,700	1,199,300	410,900
Total Marsh/Wetland[3]	807,500	677,100	1,200,100	811,500
Upland (Other)[4]	42,400	33,600	59,500	106,800

[1]Existing conditions taken as of year 2000, data provided by USGS for LCA Study.
[2]Wetland scrub was not evaluated separately, but acreage is included with associated primary wetland types.
[3]Total wetland acres does not include upland or open water acres.
[4]Uplands (Other) category includes all other areas, including upland agricultural areas and urbanized areas.

2.2.2.1.2 *Quantification of coastal land loss*

Across much of the Louisiana coast, wetland loss and shoreline erosion continue largely unabated, resulting in accelerated coastal land loss and ecosystem degradation. Over time, the rates of Louisiana's coastal land loss have varied. For example, the conversion of numerous large areas (greater than 40 acres [16.1 ha]) of interior marsh to open water, prevalent between 1956 and 1978, continued to occur, to a lesser extent, from 1978 to 1990 and further decreased between 1990 and 2000 (**table MR2-2**). Continued shoreline erosion and conversion of interior marsh habitat to open water (ponds) are the primary loss patterns dominating the last decade. Interior ponds range in size from 2.5 to5.0 acres (1 or 2 ha) to 125 acres (50 ha), with the majority of ponds occurring within the coastal fresh to intermediate marshes. Detectable shoreline erosion in larger lakes, bays, and ponds ranged from 165 to 1,000 feet (50 to 300 m).

Table MR2-2. Net Loss Trends by Subprovince.

	1978-1990 Net loss Mi^{2*}	1990 - 2000 Net Loss Mi^2	1978 – 2000 Net Land Loss Mi^2	Net Loss 22 Years Mi^2/Year	% Total Loss from 1978 to 2000 by Area
Subprovince 1	52	48	100	4.5	15%
Subprovince 2	148	65	213	9.7	32%
Subprovince 3	134	72	206	9.4	31%
Subprovince 4	85	54	139	6.3	21%
Total	419	239	658	29.9	100%

*1978-1990 Net loss figures were based on Barras et al. (1994). The 1978 to 1990 basin level and coast wide trends used in this study were aggregated to reflect LCA subprovinces for comparison with the 1990-2000 data. The basin boundaries used in Barras et al. (1994) were based on older CWPPRA planning boundaries and are not directly comparable to the LCA boundary used to summarize the 1990 to 2000 trend data. The 1990 to 2000 net loss figures include actively managed lands for comparison purposes with the 1978 to 1990 data.

Subprovince 1

Subprovince 1 contains great habitat diversity, including extensive bottomland hardwood forests adjacent to the Mississippi River and barrier islands bordering the Chandeleur Sound. Cypress-tupelo swamp is the dominant ecosystem type in the upper portion of the subprovince. South of the swamps, marshes extend to the Gulf of Mexico and the Mississippi Delta. Freshwater marshes are found in the north, with a band of intermediate marsh lying southward. Portions of the basins contain brackish marshes, and saline marshes fringe the gulf and Breton Sound. Approximately 73 percent of the coastal habitat in Subprovince 1 is open water. Freshwater habitats dominate the basin, comprising approximately 48 percent. The remaining coastal habitat is fairly evenly distributed between intermediate, brackish, and saline marsh.

Subprovince 2

Subprovince 2 contains great habitat diversity, including extensive bottomland hardwood forests adjacent to the Mississippi River and Bayou Lafourche. Cypress-tupelo swamps cover the upper Barataria Basin. South of the swamps, marshes extend to the gulf in the Mississippi Delta and lower Barataria Basin. Portions of the basin contain brackish and saline marshes that fringe the Gulf of Mexico. The southern end of the Barataria Basin is bounded by a series of barrier headlands, islands, and shorelines. In Subprovince 2, approximately 53 percent of the coastal habitat is open water. Of the remaining habitat, about 61 percent consists of freshwater habitat types. Saline marsh is slightly more abundant than intermediate or brackish marsh.

Subprovince 3

Subprovince 3 contains barrier islands, forested wetlands, coastal marshes, and large lakes. Portions of the subprovince, including the Penchant Basin, also contain large areas of fresh floating marsh (flotant). About 50 percent of the coastal habitat in Subprovince 3 is open water. Wetland forest/swamp is the second most abundant habitat type. Freshwater habitats account for approximately 58 percent of the coastal habitat, excluding open water. The remainder is evenly distributed between intermediate, brackish, and saline marsh.

Subprovince 4

Subprovince 4 consists of open water ponds and lakes, cheniers, gulf shorelines, and freshwater, intermediate, and saline marsh. Over time, many of the freshwater marshes have been impounded, inundated, and converted to open water ponds or impounded, drained, and converted to more saline marsh. Nevertheless, freshwater habitats, dominated by freshwater marsh, still account for the majority (45 percent) of coastal habitat. Approximately 37 percent of the coastal habitat is open water. Intermediate marsh dominates the remaining habitat, followed by brackish marsh, and then saline marsh.

Barrier Island Systems

Barrier island systems, composed primarily of barrier shorelines (beaches), headlands, and islands, are the remnant geomorphic structures in the latter phases of deltaic abandonment.

They are located principally in the Deltaic Plain and include the Chandeleur, Plaquemines, Bayou Lafourche, and Isles Dernieres barrier systems.

The Chandeleur Island system is the oldest barrier island arc on the Deltaic Plain. These islands enclose Breton Sound and Chandeleur Sound. The Breton Island National Wildlife Refuge (NWR) is included in this system. It is the second oldest NWR in the country and is managed by the USFWS on behalf of the public. The Plaquemines barrier island system forms the seaward geologic framework for the eastern Barataria Basin and consists of remnant barrier spits and islands defined either by a tidal pass, or the entrance to a bayou. The Bayou Lafourche barrier island system forms the seaward geologic framework of the western Barataria Basin and the eastern Terrebonne Basin. This barrier island system consists of the only human and commercially developed barrier island in Louisiana: Grand Isle. The Isles Dernieres barrier island system forms the seaward geologic framework for the western Terrebonne Basin. Although this barrier island system was a continuous shoreline system in 1853, today it consists of five main islands. Detailed descriptions of Louisiana's barrier island systems, including land loss comparisons over the past 100 years, are provided in Williams, Penland, and Sallenger (1992) "Atlas of Shoreline Changes in Louisiana from 1853 to 1989" and in appendix D LOUISIANA GULF SHORELINE RESTORATION REPORT.

Barrier island systems provide protection to the wetlands, bays, and estuaries behind them and help reduce wave energy at the margins of coastal wetlands, thereby limiting erosion (Williams, Penland, and Sallenger 1992) and tropical storm impacts. As such, barrier island systems are key geomorphic structures that help sustain other coastal habitats, particularly the interior coastal marshes and swamps, by reducing marine influences and tropical storm impacts. These structures also serve as essential habitat for many terrestrial and aquatic species, including those listed by USFWS as threatened or endangered.

Another component of barrier island systems is the offshore sand shoals and nearshore sand deposits. These features developed as part of the deltaic process that eroded and submerged barrier headlands and barrier islands. Because of the large volumes of sand associated with these features, they are often mined for industry or for coastal restoration purposes. Four major sand shoals occur along the Louisiana coastline. These shoals are Trinity Shoal, Outer Shoal, St. Bernard Shoals, and Ship Shoal. Although the offshore and nearshore features are no longer as efficient in providing shoreline protection as the headlands or barrier islands, they do provide some buffering effect from wave action.

Louisiana's barrier island systems are experiencing some of the highest land loss rates in the Nation, particularly the Plaquemines, Bayou Lafourche, and Isles Dernieres systems. While the deterioration of barrier island systems is a natural feature of the deltaic cycle, historically their loss was offset with the creation of a system in another portion of the Deltaic Plain, a function of river switching and the subsequent delta abandonment phase. Today, there is not another barrier island system "waiting in the wings" to replace those that are being lost.

Several portions of the gulf shoreline in the Chenier Plain are also experiencing severe rates of land loss as a result of erosion from marine influences and storm events. Rates of loss in some areas exceed 35 to 40 feet per year (10.6 to 12.1 meters per year). The gulf shorelines in the Chenier Plain provide similar protection to interior coastal habitats as that provided by barrier islands, by reducing marine influences and tropical storm impacts.

2.2.2.2 Future without-project conditions

The following future without-project conditions assume no further actions beyond the presently planned/approved construction or maintenance actions in the study area, including those contained in the CWPPRA and other flood control, navigation, and restoration programs described in section 1 INTRODUCTION.

2.2.2.2.1 *Deltaic & Chenier Plains*

Without action, marine influences and other natural and human factors, such as subsidence, sea level change, navigation channels, and oil and gas canals would result in continued coastal habitat loss in both the Deltaic and Chenier Plains. Land building would continue in the Deltaic Plain at the two active deltas, as well as in areas influenced by CWPPRA projects and the Davis Pond and Caernarvon Freshwater Diversion Projects. Coastal habitats in these areas of land creation would primarily be freshwater marsh, a result of the riverine influence that formed them. Other areas in the Deltaic and Chenier Plains would experience habitat switching from freshwater marsh and bottomland hardwood forest, including cypress/tupelo swamp, to intermediate, brackish, and saline marshes as salinity regimes adjust with increased saltwater intrusion and marine influence.

Louisiana coastal wetlands have been subjected to high rates of relative sea level change (rise) for centuries in part due to high subsidence rates associated with the compaction and dewatering of deltaic sediment. Some Louisiana marshes have adjusted to these high rates, and still survive in areas where measured rates from tide gauges are over 1 cm per year, and others are experiencing stress which may in part be driven by the relative sea level change. In Louisiana it is well documented that high water events associated with frontal passages and tropical storms and hurricanes deliver most of the sediment that is currently deposited in coastal marshes (Reed 1989; Cahoon et al. 1995), while some freshwater areas will still be able to maintain elevation through underground vegetative growth (Nyman and DeLaune 1991). These factors undoubtedly contribute to sustainability of existing Louisiana marshes and it is not known how marshes will accommodate future increases in relative sea level.

Despite a future increase of habitat switching of low salinity coastal habitats (e.g. freshwater marsh, cypress/tupelo swamp, intermediate swamp) to those that survive under more saline conditions (e.g. brackish and saline marshes), the accelerated rate of land loss across the coast and the narrowing of zones based on differing salinity regimes would result in significant reductions of the brackish and saline marshes under a future without-project condition (**table MR2-3**). Land loss, saltwater intrusion, and marine influences, conditions that would be exacerbated with the loss of the barrier island systems, would result in the narrowing of the broadly delineated zones of coastal habitat types that exist today. As the zones narrow into smaller bands of coastal habitat types, the acreage associated with each coastal habitat type, particularly brackish marsh and saline marsh, would also diminish.

In **table MR2-3**, the percent acreage of each habitat type for existing (Year 0) and future without-project (no action at Year 50) conditions is displayed. In addition, for each subprovince, graphs depict the change in habitat acreage and vegetative productivity for Year 0, 10, 20, 30, 40, and 50, assuming there is no additional action (**figures MR2-10** to **MR2-13**). It is important to note that the significant increases of freshwater marsh in Subprovinces 1 and 2 largely represent the effects from ongoing restoration projects, such as the Davis Pond and Caernarvon Freshwater Diversion projects, especially the running of Davis Pond at an average of 5,000 cfs. The substantial increase in intermediate marsh within Subprovince 3 is likely due to the averaging of salinities across large, predominantly fresh marsh tracts in the salinity/habitat forecasting methodology. Further refinements to habitat distribution methodology may be undertaken to improve forecasting. Finally, **figures MR2-10** to **MR2-13** illustrate that decreases in plant productivity across the entire coast are a function of land loss and mirror the continued trend of coastal land loss throughout the study area (see appendix C HYDRODYNAMIC AND ECOLOGICAL MODELING for more information on plant productivity modeling and calculations).

Table MR2-3. Percent Habitat Composition. *With the Future Without-Project Conditions at Year 0 and Year 50 By Subprovince.*

	Percent Composition						
	Fresh Marsh	Intermediate Marsh	Brackish Marsh	Saline Marsh	Swamp	Water	Upland[1]
Subprovince 1							
No Action Year 0	2.0	4.4	5.0	3.1	9.7	61.8	14.0
No Action Year 50	5.7	2.7	3.9	1.5	9.0	63.2	14.0
Percent Change	185.0	-38.6	-22.0	-51.6	-7.2	2.3	0.0
Subprovince 2							
No Action Year 0	10.1	4.8	3.6	6.6	16.4	40.4	18.1
No Action Year 50	14.2	2.9	0.0	0.0	15.9	48.9	18.1
Percent Change	40.6	-39.6	-100.0	-100.0	-3.0	21.0	0.0
Subprovince 3							
No Action Year 0	12.6	7.1	7.4	4.2	14.3	44.4	10.0
No Action Year 50	1.2	22.8	1.5	0.2	12.4	51.9	10.0
Percent Change	-90.5	221.1	-79.7	-95.2	-13.3	16.9	0.0
Subprovince 4							
No Action Year 0	25.4	20.8	10.1	2.2	0.3	29.8	11.5
No Action Year 50	22.9	17.4	14.8	0.0	0.2	33.2	11.5
Percent Change	-9.8	-16.3	46.5	-100.0	-33.3	11.4	0.0

[1]Approximate percent composition is provided for upland habitat, but uplands were not assessed in the coastal land loss modeling effort, as described in appendix B HISTORIC AND PROJECTED COASTAL LOUISIANA LAND CHANGES: 1978-2050 USGS LAND LOSS.

Note: The "Percent Change" represents the change for each specific habitat class in each subprovince from Year 0 to Year 50 with no action. Future without-project conditions were generated from the ecological modeling efforts described in appendix C HYDRODYNAMIC AND ECOLOGICAL MODELING.

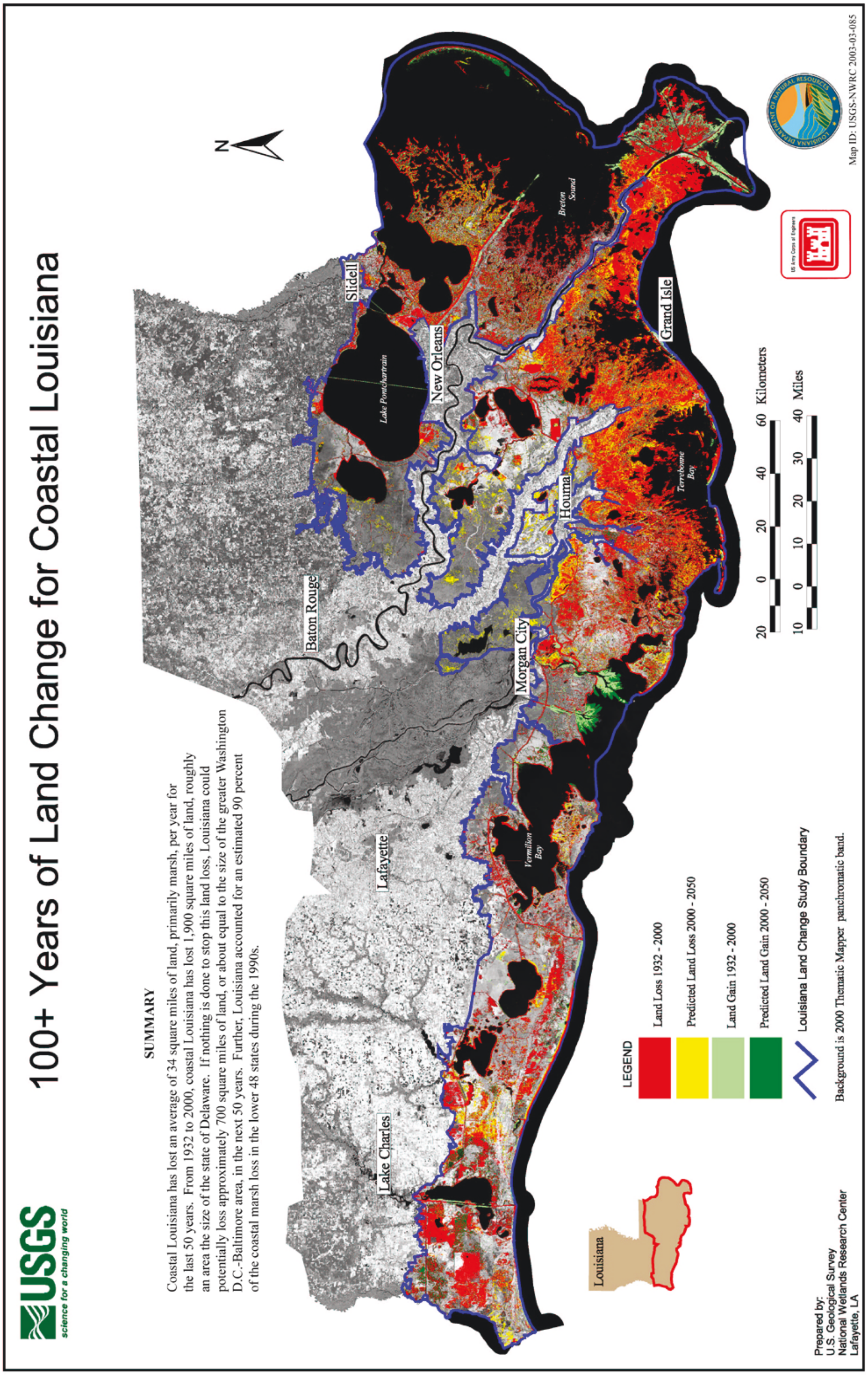
2.2.2.2.2 *Quantification of future land loss*

According to the latest USGS information (see appendix B HISTORIC AND PROJECTED COASTAL LOUISIANA LAND CHANGES: 1978-2050), the projected 2000-2050 land changes are a future land loss of 674 square miles (1,746 square kilometers) and a future land gain of 161 square miles (417 square kilometers). These gains were from the following sources: CWPPRA projects, 54 square miles (140 square kilometers); Caernarvon diversion, 25 square miles (65 square kilometers); Davis Pond diversion, 53 square miles (137 square kilometers); Atchafalaya Delta building, 14 square miles (36 square kilometers); and Mississippi River Delta building, 15 square miles (39 square kilometers). Land gains for Davis Pond and Caernarvon diversion reflect new land created and land projected to be saved from loss by the project's operations over the next 50 years. Thus, the projected net land loss is 513 square miles (1,329 square kilometers) (**table MR2-4**). Estimates of land loss from 1956 to 2050 project gross loss (without projected gain) at 2,199 square miles (5,695 square kilometers) and net loss (with projected gains) at 2,038 square miles (5,278 square kilometers) over this 94-year period. Patterns of past and predicted land loss and gain are illustrated in **figure MR2-9**.

Table MR2-4. Projected Net Land Loss Trends by Subprovince from 2000 to 2050.

	Land in 2000 Mi^2	Projected Land in 2050 Mi^2	Net Land Loss Mi^2	% Land loss between 2050 and 2000	Land Loss Mi^2/yr	% Total loss by area
Subprovince 1	1,331	1,270	61	4.61%	1.26	12%
Subprovince 2	1,114	928	186	16.68%	3.58	36%
Subprovince 3	1,975	1,746	229	11.59%	4.44	45%
Subprovince 4	1,431	1,394	37	2.59%	0.72	7%
Total Mi^2	5,851	5,338	513	8.77%	10.00	100%
Km^2	15,154	13,825	1,329		25.90	

Note that total percentage of land loss is the percentage of total net land loss (513 square miles) in 2050 to the existing land (5,851 square miles) in 2000.


100+ Years of Land Change for Coastal Louisiana
USGS
science for a changing world
SUMMARY
Coastal Louisiana has lost an average of 34 square miles of land, primarily marsh, per year for the last 50 years. From 1932 to 2000, coastal Louisiana has lost 1,900 square miles of land, roughly an area the size of the state of Delaware. If nothing is done to stop this land loss, Louisiana could potentially loss approximately 700 square miles of land, or about equal to the size of the greater Washington D.C.-Baltimore area, in the next 50 years. Further, Louisiana accounted for an estimated 90 percent of the coastal marsh loss in the lower 48 states during the 1990s.
Lake Charles
Lafayette
Baton Rouge
Morgan City
Houma
New Orleans
Slidell
Grand Isle
Lake Pontchartrain
Vermilion Bay
Terrebonne Bay
Breton Sound
Louisiana
LEGEND
Land Loss 1932 - 2000
Predicted Land Loss 2000 - 2050
Land Gain 1932 - 2000
Predicted Land Gain 2000 - 2050
Louisiana Land Change Study Boundary
Background is 2000 Thematic Mapper panchromatic band.
20 0 20 40 60 Kilometers
10 0 10 20 30 40 Miles
N
Prepared by:
U.S. Geological Survey
National Wetlands Research Center
Lafayette, LA
Map ID: USGS-NWRC 2003-03-085

Subprovince 1

In Subprovince 1, saline marsh, brackish marsh, and intermediate marsh areas are all expected to decrease in percentage, while freshwater marsh, swamp, and open water areas are expected to increase by 2050. The increase in water area percentage lessens habitat diversity and is indicative of a net land loss. Overall, habitat is expected to change to a fresher marsh condition. The habitat distribution is expected to continue to reflect a salinity gradient that is predominantly fresh. Land acreage would continue to decrease through Year 50, while plant productivity would initially increase through Year 10, and then decrease through Year 50 (**figure MR2-10**).

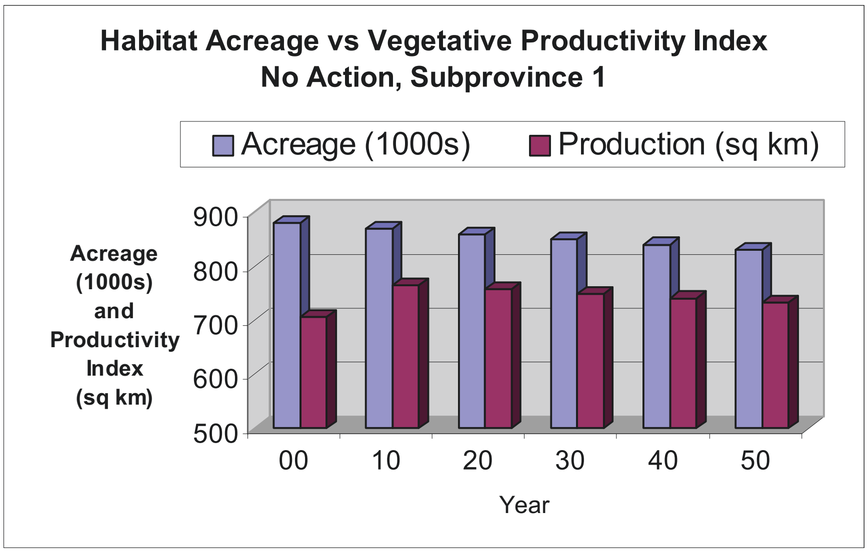


Figure MR2-10. Habitat Acreage and Vegetative Productivity for Subprovince 1 under Future Without-Project Conditions.

Without action, the Maurepas Swamp, which contains extensive cypress swamps, would continue to deteriorate as a result of subsidence, a lack of freshwater circulation, and a lack of riverine influence. Under these conditions, many of the cypress stands would continue to be starved for land building sediment and nutrients, which would prevent regrowth and prevent them from keeping pace with subsidence.

The Central Wetlands, located near the land bridge that separates Lakes Pontchartrain and Borgne, are composed of intermediate and brackish marshes. Without action, intermediate and brackish marshes would continue to be stressed by subsidence and a lack of riverine influence (e.g., freshwater, sediment, and nutrients). In addition, these wetland communities would continue to experience deterioration and loss due to erosion from wave energies in Lake Borgne.

Saltwater intrusion from navigation channels and oil and gas canals would continue to result in the loss of freshwater marshes and accelerated habitat switching from freshwater marshes to intermediate and brackish marshes in the Biloxi Marshes, the Central Wetlands, and the Golden Triangle Wetlands. Farther south and southeast, the intermediate and brackish marshes of Breton Sound would continue to experience deterioration and loss due to subsidence, a lack of freshwater circulation, and a lack of new sediment and nutrients.

Subprovince 2

In Subprovince 2, the percent of acreage in swamp, intermediate marsh, brackish marsh, and saline marsh areas are all expected to decrease while fresh marsh and open water areas are expected to increase by 2050. The increase in open water area indicates a reduction in habitat diversity and a net land loss. Virtually all of the brackish and saline marshes along the central and southern edges of Subprovince 2 would be lost by 2050. The remaining marsh habitat would be freshwater marsh and wetland forest habitats, with some intermediate marsh interspersed within them. A narrow band of brackish marsh habitat is likely to occur along the coastal shoreline. Land acreage would continue to decrease through Year 50, while plant productivity would initially increase through Year 10, and then decrease through Year 50 (**figure MR2-11**).

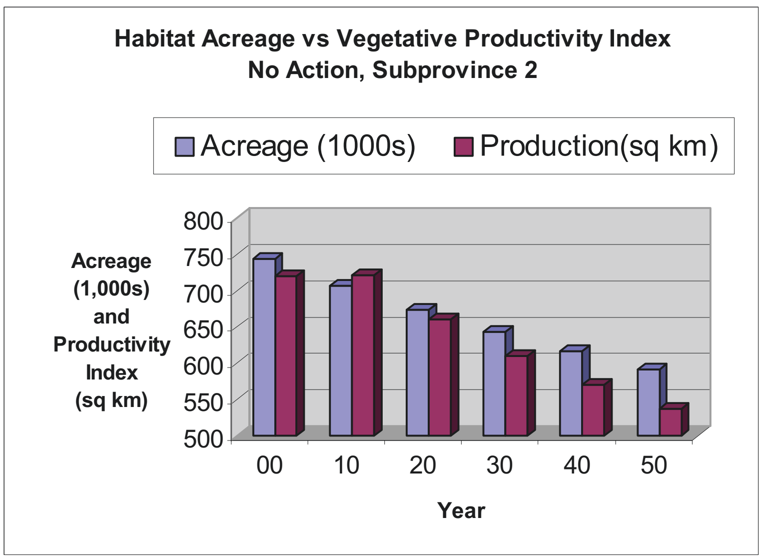


Figure MR2-11. Habitat Acreage and Vegetative Productivity for Subprovince 2 under Future Without-Project Conditions.

Without action, the wetlands surrounding Lac Des Allemands, primarily composed of forested wetlands, would continue to experience severe deterioration and swamp loss due to subsidence, a lack of freshwater circulation, and a lack of riverine influence. Similar to the cypress stands within the Maurepas Swamp in Subprovince 1, the swamps surrounding Lac Des Allemands would continue to be starved for land building sediment and nutrients, which would prevent re-growth and prohibit them from keeping pace with subsidence.

The wetlands in the upper Barataria Basin would continue to deteriorate due to subsidence, saltwater intrusion, and a lack of riverine influence (e.g., freshwater, sediment, and nutrients), while the middle and lower Barataria Basin wetlands would continue to experience severe deterioration and loss due to subsidence, a lack of riverine influence, and increased tidal influences, which would be exacerbated by oil and gas canals and the loss of the barrier island systems. Wetland communities in the west and southwest area of the basin, primarily brackish and saline marshes, would experience the greatest degree of habitat loss because the area is so far removed from the Mississippi River.

Subprovince 3

In Subprovince 3, the percent of acreage in swamp, freshwater marsh, brackish marsh, and saline marsh areas are all expected to decrease while intermediate marsh and open water areas are expected to increase by 2050. The increase in water area percentage indicates a net land loss and loss of habitat diversity. Salinity modeling in the forecasting model shows that a large portion of existing emergent wetland habitat would be converted to open water and more than half of the remaining emergent wetland habitat would likely be converted to intermediate marsh. Land acreage would decrease (**figure MR2-12**).

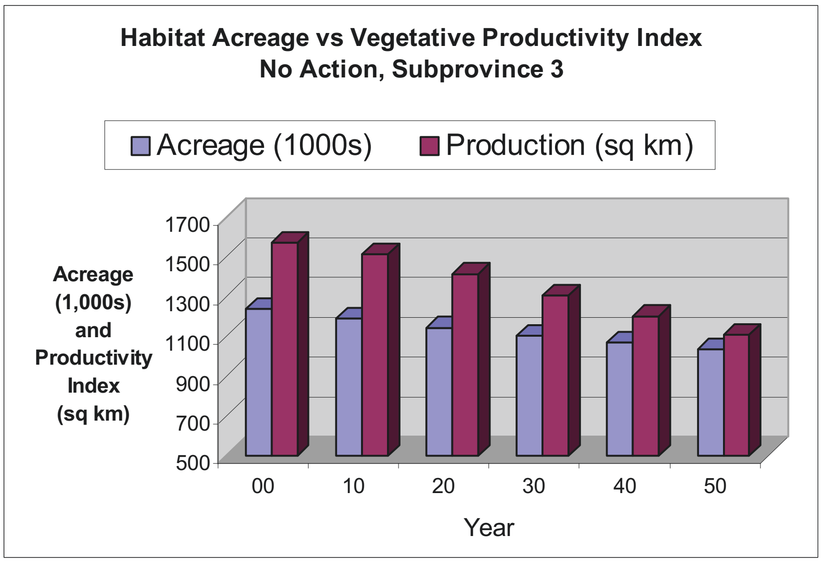


Figure MR2-12. Habitat Acreage and Vegetative Productivity for Subprovince 3 under Future Without-Project Conditions.

Without action, the freshwater, intermediate, and brackish marshes in the northern and eastern areas of Terrebonne Basin would continue to deteriorate and disappear due to the combined effects of subsidence, saltwater intrusion, and a lack of riverine influence. The flotant marshes within the Penchant Basin, located in northwest Terrebonne Basin, would continue to deteriorate due to excessive backwater flooding events from the Atchafalaya River. To the south, the brackish marshes surrounding Lake Mechant would continue to deteriorate due to saltwater intrusion and a lack of riverine influence.

Wetland communities in East Cote Blanche Bay would continue to deteriorate and erode due to increased marine influences, such as wave action. Without action, the intermediate and brackish marshes on Point Au Fer Island would likely deteriorate and be lost as saltwater intrusion and marine influences move through breaches of the gulf shoreline of the island, despite the restoration projects under CWPPRA designed to stabilize portions of the shoreline. These wetland communities are currently sustained by riverine influences from the Atchafalaya River.

Without action, the saline marshes surrounding Caillou Lake, whose salinities are relatively lower than typical saline marshes along the coast, would likely experience increased saltwater intrusion and marine influences resulting from breaches in the land bridge separating the gulf from Caillou Lake. Today, these saline marshes, with their lower salinity levels, allow for open water bottoms to serve as important oyster seed grounds.

Subprovince 4

In Subprovince 4, existing trends are expected to continue with saline marsh, intermediate marsh, fresh marsh, and swamp areas decreasing in percentage while brackish marsh and open water areas increase in percentage by 2050. The increase in water area percentage indicates a net land loss and a change in habitat diversity. Loss of portions of emergent wetland habitat is anticipated by 2050, primarily due to subsidence and hydrologic influences. Land acreage would continue to decrease, while vegetative productivity would increase slightly from Year 0 to Year 10, and then decrease through Year 50 (**figure MR2-13)**.

Without action, the Sabine Lake wetlands, located near the Texas-Louisiana border, would continue to experience severe wetland deterioration and loss due to increased salinity levels and marine influences resulting from the Sabine-Neches Waterway and the GIWW. To the east, the freshwater, intermediate, and brackish marshes surrounding Calcasieu Lake would continue to experience severe wetland deterioration and loss due to increased salinity levels and marine influences resulting from the Calcasieu Ship Channel and the GIWW.

Wetland communities in the Mermentau Basin, located in the eastern portion of the Chenier Plain, would continue to be stressed and lost due to excessive water levels, or ponding. Conversely, the Grand Chenier wetlands, located to the south of the Mermentau wetland communities, would continue to experience deterioration and loss due to saltwater intrusion and a lack of riverine influence.

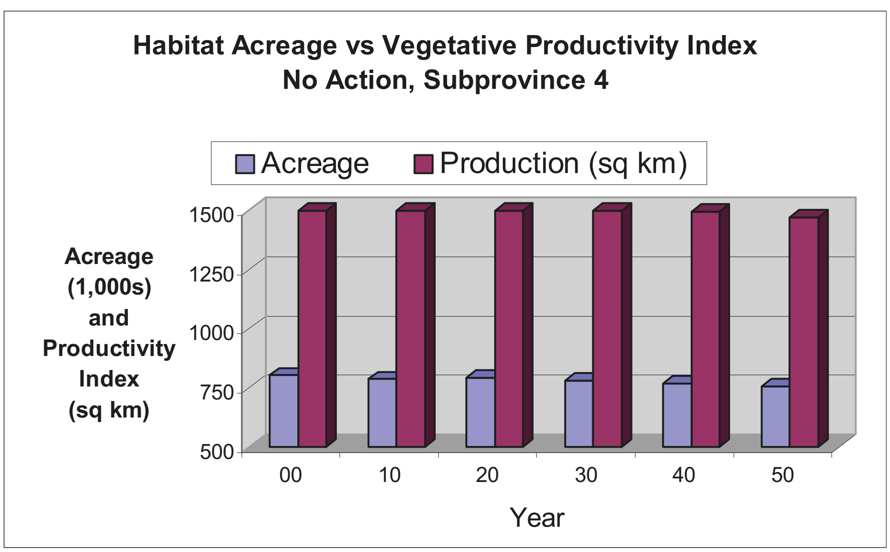


Figure MR2-13. Habitat Acreage and Vegetative Productivity for Subprovince 4 under Future Without-Project Conditions.

Barrier island systems

Without action, barrier island systems would continue to erode and, in many cases, disappear by 2050. Marine influences and tropical storm events would be the primary factors affecting land loss of the barrier island systems. As this land loss trend continues, hydrologic connections between the gulf and interior areas would increase and exacerbate land loss and conversion of habitat type within the interior wetland communities. Without the protective buffer provided by the barrier island systems, interior wetlands would be at an increased risk to severe damage from tropical storm events. In addition, critical habitats for threatened and endangered species and essential and diverse habitats for many terrestrial and aquatic organisms would continue to diminish.

While all the barrier island systems in the study area would continue to experience varying rates of land loss, the greatest occurrence is within the Barataria/Terrebonne shoreline, particularly the Isles Dernieres. Additional information on the barrier island systems can be found in appendix D LOUISIANA GULF SHORELINE RESTORATION REPORT.

2.2.3 Socioeconomic Analysis and Infrastructure

Nearly two million people, representing approximately 43 percent of the state's population, reside within the coastal area. The rich soil conditions, mild climate, natural waterways, and abundance of water and other natural resources have long attracted and supported economic development in coastal Louisiana. The diversified economy that exists in the region today includes oil and gas production and transportation, navigation, commercial fishing, agriculture, recreation, and tourism. Employment has varied widely with periods of rapid growth and contraction; in 2000 there were more than 800,000 jobs in coastal Louisiana. The most influential industries for the study area's economy include: oil, gas, and pipeline; navigation; commercial and recreational fishing and hunting; and agriculture, all of which are essential for supporting Louisiana's economy.

2.2.3.1 Oil, gas, and pipeline

2.2.3.1.1 *Existing conditions*

Louisiana plays an important part in the production of natural gas and crude oil for the Nation. Production of these resources in Louisiana occurs inland, in coastal areas, and offshore. In 2003, over one-third of the Nation's natural gas and more than one-quarter of the crude oil supply was produced in, processed in, or traveled through coastal Louisiana (LDNR 2003b). Louisiana's on-shore production of crude oil has declined by about 30 percent since 1980 although production in the Louisiana OCS has increased steadily since 1990 and now greatly exceeds the onshore production rate (**figure MR2-14**). The state's production of natural gas has remained essentially unchanged (**figure MR2-15**), yet its share of total U.S. production has increased. Interruption of the state's production of these two sources would have adverse socioeconomic impacts across the U.S. If U.S. energy consumption continues to increase and production remains constant, facilities located in the Louisiana coastal area will continue to be relied upon for the importation of additional energy.

Natural gas is the second largest source of energy for the United States. As with crude oil, Louisiana plays an important part in the production of natural gas for the Nation. Louisiana, Texas, and Oklahoma account for over half of all natural gas produced in the U.S. Louisiana produces slightly less total gas than Texas, but the majority of Louisiana production comes from offshore sources. Louisiana's natural gas production is currently greater than the total imported into the Nation.

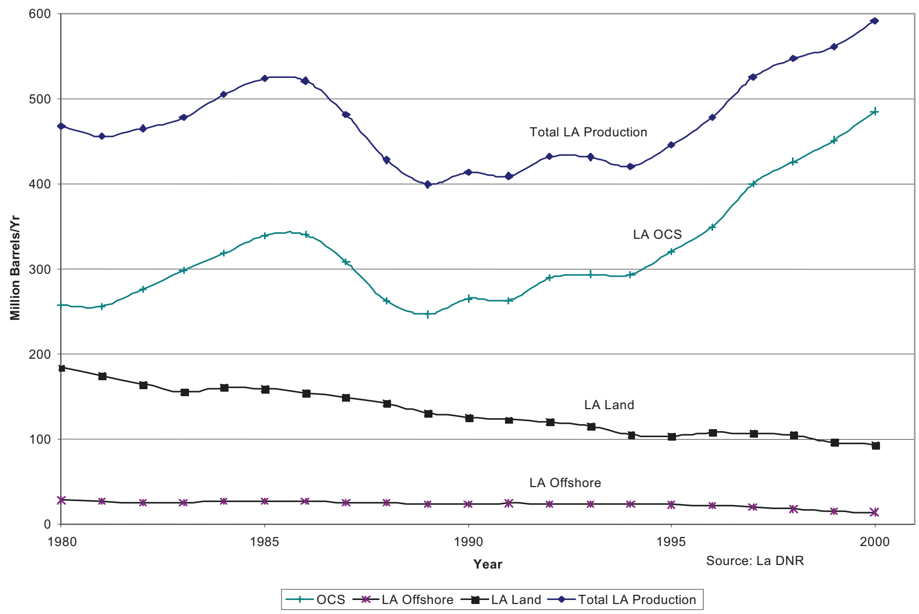


Figure MR2-14. Breakdown and Summary of Louisiana Crude Oil Sources.

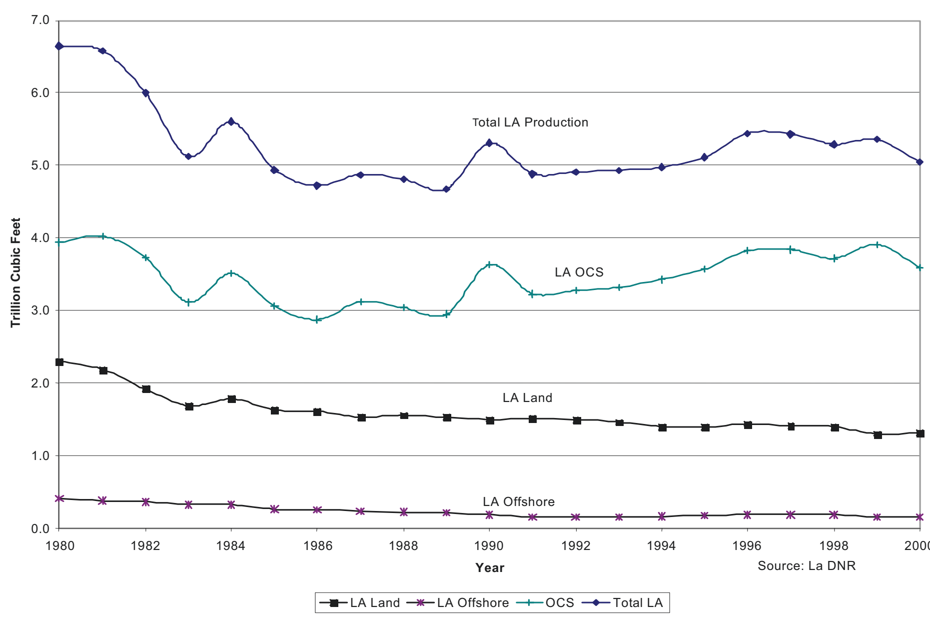


Figure MR2-15. Breakdown and Summary of Louisiana Natural Gas Sources.

Two of the four major storage facilities of the Nation's Strategic Petroleum Reserve are located in coastal Louisiana. Also, the Louisiana Offshore Oil Port (LOOP), 19 miles (30.6 kilometers) southeast of Port Fourchon, is the Nation's only Superport, serving as the central unloading and distribution point for incoming supertankers in the Gulf of Mexico. Louisiana's landscape is criss-crossed with thousands of crude oil, natural gas, and other liquid and gaseous hydrocarbon product pipelines (**figure MR2-16**). There are 13 major crude oil pipelines, 9 major product pipelines, and 13 liquefied petroleum gas pipelines in the state. Eighteen petroleum refineries distill a combined crude oil capacity of more than 2.7 million barrels per calendar day, which is the second highest in the Nation after Texas.

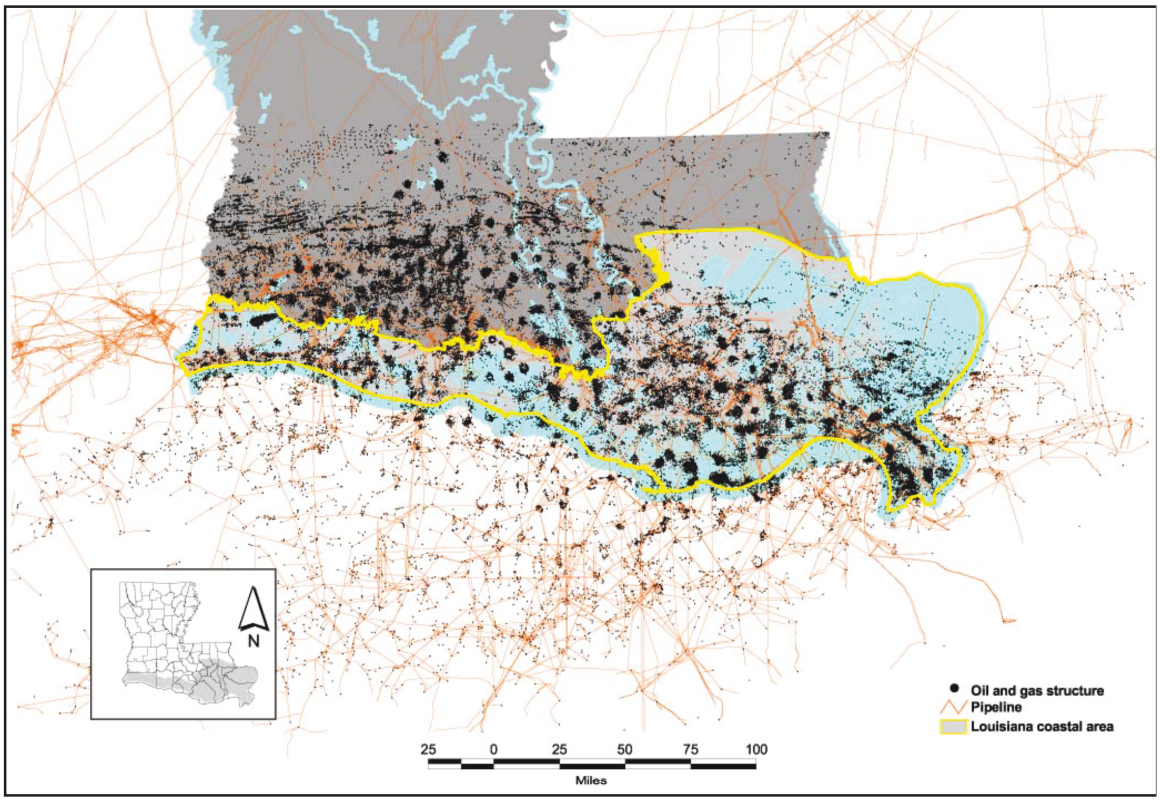


Figure MR2-16. Oil and Gas Structures and Pipelines within the Louisiana coastal area.

A study conducted by the Louisiana Mid-Continent Oil and Gas Association estimated that the direct and indirect impacts of the oil and gas industry on the Louisiana economy totals $92.6 billion. The study also indicated that in Louisiana approximately 341,569 direct and indirect jobs are supported by the industry and that the industry is responsible for more than $12.2 billion in household earnings (13 percent of total in Louisiana).

2.2.3.1.2 *Future without-project conditions*

Most of Louisiana's onshore oil and gas production occurs in the Louisiana coastal area. As previously discussed, this area is at an elevated risk due to the land loss and ecosystem degradation. Loss of wetland, marsh, and barrier islands presents a range of threats to inshore and offshore oil and gas infrastructure. Existing inshore facilities are not designed to withstand excessive wind and wave actions, which would become more commonplace as existing marshes are lost or converted into open bays. In addition, erosion and the subsequent disappearance of barrier islands would allow gulf type swells from tropical storm events to travel farther inland. The combination of these factors would increase the risk to inshore facilities. To address this risk, the oil and gas industry will be faced with the decision to invest in improvements to maintain production/transmission or, conversely, the closure and abandonment of infrastructure.

The offshore oil and gas industry in the coastal area is an important component in meeting National energy requirements. Coastal land losses have, and will continue to have, a negative effect on the extensive pipeline network located in coastal areas. As the open water areas behind the barrier islands increase in size, the tidal exchange volumes and velocities increase in the tidal passes and channels. This action can lead to the scouring away of sediment atop buried pipelines, exposing the pipelines and increasing the risk of failure or damage due to lack of structural stability, anchor dragging, and boat collisions. Resulting production or transmission shortfalls may result in disruptions in the availability of crude oil or natural gas to a significant part of the U.S. As the Caminada Headland continues to erode, Port Fouchon, a major oil and gas port and the terminus of the LOOP pipeline, would be at increased risk.

2.2.3.2 Navigation/shipping

2.2.3.2.1 *Existing conditions*

The ports and shipping lanes of coastal Louisiana serve as vital linkages between producers and consumers throughout the Nation and as gateways for international trade. Two of the Nation's most commercially important waterways in the U.S., the Mississippi River and the GIWW, traverse coastal Louisiana. On a ton-mile transported basis, the Mississippi River carries more cargo than any other navigable waterway in the country (Waterborne Commerce of the United States 2003). In addition, the Louisiana coastal area contains thousands of miles of coastal and inland waterways and numerous ports. The megaports of South Louisiana (stretching 54 miles along the Mississippi River), New Orleans, Baton Rouge, and Lake Charles are consistently ranked 1st, 4th, 9th, and 13th, respectively by annual U.S. port tonnage statistics. These ports handle approximately 14 percent of all U.S. crude oil imports and approximately 57 percent of all grain exports.

The Mississippi River from Baton Rouge to the Mouth of the Passes (Gulf of Mexico) is utilized by a variety of barge and ocean-going vessels and is one of the busiest waterways in the world. The river connects the megaports of South Louisiana, Baton Rouge, and New Orleans to the Gulf of Mexico. These intermodal port facilities support distribution and consolidation of goods and commodities between inland barge traffic, ocean-going vessels, and container facilities for truck and rail.

The GIWW intersects the Mississippi River at the Port of New Orleans. The GIWW provides safe and efficient shallow-draft navigation for all of the gulf states from the Texas/Mexico border to the western shore of Florida. In Louisiana, the GIWW spans 366 miles (589 kilometers) and is utilized by both small and large vessels to reach channels flowing into the gulf. The principle commodities moving on this waterway include chemicals, petroleum products, and crude oil. Many of these products are considered "red flag" (hazardous) cargos and cost less to move via waterway than truck or rail.

2.2.3.2.2 *Future without-project conditions*

A majority of Louisiana's navigable waterways would be adversely impacted without action as marshes and barrier islands that protect waterborne traffic on inland waterways continue to erode. As land adjacent to and connecting these waterways disappears, waterways currently protected would be exposed to wind, weather, and waves found in open bays and the Gulf of Mexico. Additionally, navigation channels that cross open bays may silt in more rapidly or begin to shoal in less predictable ways. The potential impacts to these waterways and the vessels that use them include increased maintenance costs (e.g., dredging), the necessity for higher horsepower vessels to counteract increased currents and wave forces, and increased risk of groundings, collisions, or storm damage to vessels and cargo. Moreover, shoaling causes the thousands of tows that traverse this area annually to slow down, thereby increasing both the transit time and cost of transportation. Due to increased safety concerns, alternate methods of transportation may have to be taken by hazardous commodities now utilizing the GIWW. These impacts would have a corresponding effect on cargo rates, which would affect the local and national economies.

Continued coastal erosion in south Louisiana could also increase the risk of obstruction or closure of the lower Mississippi River to navigation because of siltation or the loss of channel due to hurricane damage. Any closure of the river would result in increased operating costs of the ships waiting to enter or leave port as well as possible higher costs for inventory, additional storage costs, commodity flow restrictions, etc. It is estimated that a 7-day closure of the lower Mississippi River Navigation Channel would result in a loss of approximately $50 million, and a 14-day closure would result in a loss of approximately $200 million. These estimates only include increased operating costs of the ships waiting to enter or leave port. Additional costs would likely occur because of value of inventory, additional storage costs, commodity flow restrictions, etc.

2.2.3.3 <u>Commercial fishing</u>

2.2.3.3.1 *Existing conditions*

Louisiana's coastal estuaries are the most productive in the Nation. This large expanse of coastal wetlands and estuaries provides support during the critical life stages of important commercial species. As such, Louisiana has historically been an important contributor to the Nation's domestic fish and shellfish production, and one of the primary contributors to the Nation's food supply for protein. Dockside revenues in 2002 for commercial fisheries in coastal Louisiana, estimated at $343 million, were the largest for any state in the contiguous U. S. and second only to Alaska (NMFS 2003). They represent over 44 percent of the total dockside revenue for the gulf region and over 10 percent for the entire U.S. The estimated contribution of the commercial fishing industry to the state and National economies is $2.8 billion per year. Commercial fishing supports approximately 31,400 jobs in Louisiana alone.

Shrimp were the most profitable species in terms of Louisiana dockside revenue in 2001, valued at over $188 million. Almost all of the shrimp caught in Louisiana and along the gulf coast have spent key portions of their life cycle living and growing in the Louisiana coastal marshes. In fact, this habitat is critical for their development, making coastal habitats essential to the survival of all shrimp species in the Louisiana coastal area.

The Louisiana fishing fleet had over 14,000 vessels in 2001. Approximately 83 percent of these vessels were boats (under 5 tons) designed for inshore fisheries harvest. In 2001, there were 91 processing plants in the state, employing 2,239 residents, and 105 wholesale plants, employing 749 residents (NMFS 2003).

Important facts regarding the commercial fisheries in Louisiana include:

- The Louisiana menhaden fisheries landings were the largest in the Nation, twice as much as the next closest state. Menhaden is processed to produce both fishmeal and fish oil that is used as a high protein animal feed and for human consumption as an edible fat. In 2001, over 83 percent of the gulf catch and over 55 percent of the total U.S. catch was landed in Louisiana.
- Louisiana led the Nation in eastern oyster production, contributing just under half of the U.S. production. In terms of total (all species) oyster production in the U.S., Louisiana produced 37 percent of the Nation's oyster meats.
- Louisiana produced about 26 percent of the Nation's blue crabs in 2001. As with eastern oyster production, the trend has been for Louisiana to become the largest producer of blue crabs in the Nation.
- Louisiana produces almost half of the Nation's shrimp harvest. Shrimp landings in Louisiana were approximately 125 million pounds (56.8 million kilograms) during 2001, over 45 percent of total landings in the U.S.
- The Louisiana coastal wetland system represents critical breeding grounds for a variety of fish and shellfish species. It is estimated that over 75 percent of Louisiana's commercially harvested fish and shellfish populations are dependent on these wetlands during at least some portion of their lifecycle.

2.2.3.3.2 *Future without-project conditions*

Concurrent with projected land loss would be an increase in saltwater intrusion into the upper estuaries as barrier islands and marshes degrade. This would result in a shift in the populations of fishes and invertebrates, with more saline-dominated species replacing freshwater species. The band of intermediate salinity necessary for oyster production would likely narrow significantly, and essential fish habitat for many commercial fishery species would likewise decline, leading to a net loss in fisheries population size and diversity. Continued hypoxia could also adversely impact commercial fish landings.

Wetland habitat losses would decrease the productivity of Louisiana's coastal fisheries. The seafood industry would likely suffer significant losses in employment as estuaries, which are necessary to produce shrimp, oysters, and other valuable species, erode. Job losses would occur in the areas reliant on fishing, harvesting, processing, and shipping of the seafood catch. Thus, changes in existing fisheries habitat caused by wetland loss, saltwater intrusion, and reduced salinity gradients would likely increase the risk of a decline in the supply of nationally distributed seafood products from Louisiana's coast.

2.2.3.4 Agriculture

2.2.3.4.1 *Existing conditions*

Agriculture is an important component of coastal Louisiana's economy. More than $2.8 billion of crops and livestock were produced in Coastal Louisiana in 2001. The rich deltaic soil and mild climate are conducive to the production of a wide variety of crops, including sugar cane, rice, and soybeans. Much of this agricultural land is considered prime farmland and protected under the Farmland Protection Policy Act of 1981. Approximately 20 percent of the Nation's rice and 37 percent of the Nation's sugar are produced in Louisiana.

Timber production in Louisiana's forested wetlands is an important renewable resource. In 1996, the south delta region of Louisiana produced about 22 million cubic feet of lumber (Stratton and Westbrook 1996).

Agricultural production in the area has traditionally been supported by water obtained from the local bayous, but the bayous have recently begun to experience higher salinity levels, which is detrimental to crop production. In areas where saltwater intrusion has not occurred, the loss of adjacent wetlands and barrier islands makes croplands more susceptible to storm damages.

2.2.3.4.2 *Future without-project conditions*

Salinity levels in water used for crop irrigation is expected to increase in some areas, and with continued land loss, the risk of storm damage to agricultural resources would also increase. As the coastal landscape erodes and tidal surges force higher salinity waters farther inland, many areas would have to counteract this effect by relocating water intakes to more northerly locations or by installing saltwater barriers to protect their existing intakes. These expenses would undoubtedly be passed on to consumers.

Agricultural damages, including losses to crops such as sugar cane, rice, soybeans, pastureland, etc. associated with future without-project conditions were estimated along the Louisiana coast. This study indicated that continued loss of barrier islands and wetlands would increase the risk of storm damage to agricultural resources. The loss of agricultural productivity associated with reduced amounts of freshwater available for crop irrigation and increased risk of storm damages would result in adverse economic impact to Louisiana and the Nation.

2.2.3.5 Recreation

2.2.3.5.1 *Existing conditions*

The abundance of natural and cultural resources in the Louisiana coastal area supports a vast number and diversity of recreational activities. The present day recreational activities are deeply rooted in historical, vocational, and cultural traditions of southern Louisiana. The hundreds of local and regional festivals celebrated throughout the coastal area exemplify this with their focus on harvests of rice, sugar cane, shrimp, crawfish, oyster, and alligator. Other festivals celebrate the birds that pass through the state. The festivals also celebrate cultures and heritages such as Cajun, Native American, African American, and many European cultures.

The study area is also rich in renewable resources and serves as home to thousands of wildlife species that attract individuals for many types of recreational activities. From Texas to Mississippi, the recreating public has access to fresh, estuarine, and marine resources for fishing, hunting, boating, swimming, camping, bird watching, crabbing, and crawfishing. Additionally, the USFWS manages more than 300,000 acres (121,458 ha) of NWR lands in coastal Louisiana on behalf of the public. Traditional non-consumptive recreation includes, but is not limited to, tennis, golf, zoos, aquariums, baseball, picnicking, biking, cycling, RV-ing, camping, hiking, wildlife viewing, photography, and other activities. Nearly half of Louisiana's campgrounds, state historic sites, national historic parks, NWRs, WMAs, state parks and commemorative areas, important bird-watching areas, and other sites of interest are scattered throughout the coastal area.

Sportspersons and wildlife watchers across the U.S. spend $110 billion annually, 1.1 percent of the Nation's gross domestic product. Various studies have indicated that recreational fishing in Louisiana accounts for between $703 million and $1.2 billion per year in total expenditures (USFWS 2002; Gentner et al. 2001). Preliminary findings in the State of Louisiana, from the USFWS 2001 National Survey of Fishing, Hunting and Wildlife-Associated Recreation, show that in 2000, 718,716 sportspersons participated in fishing and 3.8 million recreational fishing trips were made, with expenditures of $1.2 billion. Total hunting expenditures by Louisiana hunters in 2001 were $446 million, with big game expenditures comprising over half of the total. Wildlife-watching participants numbered 802,000 state residents and 38,000 non-state residents, with expenditures of $168.4 million. In this region of the country, 19 percent of the population are anglers, 9 percent are hunters, and 25 percent of the population participates in wildlife watching activities.

Americans traveling to Louisiana spent approximately $8.1 billion in 2001. This supported over 113,000 jobs in the state with annual income of about $1.8 billion. Tax revenues associated with recreation and tourism in Louisiana were about $1.1 billion for all levels of government. Thus, tourism is an important resource in the state of Louisiana.

2.2.3.5.2 *Future without-project conditions*

Recreational resources in the Louisiana coastal area that would be most affected in the future without-project condition are those that would be impacted by loss of wetlands and reduced habitat diversity and include some NWR lands managed by the USFWS in coastal Louisiana. Many recreational activities are based on aquatic resources and directly related to the habitat and species in an area. At the projected rate of land loss, the coastal area would experience the loss of 513 square miles (1,329 square kilometers) of existing marsh and swamp by 2050. Habitat changes affect wildlife populations, thereby affecting many recreational resources.

In general, wildlife abundance trends indicate a decrease in wildlife numbers where high rates of land loss occur and an increase in wildlife numbers where freshwater input or land building, often resulting from restoration projects, occurs. The populations of migratory birds and other animals directly dependent on the marsh and swamp would decrease dramatically, an impact which would be felt in much of North America. With the continued conversion of marsh to open water, fishery productivity (particularly estuarine-dependent species) is expected to peak, followed by a sharp decline.

The coastal area's changing environment would affect the recreational resources within that area. Where populations of freshwater or saltwater species decline, so would fishing (including crawfishing, crabbing, and oyster harvesting) opportunities. In areas where the populations of game species fluctuate, so would the hunting opportunities. As populations of migratory birds are affected, so would the opportunities for viewing them.

As existing freshwater wetland areas convert to saltwater marsh, then to open water, the recreational opportunities would change accordingly. For example, freshwater fishing opportunities may become saltwater opportunities. If the expected peak and subsequent decline of fishery production occurs in these open waters, the associated marine fishery recreational opportunities would also decline. As populations of migratory birds and other animals dependent on marsh and swamp decrease, associated recreational opportunities, such as hunting and wildlife viewing, would decrease.

Another major impact of land loss would be the possible loss of facilities and infrastructure that support or are supported by recreational activities. Land loss and the increased risk of storm damage can directly result in the loss of boat launches, parking areas, and access roads, as well as marinas and supply shops. The loss of access features, such as roads and boat launches, would directly impact the public's ability to recreate.

2.2.3.6 Cultural resources

The USACE is obligated under the National Historic Preservation Act (NHPA), as amended (16 U.S.C. 470 et seq.), and NEPA to take into account the effect its undertakings have upon cultural resources within a given project area. Under these laws and regulations, the USACE assumes responsibility for the identification and evaluation of all cultural resources within the project boundaries. In addition, the USACE must afford the State Historic Preservation Officer (SHPO), and on occasion the Advisory Council on Historic Preservation (ACHP), the opportunity to review and comment upon proposed undertakings and associated cultural resource investigations.

2.2.3.6.1 *Existing conditions*

Humans have made a progressive mark on the lower Mississippi Valley and coastal Louisiana for thousands of years. Archaeological remains found in Louisiana indicate that man has occupied the area since around 10,000 B.C., primarily as nomadic hunter-gatherers that migrated with the fluctuations of the Mississippi River. European settlement of the lower Mississippi Valley and coastal Louisiana began between 1698 and 1763. During that time, permanent settlements were established along the primary means of transportation in the area, the Mississippi River. As population along the Mississippi River increased, land along its natural levees became scarce and new settlements began to be established on other waterways such as bayous Lafourche, Teche, and Terrebonne, and the Vermilion River. Shortly after European settlement along the Mississippi River and other waterways, the network of levees and canals currently used across coastal Louisiana for flood control and navigation began to take shape.

As previously mentioned, the diverse resources available in coastal Louisiana have led to a diverse history and rich culture in the Louisiana coastal area. As a result, cultural resources are abundant in the area. Over the last 50 years, as land loss has progressed and saltwater intrusion has increased, many of these cultural resources have been put at risk or lost to erosion, inundation, and construction of canals.

The 20 coastal parishes of the LCA study area contain thousands of cultural resources. The Louisiana State Historic Preservation Office is charged with the responsibility of maintaining the central files of all the archaeological and historical standing structures data. All cultural resources survey reports and forms conducted under the NHPA are archived in their offices in Baton Rouge.

2.2.3.6.2 *Future without-project conditions*

As inland marshes and barrier islands erode or subside, cultural resources existing on them could be exposed to elements or inundated, putting them at a greater risk of damage or destruction. Resources could also be adversely impacted over time by an increased risk of storm damage as barrier islands and marshes continue to degrade. Cultural resources would continue to be affected as historical and archaeological sites are exposed to these forces.

2.3 PROBLEMS, CRITICAL NEEDS, AND OPPORTUNITIES

2.3.1 Problems

The natural processes of subsidence, habitat switching, and erosion of wetlands, combined with a widespread human alteration, have caused significant adverse impacts to the Louisiana coastal area, including increased rates of wetland loss and ecosystem degradation. Without action, Louisiana's healthy and highly productive coastal ecosystem, composed of diverse habitats and wildlife, is not sustainable. Construction of levees along the Mississippi River has cut the coastal ecosystem off from a primary source of sediment and nutrients, and hindered the wetlands' ability to maintain their elevation in the face of sea level change and subsidence. This accompanying reduction of freshwater input has enabled saltwater to intrude into more sensitive freshwater habitats. Confinement of the Mississippi River to a channel has also resulted in the bed sediment load of the river being deposited in progressively deeper waters of the Gulf of Mexico; from these locations the sediment cannot efficiently nourish the coastal barrier shorelines. These shorelines are starved for sediment and are retreating. Infrastructure constructed for access into and across the wetlands has modified the hydrology of the coastal area, thus facilitating and accelerating saltwater intrusion and conversion of wetlands to open water. In addition, there has been a decline in the measured sediment load delivered by the Mississippi River from the rest of the drainage basin in the last 50 years.

These alterations have impacted the natural sustainability and quality of the Louisiana coastal ecosystem. This loss of sustainability has manifested itself as accelerated land loss. If recent loss rates continue into the future, even taking into account current restoration efforts, coastal Louisiana is projected to lose an additional 328,000 acres (13,284 ha) of coastal marshes, swamps, and barrier islands by the year 2050. Today, the high biological productivity of the coastal wetlands, most visibly expressed in abundant waterfowl and commercial and recreational fishery resources, masks the potential for a downward trend in biological productivity and coastal ecosystem health. The best available science on deltaic processes illustrates that biological productivity is highest during periods of wetland conversion and degradation, and that the current level of high biological productivity is unsustainable (**figure MR1-7**). Unless the trend of accelerated land loss is reversed, the health and productivity of the coastal ecosystem cannot be sustained.

The loss of wetlands could result in ecosystem conversion to open water by placing the following ecosystem functions at risk:

- Vegetative habitat suitability and community diversity;
- Elevational maintenance and soil contribution from decomposing organic material;
- Protection against substrate erosion;
- Water quality improvement;
- Nutrient uptake and carbon sequestration;
- Important nursery habitat;
- North American Central Flyway and North American Mississippi Flyway waterfowl wintering habitat; and
- Resting and feeding areas for neotropical migrants.

The abundance and diversity of aquatic and terrestrial habitat types affects the biological productivity of the fish and wildlife resources in the estuarine-marsh complex. Measurement of the relationship between habitat and productivity of all resources is difficult and can best be discussed primarily in qualitative terms; that is, a beneficial or an adverse change in environmental conditions is followed by a corresponding change in productivity. However, the relationship of marsh vegetation to the productivity of the commercial fish and wildlife resources has been documented. Biologists generally agree that habitat reduction would be accompanied by diminished harvests (Craig et al. 1979). Shrimp and menhaden yields have been correlated directly to the area of intertidal wetlands (Turner 1979). Neotropical and other migratory avian species have been shown to depend on habitats that are in need of restoration and management in the coastal area (Barrow et al. 2000; Helmers 1992).

Land loss and ecosystem degradation also threaten the continued productivity of Louisiana's coastal ecosystems, the economic viability of its industries, and the safety of its residents. The following valuable social and economic resources could be impacted:

- Commercial harvest of fishery resources;
- Oil and gas production;
- Petrochemical industries;
- Recreational saltwater and freshwater fisheries;
- Ecotourism;
- Agriculture;
- Strategic petroleum reserve storage sites;
- Flood control, including hurricane storm surge buffers;
- Navigation corridors and port facilities for commerce and national defense; and
- Actual and intangible value of land settled 300 years ago and passed down through generations.

2.3.2 Critical Needs

The cumulative effect of human activities, both past and present, has been to tilt the balance between land building and land loss in the direction of net land loss. The reintroduction of riverine processes and resources, as well as the management of activities within the coastal area consistent with the objectives of wetland restoration, is needed to achieve a balanced and sustainable system. Consistency in operation and management of all existing and future measures and activities to optimize multiple system outputs would be required to ensure the success of any restoration program.

Critical needs in the study area include:

Prevent future land loss where predicted to occur

Addressing this need would create and sustain diverse coastal habitats, sustain wildlife and plant diversity, and sustain socio-economic resources. Effective measures to reverse coastal land loss should affect plant communities, in their root zone, in such a way as to promote healthy growth and reproduction, plant succession, or revegetation of denuded surfaces. Increasing nutrients and sediment in the estuarine area would increase the growth of marsh vegetation and slow the rate of land loss. Increased plant growth would result in greater production of organic detritus that is essential for a high rate of fisheries and wildlife production. Production of phytoplankton and zooplankton would increase in areas where turbidity is not limiting, and, as a result, the harvest of sport and commercial finfish and shellfish that depend on these microorganisms would increase.

Restore fundamentally impaired or mimic deltaic processes through river reintroductions

Addressing this need would reduce habitat deterioration by increasing nutrients and sediment delivered to the estuarine-marsh areas, which would increase marsh vegetation sustainability and improve fish and wildlife production. In addition, restoring riverine influences to coastal wetlands and creating wetlands would help address the need to reduce the nutrient loading into the northern gulf and to reduce the hypoxic zone. This need can be met by restoring or mimicking distributary flows, crevasses, and over-bank flow, as well as mechanical marsh creation with river sediment, if sustained by freshwater diversions.

Restore or preserve endangered critical geomorphic structures

Addressing this need would restore geomorphic structures, such as natural levee ridges, lake rims, land bridges, gulf shoreline barrier islands, barrier headlands, and chenier ridges. These features are essential to maintaining the integrity of coastal ecosystems because they are an integral part of the overall system and in many instances represent the first line of defense against marine influences and tropical storm events.

Protect vital local, regional, and national socio-economic resources

Addressing this need would reduce the increased risk of damage to cultures, communities, infrastructure, business and industry, and flood protection. Accelerated land loss and ecosystem degradation places over $100 billion of infrastructure at increased risk to damage as a result of storm events. This need could be met by increasing the marsh's capacity to buffer hurricane-induced flooding through wetland creation and sustenance and retention of barrier island systems.

2.3.3 Opportunities

The resources of the Mississippi River system remain available to contribute to the restoration of the coastal Louisiana ecosystem. The Federal Government and State of Louisiana have been conducting ecosystem restoration efforts for the past 14 years under the CWPPRA. In addition, the scientific community in Louisiana is recognized internationally for their expertise in climate and wetland research. The lessons learned and extensive experience gained from past restoration and research efforts have been applied in the LCA Study and can continue to be applied in a systematic way to develop and implement a coast wide plan for addressing the land loss problem and critical needs facing coastal Louisiana. Opportunities for ecosystem restoration include:

- Freshwater reintroductions and outfall management - Diverting water from the Mississippi River into hydrologic basins can 1) nourish existing marshes to increase their productivity and build wetlands in areas of open water, 2) potentially reduce the extent of the hypoxic zone in the gulf, 3) help satisfy the need for maintaining salinity gradients that correspond to the diversity of vegetative habitat, and 4) reintroduce and distribute sediment and nutrients throughout the ecosystem;

- Barrier island restoration, through placement of sand from offshore sources or the Mississippi River, could sustain these geomorphic structures, which would provide additional protection from hurricane storm surges and protect the ecology of estuarine bays and marshes by reducing gulf influences, as well as protect Nationally important water bird nesting areas;
- Hydrologic modification, such as degrading excavated dredged material banks or re-establishing ridges or natural banks, can help restore salinity and marsh inundation patterns and provide fishery access in previously unavailable habitats; and
- The use of sediment material from dedicated dredging or maintenance dredging (e.g., beneficial use) to create a marsh platform can create large amounts of coastal habitat quickly.
- Many of the above techniques can be applied in combination to produce synergistic effects while minimizing disruptions to the surrounding ecology and economy (e.g., dedicated dredging in conjunction with a small river diversion to increase the sustainability of the created marsh).

By applying ecologically sound principles and restoration methods developed in recent years, and through improved understanding of coastal system processes and ecosystem responses to restoration projects, there is an opportunity available for Louisiana and the Nation to reverse the current trend of land loss and move the Louisiana coastal area ecosystem toward a sustainable future.

2.3.3.1 Freshwater and sediment diversions

There is an opportunity to use riverine resources, such as freshwater, sediment, and nutrients, transported down the Mississippi River and its distributaries to reverse coastal land loss, restore hydrologic connectivity, and improve ecosystem function. Controlled diversions into marshes with water depths averaging about 5 feet (1.5 meters) or less would require relatively less sediment for each acre (hectare) of new land and would likely be more effective in counteracting land loss than the building of sub-deltas in relatively deep water. Mimicking crevasses through reintroductions into waters with depths of approximately 12 feet (3.7 meters) may be a practical and effective means of creating land in bays and sounds adjacent to the Mississippi River, but would require substantially more sediment for each acre (hectare) of marsh created.

In creating new land, it is not desirable to completely fill the receiving water bodies. Rather, it would be more desirable to transform large lakes and bays into a series of interconnecting ponds with shallow water depths. Judicious spacing of the sub-delta lobes would substantially increase the land/water interface, which is more attractive to marsh and estuarine life forms. The introduction of sediment should be carried out periodically. This would allow plants and animals to enter and establish themselves in the newly made areas shortly after the land is formed.

In addition to freshwater diversions, hydrologic restoration can also be accomplished through salinity control management in areas where riverine sources are less abundant, such as in the Chenier Plain.

2.3.3.2 Beneficial use of dredged materials

The beneficial use of dredged material can also reduce land loss. The USACE-Mississippi Valley, New Orleans District (District) excavates an average of 70 mcy (53.5 million cubic meters) of material annually in maintenance dredging of navigation channels. A major portion of this volume is either re-suspension or hopper dredged material, however, and is therefore not available for beneficial placement. The District, along with other Federal and state local cost sharers, has beneficially placed dredged material to create over 18,000 acres (7,200 hectares) of land between 1976 and 2003..

Sediment will be tested as appropriate on a project specific basis. Furthermore, the Clean Water Act 404 (b)(1) Guidelines (40 CFR 230) are the environmental criteria for evaluating the proposed discharges of dredged or fill material into waters of the U.S. Compliance with these guidelines is the controlling factor used by the USACE to determine the environmental acceptability of disposal alternatives. The USACE must demonstrate through completion of a 404 (b)(1) evaluation that any proposed discharge of dredged material is in compliance with the Guidelines.

2.3.3.3 Nearshore and offshore sand resources

Barataria offshore sand resources

Identification of sand resources to support the coast wide restoration of Louisiana's barrier islands and back-barrier marshes requires finding large volumes of high-quality sand and developing cost-effective delivery systems to move these materials. The recent cooperative study by the USGS, the University of New Orleans, and USACE (Kindinger et al. 2001) as part of the Barataria Feasibility Study provides such information for the offshore Barataria Basin area.

Seismic and sonar interpretations, verified by geologic core samples, confirm that there are several nearshore sand bodies within the Barataria offshore area that meet or exceed the minimum criteria for potential mining sites. These sand bodies potentially contain between 396 and 532 mcy (303 to 407 million cubic meters) of sand and can be characterized into surficial and buried sites. However, while these potential sand sources consist primarily of fine sand, a full 90 percent of the sand body areas will need almost 570 mcy (436 million cubic meters) of overburden removed if the entire resource is mined. Kindinger et al. (2001) recommend using the sand for barrier island shoreface restoration and the overburden to build back-barrier platforms for marsh restoration. The researchers also recommend consideration of Ship Shoal as an alternative resource.

Terrebonne/Timbalier offshore sand resources (Ship Shoal)

Ship Shoal, the largest submerged shoal off Louisiana, is a sand body located on the south-central Louisiana inner shelf about 9.5 miles (15.3 kilometers) seaward of the Isles Dernieres. Ship Shoal is approximately 31 miles (50 kilometers) long and 3 to7.5 miles (4.8 to

12.1 kilometers) in width, with relief of up to 12 feet (3.6 meters). Water depth ranges from 23 to 30 feet (7 to 9 meters) on the eastern side of the shoal to approximately 10 feet (3 meters) over the western reaches (Penland et al. 1986). It is composed primarily of well-sorted quartz sand, a benthic substrate not commonly found on the Louisiana inner shelf (Stone 2000) and, as the name implies, may have significant historical sites associated both within and on its surface. The Minerals Management Service (MMS) recently completed an environmental assessment on proposed dredging of sand from Ship Shoal for coastal and barrier island restoration projects and for flood levee construction. This analysis determined that the proposed action to dredge and emplace sand from Ship Shoal would not significantly affect the quality of the human environment.

2.3.3.4 Availability of coastal wetlands to remove nutrients

In January 2001, the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force issued the *Action Plan for Reducing, Mitigating, and Controlling Hypoxia in the Northern Gulf of Mexico* (Action Plan). According to the Action Plan, restoring and enhancing de-nitrification and nitrogen retention in the Mississippi River Basin, including the Deltaic Plain in southeastern Louisiana, are the primary approaches for reducing gulf hypoxia. Mitsch et al. (2001) also identify Mississippi River diversions as a tool for reducing gulf hypoxia, and estimate that potential nitrate reduction using diversions "is probably limited to less than 10 percent to 15 percent of total flux in the river."

Preliminary results of earlier coastal area water quality modeling efforts (see appendix C HYDRODYNAMIC AND ECOLOGICAL MODELING) along with existing literature on the subject (Mitsch et al. 2001) suggest that large-scale river diversions may contribute significantly to the National effort to reduce hypoxia in the northern Gulf of Mexico. Because some river diversion features evaluated during plan formulation are relatively small, implementation of such projects would likely result in nutrient reductions that are small in comparison to total nutrient inputs from the Mississippi River to the gulf. Implementation of a LCA Plan would, however, provide an excellent opportunity to add to our understanding of the effectiveness of river diversions in reducing nutrient inputs from the Mississippi River to the Gulf of Mexico, while also further studying any potential adverse effects of such projects. In this way, the lessons learned from implementation of the river diversion features could facilitate large-scale river diversion projects in the future, along with the potentially significant nutrient reductions such projects might provide.

This page intentionally left blank.

3.0 PLAN FORMULATION

3.1 PLANNING CONSTRAINTS

The development and evaluation of restoration alternatives within coastal Louisiana was constrained by several factors. Foremost among these factors was the fundamental premise that restoration of deltaic processes would be accomplished in part, through reintroductions of riverine flows, but that natural and historical "channel switching" of the Mississippi River would not be allowed to occur. The availability of freshwater, primarily water transported down the Mississippi River, was considered a planning constraint because minimum levels or water flows are required to maintain navigation, flood control, and public water supply, and limit saltwater intrusion. The availability of sediment for restoration efforts was also considered a planning constraint for this study because there is not an unlimited, easily accessible, and low-cost source for restoration efforts.

Another significant category of constraints is the scientific and technological uncertainties inherent in large-scale aquatic ecosystem restoration projects. While many of these were known as the plan formulation process began, others became more evident as the formulation process was completed. A summary of the key scientific uncertainties and technological challenges as they are currently understood, along with proposed strategies to address these uncertainties and challenges, is presented below.

3.1.1 Scientific and Technological Uncertainties

Scientists have documented the importance of the Louisiana coastal area for fish and wildlife habitat (Coalition to Restore Coastal Louisiana 1989; Keithly 1991; Herke 1993; Michot 1993; Olsen and Noble 1976), estuarine productivity (Morris et al., 1990), and ecological sensitivity to human activity (Templet and Meyer-Arendt 1988; McKee and Mendelssohn 1989; Reed 1989). This recognition has resulted in considerable efforts to investigate and understand the complex physical (Morris et al. 1990), chemical (Mendelssohn et al. 1981; Morris 1991), and ecological (Montague et al. 1987) processes that drive the system, providing Louisiana with a rich history of scientific studies. Studies on understanding relationships between different habitats and different aquatic species (Minello and Zimmerman1991) have been conducted due to the importance of the Louisiana coast's support to numerous estuarine dependent fish and its ability to provide important nursery habitat for diverse fish communities. The coastal areas have also been important for wintering waterfowl with several studies conducted to understand relationships between waterfowl use and habitat conditions. Oil and gas exploration and production have prompted numerous studies on subsurface geologic conditions. Additional geologic conditions have been investigated to aid in understanding deltaic processes that have shaped the Louisiana coast (Fisk 1944; Kolb and Van Lopik 1958; Frazier 1967; May 1984; Smith et al. 1986; Penland et al. 1988a, 1988b, 1988c; Dunbar et al. 1994; 1995). Studies on the Atchafalaya River and delta have also contributed to our understanding of deltaic processes (USACE 1951; Fisk 1952; Shlemon 1972). In addition, numerous studies performed in other ecosystems are applicable in understanding the ecology and function of the Louisiana coastal area. The results of these investigations provide considerable understanding of the physical, chemical, and biological processes that formed and sustain the Louisiana coast. The numerous state-sponsored studies generated from CWPPRA have developed basic trend information over the past 14 years. Studies funded by the National Science Foundation and others have aided in an understanding of impacts and have provided recommendations for improved operations for some existing diversion projects.

The LCA Study builds upon the best available science and engineering knowledge, which has resulted in part from the work described above. However, many of the studies conducted in the Louisiana coastal area have been limited in geographic extent or technical scope. Therefore, while previous research efforts have contributed to a strong understanding of the processes affecting the Louisiana coastal area, scientific and technical uncertainties still remain. Additional investigations to further reduce the scientific and technical uncertainties and to enhance the likelihood that restoration projects will successfully meet restoration goals would be necessary during LCA Plan implementation. The use of newer techniques like geospatial technology (e.g. GIS and remote sensing) should be investigated to determine their capabilities in answering areas of uncertainty. It is expected that geospatial technologies will be able to answer many of the uncertainties associated with the LCA Study. The LCA Project Delivery Team (PDT) reviewed annual Adaptive Management reports prepared to assess previously constructed CWPPRA projects. These efforts are an extension of the existing monitoring program used to identify "lessons learned" from the many CWPPRA projects, past and future, and will also serve as a valuable assessment of "what worked" and "why it worked" on projects that have been built long enough to provide useful data. Identification of the reasons why other projects did not meet initial project goals is also essential to reduce uncertainties.

This discussion on scientific and technological uncertainties is intended to illustrate that considerable information has been developed from prior studies, but that data gaps still exist and considerable scientific and engineering uncertainties remain. The PDT recognized the uncertainties and conducted plan formulation and evaluation with this recognition. The discussion that follows details the different broad types of uncertainties, with appropriate actions to resolve them during LCA Plan implementation.

3.1.2 Types of Uncertainty and Resolution Strategy Within the LCA Plan

There are numerous types of uncertainties that need to be addressed to support and improve Louisiana coastal area restoration efforts. Each uncertainty requires a different resolution strategy, based on the effects of the uncertainty on the program, degree of uncertainty, cost of addressing the uncertainty, and importance of reducing the uncertainty. Some of the known and most relevant uncertainties associated with the LCA Program are listed below, grouped by type of uncertainty. Many of these reflect uncertainties and engineering challenges inherent in all large-scale coastal restoration efforts. Most important in this discussion are the strategies presented to resolve the four uncertainty types presented.

3.1.2.1 Type 1 - Uncertainties about physical, chemical, geological, and biological baseline conditions

The existing knowledge base regarding baseline conditions is sufficient (low uncertainty) to facilitate construction of many of the restoration features evaluated in the LCA Study. Continued improvement of tools, networks, and the acquisition of data to better establish these baseline conditions would allow for more detailed and coast wide monitoring and assessment, which would better support program level, as well as project level, Adaptive Management, described in appendix A SCIENCE AND TECHNOLOGY PROGRAM. Some specific examples of uncertainties and potential investigations designed to reduce the uncertainties are:

- *Determine quantity and quality of Mississippi River resources (sand, silt, clay, nutrients, water) available for restoration efforts.* Because the USACE and USGS have collected hydrologic stage, discharge, and water quality data for the Mississippi River and its distributaries for many years, there is a general understanding of flow volumes down the Mississippi and Atchafalaya channels. However, additional detailed analyses of the seasonal availability and qualities of the water/sediment stream would be necessary to make strategic decisions about resource allocation within the system.

- *Determine relative sea level change due to subsidence and the processes that contribute to the overall rate of change within the coastal region.* Accurate elevations across the coastal area are necessary for documenting and modeling subsidence and sea level change. Processes that contribute to subsidence include, but are not limited to, consolidation, faulting, fluid withdrawal, and regional tectonic movement. Considerable work to address these processes has been done for specific locations of the coast.

  In 1996, as part of the Morganza to the Gulf Feasibility Study, a contract report was prepared entitled "Datum Epochs, Subsidence and Relative Sea Level Rise for Southeastern and South-Central Coastal Louisiana." In 1995, BTNEP gathered elevation data in the Barataria Basin and Terrebonne Parish to evaluate subsidence rates. These data were compared to those in the feasibility report and a 1987 USACE funded report entitled "Terrebonne Marsh Subsidence Study." Subsidence is expected to magnify flooding problems for Terrebonne and Lafourche parishes in the future.

  Although these studies provide valuable insight to subsidence rates in selected portions of the coastal area, other portions of the coast are not as well characterized. Currently, local, state, and Federal agencies, as well as private industry, are working closely with the National Geodetic Survey (NGS) to establish a network of NGS High Accuracy Reference Network (HARN) monuments, NGS horizontal control monuments, and NGS vertical benchmarks using Global Positioning System (GPS) equipment to determine accurate horizontal and vertical positions relative to North American Vertical Datum of 1988 (NAVD 88) to meet the standards set forth by NOAA. Once the GPS data are adjusted, the benchmarks will be published by NGS.

This network of benchmarks will be used to help determine the processes contributing to subsidence at site-specific areas across the coast and the rates of subsidence. This information will be a critical component to future modeling efforts, which would influence future project design, cost, and success.

- *Collect detailed bathymetric data throughout the coast.* Information from the studies discussed above for subsidence also provides valuable insight into bathymetry of segments of the coastal area. Several of the LCA Study modeling tools and most future numerical models require detailed bathymetry to compute water depth and other wetland characteristics, but these data are currently not available throughout the coast. There is a need to rapidly and accurately depict coast wide bathymetry and regularly update the data to reflect changes due to sea level change, erosion, and sediment transport. The need is especially critical in the shallow, interior lakes and bays where data are difficult to collect.

- *Collect detailed topographic data throughout the coast.* Several of the LCA Study modeling tools relied on, and many future modeling efforts will require, detailed topography to compute water depth, duration and frequency of inundation and other wetland characteristics. However, these data are currently not available throughout the coast. Application of technological advances, such as light detection and ranging (LIDAR), would allow for rapid and accurate depiction of coastal topography. To be most useful, these data would need to be regularly updated to reflect changes caused by sea level change, subsidence, erosion, and sediment transport.

- *Determine sources of material (sand, silt, and clay) to meet needs of restoration efforts.* While much is known about the location, quantity, and quality of material available for use in restoration efforts, additional and unknown sources of material may be suitable and available. LDNR is currently working with Minerals Management Service (MMS) to develop a central database of known sand resources. Existing data are being used to develop a plan for additional data collection, including high resolution seismic, cores, and geologic mapping. These data would support modeling efforts to address sediment transport and linkages between nearshore and offshore environments.

- *Establish a coast wide network of monitoring stations to support understanding of natural variability, reference conditions, and performance measures, and provide a database, upon which future modeling efforts can be built.* Through CWPPRA, a Coastwide Reference Monitoring System (CRMS) for wetlands (Steyer et al. 2003) is being established to allow for more effective monitoring of the effectiveness of restoration features on reducing wetland loss along the Louisiana coast. Additionally, a CRMS Coastal Waters Monitoring program and a Barrier Island Coastwide Monitoring (BICM) program are also being developed. Networking the CRMS and BICM to function as one comprehensive monitoring program would help addresses network needs to focus on all major ecosystem components. A monitoring database and network that addresses physical, geological, biological, chemical and landscape components and/or processes of the ecosystem would be the most beneficial.

3.1.2.2 Type 2 - Uncertainties about engineering concepts and operational methods

There are several engineering techniques and operational approaches that could potentially improve the effectives of wetland restoration efforts, however, associated technological uncertainties with the techniques and approaches warrant further investigation. For example, there exists a capability with currently available dredging technologies to transport sediment long distances through pipeline conveyance. There is also a high degree of uncertainty about the availability of sufficient quantities of sediment resources and the sustainability of those resources.

In addition, uncertainties exist regarding the manner in which sediment materials can be properly discharged and dispersed to promote the establishment of new marsh vegetation while minimizing damage to existing marsh. Several of these uncertainties, and the potential investigations designed to reduce them, are:

- *Ability to use dredged material to restore coastal marshes using thin layer placement techniques.* "Thin layer placement" could provide the ability to distribute dredged material within interspersed marsh areas in order to increase substrate elevation to a level suitable for vegetation to spread into currently open water areas. However, the depth and impacts on existing vegetation need to be determined and techniques for proper dispersion to maximize plant growth and minimize suffocation of vegetation need to be refined. A reduced uncertainty about sources of sediment and appropriate particle size for enhancing productivity and maintenance of the marsh would also be beneficial. Prior to large-scale use of this restoration approach, different techniques for thin placement would need to be tested, including but not limited to, spray dredge and unconfined/semi-confined traditional hydraulic techniques. Additional information on plant mortality with different depths of fill would also reduce uncertainty associated with this restoration approach. In addition, impacts related to the acquisition of borrow material and its effect on the local ecosystem would need to be addressed.

- *Methods and outcomes from sediment delivery via pipeline.* Uncertainty about the cost-effectiveness of conventional dredging techniques to transport large quantities of sediment long distances from sediment sources would need to be addressed prior to its wide spread use in LCA restoration efforts. Conventional dredging equipment typically requires large pipelines for transport of sediment. However, there are uncertainties about how the material can be effectively transported efficiently over long distances and ultimately distributed within marsh habitats. Conventional sediment delivery equipment could result in large piles of sediment being deposited above tidal elevations, disrupting vegetative growth, and causing undesirable lateral water movements within the marsh. Therefore, new techniques should be developed and/or existing techniques refined to effectively transport large quantities of sediment to the marsh and to carefully redistribute those materials to appropriate elevations to promote marsh establishment. Additional tests should also be conducted to address uncertainties including final grade vs. design grade, dewatering periods, and potential water quality effects of transported materials. Tests should also be conducted to apply a two-tiered approach whereby large pipeline systems are used to convey high volumes of material and smaller dredges are used to then disperse the material into the marshes. Uncertainties regarding planting techniques on large scales should also be resolved. Addressing this uncertainty could be done in combination with addressing the thin layer disposal described previously.

When offshore sediment are used, the effects of using highly saline material as they relate to creating a healthy marsh environment should also be considered. In addition, impacts related to the acquisition of borrow material and its effect on the local ecosystem must be addressed.

- *Sources for marsh creation, restoration of maritime forests, and restoration of freshwater cheniers.* There is uncertainty regarding the efficacy of using saline mineral soils to support freshwater habitats. Uncertainties regarding the time required for soil to leach out salts and increase organic matter content in order to make the soils suitable for the establishment of freshwater vegetation would need to be resolved prior to using this technique on a large scale.

- *Combining techniques of marsh platform creation and freshwater/sediment diversion.* Individually, marsh creation and diversion techniques have been utilized successfully along the Louisiana coast. Combined, these two techniques may provide even greater results by creating land quickly while sustaining it in the face of relative sea level change. However, uncertainties should be resolved prior to utilizing this combination of restoration techniques on a large scale. When creating a marsh platform alone, the area is filled to a height that will settle to marsh elevation after dewatering and compaction have occurred. When combined with a diversion, however, it may be more effective to build the platform to a lower elevation and allow the diversion to build the platform to a more natural elevation for marsh establishment. The best combination of initial platform height and diversion operation that would minimize cost and maximize benefits would need to be determined.

- *Operational strategies for water diversions.* The LCA Study evaluates opportunities to reintroduce large quantities of river water into coastal marshes, but uncertainties exist about the most effective operational strategies to maximize restoration benefits. This operational uncertainty also limits the reliability of the size and design of the structures required for diversion. Several recent studies on the Caernarvon Freshwater Diversion have indicated that altering the operational strategy may increase marsh establishment or retention below the diversion. To optimize long-term sustainability of marsh landscapes, additional studies are needed to test different operational strategies, including pulsing methods and timing of the delivery of freshwater, sediment, and nutrients from diversions. In addition, there is uncertainty about potential water quality effects associated with diversions. Evaluation of potential water quality impacts could be done as part of project planning and NEPA compliance.

- *Sediment sources for reestablishment of barrier islands and land bridges.* Focused research and restoration projects already completed in the Louisiana coastal area have contributed to an understanding about the most effective and sustainable island geometry design. However, several issues remain regarding the potential sources of the large quantities of sediment that would be required to re-establish or restore coastal barrier islands. Two sand sources already identified are Ship Shoal and the Lower Mississippi River. Issues related to Ship Shoal are the quantity of available material and the cost-effectiveness of using this source relative to other sources. The sources of sands must be quantified and different transport mechanisms tested to determine a cost-effective approach to establishment. Studies to determine the type of sediment (percentage of sand/silt/clay) that may be used for barrier islands and back barrier marsh creation while facilitating vegetation growth and island stability would also be beneficial.

- *Remediation of canals for marsh restoration.* Canals cut throughout coastal marshes and their associated dredged material banks have resulted in fragmentation and accelerated loss of many coastal marshes. There has been considerable uncertainty and debate about the most effective approach for remediation of existing canals. Uncertainties about the viability of associated marsh restoration efforts and the timing of restoration also exist. Several different approaches to marsh restoration in existing pipeline canals could be examined and monitored, including: 1) backfill with small hydraulic dredge; 2) cross dikes to construct cells and improvements on effluent discharge location; 3) mechanical backfill; 4) gaps in the dredged material embankments to restore natural hydrology; and 5) test plugs as stand-alone features to reduce erosion within the canal. If backfill is used, impacts related to the acquisition of borrow material and its effect on the local ecosystem (e.g., neotropical migrants) may need to be addressed.

- *Erosion protection structures.* Erosion along open bays and channels has lead to wetland losses across the coast. Different approaches to reduce future erosion should be examined and effectiveness determined. Methods of construction and prediction of constructed structure sustainability should also be determined. It is necessary to construct and monitor a variety of erosion protection/foreshore protection features in a variety of foundation conditions. Improved designs and more accurate project cost projections would also benefit all future related restoration efforts.

3.1.2.3 Type 3 - Uncertainties about ecological processes, analytical tools, and ecosystem response

Although numerous scientific studies have been conducted within the coastal environments, a considerable degree of uncertainty remains about ecological processes. Limitations in analytical tools to assess ecosystem responses also exist. Information obtained during baseline monitoring can be integrated into understanding of ecological processes. For example, processes that influence land-water exposure also have a significant influence on the ability to accurately compute land loss rates. Ecosystem models developed and calibrated with data collected for baseline conditions and from monitoring efforts can be used to refine model outputs. Some examples of potential studies to address these uncertainties include:

- *Develop a coast wide network of monitoring stations to support understanding of natural variability, establish reference conditions, assess performance measures, and provide a database upon which future modeling efforts can be built*. This effort can address Type 1 and Type 3 uncertainties.

- *Develop process-based models for prediction of land-building response to restoration features.* Models were developed to support LCA Plan formulation and evaluation, discussed in detail in appendix C HYDRODYNAMIC AND ECOLOGICAL MODELING. These models served as useful tools for evaluating restoration alternatives along with ecological benefits on a basin-level scale. While these tools were useful, refinement of the models and the incorporation of additional data, once it becomes available, would help reduce uncertainties. The incorporation of inorganic and organic components of the land building process would be an important aspect in the refinement of the models. Current modules have been based on natural analogs from the Atchafalaya and Wax Lake Outlet Delta that are of an inappropriate scale for application to many proposed restoration features. Incorporating organic production into a land building module would facilitate linkage with a habitat switching and production module.

3.1.2.4 Type 4 - Uncertainties associated with socioeconomic/political conditions and responses

To date, the vast majority of modeling and assessment in support of the LCA Study has been derived from the natural sciences, geology, ecology, and engineering disciplines. Though most of these studies are predicated on National Ecosystem Restoration (NER)-based justifications and project costs, socioeconomic research is, by comparison, limited. Lack of economic linkages to biophysical processes limits the ability to assess direct risks of coastal land loss to dollars in market-based resources and infrastructure. As part of LCA Plan formulation, an economic linkage study and an economic impact assessment study were commissioned. While these studies developed estimates of economic impacts within the coastal area for future without-project conditions, more analysis would be required to detail National Economic Development (NED) costs and benefits at the project-specific level. To rectify this situation, socioeconomic modeling and assessment would be used to assist LCA Plan implementation.

Social sciences should be integrated with physical and ecological sciences in the planning and management processes, and by communicating with, considering, and including the public in the planning and implementation process. The following bullets are examples in the strategy to resolve the socio-political conditions and responses.

- *Develop behavioral analysis databases that utilize primary data collection techniques*. Uncertainty exists in how individuals and industries react to storms, hurricanes, and the future increasing vulnerability of the coastal area. This behavioral analysis could include investigations ranging from whether a Native American fisherman would relocate to follow the catch, to how a large industry would respond to increasing damages to pipelines. In-depth interviews and surveys would identify and quantify the risk and uncertainty related to human and industry behavior.

- *Develop spatial analysis tools in a Geographic Information System (GIS) environment that allows for project specific social and political impact assessment*. Modeling in a GIS environment would allow more refinement in identifying populations and sub-groups at risk from implementation of restoration projects. For example, issues such as environmental justice would benefit from this type of geographically refined analysis.

- *Economic Risk Assessment.* Stochastic modeling could be used to calculate the level of economic risk associated with landscape responses to various climatic probabilities (i.e. hurricanes, sea level change, and drought).

3.2 PLAN FORMULATION RATIONALE

In order to ensure that sound decisions are made with respect to development of alternatives and ultimately plan selection, the plan formulation process requires a systematic and repeatable approach. The Economic and Environmental Principles and Guidelines for Water and Related Land Implementation Studies (P&G) describes the USACE study process and requirements and provides guidance for the systematic development of alternative plans that contribute to the Federal objective. Alternatives should be formulated in consideration of four criteria: completeness, effectiveness, efficiency, and acceptability.

Completeness is the extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects.

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

Efficiency is the extent to which an alternative plan is the most cost-effective means of alleviating the specified problems and realizing the specified opportunities, consistent with protecting the Nation's environment.

Acceptability is the workability and viability of the alternative plan with respect to acceptance by state and local entities and the public and compatibility with existing laws, regulations, and public policies.

The first phase of the plan formulation process is the initial problem identification. The second phase is a thorough evaluation of the resources within the study area and an assessment of what currently exists within the area compared to estimates of the change in those resources over time. This evaluation, or inventorying phase, accounts for the level or amount of a particular resource that currently exists within the study, i.e. the "Existing Conditions." The phase also involves forecasting to predict what change(s) will occur to resources throughout the period of analysis, assuming no actions are taken to address the problems of marsh/land loss in Coastal Louisiana, i.e. the "Future Without-Project Conditions." Comparison of these two conditions of the study area measures the "Problems" resulting from the change in resources over time and identifies the "Needs" that must addressed as a result of the problems. Study area "Problems" and resulting "Needs" should be quantified based on this predicted change in resources. This second phase also results in the delineation of "Opportunities" that fully or partially address the "Problems and Needs" of the study area. An "Opportunity" is a resource, action, or policy that, if acted upon, may alter the conditions related to an identified problem. An example "Opportunity" is the utilization of the river for sediment delivery by diversion or dredge disposal.

The third phase is to then assess potential "Opportunities" to generate alternative solutions. Alternative plans are then formulated across a range of potential scales to demonstrate the relative effectiveness of various approaches at varying scales.

In the fourth phase, after alternative plans are developed, they must be "Evaluated" for their potential results in addressing the specific problems, needs, and objectives of the study. The measure of output is expressed by the difference in amount or effect of a resource between the "Future Without-Project" (No Action) conditions and those predicted to occur with each alternative in place (future with-project conditions). This difference is referred to as the benefits of the alternative. The LCA Study focus was on ecosystem restoration benefits, which are measured in metrics that reflect the area, productivity, and value of wetlands that are rehabilitated, restored, or maintained to the extent practicable.

The plan formulation process continues with the fifth phase, comparison of alternative plans to each other utilizing the benefit outputs and costs of the alternatives. A relationship between costs and varying levels of ecosystem restoration outputs across a full range of scales is compared.

The final phase in the process is selection of the plan that best meets the study objectives and the P&G's four criteria: completeness, effectiveness, efficiency, and acceptability.

Using the six-phase formulation process, the LCA Plan that best meets NER objectives was developed.

3.2.1 Objectives and Principles for Plan Formulation

In conjunction with the study constraints, two sets of strategic level principles guided the LCA Plan formulation process. The first was the USACE-adopted Environmental Operating Principles (EOPs). The second was the Study Guiding Principles for Plan Formulation (Guiding Principles). While the EOPs direct a general, strategic "way of doing business" for all USACE efforts, the Guiding Principles, developed during the first plan formulation scoping process, provide a "way of doing business" to address system-wide problems, needs, and opportunities associated with the Louisiana coastal area. At the tactical level, specific Planning Objectives were necessary to focus formulation of a plan intended to achieve specific outcomes contributing to the attainment of the overarching goal of reversing the current trend of ecosystem degradation and ultimate loss of function in the Louisiana coastal area (as indicated by points, A, B, and C in **figure MR 3-1)** . This graph demonstrates that multiple outcomes representing restoration of combined ecosystem functions are possible. The planning objectives further describe the elemental system functions that the PDT viewed as essential to reflecting successful restoration.

3.2.2 Planning objectives

In an effort to guide plan formulation, two tiers of tactical planning objectives were established - hydrogeomorphic and ecosystem. Concepts and features considered in this study, including freshwater diversions, sediment diversions, dedicated dredging/marsh creation, and barrier island protection, may effectively accomplish these planning objectives.

Hydrogeomorphic Objectives:

1. Establish dynamic salinity gradients that reflect natural cycles of freshwater availability and marine forcing (fluctuation related to normal daily and seasonal tidal action or exchange).
2. Increase sediment input from sources outside estuarine basins, and manage existing sediment resources within estuarine basins, to sustain and rejuvenate existing wetlands and rebuild marsh substrate.
3. Maintain or establish natural landscape features and hydrologic processes that are critical to sustainable ecosystem structure and function.

Ecosystem Objectives**:**

1. Sustain productive and diverse fish and wildlife habitats.
2. Reduce nutrient delivery to the Continental shelf by routing Mississippi River waters through estuarine basins while minimizing potential adverse effects.

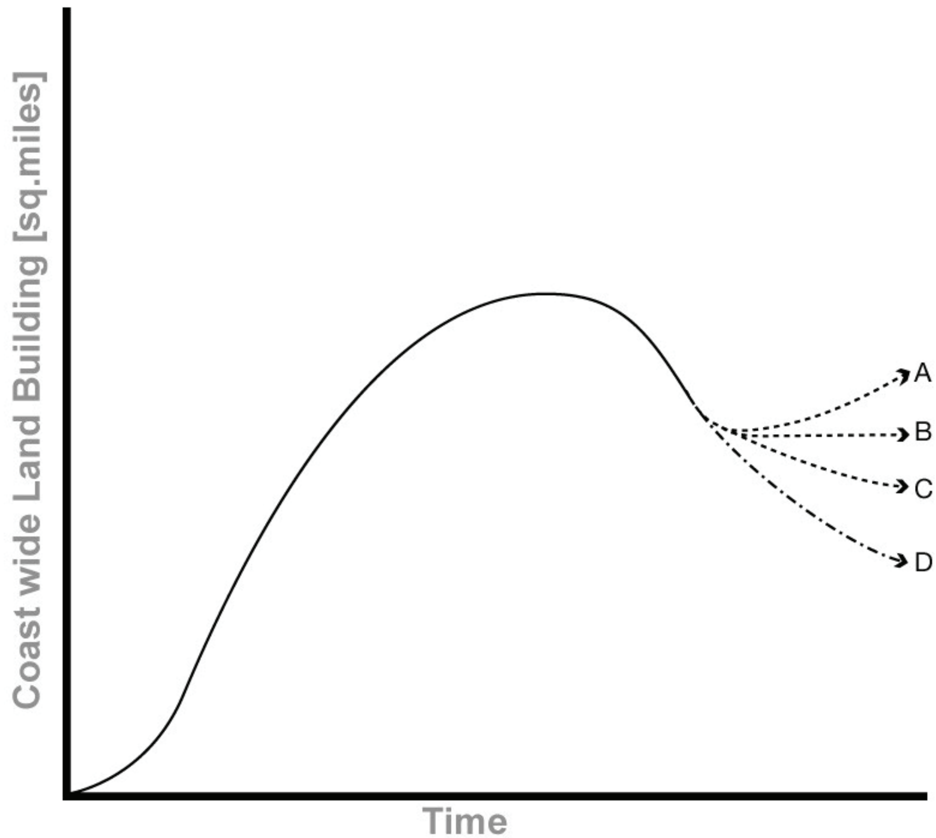


Figure MR 3-1. Ecosystem Degradation Trend Over Time. *The arrows represent conceptual outcomes for restoration (A, B, C) and the predicted future without-project (D).* ***(Not to scale.)***

3.2.2.1 Environmental operating principles

In 2002, the USACE reaffirmed its long-standing commitment to the environment by formalizing a set of EOPs applicable to decision-making in all programs. The principles are consistent with NEPA; the Department of the Army's Environmental Strategy with its four pillars of prevention, compliance, restoration, and conservation; and other environmental statutes and WRDAs that govern USACE activities. The EOPs have informed the plan formulation process and are integrated into all proposed program and project management processes. The EOPs are:

1. Strive to achieve environmental sustainability, and recognize that an environment maintained in a healthy, diverse, and sustainable condition is necessary to support life.
2. Recognize the interdependence of life and the physical environment, and proactively consider environmental consequences of USACE programs and act accordingly in all appropriate circumstances.

3. Seek balance and synergy among human development activities and natural systems by designing economic and environmental solutions that support and reinforce one another.
4. Continue to accept corporate responsibility and accountability under the law for activities and decisions under our control that impact human health and welfare and the continued viability of natural systems.
5. Seek ways and means to assess and mitigate cumulative impacts to the environment and bring systems approaches to the full life cycle of our processes and work.
6. Build and share an integrated scientific, economic, and social knowledge base that supports a greater understanding of the environment and impacts of our work.
7. Respect the views of individuals and groups interested in USACE activities, listen to them actively, and learn from their perspective in the search to find innovative win-win solutions to the Nation's problems that also protect and enhance the environment.

3.2.2.2 Guiding principles

The PDT compiled the Guiding Principles for Plan Formulation in coordination with key stakeholder groups and with public comments provided during the scoping process.

1. It is evident that management of Louisiana's coast is at a point of decision. Only a concerted effort now will stem this on-going degradation, and thus alternatives must include features which can be implemented in the near-term and provide some immediate benefits to the ecosystem, as well as those which require further development and refinement of techniques and approaches.
2. Appreciation of the natural dynamism of the coastal system must be integral to planning and the selection of preferred alternatives. This should include assessing the risks associated with tropical storms, river floods, and droughts.
3. Alternatives that mimic natural processes and rely on natural cycles and processes for their operation and maintenance will be preferred.
4. Limited sediment availability is one of the constraints on system rehabilitation. Therefore, plan elements including mechanical sediment retrieval and placement may be considered where landscape objectives cannot be met using natural processes. Because sediment mining can contribute to ecosystem degradation in the source area, such alternatives should, to the extent practicable, maximize use of sediment sources outside the coastal ecosystem (e.g., from the Mississippi River or the Gulf of Mexico).
5. Plans will seek to achieve ecosystem sustainability and diversity while providing interchange and linkages among habitats.
6. Future rising sea levels and other global changes must be acknowledged and incorporated into planning and the selection of preferred alternatives.
7. Displacement and dislocation of resources, infrastructure, and possibly communities may be unavoidable under some scenarios. In the course of restoring a sustainable balance to the coastal ecosystem, sensitivity and fairness must be shown to those whose homes, lands, livelihoods, and ways of life may be adversely affected by the implementation of any selected alternatives. Any restoration-induced impacts will be

consistent with NEPA in that actions will be taken to avoid, minimize, rectify, reduce, and then, only if necessary, compensate for project-induced impacts.

8. The rehabilitation of the Louisiana coastal ecosystem will be an ongoing and evolving process. The selected plan should include an effective monitoring and evaluation process that reduces scientific uncertainty, assesses the success of the plan, and supports adaptive management of plan implementation.
9. Recognizing that disturbed and degraded ecosystems can be vulnerable to invasive species, implementation needs to be coordinated with other state and Federal programs addressing such invasions, and project designs will promote conditions conducive to native species by incorporating features, where appropriate, to protect against invasion to the extent possible without diminishing project effectiveness.
10. Net nutrient uptake within the coastal ecosystem is maximized through increased residence time and the development of organic substrates, and thus project design should promote conditions that route riverine waters through estuarine basins and minimize nutrient export to shelf waters.

3.2.3 Coordination to Complete Plan Formulation

The plan formulation effort was conducted as a coordinated and collaborative effort involving a host of Federal and state agencies, the Louisiana academic community, and experts across the Nation. Multi-disciplinary teams have been convened to provide technical expertise and expedite review and decision-making within the plan formulation process based on the broad geographic scope of the coastal area and the complexity of aquatic ecosystem restoration efforts. The teams generally fell into one of three categories: coordination, project execution, and special. The role of each team is described in the following sections.

3.2.3.1 Coordination teams

Federal Principals Group **-** A Federal Principals Group (FPG) was established to provide Washington, D.C. level collaboration among Federal agencies for the LCA Study. The FPG for the LCA Study includes regional representatives from the following:

- USEPA (Headquarters);
- Department of Interior - USFWS;
- Department of Interior - Mineral Management Service (MMS);
- Department of Commerce - NMFS;
- Department of Interior - USGS;
- Department of Agriculture - Natural Resources Conservation Service (NRCS);
- Department of Energy (DOE);
- Department of Transportation - Maritime Administration; and
- Department of Homeland Defense - Federal Emergency Management Agency (FEMA).

Regional Working Group **-** A Regional Working Group (RWG) was formed to support the Washington-level Federal Principal's Group and facilitate regional level collaboration and coordination on the LCA Study. The RWG membership mirrors the composition of the FPG.

Executive Team - An Executive Team was formed to provide executive-level guidance and support for the LCA Study. In addition, the Executive Team worked with the District Engineer on various issues throughout the LCA Study and plan formulation. The Executive Team consisted of the following members:

- District Engineer, New Orleans District, USACE
- Deputy District Engineer for Project management, New Orleans District, USCAE
- Secretary of the Louisiana DNR
- Deputy Secretary of the Louisiana DNR

Governor's Advisory Commission on Coastal Restoration and Conservation - By statute, the State of Louisiana recently established a Governor's Advisory Commission on Coastal Restoration and Conservation. The primary purpose of the Advisory Commission is to advise the governor and state legislature on the overall status and direction of the state's coastal restoration program.

Framework Development Team **-** A Framework Development Team (FDT) was formed to provide a forum for Federal interagency representatives, environmental non-governmental groups (NGOs), and State of Louisiana resource agencies to discuss LCA Study activities and technical issues.

3.2.3.2 Project execution teams

Vertical Team - The Vertical Team (VT) was formed for the purpose of ensuring communication and coordinating activities within the USACE at the district, division, and headquarters levels. The VT has also provided guidance regarding the level of detail and overall approach for completing the LCA Study.

Project Delivery Team (PDT) - Execution of the LCA Study and PEIS rested primarily with the PDT. The PDT was comprised of professional personnel representing several Federal and state agencies, many of whom were "collocated" at the District office. Member agencies included the District, LDNR, USEPA, NRCS, USGS, USFWS, and NOAA.

The PDT also included researchers affiliated with Louisiana State University (LSU), the University of New Orleans (UNO), Southeastern Louisiana University (SLU), and the University of Louisiana at Lafayette (ULL), as well as various contractors.

The PDT was organized into various teams to support key elements of the planning process. The team organization was as follows:

- Public Outreach Work Group
- Goals and Objectives Work Group
- Numerical Modeling Work Group
- Desktop Modeling and Verification Work Group
- Benefits Protocol Work Group
- Environmental Impact Statement Work Group

- Institute of Water Resources (IWR) Plan Assessment Work Group
- Economics Work Group
- Real Estate Work Group
- Engineering Work Group
- Cultural/Recreational Work Group

3.2.3.3 Special teams

National Technical Review Committee – The District formed a National Technical Review Committee (NTRC) to provide external, independent technical review of the LCA Study. The purpose of the NTRC was to ensure quality and credibility of the results of the planning process. The first seven meetings of the NTRC focused on ongoing review, comment study formulation, and plan development efforts. The NTRC held its eighth meeting to complete the review and provide comments on the LCA Study and plan development on 16–17 August 2004. Members of the NTRC included representatives from academia, the oil and gas industry, the Smithsonian Institution, and the USACE Institute for Water Resources. Each person was selected for their technical expertise in coastal geomorphology, river engineering, wetland ecology, socioeconomics, and planning.

Independent Technical Review Team - In coordination with the USACE Office of the Chief of Engineers Value Engineering Study Team (USACE-OVEST) and the Division, a Value Engineering/Independent Technical Review (VE/ITR) Team was established to perform an independent review of the plan formulation process and to perform an evaluation of the conclusions and recommendations of this report. Members of the VE/ITR included employees from the Jacksonville, Mobile, and Wilmington Districts.

Office of the Chief of Engineers Value Engineering Study Team – USACE-OVEST is a organization of the USACE that optimizes the value of programs/projects/processes by the employment of Value Engineering. The team consists of technically skilled people with a cross section of experience in construction, design, operations and maintenance (O&M), and project management. The team is also augmented with resources from throughout USACE. The VE methodology was applied at an early point in the LCA Study to assure the optimization of the scoping effort and subsequent study investigations. The VE study duration, team composition, and study outputs were adjusted to the LCA Study to produce optimum plan formulation results.

3.3 PLAN FORMULATION

This section summarizes the six phases of plan formulation. Each phase of the plan formulation process provided distinct results that were then used to initiate the next phase. A more detailed description of the entire plan formulation effort is available at the District upon request.

The LCA Study planning process used by the PDT evolved over two years, ultimately resulting in selection of a recommended near-term course of action. During this time, the PDT used an iterative planning process to identify and evaluate the merits of individual restoration features, the effects of combining these features into different coast wide frameworks, and ultimately the ability of these frameworks to address the most critical needs. **Table MR 3-1** highlights the purpose, decision criteria, and results of the major iterations.

Near the completion of the fifth phase of the plan formulation effort on going review of the study effort by the Vertical Team and PDT identified specific long-range uncertainties regarding the dynamic nature of the coastal ecosystem, science and technology (S&T) for implementation and model predictive capability. The Vertical Team and PDT, with guidance in the form of the Fiscal Year 2005 Federal budget, redirected the plan formulation effort towards the identification of a plan that focused on the critical restoration needs in the near-term, the next 5 to 10 years, along with investigative initiatives to provide better certainty on appropriate long-range restoration needs and activities. The PDT determined that an LCA Plan would best meet the overall study objectives through inclusion of several complementary plan components that differ in scale and time.

3.3.1 Phase I - Establish Planning Objectives and Planning Scales

In Phase I, the PDT developed the tactical Study Planning Objectives and planning scales for the study. The Planning Objectives were developed based on professional knowledge and extensive experience in coastal Louisiana restoration. The PDT also created planning scales to facilitate the development of different alternatives to meet the planning objectives. For the purposes of this report, the term "scale" does not refer to a specific state of the landscape. Rather, it reflects the degree to which fundamental environmental processes would be restored or reestablished, and the resulting ecosystem and landscape changes that would be expected over the next 50 years. The planning scales were developed in consideration of the tactical planning objectives and the strategic principles and established a minimum range of alternative restoration output necessary for plan formulation in each subprovince.

The PDT determined that the highest, most ambitious scale would be an annual net increase in ecosystem function. This uppermost scale, affecting an approximate 50 percent increase over no net loss, is referred to as "*Increase.*" The PDT determined that no net loss of ecosystem function would be an appropriate intermediate scale. This scale is referred to as "*Maintain.*" Reducing the projected rate of loss of function was judged to be another appropriate intermediate scale, as it is sufficiently different from the other scales and would offer an option that could provide substantial benefits over no action. This scale, achieving an approximate 50 percent reduction in the current loss rate, is referred to as "*Reduce.*" The lowest possible scale was no further action above and beyond existing projects and programs, such as CWPPRA. This scale was the basis for the No Action Alternative.

Table MR 3-1. Major Iterations of Plan Formulation.

	Iteration We started with:	**Purpose** Our intent was to:	**Criteria** We made decisions based on:	**Result** The iteration ended with:
Phase 1	EOPs and Guiding Principles	Develop Planning Objectives and Planning Scales	• Professional judgment • Extensive CWPPRA experience • Scoping Comments	Planning Objectives Planning Scales
Phase 2	Coast 2050 Plan Section 905(b) Report	Assess broad scale strategies in 2050 Plan to identify Core Strategies for LCA Study effort	• Existing resources available in each of the four Subprovinces	LCA Core Strategies
Phase 3	LCA Core Strategies	Develop restoration features that would support LCA Core Strategies	• Planning Objectives • Creating features that would meet various Planning Scales • Developing features for all LCA Core Strategies	Restoration Features
Phase 4	Restoration Features	Combine Restoration Features into Subprovince Alternative Frameworks	• Need to combine Restoration Features into Alternative Frameworks that achieve different Planning Scales • Need to develop significantly different Restoration Features for all LCA Core Strategies	Subprovince Frameworks
	Subprovince Frameworks	Create, assess, and select Coast Wide Restoration Frameworks	• Cost effectiveness (CE) • Incremental Cost Analysis (ICA)	Tentative Final Array of Coast Wide Restoration Frameworks
Phase 5	Tentative Final Array of Coast Wide Restoration Frameworks	Address completeness of Coast Wide Restoration Frameworks in Tentative Final Array	• Public meeting and stakeholder comments • Re-verification of CE/ICA	Final Array
Phase 6	Final Array	Identify highly cost-effective Restoration Features within the Final Array that address most critical needs	• Critical need sorting criteria • Critical need assessment criteria	LCA Plan

3.3.2 Phase II - Assess Restoration Strategies from the Coast 2050 Plan

The PDT, in conjunction with the Vertical Team and FDT, reviewed the Coast 2050 Plan and the LCA Section 905(b) reconnaissance report (for which the Coast 2050 Plan was the basis). These plans are described in Attachment 2, Prior Studies, Reports and Existing Water Projects. These reports identified problems in both the current and future coastal landscape and laid out 93 broad-scale strategies for addressing ecosystem restoration. Strategies in the context of the Coast 2050 and 905(b) reports often translate directly to restoration projects. However, since many of the 93 strategies in these documents represented common restoration methods, the strategies captured for incorporation in the LCA plan formulation effort represent those most common or "core" restoration methodologies identified both coast wide and in each subprovince.

Overall, the strategies would describe methods to accomplish:

- Creation and sustenance of wetlands through input and accumulation of sediment;
- Maintenance of estuarine and wetland salinity gradients for habitat diversity; and
- Maintenance of ecosystem linkages for the exchange of organisms and system energy.

Because these accomplishments were very similar to the tactical planning objectives developed in Phase I, the PDT assessed the 93 broad-scale strategies to determine common methodologies for effecting restoration of wetland and system functions. As part of this study, the PDT identified a smaller subset of core strategies for coastal restoration efforts in the four subprovinces.

For Subprovince 1, the core restoration strategies included basin-wide freshwater reintroduction and salinity control. Reintroductions were selected because of the readily available freshwater resource, the Mississippi River. Because of its function as a conveyance of saline water into the central portion of the subprovince, the closure or constriction of the existing MRGO navigation project was identified as a potentially significant component of the salinity control strategy.

For Subprovince 2, the core restoration strategies included: sustaining barrier islands, headlands, and shorelines; managing the available sediment of the Mississippi River; freshwater introduction; Mississippi River water and sediment introduction via the formation of a new delta; and preserving land bridges within the Barataria Basin.

For Subprovince 3, the core restoration strategies included: restoring Terrebonne / Timbalier barrier islands; rebuilding land in eastern Terrebonne Basin; modifying the Old River Control Complex operation scheme to increase sediment input to the Atchafalaya River; Mississippi River water and sediment introduction via the formation of a new delta; and management of Atchafalaya River freshwater, sediment, and nutrients.

In the Chenier Plain (Subprovince 4), there are no excess riverine resources available to promote land building and to control salinities in the estuarine system. As such, the core strategy for this subprovince is the control of estuarine salinities through the management of rainfall and runoff inputs to the system and the management of existing hydrologic structures and geomorphic features.

3.3.3 Phase III - Develop and Evaluate Restoration Features

In Phase III, the PDT developed 166 potential restoration features that would support the restoration strategies identified for each of the subprovinces in Phase II and that would achieve some level of the planning scales identified in Phase I. The term feature is used to describe any specific restoration project or defined collection of structural and non-structural elements combined to affect a wetland restoration action. Features represent the specific solutions for which costs were developed and from which restoration plans, or “frameworks”, would be created. The term framework will be used to describe an assemblage of features developed to produce a discreet, cohesive, logical plan for achieving systemic restoration within a definable hydrologic or ecologic area.

The intent of this effort was to provide an initial identification of the most effective frameworks for meeting the overarching study objectives in concert with key strategies in each subprovince. Within this context, in addition to the programmatic nature of the NEPA documentation, the potential restoration features are intended to be representative of the most promising restoration actions and plan combinations for planning purposes. These features provide a basis for estimating costs and potential benefits and provide a starting point for identifying the most efficient framework combinations, most effective steps for addressing critical ecosystem needs, and estimating the overall cost of the ultimate implementation effort. The final refinement of feature scale and location is intended to be addressed in decision documents subsequent to the approval of this report. In developing the restoration features, the PDT took advantage of the extensive experience gained from other coastal restoration efforts, such as CWPPRA.

Preliminary costs and estimates regarding the potential for each feature to modify ecosystem functioning were based on experience and insight gained through the execution of the CWPPRA program, along with professional judgment and the best available information. The fourteen years of effort in project development and design under the CWPPRA program, along with design work completed under other Federal and state programs, provided an extensive base of design information to build on with basic component costs developed in the CWPPRA Engineer Work Group. Detailed documentation of the design assumptions, feature level of detail, and the development of the cost estimates are available at the District. The result of this phase was a “tool box” of restoration features for each subprovince, including features that addressed freshwater reintroduction (diversion), sediment diversion, hydrologic restoration, hydrologic modification, land acquisition, interior shoreline protection, barrier island and barrier headland restoration, and marsh creation and restoration. **Table MR 3-2** lists the number of features for each subprovince and categorizes them by feature type.

In addition, the PDT developed features whose implementation would result in varying levels of ecosystem function restoration. This exercise provided the PDT with similar features in some of the subprovinces, particularly in Subprovinces 1 and 2, that would address the reduce, maintain, and increase planning scales. For example, of the 21 freshwater reintroduction features identified for Subprovince 1, the PDT developed small, medium, and large freshwater diversion features to influence the same geographic area. Each of the diversions would result in a different level of ecosystem function restoration, and thus each would be more or less appropriate to satisfy a particular planning scale (i.e., a small freshwater diversion may or may not achieve the “increase” planning scale, whereas a large freshwater diversion in the same area would be more likely to achieve the “increase” scale).

The composition of restoration features (e.g., beneficial use of dredged materials, sediment diversion, etc.) developed for each subprovince was largely guided by the need to implement the restoration strategies previously identified in Phase II. For example, in Subprovinces 1 and 2, freshwater reintroduction was a restoration strategy. As such, the composition of restoration features for those subprovinces weighs heavily in favor of freshwater reintroductions because of the presence of an available resource, the Mississippi River. Careful examination of the distribution of restoration features developed in each subprovince can identify the nature of the ecosystem function in the area. Areas with or adjacent to abundant freshwater resources present ample diversion opportunities (i.e., Deltaic Plain) while areas with limited riverine resources (i.e., Chenier Plain) tend to provide more focus on preservation and management.

Table MR 3-2. Types of Restoration Features by Subprovince.

Restoration Feature	Subprovince 1	Subprovince 2	Subprovince 3	Subprovince 4
Freshwater Reintroduction (Diversion)	21	30	1	
Sediment Diversion	21	18	1	
Dedicated Dredging and Beneficial Use / Marsh Creation and Restoration	12	4	1	1
Salinity Control	1		2	16
Structure Modification (Hydrologic Restoration)	4	1		
Hydrologic Modification (Hydrologic Restoration)	1		12	4
Land Acquisition	1			
Barrier Island, Barrier Headland, and Interior Shoreline Protection and Restoration	1	1	10	2
Subprovince Totals	62	54	27	23
Total Number of Restoration Features for All Subprovinces	166			

As a final step in Phase III, the PDT made initial assessments of the positive, negative, or neutral fit of the features to address the planning objectives established for the study. This positive, negative, or neutral assessment was also made for each feature against a broad range of resources. These assessments were used to identify strengths and weaknesses of features and as a basis for including them in appropriate subprovince frameworks in Phase IV.

3.3.4 Phase IV - Develop and Evaluate Subprovince Frameworks

3.3.4.1 <u>Development of subprovince frameworks</u>

In Phase IV, the PDT created multiple frameworks, for each subprovince. It then evaluated the outputs and benefits of each subprovince framework using hydrodynamic and ecological models and benefit assessment protocols described in this section.

Since the resolution level and other capabilities of the available hydrodynamic and ecologic modeling system precluded adequate assessments of the effects of individual features in discreet increments, the analysis focused on combinations of features. This approach provided a basis for identifying the features that are the most likely to be effective and therefore should be included in the LCA ecosystem restoration plan. More detailed evaluations of individual features can be performed to support decisions to implement each of the features.

The combinations of restoration features in subprovince frameworks were guided by two requirements: 1) the need to combine restoration features to achieve various levels of planning scales in the subprovince, and 2) the need to develop appreciably different frameworks in each subprovince that would provide alternative planning approaches.

The PDT accomplished the second requirement with the use of restoration "approaches" that it created for each subprovince. By using different approaches to achieving restoration inside a subprovince, the PDT was able to develop appreciably different combinations of restoration features, and, in turn, an appreciably different set of frameworks. . For example, in Subprovince 1, the PDT identified "minimize salinity change" and "continuous [freshwater] reintroduction" as two different restoration approaches. The mix of restoration features in a framework to accomplish the "minimize salinity change" restoration approach would likely be one with few freshwater reintroduction features and/or where freshwater reintroduction features would be relatively small to medium. On the other hand, a mix of restoration features in a framework to accomplish the "continuous [freshwater] reintroduction" restoration approach would likely be one that relied heavily on freshwater reintroduction features, including features that would be relatively large. Restoration approaches for each subprovince are listed below:

Subprovinces 1 and 2
- Minimize Salinity Changes
- Continuous Reintroduction (w/Stage Variation)
- Mimic Historic Hydrology

Subprovince 3
- Rehabilitation/maintenance of geomorphic features
- Land Building by Delta Development
- Maximize Mississippi and Atchafalaya Flows

Subprovince 4
- Large-scale Salinity Control
- Perimeter Salinity Control
- Freshwater Introduction Salinity Control

To prevent the analysis of alternative frameworks from becoming overly complex, a maximum of nine frameworks were developed for each subprovince, with three frameworks for each planning scale (increase, maintain, and reduce). Around each planning scale a framework was developed based on the restoration approaches for that sub-province. . Subprovince 1, for example, contained 3 frameworks designed to increase ecosystem function based on minimizing salinity changes (E1), continuous reintroduction of freshwater (E2), and mimicking historic hydrology (E3). Of the 166 available restoration features in the toolbox, only 111 were found necessary to meet the criteria stated above in formulating the subprovince frameworks.

During Phase V of plan formulation, the PDT developed a reasonable, "supplemental" framework for each subprovince, the process and rationale of which is presented in the Phase V summary. To ensure that this Phase IV summary identifies all subprovince frameworks that were evaluated in this study, the supplemental framework for each subprovince is included in the total count of subprovince frameworks, described below. A total of 32 subprovince frameworks were developed and evaluated in this study in addition to the no-action alternative for each Subprovince. The individual features that make up each subprovince framework are identified in **tables MR 3-3** through **MR 3-6.** Full detailed descriptions of subprovince frameworks are available upon request through the New Orleans District office.

Subprovince Frameworks
Subprovince 1 = 10 Frameworks
Subprovince 2 = 10 Frameworks
Subprovince 3 = 5 Frameworks
Subprovince 4 = 7 Frameworks

For Subprovince 1, there were a total of ten frameworks: three "reduce" (R); three "maintain" (M); and three "increase" (E); and the supplemental framework (N) (**table MR 3-3**). For Subprovince 2, there were a total of ten frameworks: three "reduce" (R); three "maintain" (M); three "increase" (E); and the supplemental framework (N) (**table MR 3-4**). For Subprovince 3, there were a total of five frameworks: three "reduce" (R); one "maintain" (M); and the supplemental framework (N) (**table MR 3-5**). For Subprovince 4, there were a total of seven frameworks: three "maintain" (M); three "increase" (E); and the supplemental framework (N) (**table MR 3-6**).

Table MR 3-3. Subprovince 1 Frameworks.

Restoration Features	R1	R2	R3	M1	M2	M3	E1	E2	E3	N1
15,000 cfs diversion at American/California Bay				x			x	x		
110,000 cfs diversion (div.) at American/California Bay with sediment enrichment			x		x					x
250,000 cfs div. at American/California Bay with sediment enrichment						x			x	
12,000 cfs div. at Bayou Lamoque		x	x		x	x		x	x	x
5,000 cfs div. at Bonnet Carre Spillway	x	x		x						
10,000 cfs div. at Bonnet Carre Spillway						x	x	x	x	
200,000 cfs div. at Caernarvon w/ sediment enrichment								x		
1,000 cfs div. at Convent/Blind River			x			x			x	
5,000 cfs div. at Convent/Blind River		x			x		x			x
10,000 cfs div. at Convent/Blind River								x		
15,000 cfs div. at Fort St. Philip			x	x			x			
26,000 cfs div. at Fort St. Philip w/ sediment enrichment						x				
52,000 cfs div. at Fort St. Philip w/ sediment enrichment									x	
1,000 cfs div. at Hope Canal	x	x	x	x	x	x			x	x
1,000 cfs div at Reserve Relief Canal									x	
6,000 cfs div at White's Ditch							x			
10,000 cfs div. at White's Ditch		x	x		x	x			x	x
Sediment delivery by pipeline at American/California Bays				x			x		x	
Sediment delivery via pipeline at Central Wetlands	x			x			x			
Sediment delivery via pipeline at Fort St. Philip				x			x			
Sediment delivery via pipeline at Golden Triangle							x			
Sediment delivery via pipeline at La Branche	x			x			x			x
Sediment delivery via pipeline at Quarantine Bay	x						x			
Authorized opportunistic use of the Bonnet Carre Spillway										x
Increase Amite River Diversion Canal influence by gapping banks										x
Marsh nourishment on the New Orleans East land bridge										x
Mississippi River Delta Management Study										x
Mississippi River Gulf Outlet Environmental Restoration Features					x		x			x
Modification of operation of the Caernarvon freshwater diversion. (optimize for marsh creation)										x
Rehabilitate Violet Siphon and post authorization for the diversion of water through Inner Harbor Navigation Canal for increased influence into Central Wetlands										x

Note: R = Reduce; M = Maintain; E = Increase; N = Supplemental; Approaches: 1 = Minimize salinity change; 2 = Continuous reintroduction; 3 = Mimic historic hydrology.

Table MR 3-4. Subprovince 2 Frameworks.

Restoration Features	R1	R2	R3	M1	M2	M3	E1	E2	E3	N1
5,000 cfs diversion (div.) at Bastian Bay/Buras			x							
130,000 cfs div. at Bastian Bay/Buras		x								
120,000 cfs div. near Bayou Lafourche									x	
60,000 cfs div. at Boothville w/ sediment enrichment.										x
1,000 cfs div. at Donaldsonville		x	x		x	x				x
5,000 cfs div. at Donaldsonville w/ sediment enrichment								x		
1,000 cfs div. at Edgard		x	x		x	x				x
5,000 cfs div. at Edgard w/ sediment enrichment	x							x		
5,000 cfs div. at Empire			x							
90,000 cfs div. at Empire								x		
5,000 cfs div. at Fort Jackson			x							
60,000 cfs div. at Fort Jackson	x			x						
60,000 cfs div. at Fort Jackson w/ sediment enrichment						x	x	x		
90,000 cfs div. at Fort Jackson w/ sediment enrichment									x	
150,000 cfs div. at Fort Jackson w/ sediment enrichment					x					
1,000 cfs div. at Lac Des Allemands		x			x	x				x
5,000 cfs div. at Lac Des Allemands w/ sediment enrichment				x			x	x	x	
5,000 cfs div. at Myrtle Grove	x		x	x			x			x
15,000 cfs div. at Myrtle Grove		x								
38,000 cfs div. at Myrtle Grove w/ sediment enrichment					x					
75,000 cfs div. at Myrtle Grove w/ sediment enrichment						x				
150,000 cfs div. at Myrtle Grove w/ sediment enrichment								x		
5,000 cfs div at Oakville			x							
1,000 cfs div. at Pikes Peak		x	x		x	x				x
5,000 cfs div. at Pikes Peak w/ sediment enrichment								x		
5,000 cfs div. at Port Sulphur			x							
Barataria Basin barrier shoreline restoration	x	x	x	x	x	x	x	x	x	x
Implement the LCA Barataria Basin Wetland Creation and Restoration Study	x			x			x		x	x
Mississippi River Delta Management Study							x		x	x
Modification of operation of Davis Pond diversion										x
Sediment delivery via pipeline at Bastian Bay				x			x			
Sediment delivery via pipeline at Empire			x	x			x			
Sediment delivery via pipeline at Head of Passes				x			x			
Sediment delivery via pipeline at Myrtle Grove	x			x			x			x
Third Delta (120,000 cfs diversion)										x

Note: R = Reduce; M = Maintain; E = Increase; N = Supplemental; Approaches: 1 = Minimize salinity change; 2 = Continuous reintroduction; 3 = Mimic historic hydrology.

Table MR 3-5. Subprovince 3 Frameworks.

Restoration Features	**R1**	**R2**	**R3**	**M1**						**N1**
Backfill pipeline canals			x	x						
Bayou Lafourche 1,000 cfs pump	x	x		x						x
Convey Atchafalaya River water to northern Terrebonne marshes	x		x	x						x
Freshwater introduction south of Lake De Cade	x	x		x						
Freshwater introduction via Blue Hammock Bayou	x	x		x						x
Increase sediment transport down Wax Lake Outlet	x	x		x						x
Maintain land bridge between Bayous du Large and Grand Caillou	x		x	x						x
Maintain land bridge between Caillou Lake and Gulf of Mexico.			x	x						x
Maintain northern shore of East Cote Blanche Bay at Pt. Marone			x	x						x
Maintain Timbalier land bridge			x	x						
Multipurpose operation of the Houma Navigation Canal (HNC) Lock.	x	x	x	x						x
Optimize flows and Atchafalaya River influence in Penchant Basin	x	x	x	x						x
Rebuild historic reefs –Rebuild historic barrier between Point Au Fer and Eugene Island	x	x	x	x						
Rebuild historic reefs – Construct segmented reef/breakwater/jetty along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh Island to the west	x	x	x	x						
Acadiana Bays Estuarine Restoration			x	x						x
Rehabilitate northern shorelines of Terrebonne/Timbalier Bays			x	x						
Relocate the Atchafalaya navigation channel	x	x		x						x
Restore Terrebonne barrier islands.			x	x						x
Stabilize banks of Southwest Pass			x	x						
Stabilize gulf shoreline of Point Au Fer Island			x	x						x
Alternative operational schemes of the Old River Control Structure (ORCS) operational scheme	x	x		x						x
Third Delta (120,000 cfs diversion)		x		x						

Note: R = Reduce; M = Maintain; N = Supplemental; Approaches: 1 = Rehabilitation/maintenance of geomorphic features; 2 = Land-building by delta development; 3 = Maximize Mississippi and Atchafalaya flows.

Table MR 3-6. Subprovince 4 Frameworks.

Restoration Features				M1	M2	M3	E1	E2	E3	N1
Black Bayou bypass culverts										x
Calcasieu Pass lock				x			x			
Calcasieu Ship Channel beneficial use				x	x	x	x	x	x	x
Chenier Plain freshwater and sediment management and allocation reassessment.										x
Dedicated dredging for marsh restoration					x	x		x	x	
East Sabine Lake hydrologic restoration					x			x		x
Freshwater introduction at Highway 82				x	x	x	x	x	x	x
Freshwater introduction at Little Pecan Bayou				x	x	x	x	x	x	x
Freshwater introduction at Pecan Island				x	x	x	x	x	x	x
Freshwater introduction at Rollover Bayou				x	x	x	x	x	x	x
Freshwater introduction at South Grand Chenier				x	x	x	x	x	x	x
Freshwater introduction via Calcasieu lock and Black Bayou culverts						x			x	
Gulf shoreline stabilization					x		x	x	x	x
Modify existing Cameron-Creole watershed control structures					x			x		x
New lock at the GIWW					x			x		
Sabine Pass lock				x			x			
Salinity control at Alkali Ditch					x			x		x
Salinity control at Black Bayou					x			x		x
Salinity control at Black Lake Bayou					x			x		x
Salinity control at Highway 82 Causeway					x	x		x	x	x
Salinity control at Long Point Bayou.					x			x		x
Salinity control at Oyster Bayou					x			x		x

Note: M = Maintain; E = Increase; N = Supplemental; Approaches: 1 = Large-scale salinity control; 2 = Perimeter salinity control; 3 = Freshwater introduction salinity control.

3.3.4.2 Evaluation of subprovince frameworks

The four subprovinces in the LCA represent the appropriate area for evaluating and comparing specific hydrodynamic and ecologic functions. In order to evaluate the outputs and benefits of a particular subprovince framework, the PDT employed hydrodynamic and ecological models, benefit protocols, and agency and academic expertise to generate baseline information about the effects of the combinations of restoration features. Outputs and benefits evaluated by the PDT included measures of ecosystem function and response such as: land building, habitat switching, primary productivity of land and water, removal of nitrogen from Mississippi River water; and habitat use of wetlands by 12 coastal species. The outputs/benefits covered an array of ecosystem attributes and functions, and they provided a means of comparing complex patterns, both in space and time, of ecosystem change. All benefits were expressed relative to the No Action Alternative. A detailed description of the use of hydrodynamic and ecologic models, as well as the benefit protocols, to evaluate subprovince frameworks can be found in appendix C HYDRODYNAMIC AND ECOLOGICAL MODELING.

Land Building - This benefit assessment protocol measured the achievement of the subprovince framework in creating and preserving land (e.g., wetlands, barrier islands, and ridges) after 50 years. The measurement for land building was expressed in acres.

Habitat Switching - This benefit assessment protocol measured ecosystem response after 50 years by determining the conversion of wetland habitats from one type into another type, including open water. For example, freshwater reintroductions in a subprovince may result in the wetland habitat composition for the subprovince to switch to a composition where there was a greater percentage of freshwater marsh after 50 years. The measurement for habitat switching was expressed as change of habitat type in acres.

Primary Productivity of Land and Water - This benefit assessment protocol measured the change in primary productivity of land and water after 50 years. The PDT used the results from this benefit protocol and the Habitat Use benefit protocol, described below, to gauge the quality of the wetland habitats after 50 years. The measurement for primary productivity of land and water was expressed in terms of an index of composite plant productivity across the range of habitat types in the system.

Removal of Nitrogen from the Mississippi River - This benefit assessment protocol assessed the amount of nitrogen removed from the Mississippi River by the subprovince framework in tons per year. This assessment provided the PDT with information on how well a particular subprovince alternative would help address the hypoxia problem in the gulf. The measurement for removal of Nitrogen from the Mississippi River was expressed as a percentage of nutrients removed.

Habitat Use - This benefit assessment protocol measured the fish and wildlife habitat value for each marsh habitat type after 50 years. The PDT assessed habitat use for 12 coastal species, including: white shrimp, brown shrimp, oyster, gulf menhaden, spotted seatrout, Atlantic croaker, largemouth bass, American alligator, muskrat, mink, otter, and dabbling ducks. The 12 species were chosen because they provide the best representation of the ecologically diverse productivity of the coastal system. This assessment provided the PDT with information on the relative abundance of preferred habitats for the 12 coastal species in response to implementation of a subprovince framework. The measurement for habitat use was expressed in habitat units (HU).

The benefits were calculated for each of the subprovince frameworks and the end result was costs and benefits associated with each framework.

3.3.5 Phase V - Select a Final Array of Coast Wide Frameworks that Bests Meets the Planning Objectives

The subprovince frameworks developed by the PDT and evaluated through the ecologic models provided the basis for developing larger coast wide restoration frameworks. The creation of these coast wide frameworks was based on identifying the optimal combinations of the subprovince frameworks. Due to the fact that Subprovinces 1 through 3 share many of the same restoration resources, the PDT determined that these subprovince frameworks would need to be combined in a manner that determine the best allocation of resources while achieving the largest environmental benefits. Within the Deltaic Plain (Subprovinces 1 to 3), the availability of river water and sediment served to limit the number of possible combinations. There were no such limiting factors for the Chenier Plain, therefore any of the Subprovince 4 frameworks could be combined with any combination of the Subprovinces 1 to 3 frameworks. In addition a key difference in basic system function between the deltaic and Chenier Plains required that different benefit metrics be used. This allowed some simplification of the coast wide framework development process since the Subprovince 4 frameworks could be independently optimized. Therefore, combinations of frameworks in Subprovinces 1 to 3 were developed independently from the Chenier Plain frameworks.

The PDT used the IWR-Plan computer program (Version 3.3, USACE) to create and compare coast wide frameworks, which were composed of a framework from each subprovince. This automated program grouped the 32 subprovince frameworks and no-action alternatives into thousands of different combinations. The program then performed a cost effectiveness and incremental cost analysis (CE/ICA) using the outputs/benefits and the estimated costs that had been previously developed in the initial plan formulation phases.

3.3.5.1 Cost effectiveness/incremental cost analysis

The Study developed and evaluated alternative coast wide frameworks formulated to preserve coastal habitat and functions. The benefits of the various frameworks were defined in non-monetary units, as previously described. Benefits for most of the study area were evaluated using a qualitative and quantitative metric that assessed each alternative’s contribution to the stock of natural resources. In the Chenier Plain portion of the study area, benefits were measured more simply in acres of land preserved or restored. Since these feature outputs were not readily translatable to dollar terms, traditional monetary benefit-cost analysis could not be performed. Consequently, the use of the CE/ICA method was selected for the comparison of ecologic output benefits versus costs.

In the cost effective analysis, the combined weighted ecologic outputs, provided by the ecologic models and benefit assessment protocols described in the previous section, were documented for each coast wide framework. The combined weighted outputs and costs for each framework were also displayed and ordered by level of benefit. The primary factors of interest were ecological benefit versus cost. Detailed discussion of this portion of the analysis is available upon request through the New Orleans District office.

The coast wide frameworks were then assessed according to their ability to produce benefits for a given cost level. The result was a listing of coast wide frameworks that would achieve each benefit level at the lowest cost. A theoretical line, or an “efficient frontier“, was developed to show those restoration frameworks with the lowest cost to benefit ratios. Restated, alternative frameworks screened in this manner met these two criteria: (1) no other solution produces the same level of benefit for less cost, and (2) no other framework provides more benefit for the same or less cost.

The cost-effectiveness assessment and identification of the efficient frontier was followed by an incremental cost analysis. Incremental cost is the additional cost for each increase in the level of output. Changes in incremental costs, combined with other selection criteria discussed below, facilitated a process of evaluating the desirability of implementing the remaining plans in the absence of a strict guideline for determining the best outcome (such as maximizing net benefits, as is done in NED analysis

3.3.5.2 Development of the tentative final array for the Deltaic Plain

Following an initial CE/ICA analysis, the alternative framework selection process continued by applying three additional criteria to cost-effective coast wide frameworks. These criteria were developed to aid in identifying the point along the efficient frontier where coast wide frameworks could be anticipated to produce broad enough systemic benefits as to provide qualitative certainty of completeness. The three criteria were:

1. Alternative frameworks were limited to those that reduced land loss by at least one half of the current rate (based on 1990 to 2000 land loss data) of -24 mi^2/yr to -10 mi^2/yr. Reducing land loss by this amount would greatly contribute to the reduction of land loss as a result of ongoing restoration efforts.
2. Alternative frameworks were evaluated for their potential to provide storm surge protection across the coast (i.e., in all subprovinces), as well as for their potential to impact the navigation industry.
3. Alternative frameworks were assessed for their potential to add environmentally important features, such as barrier islands or a Third Delta feature, in subsequent implementation phases.

The first criteria simply assured that the frameworks identified would exceed the beneficial level that could be attained through current restoration programs. These programs have been identified as being capable of achieving only a fraction of the necessary restoration outputs. The second criteria sought to assure an adequate distribution of restoration measures by qualitatively identifying the relative damage risk to damage reduction potential. The comparison of spatially fixed investment versus potential wetland restoration effect allowed a qualified judgment of wetland restoration completeness versus relative use. The third criteria simply assessed and assured that important system needs or restoration opportunities were not being systematically overlooked as an artifact of the subprovince framework assemblages.

During this stage of the framework selection process, the PDT evaluated the frameworks that formed the cost-efficient frontier based on the above criteria and eliminated several of the frameworks from further consideration. Some cost-effective frameworks were eliminated because they did not provide comprehensive potential for coast wide restoration. Those cost-effective alternative frameworks that met the criteria occurred at approximately the point in the cost-effective curve at which the cost per unit benefit begins to rise rapidly. The CE/ICA software generates a numbered labeling to specifically identify the analyzed framework combinations these numbers will be used throughout the remainder of the report to refer to the cost effective or tentatively selected coast wide frameworks. Frameworks 5110, 7002, 7410, and 7610 represent those cost effective combinations that define the upper limit of the cost effective frontier. Framework 7002 represented the terminal point of the cost-efficient frontier shown in **figure MR 3-2**. However, upon review of these frameworks, the PDT identified several environmentally important features that were not included in or addressed by any of the cost-effective frameworks on the curve.

It was determined that additional frameworks near the cost-effective curve, particularly near the point of rapidly increasing unit cost, could fall within the limits of confidence, and as such could be considered in the final array. These additional frameworks would provide more completeness to a final array of restoration solutions. Beginning at the previously identified location on the cost-effective curve, the PDT began investigating other frameworks adjacent to the cost-efficient frontier that included important features not in the cost-effective framework combinations. A number of additional frameworks were identified that addressed the identified important features such as the barrier islands in Subprovince 3. These additional frameworks (5410 and 5610) were grouped with the remaining cost-effective frameworks to form a tentative final array. The six frameworks in the tentative final array for the Deltaic Plain were 5110, 5410, 5610, 7002, 7410, 7610 and 7002. As indicated above framework 7002 is the terminal, or maximum output framework. This framework has been included in the tentative final array as a representation of the required incremental level of investment necessary to achieve the maximum level of beneficial output. **Figure MR 3-3** graphically displays the Plan Formulation Process from Phase III through the initial CE/ICA analysis.

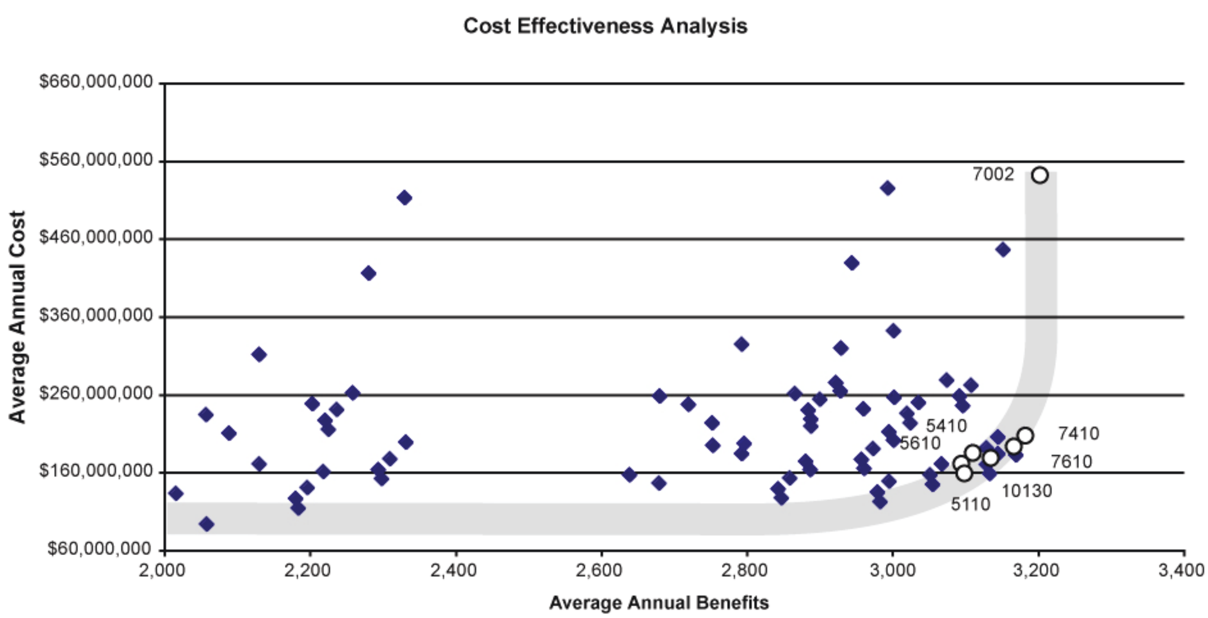


Figure MR 3-2. Preliminary Average Annual Costs and Average Annual Benefits for the Final Array of Alternative Frameworks for Subprovinces 1 to 3. *Note: the gray line denotes the cost efficient frontier.*

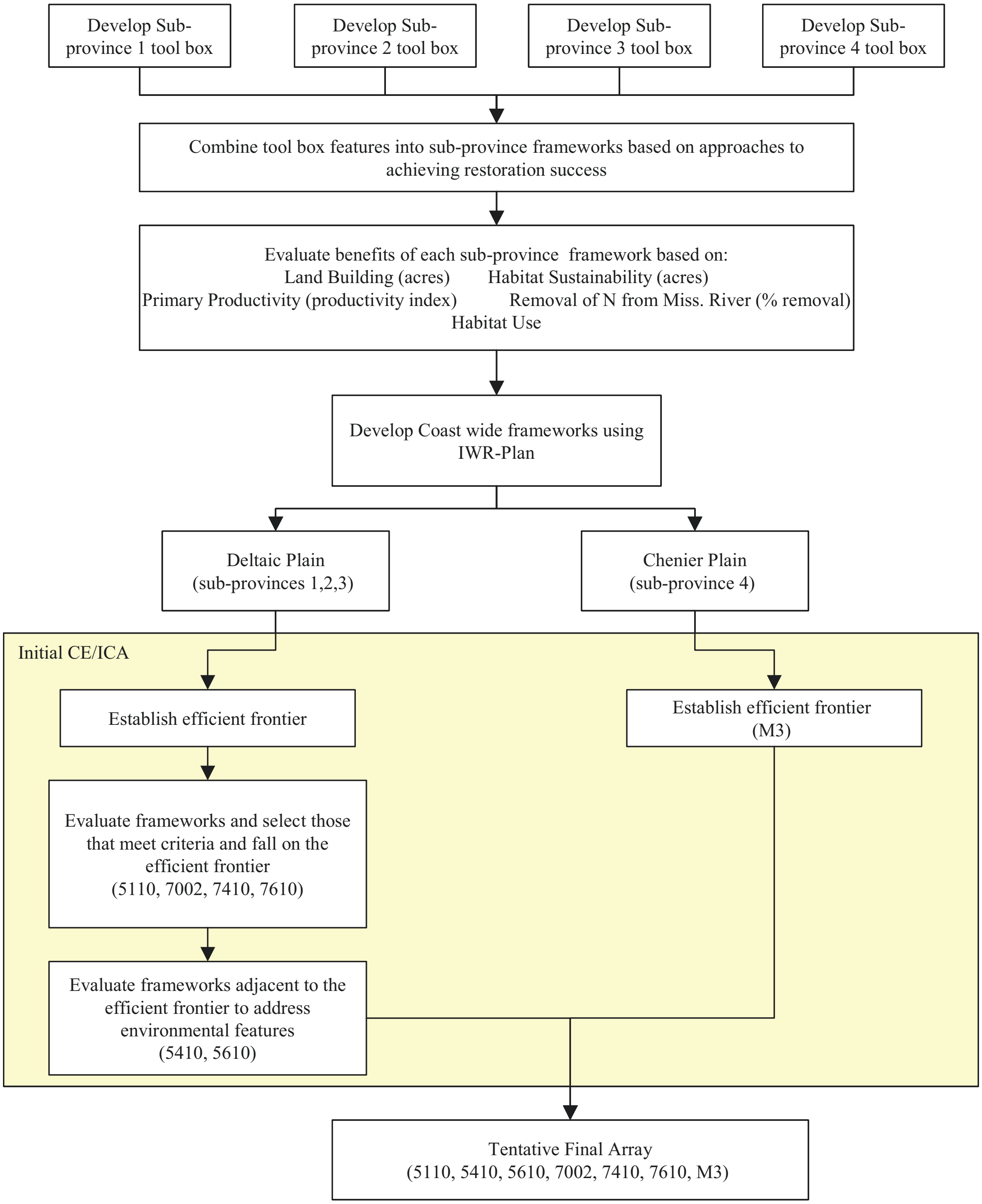


Figure MR 3-3. Plan formulation and framework selection process: Phase III through initial CE/ICA analysis

3.3.5.3 Development of supplemental frameworks to address completeness of final array for the Deltaic Plain

The vertical team, executive team, and individual members of the framework development team, reviewed the cost-effectiveness analysis and the PDT effort in developing the tentative final array. Following this review, the executive team directed the PDT to develop two supplemental frameworks to attempt to further address the criteria of incorporating environmentally important features. A second framework was desired to further assess the viability of incorporating large-scale features and the possibility of producing additional frameworks to redefine the upper limit of the efficient frontier. These frameworks were also intended to address the completeness of the final array since the tentative frameworks identified by the initial analysis omitted a number of larger-scale features that were viewed as potentially critical to long-range success. The output from the ecological modeling and the experience gained from that effort provided valuable insight regarding plan effectiveness. The results of that effort were reviewed to determine what specific restoration features might be introduced to create a more complete and effective framework.

The PDT reviewed the features, model outputs, and framework components for each subprovince. At the conclusion of this effort, the PDT assembled the two supplemental frameworks (N1 and N2), which were predominantly based on framework 5610. These two supplemental frameworks were identical, except that the second supplemental framework (N2) contained the large-scale Third Delta feature. Once the features of the supplemental frameworks were identified, preliminary costs and benefits were developed for the supplemental frameworks in a manner consistent with the previously analyzed coast wide frameworks. The data were incorporated into the IWR-Plan database. A second iteration of the CE/ICA was run to determine the position of the two supplemental frameworks relative to the existing cost-efficient frontier.

The CE/ICA analysis revealed that supplemental framework N1 created fewer benefits at similar cost than those in the efficient frontier. The second supplemental framework, N2, created slightly more output, but at a significantly increased incremental cost than the tentative final array of frameworks. Neither framework plotted within the optimal range of the existing tentative final array of frameworks. In addition a review of the features included in the second supplemental framework revealed that several of the diversion features included in the framework could be redundant and potentially not compatible with the inclusion of the Third Delta feature. Framework 7002 also included the best available estimates for several of the features identified as elements of large-scale long-range concepts and included in supplemental framework N2. As a result, it was determined that the appropriate action would be to continue to develop supplemental framework N1 and include it along with framework 7002 in the final array. The inclusion of framework 7002 in the tentative final framework provides a gauge of the level of incremental cost required to achieve the maximum ecosystem benefits beyond those provided by frameworks identified as optimal in the cost effective analysis. This also provides some insight into the relative beneficial return for extremely large-scale long-range restoration features.

To further determine whether the combinable components of the supplemental framework had any specific strengths or weaknesses, another iteration of cost-effectiveness was executed for each subprovince. The study executive team reviewed this information and was able to identify an existing framework in Subprovince 2 that in combination with the N1 supplemental framework components in Subprovinces 1 and 3 could produce a modified supplemental framework that would be more complete and cost-effective. The data for the modified supplemental framework, which was labeled 10130 (based on the IWR-Plan system of numbering solution scales), was added to the IWR-Plan database. An additional iteration of the cost-effectiveness analysis revealed the new framework to be on the cost-effective curve and consistent with the position and criteria for the final array. Therefore, the seven frameworks in the tentative final array of frameworks for the Deltaic Plain were 5110, 5410, 5610, 7002, 7410, 7610, and 10130.

The final array of frameworks are all fairly close to the efficient frontier, and, given limitations of both the benefit and cost data, are within the margin of error for the efficient frontier. That is, given the level of accuracy in the model's prediction of benefits and limitations on our ability to estimate costs, it is not possible to state with certainty that the supplemental framework 10130 is less efficient than those on the efficient frontier. The exception, since the framework that produces the maximum possible output is always a component of the efficient frontier, is framework 7002, which has costs far in excess of frameworks which produce only slightly lower benefit levels, as illustrated in **figure MR 3-2**. Therefore, any of the frameworks, with the exception of 7002, could suffice as a cost-effective framework for the Deltaic Plain. **Figure MR 3-4** graphically represents the development and evaluation of the supplemental frameworks.

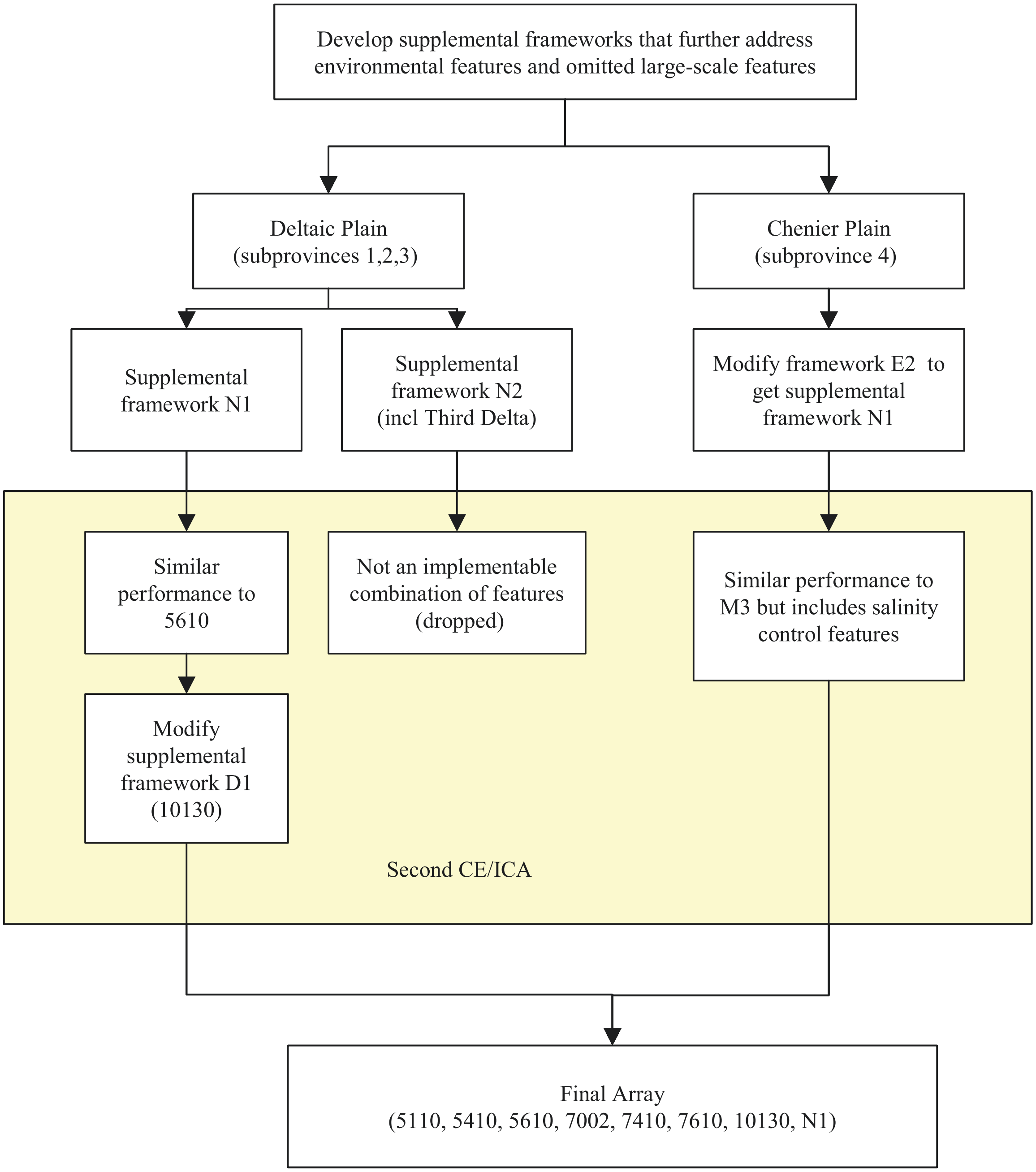


Figure MR 3-4. Plan formulation and framework selection process: development of supplemental frameworks and second CE/ICA analysis

3.3.5.4 Development of the final array for the Chenier Plain

Because habitats in the Chenier Plain were created by processes that did not include periodic overflows of the river to build and maintain land, the frameworks for Subprovince 4 were not constrained by the amount of water and sediment available in the Mississippi River and the resources used for restoration on Subprovinces 1 through 3. Consequently, the PDT evaluated Subprovince 4 separately from the other three subprovinces, which comprised the Deltaic Plain.

Because there is no nitrogen removal issue in the Chenier Plain and the habitat created in this area is expected to remain fairly uniform in quality, evaluation of Subprovince 4 frameworks was solely based on land creation. Any of the outcomes here could be combined with any of the seven frameworks in the final array for the Deltaic Plain.

The cost-effective analysis produced a cost-effective curve consisting of only one cost-effective framework, M3. The PDT reviewed the cost-effectiveness analysis results and recognized that framework M3 failed to appreciably address the core restoration strategy for the Chenier Plain of controlling estuarine salinities. In addition, the PDT suggested that the "Increase" planning scale be adopted as the minimum restoration level in this subprovince due to the relatively low rate of loss. Again, the Plan Formulation process from Phase III through the initial CE/ICA analysis is graphically depicted in **figure MR 3-3**.

3.3.5.5 Development of supplemental framework for final array for the Chenier Plain

The executive team, as well as the vertical team and members of the framework development team, again reviewed the cost-effectiveness analysis and the PDT effort in identifying the cost-effective frameworks for the Chenier Plain. The executive team directed the PDT to develop a supplemental framework to better address the core strategy. While not cost-effective, the relative ability of framework E2 to better address the core restoration strategy (i.e., salinity control) was suggested as a starting point to develop the supplemental framework. During a two-day meeting of the executive team and PDT, the PDT assembled the supplemental framework, which was based on the framework E2. The criteria concerning the identification and inclusion of any environmentally important features applied in the Deltaic Plain also applied to this subprovince.

Once the features of the supplemental alternative framework were identified, costs and benefits were developed for the framework in a manner consistent with the previously analyzed alternative frameworks. This data was incorporated into the IWR-Plan database. A second iteration of the CE/ICA was run to determine the position of the supplemental alternative framework relative to the efficient frontier. Once again, the supplemental framework was intended to add to the completeness of the final array.

Eight subprovince frameworks, including the supplemental framework and the No Action Alternative, were evaluated for the Chenier Plain (**figure MR 3-5**). As stated previously, the Chenier Plain was analyzed separately and thus frameworks that are not combinable were analyzed independently.

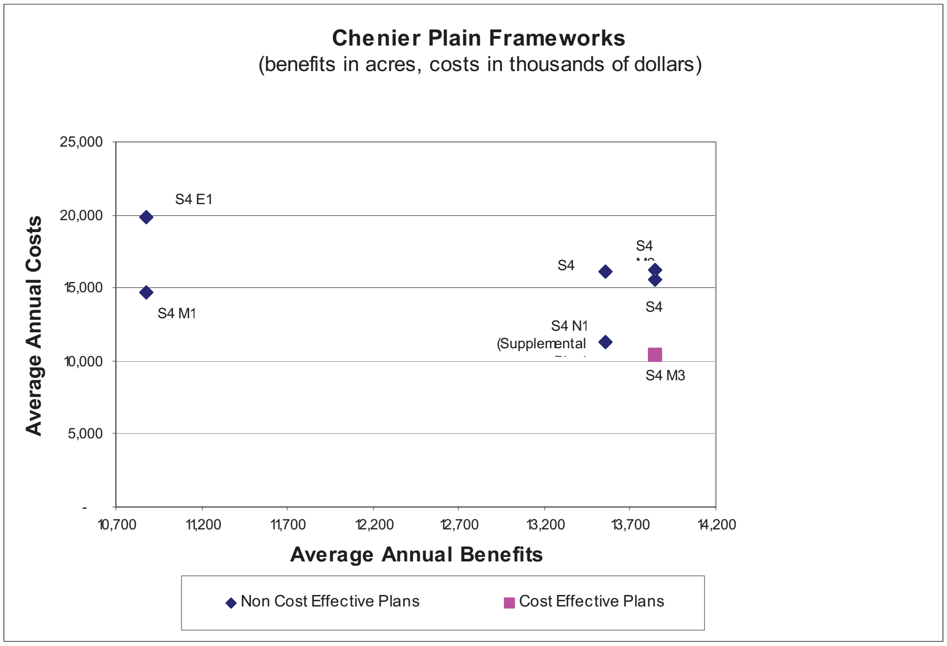


Figure MR 3-5. Costs and Benefits (acres) for all Chenier Plain Frameworks.

A second iteration once again resulted in the identification of only one cost-effective framework, M3. However, the added supplemental framework (N1) was similar in average annual cost but produced slightly fewer average annual benefits. The features in framework M3 failed to appreciably address the core restoration strategy for Subprovince 4, as previously identified by the PDT. Framework N1 included the major features of framework M3 in addition to features to address salinity control. As a result, framework M3 was dropped from the final array. The final array focuses on framework N1, the supplemental framework that was developed by modifying framework E2. Again, the Plan Formulation process from supplemental framework development through the second CE/ICA analysis is graphically presented in **figure MR 3-4**.

3.3.5.6 <u>Details of the final array of coast wide system frameworks</u>

As stated previously, the Chenier Plain framework can be added to any of the seven Deltaic Plain frameworks to construct coast wide frameworks, resulting in seven coast wide frameworks. **Table MR 3-7** identifies the subprovince framework components of each of the system frameworks identified in the final array. The subprovince frameworks considered, and the features included in them, can be found in **tables MR 3-3** through **MR 3-6.** The final array of coast wide system frameworks identified a relatively tight grouping of possible alternatives. In comparing these alternatives, the PDT observed numerous cases of common features between the frameworks. The differences in restoration features between the frameworks, however, typically resulted in an observable difference in the make up of their beneficial outputs (i.e., the balance of marsh type and resultant species usage). The end result was that any of the frameworks in the final array could be a justifiable plan depending on the nuances applied in developing a single output value for their comparison.

In addition, the PDT recognized that the relative uncertainty of quantifying ecologic performance and sustainability versus the somewhat more certain quantification of implementation cost caused a variable effect on certainty across the range of features considered in the system wide frameworks. Particularly, larger-scale, longer range restoration features compared poorly in a comparative analysis. As a result, for the longer-range features included in the various frameworks, there were lower confidence limits that have implications for the overall timing of their implementation. Conversely, features that could be implemented and produce environmental outputs in the near-term resulted in a higher degree of confidence.

Table MR 3-7. Overview of Final Array of Coast wide Restoration Frameworks.

	Framework Identification						
	5110	5610	5410	7610	7410	7002	10130
Subprovince 1							
M2	X	X	X				
E1				X	X	X	
N1 (Modified M2)							X
Subprovince 2							
R1	X						
M1			X		X		
M3		X		X			
E3						X	
N1 (Modified R1)							X
Subprovince 3							
R1	X	X	X	X	X		
M1						X	
N1 (Modified R1)							X
Subprovince 4							
N1 (Modified E2)	X	X	X	X	X	X	X

Of the 111 features listed in **tables MR 3-3** through **MR 3-6**, 79 features are contained in the final array of coast wide frameworks identified in **table MR 3-7**. Descriptions of the 79 features are found in section 3.3.6.1.

3.3.6 Phase VI - Development of Alternative LCA Restoration Plans

Upon the completion of Phase V efforts, with attention to the dynamic nature of the coastal ecosystem, the science and technology (S&T) uncertainties and model uncertainties, the Vertical Team and PDT redirected the plan formulation effort towards the identification of a plan that focused on critical restoration effort needs in the near-term, the next 5 to 10 years. The PDT determined that a LCA Plan would best meet the overall study objectives through inclusion of several complementary plan components that differ in scale and time. These would include:

- Near-term, highly certain feature concepts for development and implementation;
- Identified, feature-related uncertainties and potential methods or features to resolve them; and
- Large-scale and long-range feature concepts to be more fully developed.

Having identified the most efficient, effective, and complete combinations, of features within the final array of coast wide frameworks it was decided to not abandon the work that produced and screened those coast wide alternatives. The PDT believed that the formulation of frameworks and the identification and assessment of beneficial outputs accurately reflected the relative effectiveness and efficiency of the coast wide frameworks to meet the study planning objectives and affect coastal restoration. In meeting the set objectives and benefit parameters, in addition to being effective and efficient, the most critical restoration features should have been captured in these frameworks as well. The PDT determined that a resorting of the features included in the final alternative coast wide frameworks would provide a representative plan of those most promising critical restoration features.

The seven final coast wide frameworks were used as the starting point for the identification of alternative LCA near-term plans. The 79 restoration features that were combined into the coast wide frameworks of the final array primarily addressed areas of critical wetland loss, opportunities for the reestablishment of deltaic processes, and the protection and restoration of geomorphic features. The 79 features were the building blocks for alternative LCA Plans in Phase VI.

3.3.6.1 Description of the restoration features identified in the final array of coast wide frameworks

The PDT initially determined that the follow-on feasibility study process would analyze and optimize specific locations and dimensions for any restoration feature that would ultimately become a component of the LCA Plan that best met the objectives. Instead, general details about restoration features were included as part of this plan formulation process. For example, diversions were referred to as either small, medium, or large, where small equates to 1,000-5,000 cfs diversions, medium to 5,000-15,000 cfs diversions, and large to greater than 15,000 cfs diversions. Additionally for features involving the use of dredged sediments borrow locations are typically not specified, however, consistent with guiding principle number 4, the use of sediment sources both renewable and external to the functional coastal system are expected to be identified in final decision and NEPA documents. More detailed cost information regarding the features is available at the District upon request. The features are shown on **figures MR 3-6** through **MR 3-9**.

3.3.6.1.1 *Subprovince 1 feature descriptions*

Medium diversion at American/California Bays

This restoration feature provides for a medium non-structural, uncontrolled diversion from the Mississippi River at American/California Bays. The diversion feature would consist of an armored crevasse through the existing un-leveed riverbank into the fringe marsh and open water of the bay system. The objective of this feature is to increase sediment introduction into American/California Bays. The introduction of additional sediment would facilitate organic and mineral sediment deposition, improve biological productivity, and prevent further deterioration of the marshes.

Medium to large sediment diversion at American/California Bays

This restoration feature involves a large non-structural, uncontrolled sediment diversion from the Mississippi River with sediment enrichment at American/California Bays. The diversion feature would consist of an armored crevasse through the existing un-leveed riverbank into the fringe marsh and open water of the bay system. The objective of this feature is to maximize sediment inputs and spur large-scale land building in American/California Bays. This area was historically an outflow area of the Mississippi River, which received river discharges during flooding events. The creation and restoration of wetlands in American/California Bays would have the added benefit of stabilizing the Breton Sound marshes to the north by reducing marine influences from the Gulf of Mexico.

Rehabilitate Bayou Lamoque structure as a medium diversion

This feature provides for the refurbishment and operation of a pair of diversion structures, regulating the flow of Mississippi River water into Bayou Lamoque, a former distributary of the Mississippi River. The existing Bayou Lamoque diversion structures require mechanical rehabilitation and operational security modifications. The remote location of these structures and the frequent occurrence of vandalism have resulted in an inability to ensure consistent and reliable operation. The objective of this feature is to increase and maintain riverine inflows into Bayou Lamoque. The introduction of additional freshwater would facilitate organic and sediment deposition, improve biological productivity, and prevent further deterioration of the marshes. This feature is located in the vicinity of a historic crevasse.

Medium diversion at Bonnet Carré Spillway

This restoration feature would be located at the existing Bonnet Carre Spillway and involve a reevaluation of the existing authorized project. The spillway is currently operated to remove excess water from the Mississippi River during flooding events and pass the water through the Bonnet Carre Spillway into Lake Pontchartrain. The restoration feature consists of a medium diversion with east and west branches into the La Branche wetlands and Manchac land bridge - diverted through a modified segment of the existing flood control structure and redirected through the guide levees into adjacent wetlands. The objective of the project is to decrease salinities in Lake Pontchartrain and the surrounding marshes, especially the La Branche Wetlands, and to add nutrients and some sediment to these marshes and swamps. This feature is located in the vicinity of a historic crevasse.

Small diversion at Convent/Blind River

This restoration feature involves a small diversion from the Mississippi River into Blind River through a new control structure. The objective of this feature is to introduce sediment and nutrients into the southeast portion of Maurepas Swamp. This feature is intended to operate in conjunction with the Hope Canal diversion to facilitate organic deposition in the swamp, improve biological productivity, and prevent further swamp deterioration.

Medium diversion at Fort St. Philip

This restoration feature provides for a medium diversion from the Mississippi River into marshes northeast of Fort St. Philip, between the Mississippi River and Breton Sound. Objectives of this feature are to reduce wetland loss and facilitate riverine influences to these marshes. The diversion would facilitate organic deposition in and biological productivity of the marshes by increasing freshwater circulation and providing sediment and nutrients to the system.

Small diversion at Hope Canal

This restoration feature involves a small diversion from the Mississippi River through a new control structure at Hope Canal. The objective is to introduce sediment and nutrients into Maurepas Swamp south of Lake Maurepas. The introduction of additional freshwater via the diversion would facilitate organic deposition, improve biological productivity, and prevent further deterioration of the swamp. Work for this feature has been initiated in engineering and design and NEPA compliance under CWPPRA.

Medium diversion at White's Ditch

This restoration feature, located at White's Ditch, downstream of the existing Caernarvon diversion structure, provides for a medium diversion from the Mississippi River into the central River aux Chenes area using a controlled structure. The objective of the feature is to provide additional freshwater, nutrients, and fine sediment to the area between the Mississippi River and River aux Chenes ridges. This area is currently isolated from the beneficial effects of the Caernarvon freshwater diversion. The introduction of additional freshwater would facilitate organic sediment deposition, improve biological productivity, and prevent further deterioration of the marshes. This feature is located in the vicinity of a historic crevasse. Follow-up feasibility-level analysis will determine the ultimate size of the diversion.

Sediment delivery via pipeline at American/California Bays

This restoration feature provides for sediment delivery via pipeline through programmatic sediment mining from the Mississippi River. The moderately deep (6 to 10 feet [1.8 to 3 meters]) open water in this bay system requires a large volume of sediment to create wetlands. The objective of this feature is to create wetlands in the American/California Bays.

Sediment delivery via pipeline at Central Wetlands

This restoration feature provides for placement of sediment mined from the Mississippi River into the Central Wetlands adjacent to the MRGO and Violet canal, via pipeline. The objective of this feature is to create wetlands by placing dredged sediment in the shallow (1 to 2 feet [0.3 to 0.6 meters]) open waters of the marshes. Placement of this dredged material would counteract marsh breakup by providing sediment and nutrients to renourish the area. This feature is located in the vicinity of a historic crevasse.

Sediment delivery via pipeline at Fort St. Philip

This feature provides for sediment delivery at Fort St. Philip via programmatic sediment mining from the Mississippi River. The objective of the feature is to create and/or restore marsh habitat by depositing sediment in appropriate moderately shallow (3 to 5 feet [0.9 to 1.5 meters]) open water areas in the vicinity of Fort St. Philip. Increasing the area and improving the function of these marshes would facilitate biological productivity of the marshes and reduce wetland loss.

Sediment delivery via pipeline at Golden Triangle

This restoration feature provides for sediment delivery via sediment mined from the Mississippi River and placed in the area formed by the confluence of the MRGO, GIWW, and Lake Borgne. The objective of the feature is to create and/or restore marsh habitat by depositing sediment in appropriate shallow (1 to 2 feet [0.3 to 0.6 meters]) open water in the area adjacent to these three water bodies. Increasing the area and improving the function of these marshes would facilitate biological productivity of the marshes and reduce wetland loss.

Sediment delivery via pipeline at La Branche Wetlands

The proposed restoration feature includes the dedicated dredging of sediment from the Mississippi River, which would be delivered via pipeline to shallow (1 to 2 feet [0.3 to 0.6 meters]) open waters within the La Branche Wetlands in the southwest corner of Lake Pontchartrain. The creation and restoration of these marshes would facilitate improved biological productivity and reduce wetland loss. This feature is located in the vicinity of a historic crevasse.

Sediment delivery via pipeline at Quarantine Bay

This restoration feature provides for sediment delivery to Quarantine Bay via programmatic sediment mining from the Mississippi River. The objective of the feature would be to create wetland habitat through the placement of dredge sediment in the moderately shallow (3 to 5 feet [0.9 to 1.5 meters]) open waters of Quarantine Bay.

Opportunistic use of Bonnet Carre Spillway

This restoration feature involves freshwater introductions from the Mississippi River via the opportunistic use of the existing flood control structure at the Bonnet Carre Spillway. The spillway is currently operated to remove excess water from the Mississippi River during flooding events and pass the water through the Bonnet Carre Spillway into Lake Pontchartrain. This feature would allow for freshwater introductions to be delivered to Lake Pontchartrain and the adjacent La Branche wetlands during times of high river water levels. Thus, the river introductions would help reduce salinities in the southwest corner of Lake Pontchartrain and nourish the intermediate and brackish marshes in La Branche with sediment and nutrients. This feature is located in the vicinity of a historic crevasse.

Increase Amite River Diversion Canal influence by gapping banks

This restoration feature involves the construction of gaps in the existing dredged material banks of the Amite River Diversion Canal. The objective of this feature is to allow floodwaters to introduce additional nutrients and sediment into western Maurepas Swamp. The exchange of flow would occur during flood events on the river and from the runoff of localized rainfall events. This feature would provide nutrients and sediment to facilitate organic deposition in the swamp, improve biological productivity, and prevent further swamp deterioration.

Marsh nourishment on New Orleans East land bridge

This restoration feature involves wetland creation through the dedicated dredging of sediment from lake bottom sources. The objective of this feature is to create wetlands by placing dredged sediment in the shallow open waters within the land bridge separating Lakes Pontchartrain and Borgne. This area has experienced wetland deterioration and loss due to erosion from wave energies in Lake Borgne. Reinforcing the land bridge between the two lakes would help maintain the salinity gradients in Lake Pontchartrain and ensure the long-term sustainability of the wetland ecosystems in the area.

Mississippi River Delta Management Study

This restoration concept requires detailed investigations to address the maximization of river resources, such as excess freshwater and sediment, for wetland restoration. The objective of this concept is to greatly increase the deposition of Mississippi River sediment on the shallow continental shelf, while ensuring navigation interests. Sediment, nutrients, and freshwater would be re-directed to restore the quality and sustainability of the Mississippi River Deltaic Plain, its coastal wetland complex, and the Gulf of Mexico. The study would investigate potential modifications to existing navigation channel alignments and maintenance procedures and requirements.

Mississippi River Gulf Outlet (MRGO) environmental restoration features

This restoration opportunity involves the implementation of the environmental restoration features considered in the MRGO Reevaluation Study. In response to public concerns, adverse environmental effects, and national economic development considerations, an ongoing study is re-evaluating the viability of operation and maintenance of this authorized navigation channel. Since the construction of the MRGO, saltwater intrusion and ship wake erosion have degraded large expanses of fresh and intermediate marshes and accelerated habitat switching from freshwater marshes to brackish and intermediate marshes in the Biloxi marshes, the Central Wetlands, and the Golden Triangle wetlands. This environmental restoration study would evaluate the stabilization of the MRGO banks and various environmental restoration projects, including evaluation of freshwater reintroductions into the Central Wetlands, possible channel depth modification, and other ecosystem restoration measures. Implementation of this feature would preserve estuarine wetlands and important structural features of the lake and marsh landscape.

Modification of Caernarvon diversion

The Caernarvon diversion structure, constructed on the Mississippi River in 1992 near the Breton Sound marshes, has a maximum operating capacity of 8,000 cfs (286 cms). The structure has been operated as a salinity management feature, with freshwater introductions ranging between 1,000 cfs to 6,000 cfs (36 cms to 214 cms), but in general averaging less than half of the structure's capacity. The primary purpose of the existing Caernarvon project has been to maintain salinity gradients in the central portion of Breton Sound. This operation, in effect, partially restored the historic functions of marsh nourishment (e.g., freshwater inflow, providing nutrients and sediment to the marsh, and countering the effects of subsidence). The proposed restoration feature study would assess changes in the operation of the Caernarvon project to increase wetland creation and restoration outputs for this structure. Modified operation of this structure would allow an increase in the freshwater introduction rate, perhaps 5,000 cfs (178 cms) on average, to accommodate the wetland building function of the system. This study would identify any changes to this feature's operation that would increase restoration outputs. The introduction of additional freshwater would facilitate organic and sediment deposition, improve biological productivity, and prevent further deterioration of the marshes. This feature is located in the vicinity of a historic crevasse. Any proposed change in purpose that would require modification of the existing authorization for this structure would be submitted for Congressional approval.

Rehabilitate Violet Siphon for increased freshwater influence to Central Wetlands

This restoration feature involves the rehabilitation of the existing Violet Siphon water control structure, which is located between the Mississippi River and the MRGO, in the Central Wetlands. The objectives of this feature are to improve the operation of the Violet Siphon and enhance freshwater flows into the Central Wetlands. This action would increase freshwater in the wetlands and nourish the remaining swamp and intermediate marshes. The restoration of wetlands and improvement in ecosystem function produced by this feature would be increased by the freshwater introductions via the IHNC lock feature. This feature is located in the vicinity of a historic crevasse.

Post authorization change for the diversion of water through Inner Harbor Navigation Canal for increased freshwater influence into Central Wetlands

This restoration feature calls for a post-authorization modification of the IHNC lock. Modifications would incorporate culverts and controls to divert freshwater from the Mississippi River through the IHNC to the Central Wetlands. The objectives of this feature are to introduce freshwater and nutrients into the intermediate and brackish marshes of the Central Wetlands, boost plant productivity, and reduce elevated salinities. This restoration feature could also increase the benefits produced by the Violet Siphon structure rehabilitation restoration feature.

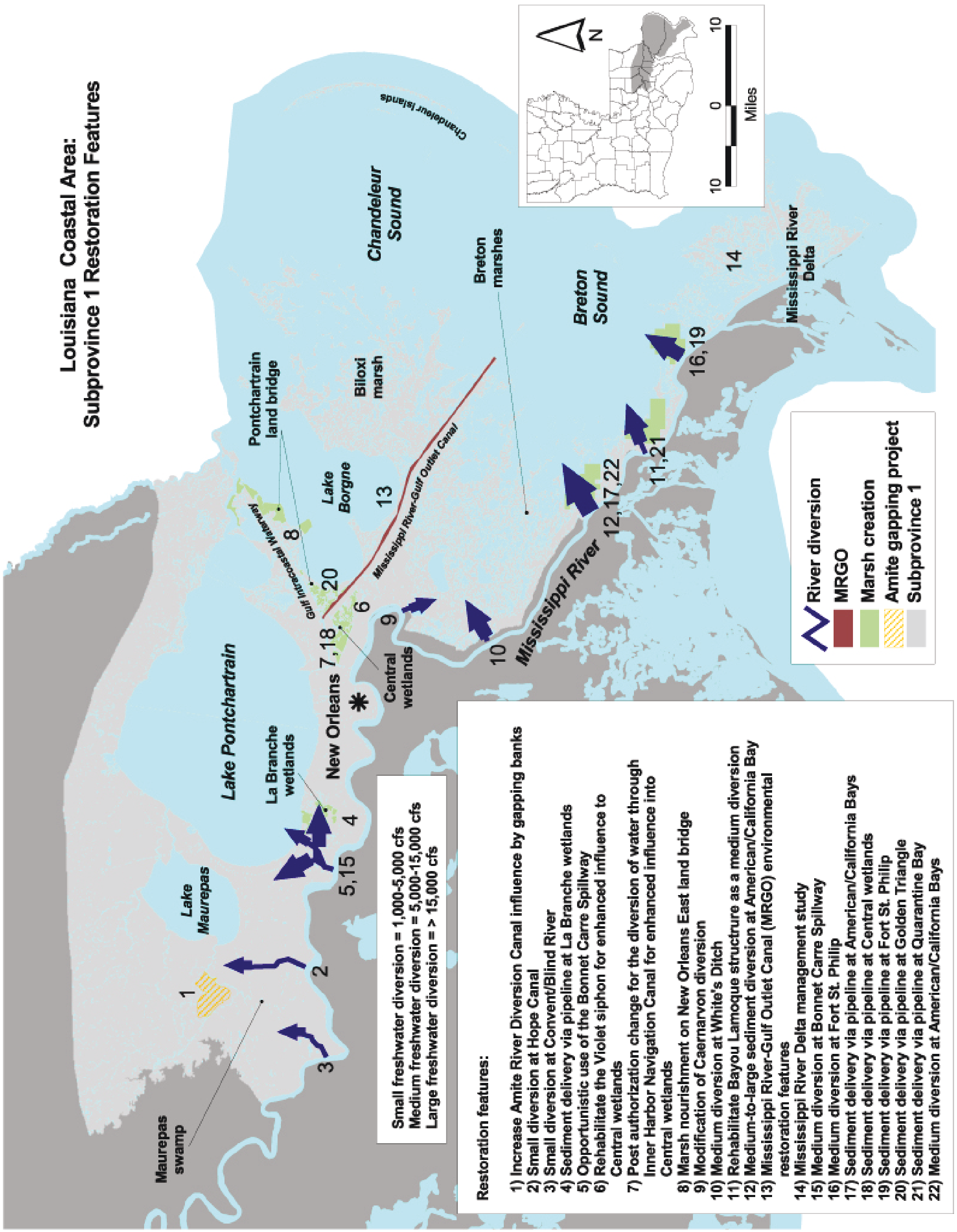


Figure MR 3-6. Subprovince 1 Restoration Features Identified in the Final Array of Coast Wide Frameworks.

3.3.6.1.2 *Subprovince 2 Feature Descriptions*

Large diversion at Boothville with sediment enrichment

This restoration feature provides for a large nonstructural, uncontrolled sediment diversion from the Mississippi River near Boothville into the Yellow Cotton/Hospital Bays area. The objective of this feature is to create wetlands by diverting sediment in the moderately deep (6 to 10 feet [1.8 to 3 feet]) open waters of Yellow Cotton / Hospital Bays. The freshwater and nutrients would also increase vegetative stability in the fringing marshes and along the Bayou Grand Liard ridge. Ultimately, sediment would reach and supplement the barrier shoreline between Red Pass and the Empire to the gulf waterway. Sediment enrichment assumes use of 20-inch (51 centimeter) dredge at capacity for three months yielding 1,468,000 cubic yards (1,120,000 cubic meters) each year. The diversion would maximize sediment and nutrient inputs and spur large-scale land building in the extreme southeastern portion of Barataria Bay.

Small diversion at Donaldsonville

This restoration feature involves a small diversion from the Mississippi River through a new control structure at Donaldsonville. The objective is to introduce freshwater, sediment, and nutrients into upper Bayou Verret, which is located to the northwest of Lac Des Allemands, to improve water quality and promote plant productivity. The wetland ecosystem in the area is classified as wetland forest, consisting primarily of bottomland hardwood forests. This feature is intended to operate in conjunction with three other small diversions in the area.

Small diversion at Edgard

This restoration feature involves a small diversion from the Mississippi River through a new control structure at Edgard. The objective is to introduce freshwater, sediment, and nutrients into Bayou Fortier, which is located to the northeast of Lac Des Allemands, to improve water quality and promote plant productivity. The wetland ecosystem in the area is classified as wetland forest, consisting primarily of bottomland hardwood forest. This feature is intended to operate in conjunction with three other small diversions in the area.

Medium diversion at Edgard with sediment enrichment

This restoration feature involves a medium diversion from the Mississippi River through a new control structure at Edgard. The objective is to introduce freshwater, sediment, and nutrients into Bayou Fortier, which is located to the northeast of Lac des Allemands, to improve water quality and promote plant productivity. The wetland ecosystem in the area is classified as wetland forest, consisting primarily of bottomland hardwood forest. Sediment enrichment would involve use of 12-inch (31 centimeter) dredge for three months. Discharge of effluent upstream of the diversion intake would allow the capture of silts and very fine sands only.

Medium diversion at Fort Jackson - Alternative to Boothville diversion

This restoration feature provides for a medium non-structural, uncontrolled sediment diversion from the Mississippi River near Fort Jackson into the Yellow Cotton/Hospital Bays area. The objective of this feature is to create wetlands by diverting sediment in the moderately deep (6 to 10 feet [1.8 to 3 feet]) open waters of Yellow Cotton/Hospital Bays. The associated freshwater and nutrients would also increase vegetative stability in the fringing marshes and along the Bayou Grand Liard ridge. The diversion would maximize sediment and nutrient inputs and spur land building in the extreme southeastern portion of Barataria Bay.

Large diversion at Fort Jackson with sediment enrichment - Alternative to Boothville diversion

This restoration feature provides for a large (50,000 to 100,000 cfs [1,800 to 3,600 cms]) non-structural, uncontrolled sediment diversion from the Mississippi River near Fort Jackson into the Yellow Cotton/Hospital Bays area. The objective of this feature is to create wetlands by diverting sediment in the moderately deep (6 to 10 feet [1.8 to 3 feet]) open waters of Yellow Cotton / Hospital Bays. The associated freshwater and nutrients would also increase vegetative stability in the fringing marshes and along the Bayou Grand Liard ridge. Sediment enrichment assumes use of 20-inch (51 centimeter) dredge at capacity for three months yielding 1,468,000 cubic yards (1,120,000 cubic meters) each year. Ultimately, sediment would reach and supplement the barrier shoreline between Red Pass and the Empire to the gulf waterway. The diversion would maximize sediment and nutrient inputs and spur large-scale land building in the extreme southeastern portion of Barataria Bay.

Small diversion at Lac des Allemands

This restoration feature involves a small diversion from the Mississippi River through a new control structure at Lac des Allemands. The objective is to introduce freshwater, sediment, and nutrients into Bayou Becnel, which is located to the north of Lac des Allemands, to improve water quality and promote plant productivity. The wetland ecosystem in Bayou Becnel and surrounding Lac des Allemands area is classified as wetland forest, consisting primarily of bottomland hardwood forest. This feature is intended to operate in conjunction with three other small diversions in the area.

Medium diversion at Lac des Allemands with sediment enrichment

This restoration feature involves a medium diversion from the Mississippi River through a new control structure at Lac des Allemands. The objective is to introduce freshwater, sediment, and nutrients into Bayou Becnel, which is located to the north of Lac des Allemands, to improve water quality and promote plant productivity. The wetland ecosystem in Bayou Becnel and surrounding Lac des Allemands area is classified as wetland forest, consisting primarily of bottomland hardwood forest. Sediment enrichment would involve use of 12-inch (31 centimeter) dredge for three months. Discharge of effluent upstream of the diversion intake would allow the capture of silts and very fine sands only. This feature is intended to operate in conjunction with three small diversions in the area.

Medium diversion with dedicated dredging at Myrtle Grove

This restoration feature involves a medium diversion of the Mississippi River near Myrtle Grove through a new control structure. The diversion would provide additional sediment and nutrients to nourish highly degraded existing fresh to brackish wetlands in shallow open water areas. This reintroduction would ensure the long-term sustainability of these marshes by increasing plant productivity, thereby preventing future loss. The introduction of sediment to this area would also promote the infilling of shallow open water areas both through deposition and marsh expansion. Dedicated dredging of sediment mined from the Mississippi River would complement this feature. This feature is located in the vicinity of a historic crevasse. Work has been initiated on engineering and design and NEPA compliance under CWPPRA.

Large diversion at Myrtle Grove with sediment enrichment

This restoration feature involves a large sediment diversion from the Mississippi River near Myrtle Grove through a new control structure. The diversion would provide additional sediment and nutrients to nourish highly degraded existing fresh to brackish wetlands in shallow open water areas throughout the central Barataria basin. This reintroduction would allow the creation of new wetland in expansive open water and bay areas and ensure the long-term sustainability of currently degraded marshes by increasing plant productivity, thereby preventing future loss. The additional introduction of sediment by enrichment assumes use of 30-inch dredge at capacity for three months yielding 6,293,000 cubic yards [4,810,000 cubic meters] each year. This feature is located in the vicinity of a historic crevasse.

Small diversion at Pikes Peak

This restoration feature involves a small diversion from the Mississippi River through a new control structure at Pikes Peak. The objective is to introduce freshwater, sediment and nutrients into Bayou Chevreuil, which is located to the north of Lac Des Allemands, to improve water quality and promote plant productivity. The wetland ecosystem in the area is classified as wetland forest, consisting primarily of bottomland hardwood wetlands. This feature is intended to operate in conjunction with three other small diversions in the area.

Barataria Basin barrier shoreline restoration

This restoration feature involves mining of offshore sediment sources to reestablish sustainable barrier islands. The feature is based on designs developed in the LCA Barataria Barrier Island Restoration study and assumes a 3,000-foot [914 meter] wide island footprint. This feature originally considered restoration elements for all the major reaches of the Barataria barrier-shoreline chain. However, for inclusion in the near-term plan some consideration to the most critically needed elements of the chain. The most critical areas of this chain, however, include the Caminada-Moreau Headland (an area between Belle Pass and Caminada Pass) and Shell Island (a barrier island in the Plaquemines barrier island system). These barrier shoreline segments are critical components of the Barataria shoreline. The Shell Island segment has been nearly lost and failure to take restorative action could result in the loss of any future options for restoration. This would result in permanent modification of the tidal hydrology of the Barataria

Basin. The Caminada-Moreau Headland protects the highest concentration of near-gulf oil and gas infrastructure in the coastal area. This reach of the Barataria shoreline also supports the only land-based access to the barrier shoreline in the Deltaic Plain. These critical endpoints in the Barataria chain also serve as sources of material for the littoral system delivering sediment to the remainder of the chain.

Implement the LCA Barataria Basin Wetland Creation and Restoration Study

This feature involves implementation of components of the LCA Barataria Basin Wetland Creation and Restoration Study. The wetlands in the lower Barataria Basin have experienced wetland deterioration due to subsidence, a lack of circulation, saltwater intrusion, and a paucity of sediment and nutrients. Sediment dredged from offshore borrow sites would be placed at specific sites near Bayou Lafourche in the Caminada Headland to create and restore marsh and ridge habitat in the area.

Modification of Davis Pond diversion

The Davis Pond diversion structure, constructed in 2002 in upper Barataria Basin, has a maximum operating capacity of 10,600 cfs [378 cms]. The structure has been operated as a salinity management feature, with freshwater introductions from the Mississippi River ranging from 1,000 cfs up to 5,000 cfs [36 cms to 178 cms] averaging, to this point in time, considerably less than half of the structure's capacity. The primary purpose of the existing Davis Pond project has been to maintain salinity gradients in the central portion of Barataria Basin. This operation, in effect, partially restored the historic functions of marsh nourishment (e.g., freshwater inflow, providing nutrients and sediment to the marsh, and countering the effects of subsidence). This restoration feature study would assess changes in the operation of the Davis Pond project to increase wetland creation and restoration outputs. Modified operation of this structure could potentially result in an increase in the freshwater introduction rate, perhaps 5,000 cfs [178 cms] on average, to accommodate the wetland building function of the system. This study would identify changes to feature's operation that would increase restoration outputs. The introduction of additional freshwater would facilitate organic and sediment deposition, improve biological productivity, and prevent further deterioration of the marshes. This feature is located in the vicinity of a historic crevasse. Any proposed change in purpose that would require modification of the existing project authorization would be submitted for Congressional approval.

Sediment delivery via pipeline at Bastian Bay/Buras

This restoration feature provides for sediment delivery via pipeline through programmatic sediment mining from the Mississippi River. The moderately deep (6 to 10 feet [1.8 to 3 feet]) open water in this bay system requires a large volume of sediment to create wetlands. The objective of this feature is to create wetlands in the highly degraded Bastian Bay and Buras area.

Sediment delivery via pipeline at Empire

This restoration feature provides for sediment delivery via pipeline through programmatic sediment mining from the Mississippi River. The moderately deep (6 to 10 feet [1.8 to 3 feet]) open water in Bay Adams and Barataria Bay requires a large volume of sediment to create wetlands. The objective of this feature is to create wetlands in the highly degraded areas south and west of Empire.

Sediment delivery via pipeline at Main Pass (Head of Passes)

This feature provides for sediment delivery via programmatic sediment mining from the Mississippi River utilizing a sediment trap above the Head of Passes. The estimated annual yield of dredge material from the sediment trap is 9 million cubic yards [6.9 million cubic meters]. The objective of this feature is to create wetlands in the degraded areas in the east and west portions of the Mississippi River Delta south of Venice.

Third Delta (Subprovinces 2 & 3)

This feature provides for a large diversion from the Mississippi River through a new control structure in the vicinity of Donaldsonville. This feature provides for an approximately 240,000 cfs diversion at maximum river stage. Flows would be diverted into a newly constructed conveyance channel (parallel to Bayou Lafourche) extending approximately 55 miles [88 kilometers] from the initial point of diversion to the eventual point of discharge. Diverted flow would be divided equally at a point north of the GIWW to enable the creation of a deltaic wetlands complex in each of the Barataria and Terrebonne Basins. A possible alternative configuration would involve a 120,000 cfs [4300 cms] diversion at maximum river stage into the Barataria Basin only. Enrichment of this diversion would also be considered and assumes use of 30-inch [77 cm] dredge at capacity for three months yielding 6,293,000 cubic yards [4,810,000 cubic meters] each year. The study requires detailed investigations of flood control, drainage, and navigation impacts in addition to environmental and design efforts because it would require construction either through wetlands or prime farmland.

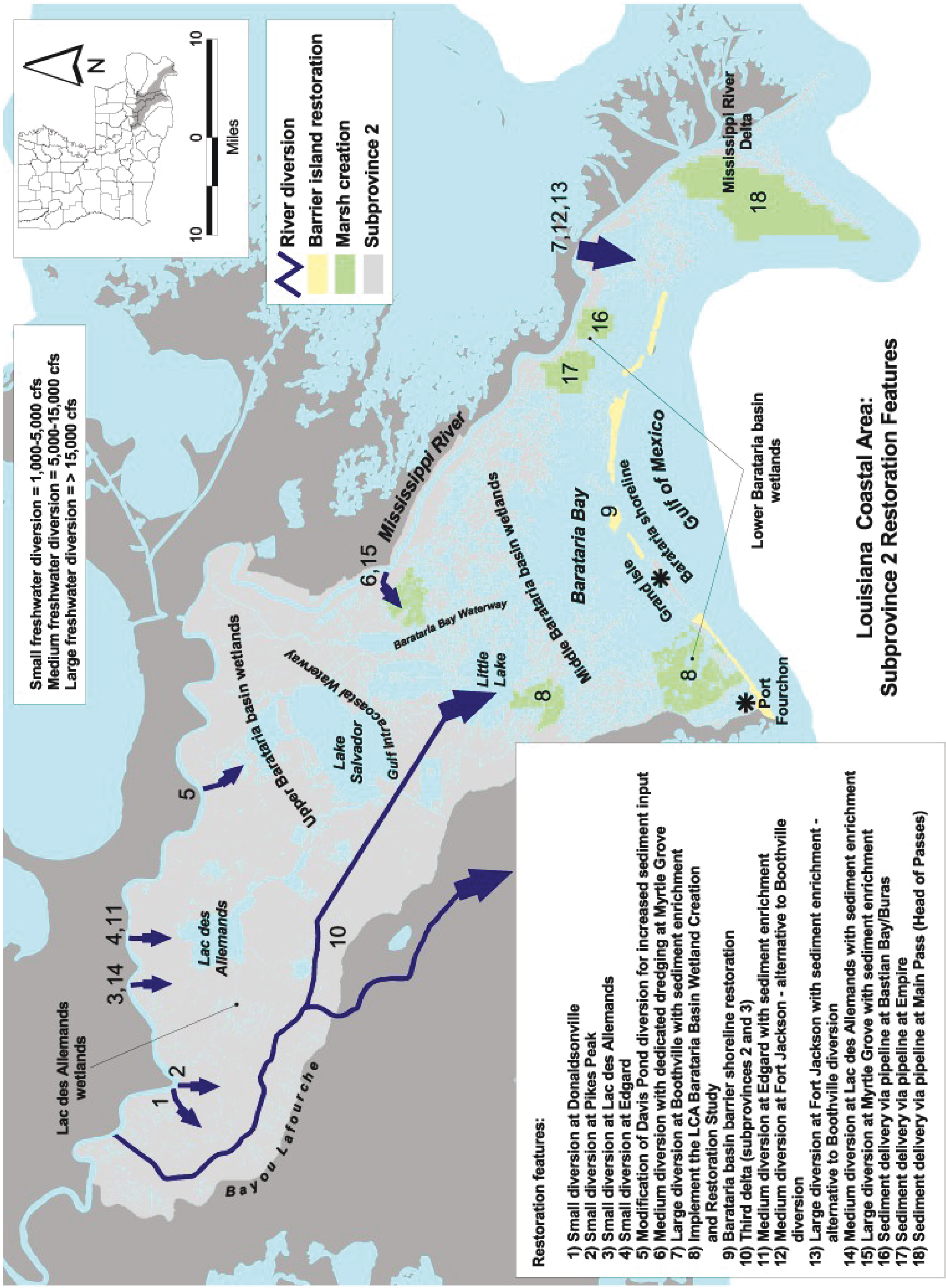


Figure MR 3-7. Subprovince 2 Restoration Features Identified in the Final Array of Coast Wide Frameworks.

3.3.6.1.3 *Subprovince 3 feature descriptions*

Backfill pipeline canals

This restoration feature provides for the backfilling of pipeline canals south of Catfish Lake. The Twin Pipeline canals in this area are crossed by numerous oilfield canals, which have greatly altered natural water circulation patterns. The 63,300 feet [19,300 meters] of pipeline canals would be filled at strategic locations to restore primary water circulation through Grand Bayou Blue. The retention time of Atchafalaya and Bayou Lafourche (pumped) flows would be increased to benefit affected wetlands.

Small Bayou Lafourche reintroduction

This restoration feature would reintroduce flow from the Mississippi River into Bayou Lafourche. The piped flow would be continuous and would freshen and reduce loss rates for the wetlands between Bayous Lafourche and Terrebonne, south of the GIWW.

Convey Atchafalaya River water to Northern Terrebonne marshes - via a small diversion in the Avoca Island levee, repairing eroding banks of the GIWW, and enlarging constrictions in the GIWW below Gibson and in Houma, and Grand Bayou conveyance channel construction/enlargement

This restoration feature would increase existing Atchafalaya River influence to central (Lake Boudreaux) and eastern (Grand Bayou) Terrebonne marshes via the GIWW by introducing flow into the Grand Bayou basin by enlarging the connecting channel (Bayou L'Eau Bleu) to capture as much of the surplus flow (max. 2000 to 4000 cfs [70 to 140 cms]) that would otherwise leave the Terrebonne Basin. Several alternatives would be evaluated through hydrologic models; however in all cases, gated control structures would be installed to restrict channel cross-section to prevent increased saltwater intrusion during the late summer and fall when riverine influence is typically low. Some alternatives may include auxiliary freshwater distribution structures. This feature also includes increasing freshwater supply through repairing banks along the GIWW, enlarging constrictions in the GIWW, and diverting additional Atchafalaya River freshwater through the Avoca Island Levee and into Bayou Chene/GIWW system.

Freshwater introduction south of Lake De Cade

This restoration feature is intended to improve Atchafalaya flows to Terrebonne wetlands between Lake De Cade, Bayou du Large, and Lake Mechant by constructing three small conveyance channels along the south shore of Lake De Cade to the Small Bayou La Pointe area. Channel flows would be controlled by structures that could be actively operated. Lowering salinities and increasing nutrient inputs would reduce intermediate marsh losses.

Freshwater introduction via Blue Hammock Bayou

This restoration feature would increase flow from the Atchafalaya River to the southwest Terrebonne wetlands by increasing the cross-section of Blue Hammock Bayou. This would increase the distribution of Atchafalaya flows from Four League Bay to the Lake Mechant wetlands. Grand Pass and Buckskin Bayou, outlets of Lake Mechant, would be reduced in cross section to increase the retention and benefits of Atchafalaya nutrients, sediment, and freshwater in these estuarine wetlands. Additional marsh would also be created with dredged material.

Increase sediment transport down Wax Lake Outlet

This restoration feature would increase sediment transport down Wax Lake Outlet by extending the outlet northward through Cypress Island to connect to the Atchafalaya Main Channel. Currently, the Wax Lake Outlet flows passes over the relatively shallow Six Mile Lake before entering the outlet. This restoration feature would connect the deep outlet directly to the deep Atchafalaya Main Channel thereby increasing bed load sediment transported to the Wax Lake Outlet Delta.

Maintain land bridge between Caillou Lake and Gulf of Mexico

This restoration feature would maintain the land bridge between the gulf and Caillou Lake by placing shore protection in Grand Bayou du Large to minimize saltwater intrusion. This feature would involve rock armoring or marsh creation to plug/fill broken marsh areas on the west bank of lower Grand Bayou du Large, to prevent a new channel from breaching the bayou bank and allowing a new connection with Caillou Lake. Some gulf shore armoring would be needed to protect these features from erosion on the gulf shoreline. Gulf shoreline armoring might be required where shoreline retreat and loss of shoreline oyster reefs has allowed increased water exchange between the gulf and the interior water bodies (between Bay Junop and Caillou Lake). Some newly opened channels would be closed to restore historic cross-sections of exchange points. By reducing marine influences in these interior areas, this feature would allow increased freshwater influence from Four League Bay to benefit area marshes.

Maintain land bridge between Bayous du Large and Grand Caillou

This restoration feature provides for construction of a land bridge between Bayous du Large and Grand Caillou south of Falgout Canal and northeast of Caillou Lake. A grid of numerous trenasses, a small human-made channel for navigation, has artificially increased the hydrologic connection between interior marshes with Caillou Lake and adjoining water bodies. This problem would be addressed by depositing hydraulically dredged material to close the trenasses and areas of broken marsh to create a continuous berm of "high marsh" in the area. This berm would separate the higher, healthy brackish/saline marshes bordering the northeast end of Caillou Lake from the deteriorating inland intermediate/brackish marshes. It would also allow the freshwater flowing down the HNC and Bayou Grand Caillou to have a greater influence on interior marshes through existing water exchange points along Bayou Grand Caillou, north of the proposed land bridge.

Maintain northern shore of East Cote Blanche Bay at Point Marone

This restoration feature would protect the north shore of East Cote Blanche Bay from Point Marone to Jackson Bayou. Bay shoreline would be stabilized to protect the interior wetland water circulation patterns in the Cote Blanche Wetlands CWPPRA project. The feature was designed to increase the retention time of the Atchafalaya flows moving from the GIWW to East Cote Blanche Bay.

Maintain Timbalier land bridge

This restoration feature provides for maintaining the Timbalier land bridge in the upper salt marsh zone. A 2,000-foot-wide (610 meter), 21-mile-long (34 kilometer), segmented marsh and low ridge land form (roughly 5,000 acres [2000 ha]) would be constructed from the east bank of Bayou Terrebonne near Bush Canal to the west bank of Bayou Lafourche near the southern terminus of the hurricane protection levee. This landform would be constructed by depositing hydraulically dredged material and could resemble the long, linear, segmented dredge material disposal islands in Atchafalaya Bay. The nine major bayous, which connect the upper subbasin to the downstream lakes and bays, would remain open; among others, they include Grand Bayou Blue and Bayous Pointe Au Chien, Jean La Croix, Barre, and Tambour. The proposed land bridge alignment is in the upper salt Marsh zone, minimizes impacts to existing oyster leases, and avoids most of the oil and gas fields in the Timbalier Subbasin.

Multi-purpose operation of Houma Navigation Canal (HNC) Lock

The restoration feature involves the multi-purpose operation of the proposed HNC Lock, located at the southern end of the HNC. The Morganza to the Gulf Hurricane Protection Study includes construction of the lock, but does not include the multi-purpose operation of the lock. The objective of this feature is to make more efficient use of Atchafalaya River waters and sediment flow, as well as maintain salinity regimes favorable for area wetlands. The proposed structure would be operated to restrict saltwater intrusion and distribute freshwater and sediment during times of high Atchafalaya River flow. The current project is designed to limit saltwater intrusion, but with a minor modification would provide additional benefits to the wetlands by increasing retention time of Atchafalaya River water in the Terrebonne Basin wetlands. An increased retention time would provide additional sediment and nutrients to nourish the wetlands and would benefit the forested wetlands, and fresh, intermediate, and brackish marshes adjacent to the lock and canal; the Lake Boudreaux wetlands to the north; the Lake Mechant wetlands to the west; and the Grand Bayou wetlands to the east.

Penchant Basin Restoration

This restoration feature involves the implementation of the Penchant Basin Plan. This would increase the efficiency of Bayou Penchant to convey flows from the area wetlands as Atchafalaya River stages fall after spring floods, and reduce excessive water levels in the upper Penchant Subbasin. Increased outlet capacities would utilize flow, increasing circulation and retention in tidal wetlands below the large fresh floating marsh area.

Rebuild Historic Reefs - rebuild historic barrier between Point Au Fer and Eugene Island and construct segmented reef/breakwater/jetty along the historic Point Au Fer Barrier Reef from Eugene Island extending towards Marsh Island to the west

This restoration feature would increase the rate of Atchafalaya Delta growth and would increase the Atchafalaya River influence in Atchafalaya Bay, Point Au Fer Island, and Four League Bay by rebuilding the historic barrier between Point Au Fer and Eugene Island. This barrier would separate these areas from the gulf following the historic Point Au Fer reef alignment. The barrier could be a reef, a barrier island, an intertidal spit, or a segmented breakwater. The barrier would increase delta development by reducing the erosive wave effects. Atchafalaya River freshwater influence would be increased in the interior areas of the Atchafalaya Basin. Constructing a segmented reef/breakwater/jetty along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh Island to the west would produce similar beneficial effects in the western portion of Atchafalaya Bay. The barrier would join the Bayou Sale natural levee feature.

Acadiana Bays Estuarine Restoration

This restoration feature provides for rebuilding historic Point Chevreuil Reef toward Marsh Island, and rehabilitating the Bayou Sale natural levee between Point Chevreuil and the gulf. The natural levee would be rebuilt in the form of a shallow sub-aqueous platform, small islands, and/or reefs. The historic shell reefs were removed by shell dredging. This feature was designed to help restore historic hydrologic conditions in the Teche/Vermilion Basin.

Rehabilitate northern shorelines of Terrebonne/Timbalier Bays

This feature provides for the rehabilitation of the northern shorelines of Terrebonne/Timbalier Bays with a segmented breakwater from the Seabreeze area to the Little Lake area. This feature would rebuild and maintain the historic shoreline integrity around Terrebonne and Timbalier Bays by constructing segmented barriers along the west side of Terrebonne Bay, across the historic shoreline alignment along the northern sides of both bays, and along the eastern side of Timbalier Bay.

Relocate the Atchafalaya Navigation Channel

This restoration feature consists of relocating the Atchafalaya Navigation Channel. The navigation channel route through the delta has been identified as the greatest impediment to the delta's growth. By rerouting the channel between the delta lobes, and by using a passive hydraulic structure at the point of departure in the Lower Atchafalaya River, river sediment would be used more efficiently in the growing delta.

Terrebonne Basin barrier shoreline restoration

This feature originally considered restoration elements for all the major reaches of the Terrebonne barrier-shoreline chain. However, for inclusion in the near-term plan some consideration to the most critically needed elements of the chain. This restoration feature provides for the restoration of the Timbalier and Isles Dernieres barrier island chains. This would simulate historical conditions by reducing the current number of breaches, enlarging (width and dune crest) of the Isles Dernieres (East Island, Trinity Island, and Whiskey Island), Timbalier Island, and East Timbalier Island.

Stabilize banks of Southwest Pass

This restoration feature would maintain the integrity of Southwest Pass channel connecting southwestern Vermilion Bay with the Gulf of Mexico by protecting its bay and gulf shorelines. This feature would involve the construction of a dike and armoring of the banks of the pass to maintain the existing pass dimensions.

Gulf shoreline stabilization at Point Au Fer Island

This feature provides for stabilizing of the gulf shoreline of Point Au Fer Island. The purpose is to prevent direct connections from forming between the gulf and interior water bodies as the barrier island is eroded. In addition to gulf shoreline protection, this feature would prevent the fresher bay side water circulation patterns from being influenced directly by the gulf, thus protecting the estuarine habitat, which has higher quality wetland habitats, from conversion to marine habitat.

Alternative operational schemes of Old River Control Structure (ORCS)

This feature would evaluate alternative ORCS operational schemes with a goal of increasing the sediment load transported by the Atchafalaya River for the purpose of benefiting coastal wetlands. Detailed studies of this feature would determine: impacts (beneficial and adverse) to the interior of the Atchafalaya Basin; the degree to which flow and sediment redistributions would be required; and the increased costs of maintaining the flood control, navigation, and environmental features along the Lower Mississippi, Red, and Atchafalaya Rivers.

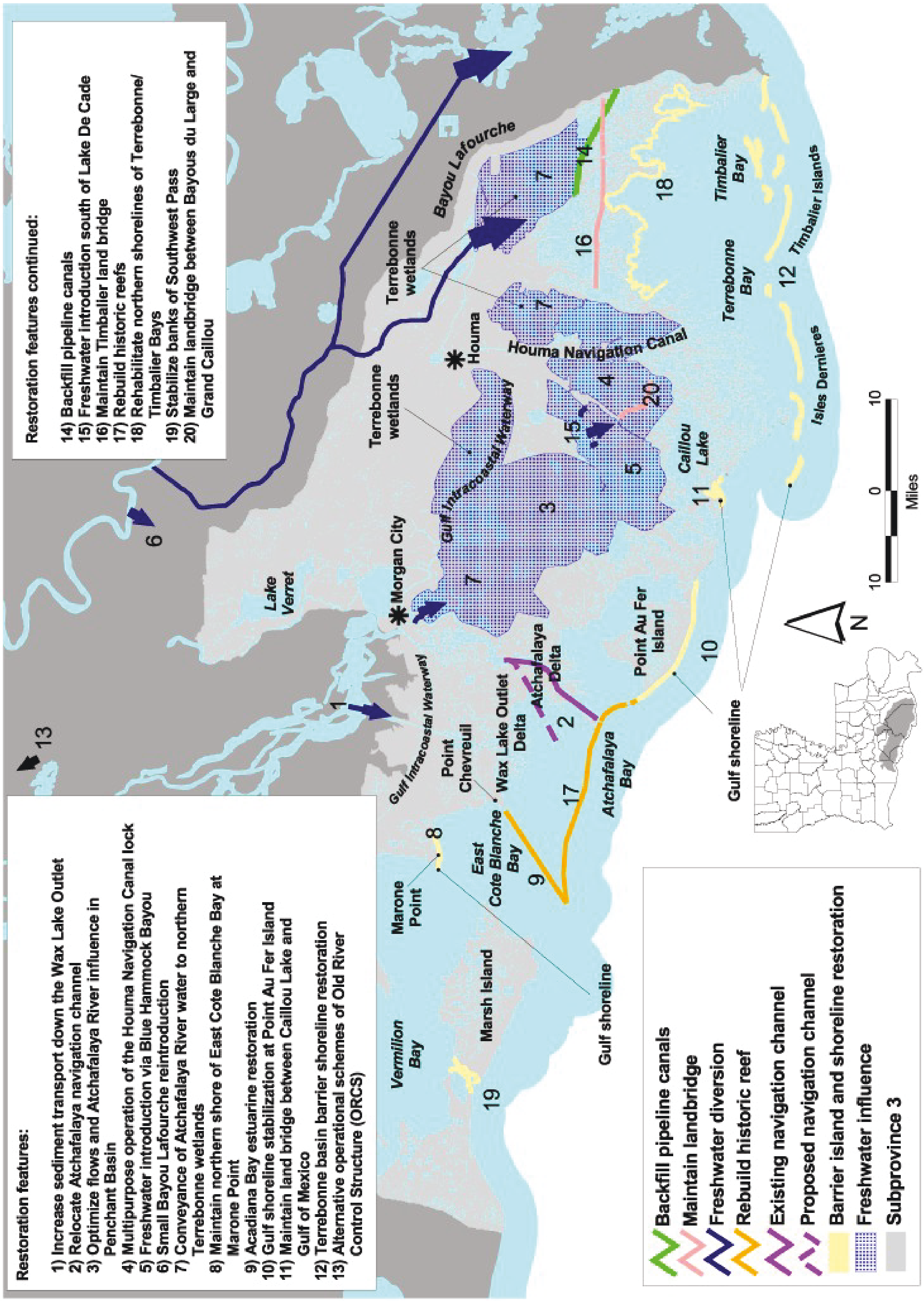


Figure MR 3-8. Subprovince 3 Restoration Features Identified in the Final Array of Coast Wide Frameworks.

3.3.6.1.4 *Subprovince 4 feature descriptions*

Black Bayou bypass culverts

This restoration feature involves the replacement of the Calcasieu Lock in the GIWW west of the Hwy 384 Bridge and uses the old lock for freshwater introduction to the upper Calcasieu estuary from the Mermentau Basin. This feature also incorporates freshwater introduction via the Black Bayou Culverts feature at the intersection of Black Bayou and Hwy 384.

Calcasieu Ship Channel Beneficial Use

This feature capitalizes on the existing navigation maintenance activity by expanding beneficial use of dredged material from the Calcasieu Ship Channel. It accomplishes this by extending the application of material dredged from the channel for routine maintenance beyond the normal standard. Average annual maintenance dredging volume is approximately 4 million cubic yards (3.1 million cubic meters). The expanded use of this material would result in wetland creation over 50 years of application.

Chenier Plain freshwater management and allocation reassessment

This restoration opportunity requires detailed investigations involving water allocation needs and trade-off analysis in the eastern Chenier Plain, including the Teche/Vermilion Basin, to provide for wetland restoration and support continued agriculture and navigation in the region. A series of navigation and salinity control structures are currently authorized and operated in the eastern portion of the Chenier Plain. These structures maintain a freshwater source for agricultural applications and prevention of salinity intrusion in the area. Tidal stages have predominantly exceeded stages within the managed area creating a ponding issue for the fresh and intermediate marshes in the area. In addition, the natural ridges that define this area continue to be impacted by erosion, further threatening the ability for continued management and sustainability of the interior marshes. The study would address water management and allocation issues including salinity control, drainage, and fisheries accessibility.

Dedicated dredging for marsh restoration

This restoration feature would apply dredged material from offshore sources beneficially to restore subsided wetlands on Sabine National Wildlife Refuge (NWR) and adjacent properties. Locations for marsh restoration would be north and northwest of Browns Lake on Sabine NWR. Average open water depth is 1.5 to 2 feet (0.4 to 0.6 meters) deep.

East Sabine Lake hydrologic restoration

This restoration feature involves restoration of East Sabine Lake between Sabine Lake and Sabine NWR Pool 3. This feature would include salinity control structures at Willow Bayou, Three Bayou, Greens Bayou, and Right Prong of Black Bayou. Sediment terracing would also be used in shallow open water areas along with shoreline protection along Sabine Lake and some smaller structures.

Freshwater introduction at Highway 82

This restoration feature provides for drainage of "excess" freshwater from the Mermentau Basin Lakes Subbasin across Hwy 82 to the Chenier Subbasin at the Highway 82 area between Rollover Bayou and Superior Canal to the eastern portion of Rockefeller Refuge. This introduction would involve the replacement or modification of culverts under Hwy 82. The objective of this feature is to relieve elevated stages in the northern area and provide freshwater input to the brackish and intermediate marshes to the south. This feature is intended to work in concert with four other restoration feature located along the Hwy 82 alignment.

Freshwater introduction at Little Pecan Bayou

This restoration feature provides for drainage of "excess" freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 to the Chenier Subbasin west of Rockefeller Refuge at the Thibodeaux Bridge. This introduction would involve the replacement or modification of culverts under Hwy 82. The objective of this feature is to relieve elevated stages in the northern area and provide freshwater input to the brackish and intermediate marshes to the south. This feature is intended to work in concert with four other restoration feature located along the Hwy 82 alignment.

Freshwater introduction at Pecan Island

This restoration feature provides for drainage of "excess" freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 near Pecan Island to the Chenier Subbasin. This introduction would involve the replacement or modification of culverts under Hwy 82. The objective of this feature is to relieve elevated stages in the northern area and provide freshwater input to the brackish and intermediate marshes to the south. This feature is intended to work in concert with four other restoration feature located along the Hwy 82 alignment.

Freshwater introduction at Rollover Bayou

This restoration feature provides for drainage of "excess" freshwater from the Mermentau Basin Lake Subbasin across Hwy 82 at Rollover Bayou to the Chenier Subbasin. This introduction would involve the replacement or modification of culverts under Hwy 82. The objective of this feature is to relieve elevated stages in the northern area and provide freshwater input to the brackish and intermediate marshes to the south. This feature is intended to work in concert with four other restoration feature located along the Hwy 82 alignment.

Freshwater Introduction at South Grand Chenier

This restoration feature provides for drainage of "excess" freshwater from the Mermentau Basin Lakes Subbasin from the Mermentau River across Hwy 82 to the Chenier Subbasin Hog Bayou watershed. This introduction would involve the replacement or modification of culverts under Hwy 82. The objective of this feature is to relieve elevated stages in the northern area and provide freshwater input to the brackish and intermediate marshes to the south. This feature is intended to work in concert with four other restoration feature located along the Hwy 82 alignment.

<u>Stabilize Gulf shoreline near Rockefeller Refuge</u>

This restoration feature provides for gulf shoreline stabilization from Mermentau Ship Channel to near Rollover Bayou east of Rockefeller Refuge. Stabilization methods include rock foreshore dikes, offshore reefs, or segmented breakwaters, similar to Holly Beach breakwaters, placed closer to shore and with narrower gaps. The objective of this feature is the prevention of shoreline breaching into the landward brackish and intermediate marshes.

<u>Modify existing Cameron-Creole watershed structures</u>

The Cameron-Creole watershed feature, constructed in 1989, consists of 5 large concrete water control structures and a 16 mile-long levee along the shoreline of Calcasieu Lake. Three of the five structures (Grand Bayou, Bois Connine Bayou, and Lambert Bayou) are adjustable structures with slide gates and the remaining two (Mangrove Bayou and No Name Bayou) are fixed crest weir structures. The fixed crest weir sill heights may be set too high. This higher setting could be contributing to the impoundment problem within Cameron-Creole marshes adjacent to those structures. If the weir sills for these two structures could be modified to lower weir crests, reduced impoundment, greater water flow, and increased fisheries access (above that afforded by the vertical fish slots already present in the structures) would occur independent of salinity control at Calcasieu Pass.

<u>New Lock at the GIWW</u>

This feature consists of a new lock at the GIWW east of Alkali Ditch with dimensions of 75 to 110 feet (23 to 34 meters) wide by 15 feet (4.6 meters) deep. This restoration feature would limit the exchange of water between the Sabine River and the GIWW eastward to the Calcasieu River. The existing circulation pattern provides a mechanism for the intrusion of higher salinity waters transmitted by the deeper navigation channels in each of the rivers to reach the interior marshes. The objective of the feature is the reduction of circulation of higher salinity water through the Calcasieu-Sabine sub-basin, thereby reducing future wetlands loss.

<u>Salinity control at Alkali Ditch</u>

This restoration feature provides salinity control at the Alkali Ditch, northwest of Hackberry at the GIWW, with a gated structure or rock weir with barge bay. The existing dimensions of the feature are approximately 150 to 200 feet (45 to 60 meters) wide by 8 to10 feet (2.4 to 3 meters) deep; the structure or weir with approximate dimensions 70 feet wide (21 meters) by 8 feet (2.4 meters) deep. The objective of this feature is to regulate saltwater intrusion in order to stabilize the brackish and intermediate marshes in the area and reduce future loss.

Salinity control at Black Bayou

This restoration feature calls for a salinity control structure with boat bay at the mouth of Black Bayou (either a gated structure or a rock weir), located at the intersection of Black Bayou and the northeastern shoreline of Sabine Lake. The existing bayou dimensions are 150 to 200 feet (45 to 60 meters) wide by 10 feet (3 meters) deep. The objective of this feature is to regulate saltwater intrusion in order to stabilize the brackish and intermediate marshes in the area and reduce future loss.

Salinity control at Black Lake Bayou

This restoration feature calls for salinity control in Long Point Bayou with a gated structure or rock weir located in Long Point Bayou north of Sabine NWR near Hwy 27, west of the Calcasieu Ship Channel. The existing dimensions are 40 feet wide (12 meters) by 5 feet (1.5 meters) deep. The structure's approximate dimensions are 10 to 15 feet (3 to 4.5 meters) wide by 4 feet (1.2 meters) deep boat bay. The objective of this feature is to regulate saltwater intrusion in order to stabilize the brackish and intermediate marshes in the area and reduce future loss.

Salinity control at Highway 82 Causeway

This restoration feature provides for a rock weir at Hwy 82 Causeway located in the southern portion of Sabine Lake north of Sabine Pass and the Sabine-Neches Waterway. Existing dimensions of the facility equal approximately 3,400 feet wide by approximately 4 feet deep, except at the approximate 10 feet (3 meters) deep center channel. The objective of this feature is to regulate saltwater intrusion in order to stabilize the brackish and intermediate marshes in the area and reduce future loss.

Salinity control at Long Point Bayou

This restoration feature provides for salinity control in Long Point Bayou with a gated structure or rock weir located in Long Point Bayou north of Sabine NWR near Hwy 27, west of the Calcasieu Ship Channel. The existing dimensions are 40 feet wide by 5 feet deep. The structure's approximate dimensions are 10 to 15 feet (3 to 4.5 meters) wide by 4 feet (1.2 meters) deep boat bay. The objective of this feature is to regulate saltwater intrusion in order to stabilize the brackish and intermediate marshes in the area and reduce future loss.

Salinity control at Oyster Bayou

This restoration feature provides for salinity control in Oyster Bayou with a gated structure or rock weir. The location in Oyster Bayou is about 1 mile west of the Calcasieu Ship Channel, which is 100 to 150 feet wide by 10 feet deep; with an approximately 15 to 20 foot (4.5 to 6 meters) wide by 4 foot (1.2 meters) deep boat bay. The objective of this feature is to regulate saltwater intrusion in order to stabilize the brackish and intermediate marshes in the area and reduce future loss.

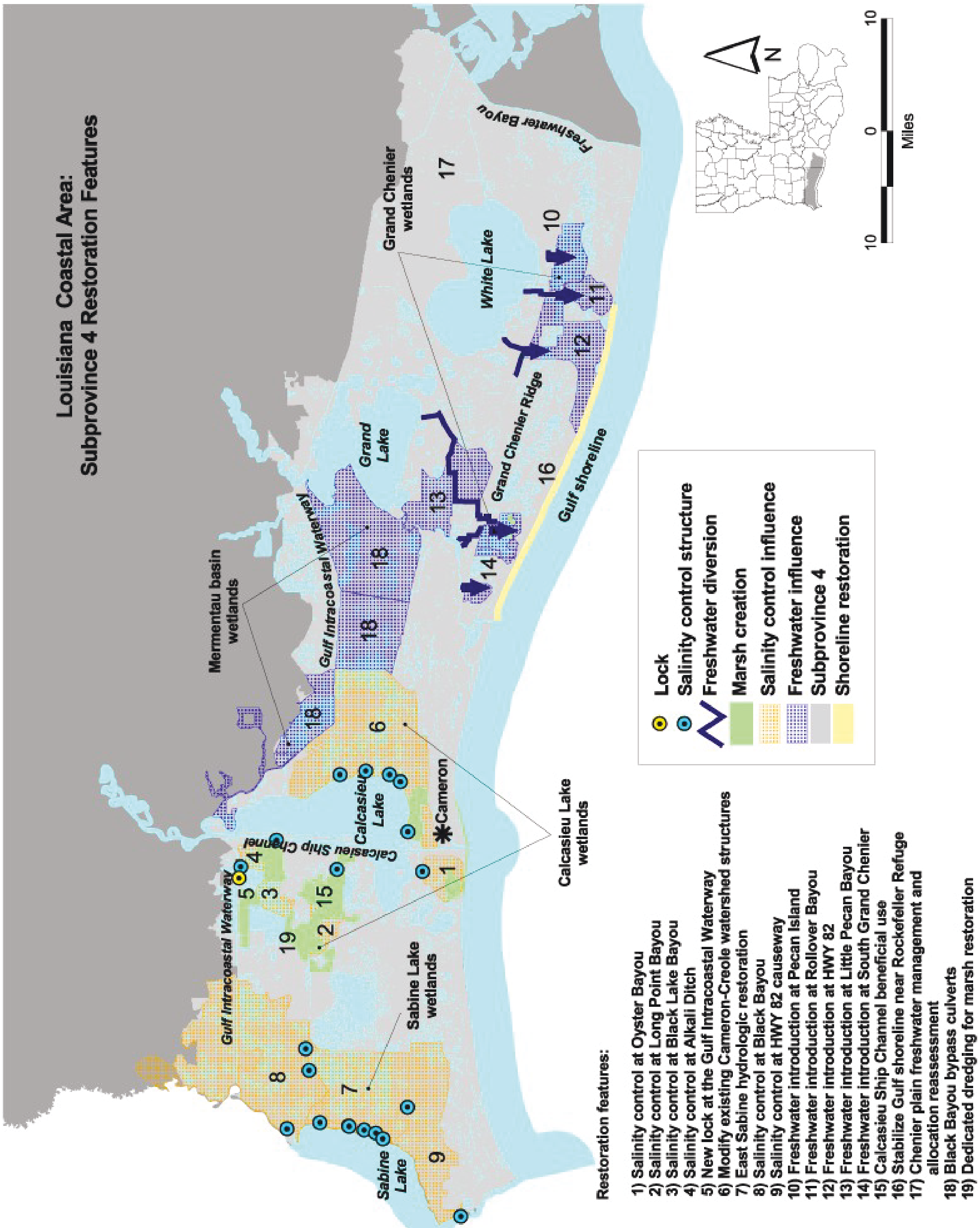


Figure MR 3-9. Subprovince 4 Restoration Features Identified in the Final Array of Coast Wide Frameworks.

3.3.7 Development of Sorting and Critical Needs Criteria

The PDT determined that use of initial sorting criteria and follow-on critical needs criteria-based evaluations was an appropriate method to determine which of the 79 features would best meet near-term requirements. Criteria were developed to identify which restoration features would be placed into the various component categories described in Section 3.3.6. In addition, the criteria helped identify the ability of each restoration feature to address critical needs.

The initial step in identifying these criteria was the gathering of input by the PDT. The Vertical Team, Framework Development Team, and the PDT developed a methodology to: 1) sort the restoration features into the component categories of the alternative LCA Plans; and 2) identify the relative value of a restoration feature in addressing critical ecologic needs in the coastal landscape. The criteria were designated as either "sorting" or "critical needs" criteria. The PDT designated three sorting criteria, and four critical needs criteria.

3.3.7.1 Sorting criteria

3.3.7.1.1 *Sorting Criterion #1 - Engineering and design complete and construction started within 5 to 10 years*

A restoration feature would meet this criterion if, over the next 5 to 10 years:

- Required feasibility-level decision documents could be completed;
- Necessary NEPA documentation could be completed;
- Pre-construction engineering & design (PED) could be completed; and
- Construction authorization could be obtained and construction could be initiated.

If a restoration feature did not meet this criterion, it was not viewed as a potential near-term restoration opportunity, but rather a potential candidate for large-scale and long-range study.

3.3.7.1.2 *Sorting Criterion #2 - Based upon sufficient scientific and engineering understanding of processes*

A restoration feature would successfully meet this criterion if it contained:

- Opportunities for which there is currently a sound understanding based in science and technology; and
- Science and engineering principles that have been applied within Louisiana and successfully achieved a beneficial ecosystem response.

Features that did not meet this criterion were not considered as potential near-term restoration opportunities. Instead, the scientific and/or engineering uncertainties associated with these restoration features provided a basis for the feature to be a potential candidate for a demonstration project.

3.3.7.1.3 ***Sorting Criterion #3 - Implementation is independent; does not require another restoration feature to be implemented first***

If a feature was not deemed to be independent, other features that potentially had overlapping or duplicative effects were identified, and the interdependent features were combined. This combination of features was then reassessed to determine if, as a composite, the group of features met the initial two sorting criteria and classified appropriately. The intent of this criterion was to ensure that those features with overlapping hydrologic or ecologic influence area were considered simultaneously in their design development. This criterion was meant to apply specifically to, but not be limited to, those features that would be implemented in the near-term restoration effort. The realization of individual feature benefits is not dependent on implementation of all features. Once they have been synergistically designed, each feature will be of an appropriate scale to operate independently without being redundant with other features within the influence area.

The sorting criteria were applied sequentially. In other words, if a feature failed to meet criterion #2, then it was not reviewed to assess whether it met criterion #3. The process of applying these sorting criteria is represented in the flow diagram in **figure MR 3-10**.

3.3.7.2 <u>Critical needs criteria</u>

If a restoration feature met all of the sorting criteria, it was then assessed against the critical needs criteria. The application of the criteria was done in an annotated manner so that the reasoning for applicability of each feature versus the criteria could be readily assessed. This approach allowed the PDT to make relative comparisons of different features based on common criteria and fine tune the overall value of features in addressing the critical ecologic and human needs of the system. The following criteria were applied to potential near-term course of action features as defined.

3.3.7.2.1 ***Critical Needs Criterion #1 - Prevents future land loss where predicted to occur***

One of the most fundamental drivers of ecosystem degradation in coastal Louisiana has been the conversion of land (mostly emergent vegetated wetland habitat) to open water. One of the most fundamental critical needs is to stem this loss. Thus, the projection of the future condition of the ecosystem must be based upon the determination of future patterns of land and water. Future patterns of land loss were based on the USGS open file report 03-334 "Historical and Predicted Coastal Louisiana Land Changes: 1978-2050" (appendix B HISTORIC AND PROJECTED COASTAL LOUISIANA LAND CHANGES: 1978-2050). This also applies to future predicted conversion of cypress swamp in areas with existing fragmenting marsh.

3.3.7.2.2 *Critical Needs Criterion #2 - (Sustainability) Restores fundamentally impaired (or mimics) deltaic function through river reintroductions*

This criterion refers to opportunities that would restore or mimic natural connections between the river and the basins (or estuaries), including distributary flows, crevasses, and overbank flow. Mechanical marsh creation with river sediment was also viewed as mimicking the deltaic function of sediment introduction if supported by sustainable freshwater and nutrient reintroduction.

3.3.7.2.3 *Critical Needs Criterion #3 - (Sustainability) Restores or preserves endangered critical geomorphic structure*

This criterion identifies opportunities that would restore or maintain natural geomorphic structures such as barrier islands, distributary ridges, cheniers, land bridges, and beach and lake rims. These geomorphic structures are essential to maintaining the integrity of coastal ecosystems. Those structures that are endangered or "nearly lost" in the near-term are especially critical.

3.3.7.2.4 ***Critical Needs Criterion #4 - Protects vital socioeconomic resources***

This criterion identifies proposed opportunities that would potentially protect vital local, regional, and national social, economic, and cultural resources. These resources include cultures, community, infrastructure, business and industry, and flood protection.

3.3.7.3 **Application of the criteria**

Following the identification of these restoration criteria and the method for their application, the PDT made an initial assessment of the 79 restoration features. This assessment indicated that the methodology could be applied effectively to identify potential alternative plans (**figure MR 3-10**).

During the week of April 19 to 23, 2004, a series of public scoping meetings were held across the LCA Study area. These meetings provided the public and stakeholder groups an opportunity to comment on the modification of the study and the specific criteria for identifying alternative LCA Plans. The participants were provided with an overview of the criteria and methodology, the written definition of each criterion's application, and a list of the 79 features. This information was also made available on the study's web site along with additional feature details. The meeting participants were encouraged to comment on and/or modify the criteria and methodology developed by the PDT, as well as to provide input on additional criteria that they considered appropriate. Finally, attendees were encouraged to take materials to other interested parties who were not able to attend or direct them to the study's web site to submit their comments.

The public input was compiled and used to make adjustments to the criteria or to the criteria's application to individual features. In addition, public input allowed the PDT to make final assessments of the appropriate components of the alternative LCA Plans.

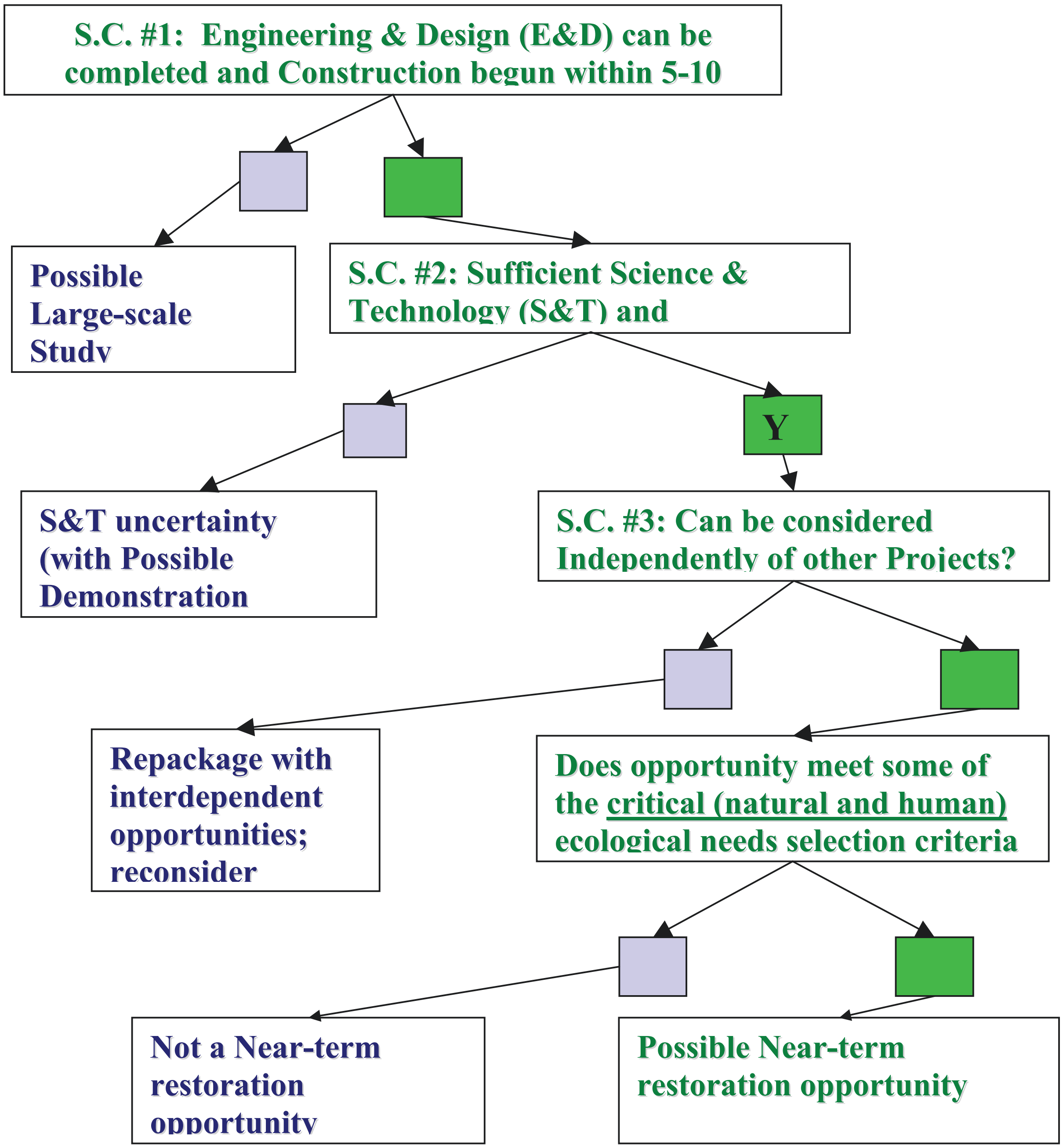


Figure MR 3-10. LCA Sorting Process Flow Diagram.

3.4 SORTING CRITERIA APPLICATION RESULTS

During Phase VI, each of the 79 restoration features was analyzed through the three Sorting Criteria (**figure MR 3-11**) and four Critical Needs Criteria. These criteria were designed to determine whether or not a restoration feature should be incorporated as a near-term component in one or more of the LCA alternative plans. In addition, if it was determined that a feature was to be included in the near-term course of action, the criteria helped determine in which component category it would best fit. For example a restoration feature could represent a potential near-term critical restoration feature or a potential large-scale study for a promising restoration concept. Alternatively, an overarching scientific or technological uncertainty could be associated with a restoration feature that would first require the development and implementation of an appropriately scaled demonstration project prior to the implementation of the feature.

3.4.1 Results of Applying Sorting Criterion #1: Engineering and Design (E&D) can be Completed and Construction Started within 5 to 10 Years

Application of Sorting Criterion #1 winnowed down the number of potential restoration features from 79 to 61. Those restoration features deemed too complex to have feasibility-level decision documents complete and construction begun within the next 5 to 10 years of plan implementation did not successfully pass through this sorting criterion and were instead considered for inclusion in the LCA Plan alternatives as potential large-scale studies. **Table MR 3-8** lists those restoration features that did not meet Sorting Criterion #1 and were, therefore eliminated from further consideration as near-term plan restoration features.

Table MR 3-8. Restoration Features Eliminated using Sorting Criterion #1: Features Whose E&D Could not be Completed and Construction Started Within the Next 5 to 10 Years.

Subprovince 1
- Medium diversion at Bonnet Carre Spillway
- Post authorization for the diversion of water through Inner Harbor Navigation Canal for increased influence into Central Wetlands
- Medium to large sediment diversion at American/California Bays
- Mississippi River Delta Management Study (Subprovinces 1 & 2)

Subprovince 2
- Medium diversion at Edgard with sediment enrichment
- Large diversion at Boothville with sediment enrichment
- Medium diversion at Fort Jackson - Alternative to Boothville diversion
- Large diversion at Fort Jackson with sediment enrichment - Alternative to Boothville diversion
- Medium diversion at Lac des Allemands with sediment enrichment
- Large diversion at Myrtle Grove with sediment enrichment
- Third Delta (Subprovinces 2 & 3)

Subprovince 3
- Relocate the Atchafalaya Navigation Channel
- Increase sediment transport down Wax Lake Outlet
- Alternative operational scheme of the Old River Control Structure (ORCS)
- Acadiana Bays Estuarine Restoration
- Rebuild historic reefs - Rebuild historic barrier between Point Au Fer and Eugene Island and construct segmented reef/breakwater/jetty along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh Island to the west

Subprovince 4

- Chenier Plain freshwater management and allocation reassessment*
  - Freshwater introduction at South Grand Chenier
  - Freshwater introduction at Pecan Island
  - Freshwater introduction at Rollover Bayou
  - Freshwater introduction at Highway 82
  - Freshwater introduction at Little Pecan Bayou
- New lock at the GIWW

** These features did not pass Sorting Criterion #3, were repackaged and are considered as a potential large-scale study within the Chenier Plain Freshwater Management and Allocation Study*

3.4.2 Results of Applying Sorting Criterion #2: Sufficient S&T and Engineering Understanding of Processes

Of the 61 features that met Sorting Criterion #1, 28 did not successfully meet Sorting Criterion #2 because they contained some form of scientific or technical uncertainty that would require resolution prior to their implementation. The various types of uncertainties are described in section 3.1 PLANNING CONSTRAINTS. These uncertainties may be resolved by the development and implementation of an appropriately scaled demonstration project (the specific features may suggest demonstration project locations). **Table MR 3-9** lists features that did not meet Sorting Criterion #2 and were, therefore eliminated from further consideration as near-term course of action restoration features.

Table MR 3-9. Restoration Features Eliminated Using Sorting Criterion #2: Features Having Significant Uncertainties About Science and Technology and Engineering Understanding of Processes.

Subprovince 1

- Marsh nourishment on New Orleans East land bridge
- Sediment delivery via pipeline at La Branche wetlands
- Sediment delivery via pipeline at American/California Bays
- Sediment delivery via pipeline at Central Wetlands
- Sediment delivery via pipeline at Ft. St. Philip
- Sediment delivery via pipeline at Golden Triangle
- Sediment delivery via pipeline at Quarantine Bay
- Opportunistic use of Bonnet Carre Spillway

Subprovince 2

- Implement the LCA Barataria Basin Wetland Creation and Restoration Study
- Sediment delivery via pipeline at Bastian Bay/Buras
- Sediment delivery via pipeline at Empire
- Sediment delivery via pipeline at Main Pass (Head of Passes)

Subprovince 3

- Maintain land bridge between Bayous du Large and Grand Caillou

- Maintain Timbalier land bridge
- Backfill pipeline canals
- Freshwater introduction south of Lake De Cade
- Freshwater Introduction via Blue Hammock Bayou

Subprovince 4

- Salinity control at Alkali Ditch
- Salinity control at Highway 82 Causeway
- Salinity control at Oyster Bayou
- Salinity control at Long Point Bayou
- Salinity control at Black Lake Bayou
- Black Bayou Bypass culverts
- Dedicated dredging for marsh restoration
- Stabilize Gulf shoreline near Rockefeller Refuge
- Modify existing Cameron-Creole watershed structures
- East Sabine Lake hydrologic restoration
- Salinity control at Black Bayou

3.4.3 Results of Applying Sorting Criterion #3: Implementation is Independent; Does not Require Other Restoration Feature to be Implemented First

The remaining 33 features were next subjected to Sorting Criterion #3 to determine their independence from other restoration features. When running these remaining features through Sorting Criterion #3, 12 features were deemed to be independent (received a "Yes" for this criterion). These 12 features then proceeded to the Critical Needs Criteria evaluation. The 21 features that were determined to be interdependent (received a "No" for this criterion) were combined with other dependent features(s), as appropriate, to create "restoration opportunities". The combined restoration opportunities were evaluated again using Sorting Criteria 1, 2, and 3. One of the restoration opportunities, Freshwater Reintroductions into Subprovince 4, (consisting of five features) failed to pass Sorting Criterion #1 and was reserved as a potential concept for large-scale studies and eliminated from consideration as a near-term restoration opportunity. The remaining 6 restoration opportunities (consisting of 16 features) passed both criteria 1 and 2 and were included for further consideration as near-term restoration opportunities. **Table MR 3-10** identifies the 12 restoration features and 6 combined restoration opportunities (made up of 16 restoration features) that were further evaluated using the Critical Needs Criteria. **Figure MR 3-11** provides a graphic representation of the Sorting Criteria Evaluation Process.

Table MR 3-10. Restoration Features and Restoration Opportunities that Passed Sorting Criteria 1 to 3.

Subprovince 1

- MRGO Environmental Restoration Features
- Maurepas Swamp Reintroductions Restoration Opportunity
  This restoration opportunity includes the following features:
  - Small diversion at Hope Canal
  - Small diversion at Convent / Blind River
  - Increase Amite River Diversion Canal influence by gapping banks
- Upper Breton Sound Reintroductions Restoration Opportunity
  This restoration opportunity includes the following features:
  - Modification of Caernarvon diversion
  - Medium diversion at White's Ditch
- Lower Breton Sound Reintroductions Restoration Opportunity
  This restoration opportunity includes the following features:
  - Rehabilitate Bayou Lamoque structure as a medium diversion
  - Medium diversion at American / California Bays
- Rehabilitate Violet Siphon for increased influence to Central Wetlands
- Medium diversion at Fort St. Philip

Subprovince 2

- Barataria Basin barrier shoreline restoration
- Mid-Barataria Basin Reintroductions Restoration Opportunity
  This restoration opportunity includes the following features:
  - Modification of Davis Pond diversion for increased sediment input
  - Medium diversion with dedicated dredging at Myrtle Grove
- Lac Des Allemands Area Reintroductions Restoration Opportunity
  This restoration opportunity includes the following features:
  - Small diversion at Lac Des Allemands
  - Small diversion at Donaldsonville
  - Small diversion at Pikes Peak
  - Small diversion at Edgard

Subprovince 3

- Small Bayou Lafourche reintroduction
- Terrebonne Marsh Restoration Opportunity
  This restoration opportunity includes the following features:
  - Optimize flows and Atchafalaya River influence in Penchant Basin
  - Multi-purpose operation of Houma Navigation Canal (HNC) Lock
  - Convey Atchafalaya River water to Terrebonne Marshes via a small diversion in the Avoca Island Levee, repairing eroding banks of the GIWW, and enlarging constrictions in the GIWW below Gibson and in Houma, and Grand Bayou conveyance channel construction / enlargement
- Terrebonne Basin barrier shoreline restoration
- Maintain land bridge between Caillou Lake and Gulf of Mexico
- Gulf shoreline stabilization at Point Au Fer Island
- Maintain northern shore of East Cote Blanche Bay at Point Marone
- Rehabilitate Northern Shorelines of Terrebonne / Timbalier Bays
- Stabilize banks of Southwest Pass

Subprovince 4

- Calcasieu Ship Channel Beneficial Use

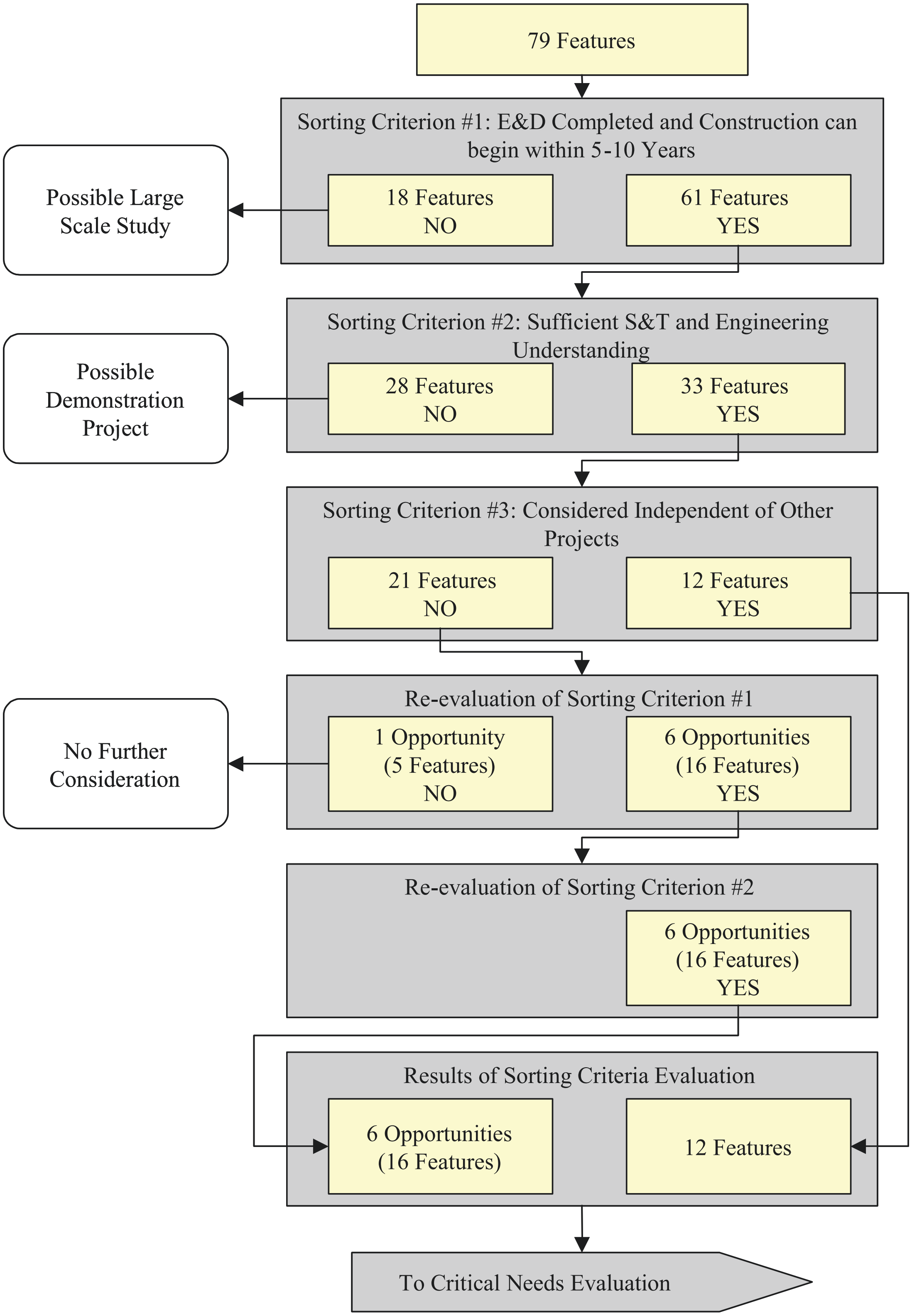


Figure MR 3-11. Application of Sorting Criteria to Restoration Features and Opportunities.

3.5 CRITICAL NEEDS CRITERIA APPLICATION RESULTS

Following the application of Sorting Criteria, the 12 restoration features and 6 restoration opportunities (made up of 16 restoration features) were further evaluated using the Critical Needs Criteria. Annotated comments were developed for each feature and opportunity to identify the particular Critical Need Criteria that a component met (or did not meet), as well as the relative ability of the feature or opportunity to address them. After evaluating the 12 features and 6 restoration opportunities using the Critical Needs Criteria, seven features and five restoration opportunities (made up of 14 restoration features) were determined to meet the Critical Needs Criteria. These features and opportunities were used to form the basis of the alternative near-term courses of action. Alternately, five features and one restoration opportunity (made up of two restoration features) did not meet the Critical Needs Criteria, and were not considered for inclusion in the near-term course of action. Below are the annotated comments of the results of the assessment of individual features and restoration opportunities following application of the four Critical Needs Criteria.

3.5.1 Features Having Major "Critical Needs Criteria" Value

3.5.1.1 <u>Subprovince 1</u>

<u>MRGO Environmental Restoration Features</u>

These features address Critical Needs Criteria 1, 3, and 4. Specifically, these features have the potential to: prevent predicted future land loss and restore previously degraded wetlands; stabilize and restore the endangered, critical lake rim geomorphic structure; and protect vital socioeconomic resources, such as developments located adjacent to the MRGO.

<u>Maurepas Swamp Reintroductions Opportunity</u>

The Maurepas Swamp Reintroduction Opportunity includes the following features:

- Small diversion at Hope Canal
- Small diversion at Convent / Blind River
- Increase Amite River Diversion Canal influence by gapping banks

This near-term restoration opportunity evaluates several features that have the potential to address Critical Needs Criteria 1, 2, and 4. Specifically, this opportunity has the potential to: prevent future cypress swamp degradation and transition currently predicted to occur; restore the deltaic process impaired by levee and dredged material bank construction; and protect vital socioeconomic and public resources, such as the growing eco-tourism industry resident in the Maurepas Swamp and the Maurepas Wildlife Management Area.

Upper Breton Sound Reintroductions Opportunity

The Upper Breton Sound Reintroduction Opportunity includes the following features:

- Modification of Caernarvon diversion
- Medium diversion at White's Ditch

This near-term restoration opportunity evaluates several features that have the potential to address Critical Needs Criteria 2 and 4. Specifically, this opportunity has the potential to restore the deltaic process impaired by levee construction at locations where historic crevassing has occurred and protect vital socioeconomic resources located in areas along the east bank of the Mississippi River in Plaquemines Parish within hurricane flood protection levees. This opportunity also includes features that capitalize on existing structures, such as the Caernarvon diversion.

3.5.1.2 Subprovince 2

Barataria Basin Barrier Shoreline Restoration

This restoration feature has multiple components, some of which have potential to address Critical Needs Criteria 1, 3, and 4. This near-term critical feature has been defined as restoration of the Caminada Headland and Shell Island reaches. These elements of the Barataria barrier-shoreline directly meet specific critical need criteria internal and external to the feature footprint. The feature has the potential to: preventing future land loss where currently predicted to occur; restoring immediately endangered, critical geomorphic structure at the gulfward boundary of the Barataria system; and providing immediate protection of vital socioeconomic resources, such as oil and gas infrastructure located on the leeward side of these islands. In addition the elements of this feature are related to the support and function of all the other elements of the Barataria barrier-shoreline chain. All other elements of this barrier-shoreline are currently being considered for restoration action under other programs. However, this feature does entail some aspects of technical uncertainty in the availability and quality of source material, delivery material by pipeline, and durability.

Mid-Barataria Basin Reintroductions Opportunity

The Mid-Barataria Basin Reintroduction Opportunity includes the following features:

- Modification of Davis Pond diversion
- Medium diversion with dedicated dredging at Myrtle Grove

This near-term restoration opportunity evaluates several features that have the potential to address Critical Needs Criteria 1, 2, and 4. Specifically, this opportunity has the potential to: prevent future land loss where currently predicted to occur; restore the deltaic process impaired by the construction of levees at locations where historic crevassing has occurred, as well as improve water quality; and protect vital socioeconomic resources located in the central and upper portions of the Barataria Basin. This opportunity would also capitalize on the existing Davis Pond diversion structure.

Lac des Allemands Area Reintroductions Opportunity

The Lac des Allemands Area Reintroductions Opportunity includes the following features:

- Small diversion at Lac Des Allemands
- Small diversion at Donaldsonville
- Small diversion at Pikes Peak
- Small diversion at Edgard

This near-term restoration opportunity evaluates several features that have the potential to address Critical Needs Criteria 1, 2, and 4. Specifically, this opportunity has the potential to: prevent significant future land loss where currently predicted to occur; restore the deltaic process impaired by levee construction in areas where historic crevassing has occurred, prevent swamp degradation and stagnation; and protect vital socioeconomic resources such as the eco-tourism industry and residents in the upper Barataria Basin.

3.5.1.3 Subprovince 3

Small Bayou Lafourche Reintroduction

This feature would reintroduce flow from the Mississippi River into Bayou Lafourche and addresses Critical Needs Criteria 1, 2, and 4. Specifically, this feature has the potential to: prevent future land loss where predicted to occur; restore a fundamentally impaired deltaic process by reintroducing water to a historic distributary of the Mississippi; and protect vital community and socioeconomic resources by supplementing channel flow and stabilizing water quality.

Terrebonne Basin Barrier Shoreline Restoration

This near-term critical feature has been defined as restoration of the Isle Dernieres and East Timbalier reaches of the Terrebonne barrier-shoreline chain. All other elements of this barrier-shoreline are currently being considered for restoration action under other programs. This restoration feature has multiple components, some of which have potential to address Critical Needs Criteria 1, 3, and 4. Specifically, this feature has the potential to: prevent future barrier island losses where predicted to occur; restore endangered, critical geomorphic structure; and protect vital socioeconomic resources such as oil and gas infrastructure and fisheries. However, this feature entails some aspects of technical uncertainty in the availability and quality of source material, delivery of material by pipeline, and durability.

Maintain Land Bridge Between Caillou Lake and Gulf of Mexico

This restoration feature addresses Critical Needs Criteria 1 and 3. This feature would stem shoreline retreat and prevent further breaches that have allowed increased water exchange between the gulf and the interior water bodies (between Bay Junop and Caillou Lake). Prevention of increased marine influence would reduce interior wetland loss as well as preserve the potential for long-range restoration. Closure of newly opened channels would restore historic cross-sections of exchange points, would reduce marine influences in interior areas, and allow increased freshwater influence from Four League Bay to benefit area marshes.

Gulf Shoreline Stabilization at Point Au Fer Island

This feature addresses Critical Needs Criteria 1, 3, and 4. Specifically, this feature has the potential to: prevent future shoreline retreat, where predicted to occur; restore endangered, critical geomorphic structure by stabilizing the island shoreline; and protect vital community and socioeconomic resources.

Terrebonne Marsh Restoration Opportunity

The Terrebonne Marsh Restoration Opportunity includes the following features:

- Optimize flows and Atchafalaya River influence in Penchant Basin
- Multi-purpose operation of Houma Navigation Canal (HNC) Lock
- Convey Atchafalaya River water to Terrebonne Marshes via a small diversion in the Avoca Island levee, repairing eroding banks of the GIWW, and enlarging constrictions in the GIWW below Gibson and in Houma, and Grand Bayou conveyance channel construction/enlargement

This near-term restoration opportunity evaluates several features that have the potential to address Critical Needs Criteria 1, 2, and 4. Specifically, this opportunity has the potential to: prevent future land loss where predicted to occur; restore fundamentally impaired deltaic processes through the re-introduction of Atchafalaya River water; and protect vital community and socioeconomic resources in the area, such as waterborne commerce and oil and gas infrastructure.

3.5.1.4 Subprovince 4

Calcasieu Ship Channel Beneficial Use

This feature addresses Critical Needs Criteria 1 and 4. Specifically, this feature has the potential to prevent future land loss where predicted to occur and protect vital community and socioeconomic resources of agricultural land use and oil and gas infrastructure. It also capitalizes on the existing navigation maintenance activity.

3.5.2 Features and Opportunities Having Limited or No "Critical Needs Criteria" Value

3.5.2.1 Subprovince 1

Lower Breton Sound Reintroductions Opportunity

The Lower Breton Sound Reintroductions Opportunity includes the following features:

- Rehabilitate Bayou Lamoque structure as a medium diversion
- Medium diversion at American/California Bays

This near-term restoration opportunity evaluates two features that have the potential to address Critical Needs Criteria 2 and 4. This opportunity also includes features that capitalize on existing structures, such as the Bayou Lamoque diversion. While this opportunity has some limited potential to restore the deltaic process in locations where historic crevassing has occurred, the proposed scale does not afford an appreciable influence on the critical need in the area. As a result, this opportunity was not included in any alternative plans.

Rehabilitate Violet Siphon for Increased Influence into Central Wetlands

This feature has some effectiveness meeting Critical Needs Criteria 1 and 2. However, the existing structure has currently been rehabilitated and is operating to capacity on a regulated schedule. Therefore, this feature was not included in any alternative plans.

Medium Diversion at Fort St. Philip

This feature has limited impact meeting Critical Needs Criterion #2. Specifically, this feature appears to have some limited potential to restore deltaic process in the area. However, the major ecologic need in the area is the introduction of large volumes of sediment. The assessment of this feature was that it fell low in the priority of possible critical near-term actions and was therefore not included in any alternative plans.

3.5.2.2 Subprovince 3

Maintain Northern Shore of East Cote Blanche Bay at Point Marone

This feature addresses Critical Needs Criteria 1 and 3 to a minor extent. Specifically, this feature has the potential to prevent some limited future shoreline retreat where predicted to occur and restore some geomorphic structure by stabilizing a small portion of this bay shoreline. The assessment of this feature was that it fell low in the priority of possible critical near-term actions and was therefore not included in any alternative plans.

Rehabilitate Northern Shorelines of Terrebonne/Timbalier Bays

This feature addresses Critical Needs Criteria 1 and 4. Specifically, this feature has the potential to prevent future shoreline retreat where predicted to occur and protect vital community and socioeconomic resources. This feature potentially duplicates the effects of the Terrebonne Basin Barrier-shoreline Restoration feature. The assessment of this feature is that in the near-term the immediate stabilization of the existing barrier-shoreline features is a more effective option. While this feature could be investigated in conjunction with the barrier-shoreline feature, it was not included in any alternative plans.

Stabilize Banks of Southwest Pass

Consideration of critical near-term criteria applied to assess the extent to which critical ecologic needs in the coast would be addressed, this feature was deemed less effective. While qualifying, with some effect relative to critical needs criteria, this feature does not appear to produce appreciable enough changes in the ecosystem to include in any alternative plans. The feature may be further investigated in conjunction with the large-scale Acadiana Bays Estuarine Restoration Study.

3.6 ALTERNATIVE PLAN EVALUATION RESULTS

As detailed previously, application of the three sorting criteria and four critical needs criteria was the basis for development of alternative plans composed of near-term critical features, candidate large-scale studies, and candidate science and technology demonstration projects. The sorting criteria application that determined what were the possible near-term critical features among the 79 initial features was considered fixed. The best opportunity to develop alternative plans resided in the application of the critical needs criteria to determine the near-term critical features. While each of the critical needs criteria were supporting and complimentary, it was possible to discern alternative combinations of near-term critical features by applying the criteria individually or in varying combinations.

Alternative plans, which include differing restoration features and restoration opportunities, were developed for evaluation based on the ability of the alternative to meet one or more of the Critical Needs Criteria. Alternatives represent combinations of specific features or actions that are capable of achieving the identified planning objectives through significantly different ecologic modifications or technical methods and thereby represent clearly different options for achieving restoration. **Table MR 3-11** presents the 15 Alternative Plans (plus the No Action Alternative), provides the corresponding plan name (represented by the letters A – O), and identifies which Critical Needs Criterion/Criteria each specific alternative strived to meet. For example, Alternative Plans A, B, D, and H all focus on meeting one of the Critical Needs Criteria (1 through 4 respectively). The remaining 11 Alternative Plans were formulated to include all remaining possible mathematical combinations of the 4 Critical Needs Criteria.

Table MR 3-11. Possible Alternative Plan Combinations Based on the Critical Needs Criteria.

Alternative Plan	Criterion 1 (Prevent Future Land Loss)	Criterion 2 (Riverine Reintroductions)	Criterion 3 (Restore Geomorphic Structure)	Criterion 4 (Protects Vital community & socioeconomic resources)
A	X			
B		X		
C	X	X		
D			X	
E	X		X	
F	X	X	X	
G		X	X	
H				X
I	X			X
J		X		X
K	X	X		X
L	X		X	X
M			X	X
N	X	X	X	X
O		X	X	X
P (No Action)				

Using the annotated comments that resulted from the Critical Needs Criteria evaluation process, specifically the consensus opinion on which Critical Needs Criteria a restoration feature or opportunity best addresses, the PDT populated each of the 15 alternative plans with the restoration features and opportunities that successfully passed through both Screening and Critical Needs Criteria. For example, Alternative A includes all viable restoration features and opportunities that address Critical Needs Criteria 1 (preventing future land loss). Continuing the example, Alternative C is comprised of all viable restoration features and opportunities that address both Critical Needs Criteria 1 and 2 (prevent future land loss and utilizing riverine reintroductions). A summary of the restoration features and restoration opportunities included in each of the 15 alternative plans is detailed in **table MR 3-12**.

Table MR 3-12. Alternative Plan Make-up.

		Alternative Plans														
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**
Restoration Feature or Opportunity	MRGO Environmental Restoration Features	X		X	X	X	X	X	X	X	X	X	X	X	X	X
	Maurepas Swamp Reintroduction Opportunities	X	X	X		X	X	X	X	X	X	X	X	X	X	X
	Barataria Basin Barrier Shoreline Restoration	X		X	X	X	X	X	X	X	X	X	X	X	X	X
	Small Bayou Lafourche Reintroduction	X	X	X		X	X	X	X	X	X	X	X	X	X	X
	Mid-Barataria Basin Reintroduction Opportunity	X	X	X		X	X	X	X	X	X	X	X	X	X	X
	Upper Breton Sound Reintroduction Opportunity		X	X			X	X	X	X	X	X	X	X	X	X
	Calcasieu Ship Channel Beneficial Use	X		X	X	X	X	X		X		X	X	X	X	X
	Terrebonne Marsh Restoration Opportunity	X	X	X		X	X	X	X	X	X	X	X	X	X	X
	Terrebonne Basin Barrier Shoreline Restoration	X		X	X	X	X	X	X	X	X	X	X	X	X	X
	Maintain Land Bridge Between Caillou Lake and Gulf of Mexico	X		X	X	X	X	X		X		X	X	X	X	X
	Gulf Shoreline Stabilization at Point Au Fer Island	X		X	X	X	X	X	X	X	X	X	X	X	X	X
	Las des Allemands Area Reintroductions Opportunity	X	X	X		X	X	X		X	X	X	X		X	X

Evaluation of the 15 alternatives was based on the identification of appreciably different alternative plans to meet the study objectives and Critical Needs Criteria. As **table MR 3-12** clearly shows, all of the restoration features and measures available to make up the suite of alternative plans were found in more than one Alternative Plan. This is due to the fact that all available restoration features and measures met multiple Critical Needs Criteria. For example, the MRGO Environmental Restoration Feature met Critical Needs Criteria 1, 3, and 4. Because of this, the process of identifying and delineating appreciably different alternative plans was one in which the 15 alternative plans underwent intense scrutiny. A discussion of the composition of, and similarities and differences between, alternative plans follows.

3.6.1 Alternative Plans Designed to Meet Only 1 Critical Needs Criterion

Alternative A (the independent application of Critical Needs Criterion #1 (*prevention of predicted land* loss), resulted in a plan combination that excluded diversions in the Breton Sound Basin, but was inclusive of all other potential near-term features and opportunities. As such, Alternative A was grouped into the numerous alternative plans that sought to meet multiple Critical Needs Criteria.

Alternative B (the independent application of Critical Needs Criterion #2 (*sustainability through restored deltaic function*), also produced broad inclusion of potential features and opportunities, but uniformly excluded all barrier shoreline and marsh creation through dredged material use features. Alternative B also excluded any near-term opportunities in the Chenier Plain. However, this alternative was appreciably different from the other 15 alternatives, and was carried forward for further evaluation.

Alternative D (the independent application of Critical Needs Criterion #3 (*sustainability through restoration of geomorphic structure*), produced a combination of features and opportunities focused on barrier shoreline restoration and direct land building focused on maintaining a protective structure. However, this alternative was appreciably different from the other 15 alternatives, and was carried forward for further evaluation.

Alternative H (the independent application of Critical Needs Criterion #4 (*protection of vital socioeconomic resources*), resulted in a diverse combination of features and opportunities that excluded restoration features and opportunities that did not directly benefit infrastructure or property. However, inclusion of Critical Needs Criterion #4 with any other criteria also provided a minor supplemental effect to most other possible alternative combinations. The absence of Critical Needs Criterion #4, in combination with any other criteria, results in only 2 to 3 feature or opportunity exclusions in any of those plans. In addition, Critical Needs Criterion #4, while defining a critical outcome of coastal restoration, could be more appropriately viewed as a synergistic factor in comparison to the critical needs for direct physical restoration of the landscape. As a result, it was determined that the independent application of criterion #4 did not produce a viable alternative plan. Therefore, Alternative H was not considered as a viable alternative plan.

3.6.2 Alternative Plans Designed to Meet Multiple Critical Needs Criteria

Alternative plans seeking to meet multiple Critical Needs Criteria, particularly those that included Critical Needs Criterion #2, quickly reached full inclusion of all or nearly all the potential restoration features and opportunities. Three of the Alternative Plans (Alternatives E, J, and M), while intending to focus on meeting different Critical Needs Criteria, were comprised of almost the same restoration features and opportunities (+/- 4 features/opportunities). Likewise, eight of the Alternative Plans (Alternatives C, F, G, I, K, L, N, and O) had the exact same make-up i.e., they included all potential restoration features and opportunities. These 11 alternative plans were therefore grouped because, due to their similarity, they did not provide a true alternative choice (they were not appreciably different). For the purpose of continued alternative plan evaluation, these 11 alternatives, and Alternative A described previously, were grouped and represented by Alternative Plan N because its inclusion of all potential restoration features and opportunities was an outcome of its design to meet all four Critical Needs Criteria.

3.6.3 Comparison of Alternative Plans

Summarizing the analysis results detailed above, three appreciably different alternatives (Alternative Plans B, D, and N) arose. A comparison of the restoration features and construction costs estimates for these three alternative plans is provided in **table MR 3-13**.

Table MR 3-13. Comparison of Alternative Plan Feature Combinations and Construction Costs.

Potential Near-term Features	Alternative Near-term Plans		
	B	D	N
Mississippi River Gulf Outlet Environmental Environmental Restoration Features		$80,000,000	$80,000,000
Maurepas Swamp Reintroductions --			
Small Diversion at Convent / Blind River	$28,564,000		$28,564,000
Small Diversion at Hope Canal	$33,029,000		$33,029,000
Amite River Diversion (spoil bank gapping)	$2,855,000		$2,855,000
Barataria Basin Barrier Shoreline Restoration -- Caminada Headland, Shell Island		$181,000,000	$181,000,000
Small Bayou Lafourche Reintroduction	$90,000,000		$90,000,000
Medium Diversion with Dedicated Dredging at Myrtle Grove	$146,700,000		$146,700,000
Calcasieu Ship Channel Beneficial Use of Dredged Material		$100,000,000	$100,000,000
Modifcation of Caernarvon Diversion for Marsh Creation	$1,800,000		$1,800,000
Modifcation Davis Pond Diversion for Marsh Creation	$1,800,000		$1,800,000
Terrebonne Marsh Restoration Opportunities --			
Optimize Flows & Atchafalaya River Influence in Penchant Baisn	$9,720,000		$9,720,000
Multi-purpose Operation of the Houma Navigation Canal (HNC) Lock	$0		$0
Convey Atchafalaya River Water to Northern Terrebonne Marshes	$132,200,000		$132,200,000
Terrebonne barrier shoreline restoration -- Isle Derniere, E. Timbalier		$84,850,000	$84,850,000
Maintain Land Bridge between Caillou Lake and Gulf of Mexico.		$41,000,000	$41,000,000
Medium Freshwater Diversion at White's Ditch	$35,200,000		$35,200,000
Stabilize Gulf Shoreline at Point Au Fer Island		$32,000,000	$32,000,000
Lac des Allemands area Reintroductions --			
Small Diversion at Lac des Allemands	$17,330,000		$17,330,000
Small Diversion at Donaldsonville	$16,670,000		$16,670,000
Small Diversion at Pikes Peak	$12,940,000		$12,940,000
Small Diversion at Edgard	$13,100,000		$13,100,000
Total Near-term Plan Construction Cost	**$541,908,000**	**$518,850,000**	**$1,060,758,000**

Alternative Plan B focused on restoration of deltaic processes (Critical Needs Criterion #2), and included 15 restoration near-term features and opportunities, all with combinations of river diversion features. Alternative Plan B exhibits some shortcomings because it does not address critical geomorphic structures. Alternative Plan D focused on restoration of geomorphic structure (Critical Needs Criterion #3), and included 11 restoration features and opportunities including shoreline protection, barrier island restoration, and marsh creation. Alternative Plan D exhibits some shortcomings because it does not address the river reintroductions. The body of knowledge concerning application of coastal restoration strategies in Louisiana suggests that while Alternative Plans B and D would have appreciable environmental benefits, they each exhibit some weaknesses in addressing the complete range of study planning objectives and Critical Needs Criteria.

Conversely, Alternative Plan N encompasses all four Critical Needs Criteria and exhibits potential for long-term sustainability because it contains the geomorphic structures, which serve to protect and buffer the diversion feature influence areas from erosive coastal wave action and storm surge. Additionally, the river diversion features contained in Alternative Plan N are more sustainable than other types of restoration features because they receive continuous sediment and nutrient nourishment from the river. **Figure MR 3-12** provides a graphical representation of this discussion.

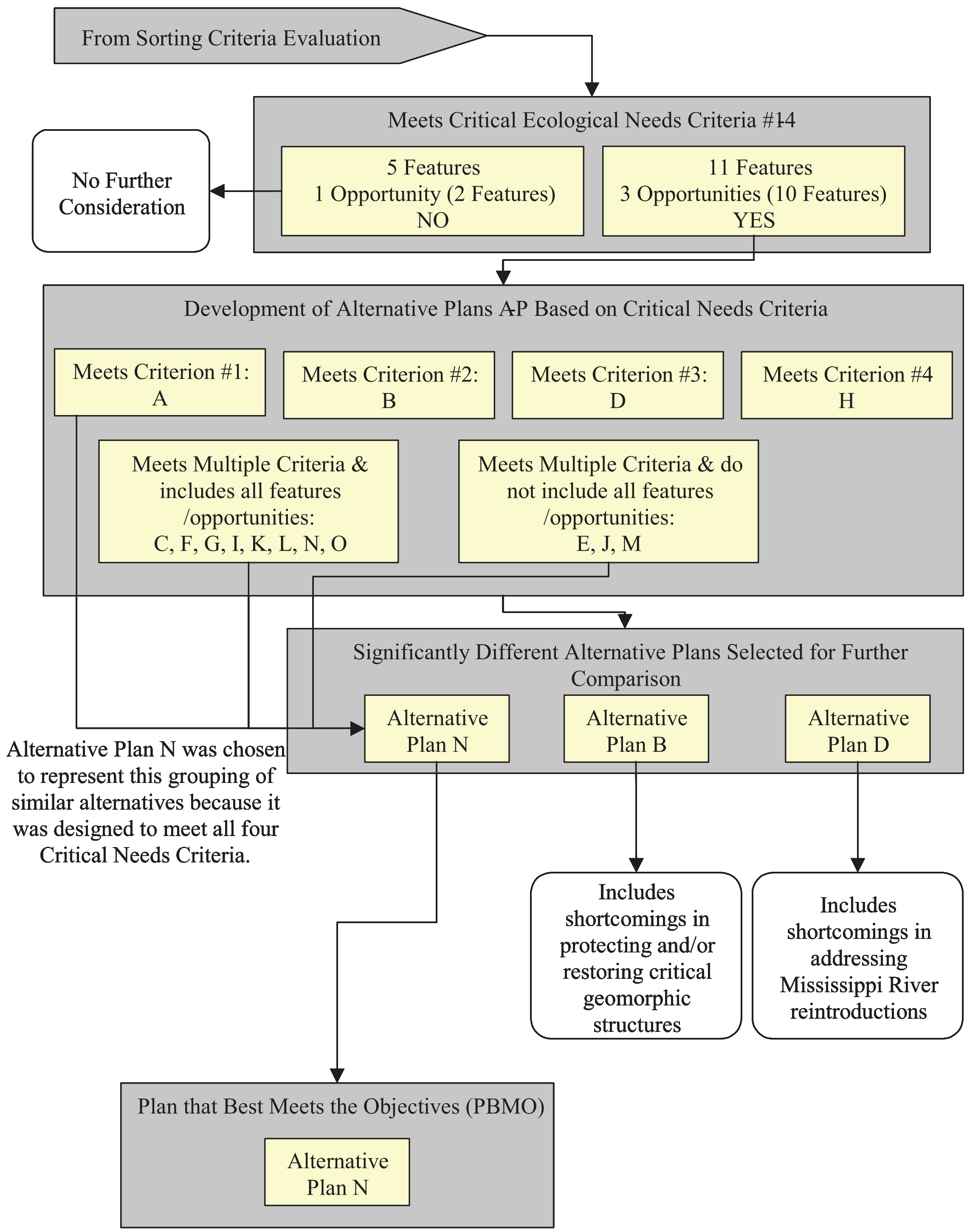


Figure MR 3-12: Alternative Plan Development and Selection Based on Critical Needs Criteria.

3.7 PLAN FORMULATION RESULTS

3.7.1 Description of the Plan that Best Meets the Objectives

As discussed in section 3.2 PLAN FORMULATION RATIONALE and section 3.3 PLAN FORMULATION, the purpose of the LCA Study was to meet study objectives and thus identify a plan that is effective in addressing the most critical needs within the Louisiana coastal area. The most critical needs are located in those areas of the coast that, without attention, would experience a permanent or severely impaired loss of system stability and function. As such, the development and evaluation of alternative plans focused on identifying combinations of restoration features that best addressed these critical need areas.

The alternative plan that best meets the planning objectives (PBMO) is Alternative Plan N. Of the three alternative plans selected for further comparison, Alternative Plan N best meets the planning objectives and the Critical Needs Criteria.

In addressing the most critical ecologic needs of the Louisiana coast, this plan is also effective in meeting the defined study objectives. As presented previously in this report, the study objectives are as follows:

Hydrogeomorphic Objectives

1. Establish dynamic salinity gradients that reflect natural cycles of freshwater availability and marine forcing (tidal action or exchange).
2. Increase sediment input from sources outside estuarine basins, and manage existing sediment resources within estuarine basins, to sustain and rejuvenate existing wetlands and rebuild marsh substrate.
3. Maintain or establish natural landscape features and hydrologic processes that are critical to sustainable ecosystem structure and function.

Ecosystem Objectives

1. Sustain productive and diverse fish and wildlife habitats.
2. Reduce nutrient delivery to the Continental shelf by routing Mississippi River waters through estuarine basins while minimizing potential adverse effects.

3.7.2 Effectiveness of the Plan in Meeting the Study Objectives

The PBMO addresses the most immediate and critical needs of the ecosystem in attaining the study objectives. The rehabilitation of the coastal ecosystem by promoting the distribution of riverine freshwater, nutrients, and sediment using natural processes and ensuring the structural integrity of the estuarine basins is key to this sustainable solution. A sustainable ecosystem would support Nationally important living resources, provide a sustainable and diverse array of fish and wildlife habitats, reduce nitrogen delivery to offshore gulf waters, and provide infrastructure protection and a sustainable resource base necessary to support NER goals.

The PBMO accomplishes the stated Hydrogeomorphic Objective 1. In the Deltaic Plain, the PBMO identifies reintroductions of freshwater from the Mississippi River in multiple locations from small to moderate scales.

The PBMO also addresses Hydrogeomorphic Objective 2 as the recommended actions for the Deltaic Plain are founded primarily on the introduction of Mississippi River water, nutrients, and suspended sediment. The PBMO identifies one restoration feature and three restoration opportunities (composed of seven features) for the introduction of Mississippi River water and recommendations for the investigation of rehabilitation or modification of two existing diversion structures in the Deltaic Plain. In addition, the PBMO identifies two restoration features capitalizing on the direct introduction of Mississippi River sediment. The PBMO directs attention to many areas where the prevention of wetland loss is critical to maintaining the ability to provide sustainable coastal restoration in the future. In the Chenier Plain, the PBMO focuses on providing continued stability to preserve the viability of future restoration actions.

Major components of the PBMO in the Deltaic Plain are directed at meeting Hydrogeomorphic Objective 3. The conservation and restoration of barrier islands and shorelines are large components of protecting the coastline from storm damage. Restoration features of the PBMO include a critical headland area and a critical land bridge in the deltaic plain. Proposed features and opportunities, located across the entire coast, assure that landscape features are restored and maintained to provide additional potential protection from storm damage.

Ecosystem Objective 1 is addressed by the PBMO, which contributes to the increased introduction of Mississippi River water, nutrients, and suspended sediment, the improved management of Atchafalaya River water, nutrients, and suspended sediment in the Deltaic Plain, and the expansion of beneficial use of dredged material in the Chenier Plain. The features recommended in the Deltaic Plain provide significant improvements in connectivity and material exchange.

While the overall quantity of wetland area is projected to increase with the execution of the proposed restoration effort, the cumulative quantities of suitable habitat are projected to decline for some species in localized areas of the coast. However, it was estimated that the overall useable amounts of the various habitat types would remain relatively plentiful throughout the 50-year period analyzed. Based on earlier ecological model analysis, certain saline species are anticipated to experience the most notable change in habitat levels. For most species across the coast, suitable habitat levels are expected to remain at or slightly below current levels. It is expected that many freshwater-associated species should see increases in levels of suitable habitat. These trade-offs are consistent with the reintroduction of deltaic land building processes. Even with the anticipated changes in cumulative habitat suitability, overall diversity is expected to remain relatively high and close to current conditions in keeping with the ecosystem objective.

The effectiveness of the PBMO in achieving Ecosystem Objective 2 has also been taken into account. The Action Plan for Reducing, Mitigating and Controlling Hypoxia in the

Northern Gulf of Mexico states that the best current science indicates that efforts to reduce nutrient loadings in the Mississippi River Basin should be aimed at achieving a 30 percent reduction (from the average discharge in the 1980-1996 time frame) in nitrogen discharges to the Gulf (on a 5-year running average) to be consistent with the coastal goal for reducing the aerial extent of hypoxia in the Gulf. Based on an average annual loading of 1.6 million metric tons, a 30 percent reduction would be 480,000 tons annually (CENR 2000). The PBMO would make a small contribution towards meeting this goal. However, the knowledge gained from implementation of the projects in the PBMO and from the large-scale studies could greatly facilitate the implementation of larger reintroduction projects, which could provide greater benefits in terms of reducing Gulf hypoxia.

3.7.2.1 Environmental operating principles/achieving sustainability

Striving to achieve environmental sustainability is a core objective both for the development and for the implementation of an NER plan. Although the result of the LCA Study effort does not identify the final NER plan, the PBMO is focused on producing economic and environmental outcomes that will support and reinforce one another over both the near and long-term. The recognition of the interdependence of biological resources and the physical and human environment has driven the development of many of the guiding principals and tools applied in this study. As a result, the restoration features and opportunities that make up the PBMO produce balance and synergy between human development activities and natural systems.

The restoration features and opportunities in the PBMO that point toward additional investigations are intended to continue to shape activities and decisions currently under the authority of the USACE in order to increase the continued viability of the natural systems within which they occur. The PBMO is also intended to provide a mechanism to continue to assess and address cumulative impacts to the environment, and to achieve consistency by applying a systems approach to the full life cycle of all related water resources activities in the Louisiana coastal area.

3.7.2.2 Components of the Plan that Best Meets the Objectives (PBMO)

The PBMO consists of the components addressed below. These combined components represent the best near-term approach for addressing coastal wetlands loss in Louisiana. The features and opportunities addressed below are viewed as representative of the most likely anticipated action and provide an optimal starting points for the detailed investigations that will lead to project justification and implementation. The projects that are ultimately authorized for construction would be optimized for location, scale, and beneficial output to be documented in a decision document supporting final NEPA compliance prior to implementation.

3.7.2.2.1 *Near-term critical restoration features and opportunities*

The first principal component of the PBMO is the group of features and opportunities identified to meet the critical near-term ecosystem needs of the Louisiana coastal wetlands. The restoration features and opportunities representing solutions to the Critical Needs included in the PBMO are:

- MRGO environmental restoration features
- Maurepas Swamp Reintroductions:
  - Small diversion at Hope Canal
  - Small diversion at Convent/Blind River
  - Increase Amite River Diversion Canal influence by gapping banks
- Barataria Basin barrier shoreline restoration
- Small Bayou Lafourche reintroduction
- Medium diversion with dedicated dredging at Myrtle Grove
- Calcasieu Ship Channel Beneficial Use
- Modification of Caernarvon diversion
- Modification of Davis Pond diversion
- Terrebonne marsh restoration opportunities:
  - Optimize flows and Atchafalaya River influence in Penchant Basin
  - Multi-purpose operation of Houma Navigation Canal (HNC) Lock
  - Convey Atchafalaya River water to Northern Terrebonne marshes via a small diversion in the Avoca Island levee, repairing eroding banks of the GIWW, enlarging constrictions in the GIWW below Gibson and in Houma and Grand Bayou conveyance channel construction/enlargement
- Terrebonne Basin barrier shoreline restoration
- Maintain land bridge between Caillou Lake and Gulf of Mexico
- Medium diversion at White's Ditch
- Gulf shoreline stabilization at Point Au Fer Island
- Lac des Allemands area Reintroductions:
  - Small diversion at Lac des Allemands
  - Small diversion at Donaldsonville
  - Small diversion at Pikes Peak
  - Small diversion at Edgard

3.7.2.2.2 *Large-scale and long-term concepts requiring detailed study*

The second principal component of the PBMO is the identification of large-scale, long-range studies of long-term restoration concepts. These long-range initiatives typically define fundamental changes to the hydrogeomorphic or ecologic structure, function, or management of the Louisiana coast. These concepts, which represent major opportunities for coastal restoration, require detailed study and development to determine the probable impacts (beneficial and adverse) of such features in order to determine if these projects are desirable and can be integrated into the plan for coastal restoration. These concepts also include some levels of uncertainty, which are typically so extensive in scale that resolution through a demonstration project is impractical. As a general rule, large-scale diversions (flow greater than 15,001 cfs [54 cms]) were deemed impractical in the near-term because of their being mutually exclusive with important concepts such as Third Delta. River resource hydrodynamic studies would necessarily evaluate these larger scale diversions in concert. The large-scale and long-term concepts identified in the PBMO include:

- Mississippi River Hydrodynamic Study
- Mississippi River Delta Management Study
- Third Delta Study
- Chenier Plain Freshwater and Sediment Management and Allocation Reassessment Study
- Acadiana Bays Estuarine Restoration Feasibility Study
- Upper Atchafalaya Basin Study (This study would include evaluation of alternative operational schemes of Old River Control Structure and will be funded under MR&T)

3.7.2.2.3 ***Science and Technology (S&T) Program and potential demonstration projects***

The third principal component of the PBMO is the establishment of a S&T Program to address both near and long-term uncertainties in the implementation and execution of the plan. A portion of this component would include the execution of focused demonstration projects to resolve specific uncertainties and provide insight to the programmatic short and long-range implementation of the PBMO.

This page intentionally left blank.

4.0 PLAN IMPLEMENTATION

Within plan implementation, there are several key individuals and organizations that are introduced and discussed in detail. For clarity, the following abbreviated terms apply:

- Assistant Secretary of the Army for Civil Works: the Assistant Secretary
- U.S. Army Corps of Engineers, Headquarters: Headquarters
- U.S. Army Corps of Engineers, Mississippi Valley Division: the Division
- U.S. Army Corps of Engineers-Mississippi Valley Division, New Orleans District: the District
- Coastal Louisiana Ecosystem Protection and Restoration Task Force: the Task Force
- State of Louisiana: the state

The State of Louisiana, acting through the LDNR, is the non-Federal cost share sponsor.

4.1 EVALUATION OF PBMO IMPLEMENTATION

Sequencing and scheduling of the alternative plan that bests meets objectives (PBMO) was required to determine an implementation plan. This implementation plan evaluation is based on the ability to meet the near-term (5 to 10 years) and critical needs. While these criteria identified the features that would comprise the most appropriate near-term restoration effort, the sequencing of the PBMO features needed to consider implementation parameters and constraints and identify the most effective means of executing the plan. The features of the PBMO were sequenced based on the highest capability for achieving construction approval first and then scheduled according to resource requirements and capabilities. Representatives of the cost share partners from the District and the LDNR, representing the state, established a set of assumptions and rules to sequence and schedule implementation of all components of the plan. The results of this evaluation are discussed in greater detail in a later part of this section.

4.1.1 Assumptions and Rules

There were five major assumptions made in the preparation of the implementation schedule prepared for this report. They are related to project authorizations, large-scale and long-term studies, demonstration projects, and funding and manpower resources. These are described in the following bullets. A set of sequencing rules was also developed to guide development of the implementation schedule. These rules are also described in more detail in the following bullets.

Assumptions

- Near-term critical restoration feature feasibility-level decision documents and feasibility studies could begin in October 2004 based upon existing authority;
- Large-scale and long-term studies could begin in October 2004 based upon existing authority;
- Feasibility-level decision document preparation for demonstration projects could begin in January 2005 based upon successful completion of the Chief's Report in December 2004 and future WRDA authorization;
- The annual cost shared execution capability of the District and non-Federal sponsor would be approximately $200 million per year on average; and
- All components should have construction initiated within the next 10 years.

Sequencing Rules

- Near-term critical restoration features that exhibit high degree of design development and have initiated NEPA compliance documentation (EIS)
- Near-term critical restoration features that if delayed, could result in "Loss of Opportunity" to restore a critical needs area;
- Modifications to existing structures already identified as major opportunities for contribution to LCA objectives; and
- Qualitative valuations that resulted in determining the features resident in the PBMO also allow for a prioritized ordering of the remaining features.

4.1.2 Implementation Scheduling Evaluation

Once the implementation sequence for the PBMO components had been determined, the Federal and State cost share partners began development of the 10-year implementation schedule. Based on the assumptions and rules for scheduling of plan components, all PBMO projects could not be implemented simultaneously. In addition, discussions with the non-Federal sponsor led to the conclusion that the total annual project expenditures would be limited to approximately $200 million per year on average (attachment 3 NON-FEDERAL SPONSOR FINANCIAL CAPABILITY). The inclusion of all plan components would force the implementation schedule to either exceed the average available funding limitation, or would result in initial construction of some features in the PBMO being delayed beyond the 10-year planning period.

To facilitate the initial efforts in sequencing the near-term critical features, a number of those features that had been grouped were considered separately to identify if they met the specific sequencing rules. The intent of grouping features was to indicate that those features required common consideration and analysis during the decision document phase. The assumption in considering implementation of grouped features separately is that the initial feature sequenced in any group would need to consider and reconcile the combined effects of the specific group. The ultimate implementation sequence of grouped features is not a dependent function if they have been properly assessed and scaled from the outset.

The critical near-term features of the PBMO were also reviewed in consideration of the 10-year timeframe to identify any additional conflicts or efficiencies in implementing the PBMO not captured by the established assumptions and sequencing rules. This review revealed that the Penchant Basin Restoration feature could be implemented more effectively by allowing the feature to proceed to approval under the CWPPRA program. The sequencing for this feature was identified as being beyond year 5 in the near-term plan. Construction approval and funding through the CWPPRA program could potentially be achieved for this feature in 2 to 3 years. As noted above, it is assumed that consideration of this feature, in conjunction with other hydrologic modification features with which it was grouped, would be performed prior to the implementation of the any of these features.

The review also revealed a consistent potential near-term conflict between the Lac Des Allemands Reintroduction features and the large-scale, long-range Third Delta study. The potential for hydrologic conflicts, or possibly more effective means of achieving the benefits through the larger feature, indicated that these near-term features should not be initiated until after completion of the large-scale study.

Considering this information, it was deemed reasonable to consider these features last in the sequencing. As a result, the Penchant Basin Restoration, and Lac Des Allemands were placed last in the sequencing and resulted in the inability to execute these features within the 10-year near-term timeframe.

Because beneficial use has been added as a program-wide component for this restoration technique, the beneficial use of dredged material from the Calcasieu Ship Channel would be evaluated for implementation as part of the larger beneficial use program. Evaluation of the Calcasieu River project, as part of the overall beneficial use program, would ensure that the most effective and feasible projects would be implemented more quickly.

Utilizing the sequencing rules, and the considerations discussed above the elements of the PBMO were sequenced as shown in **table MR4-1**.

Table MR4-1. Sequenced PBMO Components.

Near-term Critical Restoration Features
• MRGO Environmental Restoration features • Small Diversion at Hope Canal • Barataria Basin Barrier Shoreline Restoration • Small Bayou Lafourche Reintroduction • Medium Diversion with dedicated dredging at Myrtle Grove • Multi-purpose operation of Houma Navigation Canal Lock • Terrebonne Basin Barrier Shoreline Restoration • Maintain Land Bridge between Caillou Lake and Gulf of Mexico • Small Diversion at Convent / Blind River • Increase Amite River Diversion Canal Influence by gapping banks • Medium Diversion at White's Ditch • Stabilize Gulf Shoreline at Point Au Fer Island • Convey Atchafalaya River water to Northern Terrebonne Marshes • Modification of Caernarvon Diversion • Modification of Davis Pond Diversion • Penchant Basin Restoration • Lac Des Allemands Reintroductions • Calcasieu River Beneficial Use

The result of the scheduling evaluation effort was the identification of the set of near-term critical features that met sorting and critical need criteria, and could be implemented within the time and funding parameters identified for the near-term effort. This subset of the PBMO, along with other long-term and programmatic elements, was designated as the LCA Plan in the draft report prepared for public review and now represents the major features of the near-term critical restoration effort identified in the LCA Plan. A list of the near-term critical features contained in this subset is shown in **Table MR4-2**, following the discussion of authorization process considerations.

4.1.3 Project Authorization Process Analysis

After identifying the subset of near-term critical features to be included in the LCA Plan the Federal and state cost-share partners evaluated alternative implementation scenarios for all the components of the LCA Plan using two different authorization procedures:

(1) Specific Congressional authorization for all critical features with implementation subject to approval of feasibility-level decision documents by the Secretary of the Army (a process hereinafter referred to as "conditional authorization" elsewhere in the report;

(2) Future Congressional construction authorization for all critical features (i.e., the typical WRDA authorization process used for authorization of water resources projects, in which investigations are performed to complete feasibility reports and, upon completion, submitted for construction authorization under future WRDAs).

These two authorization processes have in common the requirement, which applies to all components of the LCA Plan, for completion and approval of detailed decision and NEPA compliance documents prior to the initiation of construction. In the case of the conditional authorization, the necessary Congressional authorization to proceed would be provided conditional to the approval of the required documents by the Secretary of the Army. For future Congressional construction authorization, approval of all required documents by the Secretary of the Army would be completed prior to submission to Congress, which then would provide final approval and authorization for construction at one time.

In this first scheduling iteration, the comparison of the implementation schedule results indicate that the major difference between the authorization scenarios was in the execution capability within the first five years. Both scenarios indicate execution at an annual capability averaging approximately $200 million beyond year 5.

Another iteration was conducted to investigate the effects of conditional authorization for only the five most highly critical features that met the first sequencing rule. Substantial design development and NEPA compliance efforts have been undertaken for these projects. Based on these considerations, the Federal and state cost share partners determined that these features could be ready for construction approval prior to the next opportunity for authorization. This scheduling iteration identified that conditional authorization for only the top five restoration features, with future Congressional construction authorization for the remaining 10 features, provided the same increased execution capability as the conditional authorization for all 15 restoration features. It became apparent that annual funding limitations, as well as the typical process of seeking construction approval under WRDA authorization, limited the plan's execution. The implementation scenario supported by conditional authorization for the top five restoration features is optimal for expediting implementation of features that address the most urgent needs of the coastal area. This scenario would facilitate the most effective and efficient implementation leading to the identification of the LCA plan. Without conditional authority, both the approval to proceed, and ability to budget for implementation, would setback the construction and operation of these critical restoration features.

Table MR 4-2 shows the LCA Plan near-term critical features recommended for conditional authorization and approval with future Congressional authorization.

Table MR 4-2. Scheduled LCA Plan Components.

Recommended for Conditional Authorization
Near-term Critical Restoration Features • MRGO Environmental Restoration features • Small Diversion at Hope Canal • Barataria Basin Barrier Shoreline Restoration, Caminada Headland, Shell Island • Small Bayou Lafourche reintroduction • Medium diversion with dedicated dredging at Myrtle Grove
Recommended for Approval With Future Congressional Construction Authorization
Other Near-term Critical Restoration Features • Multi-purpose operation of Houma Navigation Canal Lock • Terrebonne Basin Barrier Shoreline Restoration • Maintain land bridge between Caillou Lake and Gulf of Mexico • Small Diversion at Convent / Blind River • Increase Amite River Diversion Canal Influence by gapping banks • Medium diversion at White's Ditch • Stabilize Gulf Shoreline at Point Au Fer Island • Convey Atchafalaya River water to Northern Terrebonne Marshes • Modification of Caernarvon Diversion • Modification of Davis Pond Diversion

4.2 SUMMARY OF THE LCA PLAN COMPONENTS AND IMPLEMENTATION SCHEDULE

4.2.1 Description of the LCA Plan

As stated in section 3.1 PLANNING CONSTRAINTS, the resolution of S&T uncertainties requires continued science and technology development supported by demonstration projects. In addition, there is coastwide beneficial use of dredged material, as well as potential modifications of existing water resource projects that may offer the opportunities to advance restoration. To better achieve completeness and effectiveness, the PDT incorporated these two additional plan components for programmatic authorization. This resultant multi-component LCA Plan represents the best near-term approach for addressing ecosystem degradation in Louisiana. The LCA program relies on Congressional approval of the LCA Plan as a framework for conditional and future Congressional construction authorization actions. Components of the LCA Plan are:

- Conditional authorization for implementation of five near-term critical restoration features for which construction can begin within 5 to 10 years, subject to approval of feasibility-level decision documents by the Secretary of the Army;
- Programmatic Authorization of a Science and Technology (S&T) Program;

- Programmatic Authorization of Science and Technology Program Demonstration Projects;
- Programmatic Authorization for the Beneficial Use of Dredged Material;
- Programmatic Authorization for Investigations of Modification of Existing Structures;
- Approval of 10 additional near-term critical restoration features and authorization for investigations to prepare necessary feasibility-level reports to be used to present recommendations for potential future Congressional authorizations (hereinafter referred to as "Congressional authorization"); and
- Approval of investigations for assessing six potentially promising large-scale and long-term restoration concepts.

Figure MR 4-1 and **tables MR 4-3a** and **MR 4-3b** list the components of the LCA Plan.

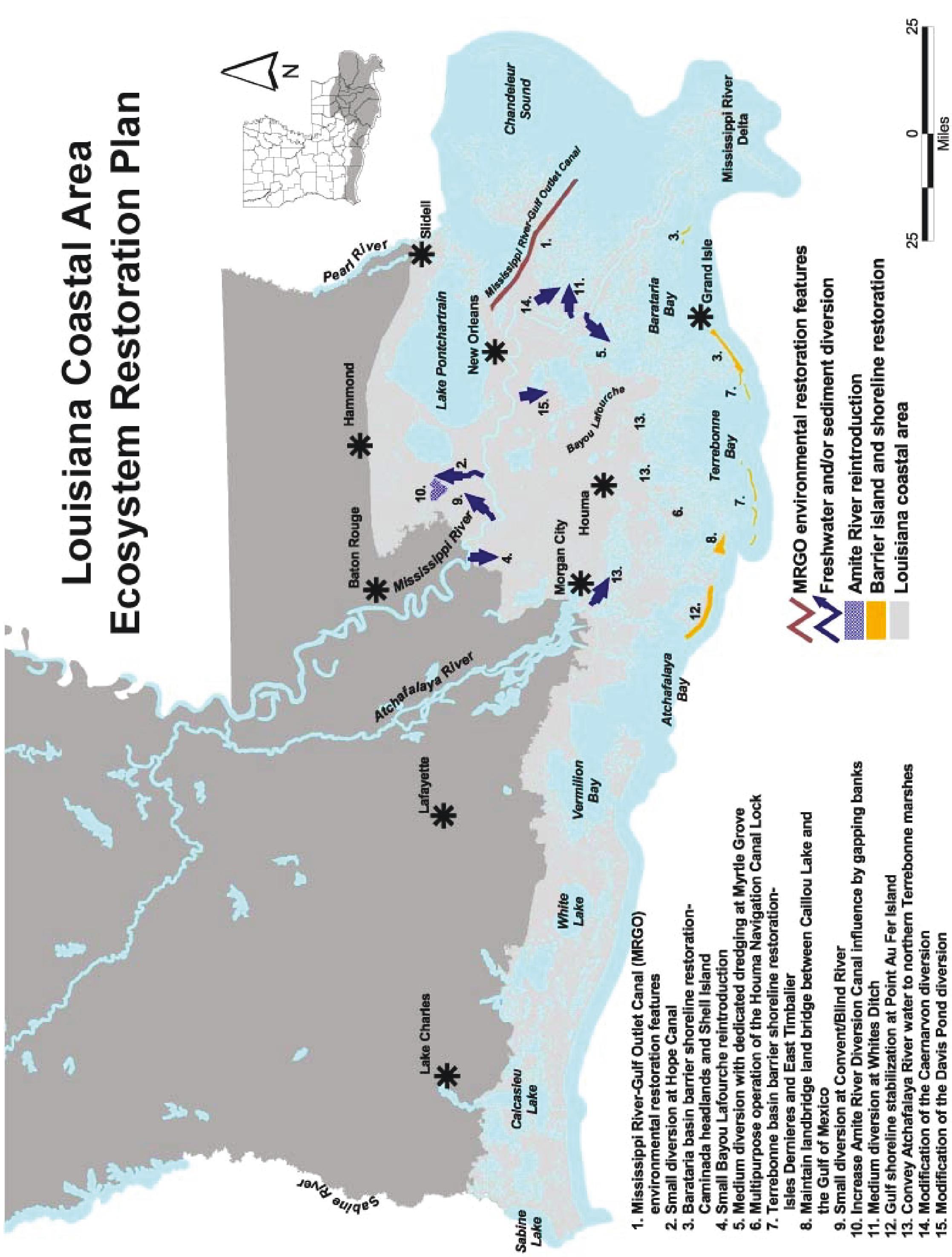


Figure MR 4-1. Critical Near-Term Restoration Features of the LCA Plan.

Table MR 4-3a. Components of the LCA Plan.

Recommended for Conditional or Programmatic Authorization
1. Conditional Authorization of Near-term Critical Restoration Features • MRGO Environmental Restoration Features • Small Diversion at Hope Canal • Barataria Basin Barrier Shoreline Restoration • Small Bayou Lafourche Reintroduction • Medium Diversion with Dedicated Dredging at Myrtle Grove 2. Programmatic Authorization of the S&T Program 3. Programmatic Authorization of Demonstration Projects 4. Programmatic Authorization for the Beneficial Use of Dredged Material 5. Programmatic Authorization to Initiate Investigations of Modifications of Existing Water Control Structures

Table MR4-3b. Components of the LCA Plan.

Recommended for Approval With Future Congressional Construction Authorization
6. Other Near-term Critical Restoration Features • Multi-purpose operation of Houma Navigation Canal Lock • Terrebonne Basin Barrier Shoreline Restoration • Maintain land bridge between Caillou Lake and Gulf of Mexico • Small Diversion at Convent / Blind River • Increase Amite River Diversion Canal Influence by gapping banks • Medium diversion at White's Ditch • Stabilize Gulf Shoreline at Point Au Fer Island • Convey Atchafalaya River water to Northern Terrebonne Marshes • Modification of Caernarvon Diversion • Modification of Davis Pond Diversion 7. Large-scale and Long-term Concepts Requiring Detailed Study • Mississippi River Hydrodynamic Study • Mississippi River Delta Management Study • Third Delta Study • Chenier Plain Freshwater and Sediment Management and Allocation Reassessment Study • Acadiana Bays Estuarine Restoration Study • Upper Atchafalaya Basin Study

4.2.2 Sequencing of the LCA Plan

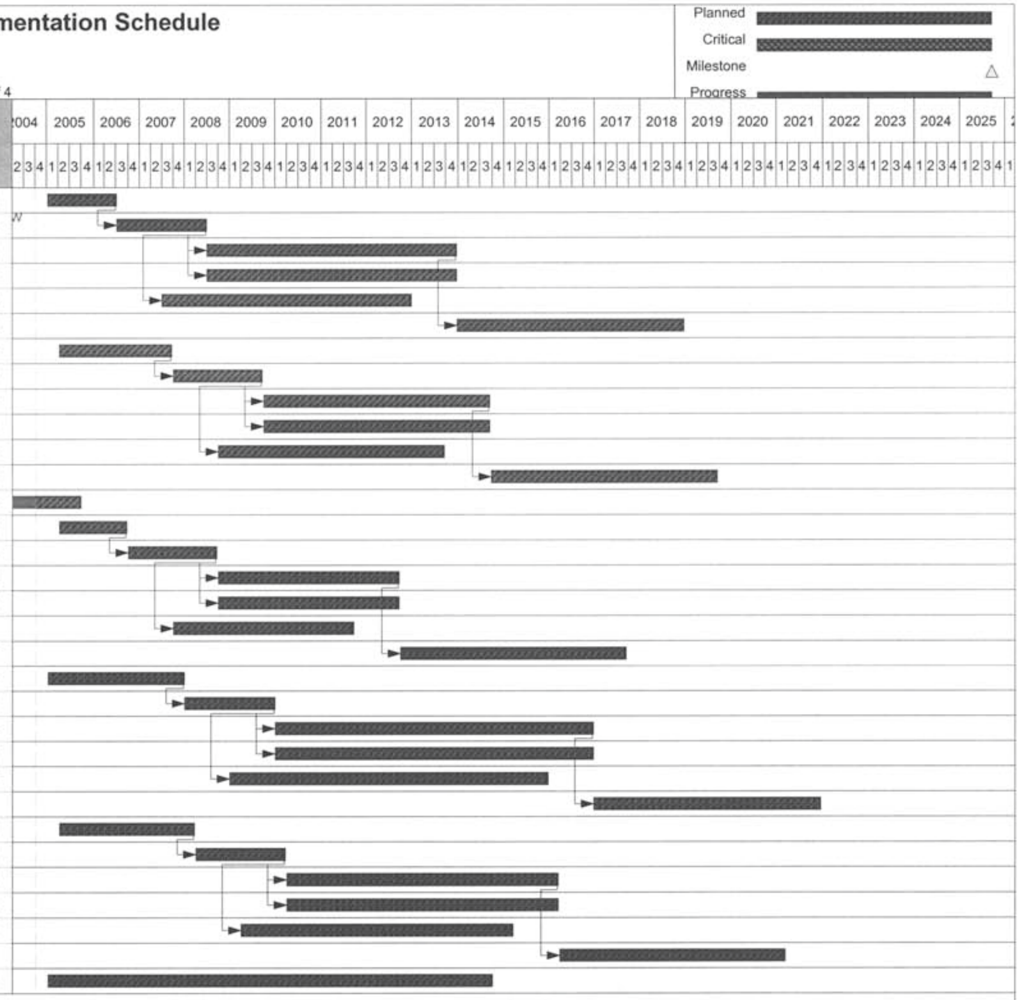
Tables MR 4 4a-d show the implementation schedule for the LCA Plan, developed with conditional authorization for five critical features, programmatic authorization features, and future Congressional construction authorization for the other 10 near-term critical features.

Project:	101204
Time Now:	10/01/04
Start:	10/01/04
Finish:	09/29/23
Run:	10/15/04

The LCA Plan Implementation Schedule

1 of 4

ID	Activity Desc.	Duration	Early Start	Early Finish
A01A	MRGO Environmental Restoration Features (SP1) DD	390d	01/10/05	07/07/06
A01B	MRGO Environmental Restoration Features (SP1) PED	520d	07/10/06	07/04/08
A01C	MRGO Enviro. Rest. Construction	1430d	07/07/08	12/27/13
A01C2	MRGO Enviro. Rest. E&D, S&A	1430d	07/07/08	12/27/13
A01C3	MRGO Enviro. Rest. RE	1430d	07/09/07	12/28/12
A01C4	MRGO Enviro. Rest. Monitoring	1300d	12/30/13	12/21/18
B02A	Small Diversion at Hope Canal (SP1) DD	650d	04/04/05	09/28/07
B02B	Small Diversion at Hope Canal -PED	520d	10/01/07	09/25/09
B02C	Div. at Hope Canal Construction	1300d	09/28/09	09/19/14
B02C2	Div. at Hope Canal E&D, S&A	1300d	09/28/09	09/19/14
B02C3	Div. at Hope Canal RE	1300d	09/29/08	09/20/13
B02C4	Div. at Hope Canal Monitoring	1300d	09/22/14	09/13/19
C03A	Barataria Basin Barrier Shore Rest. -Caminada ,Shell Is. SP2	1415d	05/01/00	09/30/05
C03B	Barat Basin Barrier Shore Rest. Cam., Shell-DD	390d	04/04/05	09/29/06
C03BA	Barat. Basin Barrier Shore Rest. Cam., Shell-PED	520d	10/02/06	09/26/08
C03C	Barat Basin Barrier Shore. Rest. Cam, Shell Is Const	1040d	09/29/08	09/21/12
C03C2	Barat Basin Barrier Shore. Rest. Cam, Shell Is E&D, S&A	1040d	09/29/08	09/21/12
C03C3	Barat Basin Barrier Shore. Rest. Cam, Shell Is RE	1040d	10/01/07	09/23/11
C03C4	Barat Basin Barrier Shore. Rest.Cam,Shell Monitoring	1300d	09/24/12	09/15/17
D06A	Small Bayou LaFourche Reintroduction (SP3)-DD	780d	01/10/05	01/04/08
D06B	Small Bayou LaFouche Reintroduction (SP3)-PED	520d	01/07/08	01/01/10
D06C	Small Bayou La Fourche Reintro Construction	1820d	01/04/10	12/23/16
D06C2	Small Bayou La Fourche Reintro E&D, S&A	1820d	01/04/10	12/23/16
D06C3	Small Bayou La Fourche Reintro RE	1820d	01/05/09	12/25/15
D06C4	Small Bayou LaFouche Reintro Monitoring	1300d	12/26/16	12/17/21
E07A	Medium Diversion w/ Dedicated Dredging at Myrtle Grove- DD	780d	04/04/05	03/28/08
E07B	Medium Diversion W/ Dedicated Dredging at Myrtle Grove-PED	520d	03/31/08	03/26/10
E07C	Medium Diversion at Myrtle Grove Construction	1560d	03/29/10	03/18/16
E07C2	Medium Diversion at Myrtle Grove E&D, S&A	1560d	03/29/10	03/18/16
E07C3	Medium Diversion at Myrtle Grove RE	1560d	03/30/09	03/20/15
E07C4	Medium Diversion at Myrtle Grove Monitoring	1300d	03/21/16	03/12/21
FST01	Science & Tech Program FY05-FY15	2537d	01/10/05	09/30/14

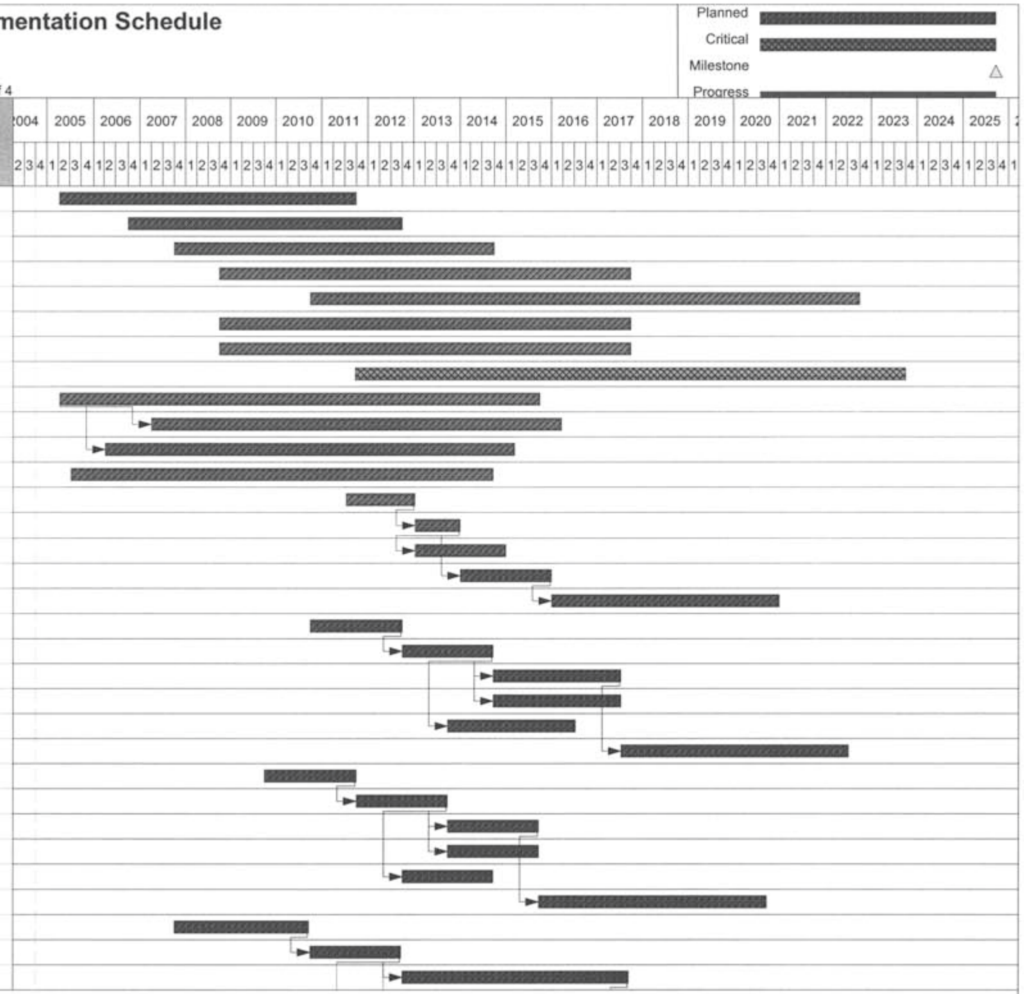


Project:	101204
Time Now:	10/01/04
Start:	10/01/04
Finish:	09/29/23
Run:	10/15/04

The LCA Plan Implementation Schedule

2 of 4

ID	Activity Desc.	Duration	Early Start	Early Finish
GDEMO5C	Demo Projects-DD	1695d	04/04/05	09/30/11
GDEMO5D	Demo Projects-PED	1565d	10/02/06	09/28/12
GDEMO5E	Demo Projects-RE	1827d	10/01/07	09/30/14
GDEMO5F	Demo Projects-CONSTRUCTION	2350d	09/29/08	09/29/17
GDEMO5G	Demo Projects-MONITORING	3135d	09/27/10	09/30/22
GDEMO5H	Demo Projects-E&D	2350d	09/29/08	09/29/17
GDEMO5I	Demo Projects-S&A	2350d	09/29/08	09/29/17
GDEMO5J	Demo Projects-MONITORING RPT	3138d	09/21/11	09/29/23
HPGMA	Prog. Auth. for Beneficial Use of Dredged Mtrl.-DD	2738d	04/04/05	09/30/15
HPGMB	Prog. Auth. for Beneficial Use Construction	2340d	04/03/07	03/21/16
HPGMB2	Prog. Auth. for Beneficial Use RE	2340d	04/03/06	03/20/15
IMODA	Investigation of Mod to Existing Structures-Other Opportun.	2410d	07/05/05	09/29/14
J08A	Multi-Purpose Ops of Houma Nav. Canal (HNC) Lock-DD	390d	07/06/11	01/01/13
J08B	Multi-Purpose Ops of Houma Nav. Canal (HNC) Lock PED	260d	01/02/13	12/31/13
J08B2	Multi-Purpose Ops of Houma Nav. Canal (HNC) Lock RE	520d	01/02/13	12/30/14
J08B3	Multi-Purpose Ops of Houma Nav Canal Lock E&D S&A	520d	01/01/14	12/29/15
J08B4	Multi-Purpose Ops of Houma Nav. Canal Lock-Monitoring	1300d	12/30/15	12/22/20
K09A	Terr. Basin Barrier Shore. Restoration -DD	520d	10/01/10	09/27/12
K09B	Terr. Basin Barrier Shore. Restoration PED	520d	09/28/12	09/25/14
K09C	Terr. Basin Barrier Shore. Restoration Construction	726d	09/26/14	07/07/17
K09C2	Terr. Basin Barrier Shore. Restoration E&D, S&A	726d	09/26/14	07/07/17
K09C3	Terr. Basin Barrier Shore. Restoration RE	726d	09/27/13	07/08/16
K09C4	Terr. Basin Barrier Shore. Rest. Monitoring	1300d	07/10/17	07/01/22
L10A	Maintain Land Bridge b/t Caillou Lk. and Gulf of Mexico-DD	520d	10/01/09	09/28/11
L10B	Maintain Land Bridge b/t Caillou Lake and Gulf of Mexico-PED	520d	09/29/11	09/25/13
L10C	Maintain Land Bridge b/t Caillou Lake & Gulf Construction	520d	09/26/13	09/23/15
L10C2	Maintain Land Bridge b/t Caillou Lake & Gulf E&D, S&A	520d	09/26/13	09/23/15
L10C3	Maintain Land Bridge b/t Caillou Lake & Gulf RE	520d	09/27/12	09/24/14
L10C4	Maintain Land Bridge b/t Caillou Lk & Gulf Monitoring	1300d	09/24/15	09/16/20
M11A	Small Diversion at Convent / Blind River DD	780d	10/01/07	09/24/10
M11B	Small Diversion at Convent/Blind River PED	520d	09/27/10	09/21/12
M11C	Small Diversion at Convent/Blind River Construction	1300d	09/24/12	09/15/17

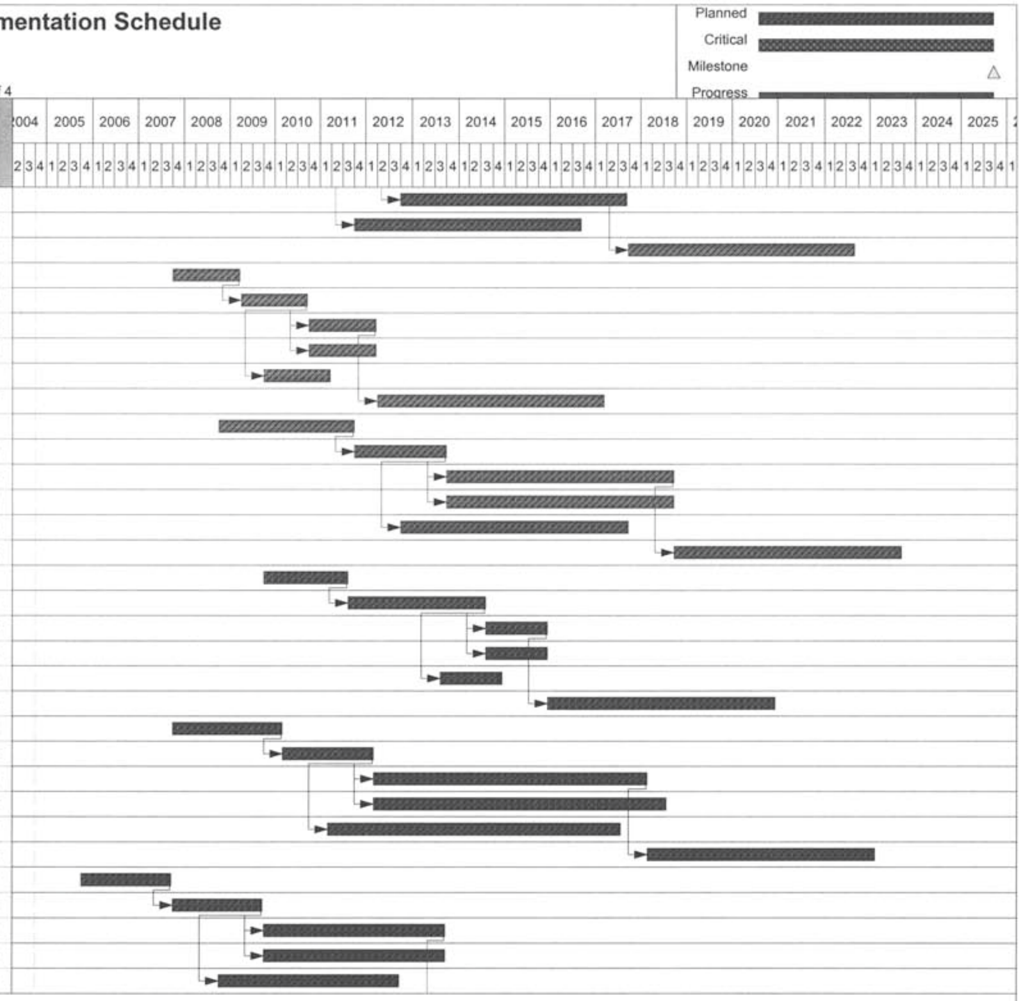


Project:	101204
Time Now:	10/01/04
Start:	10/01/04
Finish:	09/29/23
Run:	10/15/04

The LCA Plan Implementation Schedule

3 of 4

ID	Activity Desc.	Duration	Early Start	Early Finish
M11C2	Small Diversion at Convent/Blind River E&D, S&A	1300d	09/24/12	09/15/17
M11C3	Small Diversion at Convent/Blind River RE	1300d	09/26/11	09/16/16
M11C4	Small Diversion at Convent/Blind River Monitoring	1300d	09/18/17	09/09/22
N12A	Increase Amite River Influence by Gapping Bank (SP1)	390d	10/01/07	03/27/09
N12B	Increase Amite River Influence PED	390d	03/30/09	09/24/10
N12C	Increase Amite River Influence Construction	390d	09/27/10	03/23/12
N12C2	Increase Amite River Influence E&D, S&A	390d	09/27/10	03/23/12
N12C3	Increase Amite River Influence RE	390d	09/28/09	03/25/11
N12C4	Increase Amite River Influence Monitoring	1300d	03/26/12	03/17/17
O13A	Medium Diversion at Whites Ditch (SP1)	780d	10/01/08	09/27/11
O13B	Medium Diversion at Whites Ditch PED	520d	09/28/11	09/24/13
O13C	Medium Diversion at Whites Ditch Construction	1300d	09/25/13	09/18/18
O13C2	Medium Diversion at Whites Ditch E&D, S&A	1300d	09/25/13	09/18/18
O13C3	Medium Diversion at Whites Ditch RE	1300d	09/26/12	09/19/17
O13C4	Medium Diversion at Whites Ditch Monitoring	1300d	09/19/18	09/12/23
P14A	Gulf Shore. Stabilization at Pt. Au Fer Island (SP3)	484d	10/01/09	08/09/11
P14B	Gulf Shore. Stabilization at Pt. Au Fer Island-PED	780d	08/10/11	08/05/14
P14C	Gulf Shore. Stabilization at Pt. Au Fer Is. Construction	352d	08/06/14	12/10/15
P14C2	Gulf Shore. Stabilization at Pt. Au Fer Is. E&D, S&A	352d	08/06/14	12/10/15
P14C3	Gulf Shore. Stabilization at Pt. Au Fer Is. RE	352d	08/07/13	12/11/14
P14C4	Gulf Shore. Stabilization at Pt. Au Fer Is. Monitoring	1300d	12/11/15	12/03/20
Q15A	Convey Atch. River to Terrebonne Marsh via Small Div.	630d	10/01/07	02/26/10
Q15B	Convey Atch. River to Terrebonne Marsh-PED	520d	03/01/10	02/24/12
Q15C	Convey Atch. River to Terrebonne Marsh-Construction	1560d	02/27/12	02/16/18
Q15C2	Convey Atch. River to Terrebonne Marsh-E&D S&A	1672d	02/27/12	07/24/18
Q15C3	Convey Atch. River to Terrebonne Marsh-RE	1672d	02/28/11	07/25/17
Q15C4	Convey Atch. River to Terr. Marsh Monitoring	1300d	02/19/18	02/10/23
R04A	Modification to Caernarvon Div (SP1) DD	520d	10/03/05	09/28/07
R04B	Modification to Caernarvon PED	520d	10/01/07	09/25/09
R04C	Modification to Caernarvon Div Construction	1040d	09/28/09	09/20/13
R04C2	Modification to Caernarvon Div E&D, S&A	1040d	09/28/09	09/20/13
R04C3	Modification to Caernarvon Div RE	1040d	09/29/08	09/21/12

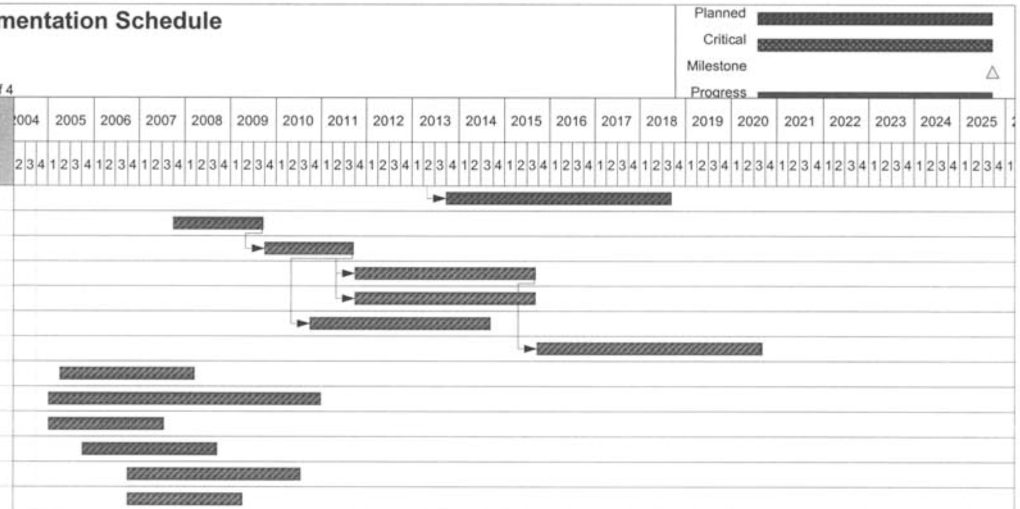


Project:	101204
Time Now:	10/01/04
Start:	10/01/04
Finish:	09/29/23
Run:	10/15/04

The LCA Plan Implementation Schedule

4 of 4

ID	Activity Desc.	Duration	Early Start	Early Finish
R04C4	Modification to Caernarvon Div Monitoring	1300d	09/23/13	09/14/18
S05A	Mod. to Davis Pond Div. for Increased Sed.SP2 DD	520d	10/01/07	09/25/09
S05B	Mod. to Davis Pond Div. for Increase Sed. PED	520d	09/28/09	09/23/11
S05C	Modification to Davis Pond Diversion Construction	1040d	09/26/11	09/18/15
S05C2	Modification to Davis Pond Diversion E&D, S&A	1040d	09/26/11	09/18/15
S05C3	Modification to Davis Pond Diversion RE	1040d	09/27/10	09/19/14
S05C4	Modivication to Davis Pond Div. Monitoring	1300d	09/21/15	09/11/20
TLS1	Mississippi River Hydrodynamic Study	780d	04/04/05	03/28/08
TLS2	Third Delta (SP2 and 3)	1560d	01/10/05	12/31/10
TLS3	Upper Atchafalaya Basin Study w/Mod Old Riv Cont Struct Scm	660d	01/10/05	07/20/07
TLS4	Chenier Plain Freshwater Mgt. and Allocation Reassess. (SP4)	780d	10/03/05	09/26/08
TLS5	Miss. River Delta Mgt. Study (SP1 & 2)	990d	10/02/06	07/16/10
TLS6	Acadiana Bay Estuarine Restoration (SP3)	660d	10/02/06	04/10/09



4.2.3 Near-Term Critical Restoration Features

4.2.3.1 Cost Effectiveness of the Near-term Critical Component of the LCA Plan

Following the identification of the critical near-term features to be implemented in the near-term restoration effort the ecologic models were run in each subprovince. The specific purpose of this modeling effort was to enable the cost effectiveness of the near-term critical features of the LCA Plan to be comparatively assessed relative to the larger frame works from which they had been developed. With the existing cost information and the benefit output for the LCA Plan in each subprovince a comparison of the cost effectiveness of the LCA Plan versus the previously analyzed coast wide frameworks was made. The overlaying of the LCA Plan on the identified cost effective frontier indicates that three coast wide frameworks previously deemed to be cost effective would be eliminated from the frontier. The comparison of the LCA Plan versus these frameworks is provided in **table MR4-5**. The effected coastwide frameworks are shaded in the table.

Table MR 4-5
LCA Plan versus Final Array of Coast wide Frameworks
forming the Cost Effective Frontier

Plan	Subprovince Framework Codes	Average Annual Benefits*	Average Annual Costs
0000	No Action	0	$ -
1000	S1R1	219	22,910,914
2000	S1R2	1074	24,350,598
5000	S1M2	1873	32,838,902
7000	S1E1	1945	55,021,432
LCA Plan		**2865**	**55,921,000**
5100	S1M2, S2R1	2984	122,043,563
7100	S1E1, S2R1	3056	144,226,093
5110	S1M2, S2R1, S3R1	3098	159,643,014
10130	S1-3 N3*	3134	179,073,919
7110	S1E1, S2R1, S3R1	3170	181,825,544
7410	S1E1, S2M1, S3R1	3182	207,599,025
7002	S1E1, S2E3, S3M1	3202	542,511,742

*Based on a composite of land building, habitat suitability, and nitrogen removal.

A comparison of the cost effectiveness of the LCA Plan versus the final array of coast wide frameworks from which the LCA Plan was derived shows that the LCA Plan produces a lesser magnitude of output. However, the efficiency of the LCA Plan is comparable to that of the larger plans in the final array. The comparison of the LCA Plan and the final array of coast wide frameworks is presented in **table MR 4-6** and **figure MR 4-2.**

Table MR 4-6
LCA Plan and Final Array of Coast wide Frameworks

Plan	Subprovince Framework Codes	Average Annual Benefits ^	Average Annual Costs
LCA Plan		**2865**	**$ 55,921,000**
5610	S1M2, S2M3, S3R1	3094	171,479,754
5110	S1M2, S2R1, S3R1	3098	159,643,014
5410	S1M2, S2M1, S3R1	3110	185,416,495
10130	S1-3 N3*	3134	179,073,919
7610	S1E1, S2M3, S3R1	3166	193,662,284
7410	S1E1, S2M1, S3R1	3182	207,599,025
7002	S1E1, S2E3, S3M1	3202	542,511,742

*Plan developed by modification of plan 5110.
^Based on a composite of land building, habitat suitability, and nitrogen removal.

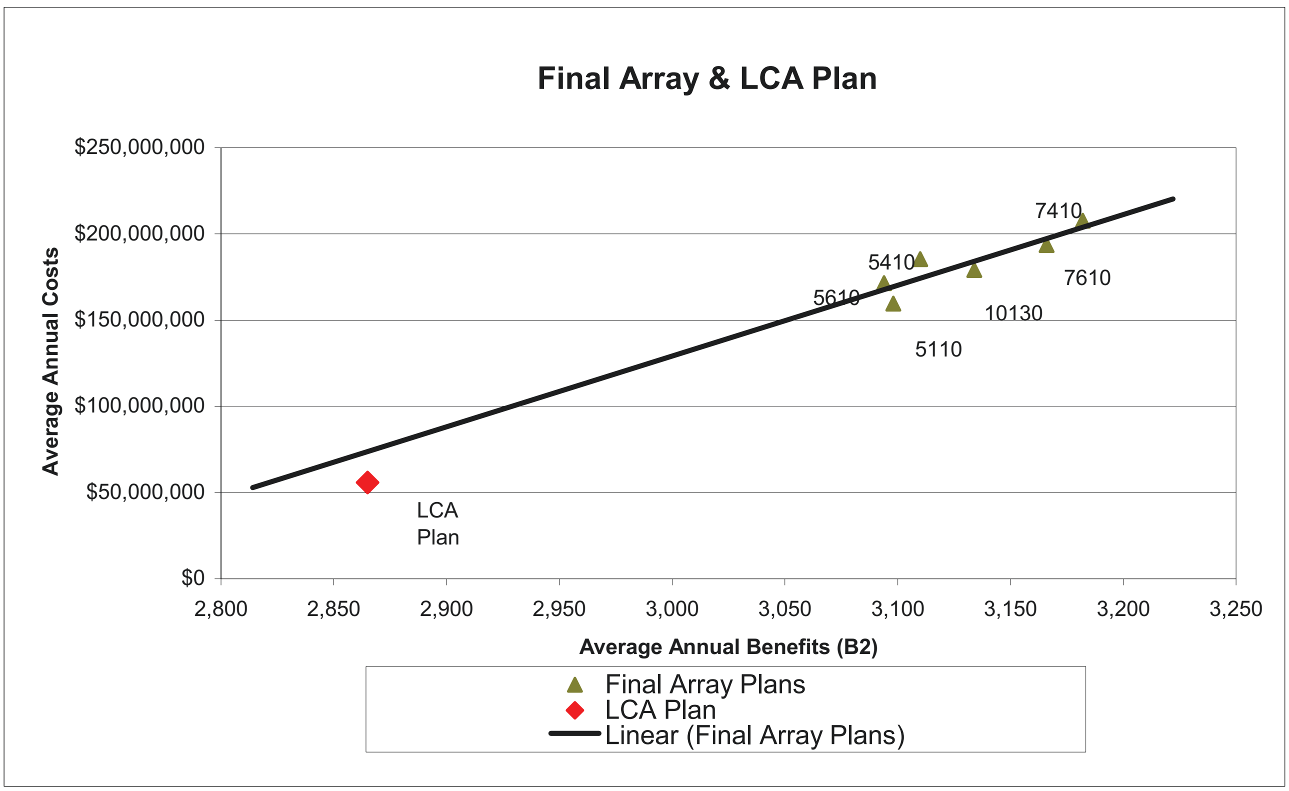


Figure MR 4-2 Effectiveness of the LCA Plan Relative to the Final Array of Coast Wide Frameworks

The ecologic model output for land building estimates that the plan would offset approximately 62.5 percent of the 462,000 acres projected to be lost within the coast under the no action alternative. The estimated land building for Subprovince 1 exceed projected no action losses. In Subprovinces 2 & 3 the models estimated that the LCA Plan prevented almost 50 percent of the expected losses in each basin. These estimates do not include any projects in Subprovince 4.

A comparison of the habitat suitability projected by the ecologic model for the LCA Plan indicates that increases in overall suitability in habitat for lower and moderate salinity species should generally occur in the Deltaic Plain subprovinces relative to no action. Subprovince 1 is an exception where lower salinity species are estimated to experience a slight decline in habitat with the LCA Plan, which is a reversal in trend as compared to the coast wide framework effects. This reversal is also apparent for moderate salinity species in Subprovince 1 with a negative habitat trend being reflected by the coast wide frameworks. In Subprovince 2, the coast wide frameworks project a slightly higher improvement for lower salinity species than with the LCA Plan. In Subprovince 3, there is no difference in projected trends from the LCA Plan to the coast wide frameworks.

For higher salinity species, the projected trends for all three subprovinces indicate slight to moderate decline in habitat suitability. The comparison of the effect of the LCA Plan versus the coast wide frameworks indicates that the habitat decline would be somewhat reduced for the LCA Plan. The models estimate that the largest effects would occur in these saline habitats. The potential declines of approximately 35 percent in these habitat types are heavily influenced by oyster habitat suitability factors.

The ecologic model also estimates the capability of restoration plans for nitrogen removal from Mississippi River flows. A target for this effectiveness is expressed as a fraction of 30 percent of the annual nitrogen load transported by the river. In relation to the coast wide frameworks, the potential of the LCA Plan to meet this objective is reduced due to the exclusion of larger-scale diversions from the near-term restoration plan.

Although the model results indicate that the LCA Plan would offset roughly 62.5 percent of the projected land loss in the future, significant need still exists to offset the past loss of approximately 1.2 million acres and subsequent reduction in overall ecosystem quality.

4.2.3.2 Conditional authority for implementation of certain near-term critical restoration features

Feasibility-level decision documents would be developed for each of the initial five near-term critical restoration features. These feasibility-level decision documents would document planning; engineering and design; real estate analyses; and supplemental requirements under the NEPA. It is recommended that Congress authorize implementation of the five near-term restoration features described below, subject to review and approval of the feasibility-level decision documents by the Secretary of the Army.

The feature descriptions below explain the justification for the requested conditional authorization for the initial five near-term critical restoration features. All of these features have a basis in cost effectiveness and in their value in addressing critical natural and human ecological needs. These five critical near-term features present a range of effects essential for success in restoring the Louisiana coast. The benefits provided by these features include the sustainable reintroduction of riverine resources, rebuilding of wetlands in areas at high risk for future loss, the preservation and maintenance of critical coastal geomorphic structure, and perhaps most importantly, the preservation of critical areas within the coastal ecosystem, and the opportunity to begin to identify and evaluate potential long-term solutions.

Based on a body of work both preceding and including this study effort, the PDT produced an estimate of average annual costs and benefits for these five features. Benefits were estimated during previous investigations of these features using a community based Habitat Evaluation Procedure (HEP) model developed by the USFWS specifically for the CWPPRA program. This model was entitled the Wetland Value Assessment (WVA) and was geared toward optimal species common parameters over a range of habitats. The model is driven by input based on multi-user professional judgment supported by available habitat data and user observation. The users must specifically prescribe the area and level of expected effect. This model expands upon professional judgment by formalizing a consensus, and standardizing methodology. The model does not mathematically extrapolate biologic response over the defined spatial extent of the project area in the manner of the desktop or a numeric model. In this regard, the WVA has some limitation in projecting beneficial output. While the desktop model is capable of capturing far reaching secondary effects related to altered hydrology or riverine input transported through a larger system, the WVA can be limited by the user defined areas, and estimated levels, of effect.

Composite information based on WVA output for these features shows that average annual environmental output for this conditionally authorized feature package would be on the order of 22,000 habitat units (HU) at an average annualized cost of $2,700 per unit provided. Summaries of the five near-term critical features presented for conditional authorization are presented on the following pages. Detailed descriptions and background information for these five features is provided in attachment 4 to the Main Report.

4.2.3.2.1 *Mississippi River Gulf Outlet (MRGO) environmental restoration features*

The Lake Borgne estuarine complex is deteriorating and recent analysis indicates that the rate of wetland loss in the area is accelerating. Rapid action is required to protect the integrity of the southern Lake Borgne shoreline and to prevent continued erosion of the Mississippi River Gulf Outlet (MRGO) channel banks from ocean going vessel wakes. Additional ecosystem restoration features are required to address serious ecological problems developing in the surrounding parts of the estuary. Without action, critical landscape components that make up the Lake Borgne estuary would be lost and future efforts to restore other parts of the ecosystem would be much more difficult and expensive if not impossible.

Construction and maintenance of the MRGO caused widespread wetland loss and damage to estuarine habitats from the outer barrier islands in the lower Chandeleur chain up to cypress forests and tidal fresh marshes in the western reaches of the Lake Borgne Basin. During construction of the MRGO, dredging and filling destroyed more than 19,000 acres of wetlands, and an important hydrologic boundary was breached when the channel cut through the ridge at Bayou La Loutre.

After the MRGO was completed, significant habitat shifts occurred because the impacted area converted to a higher salinity system with the influx of saltwater through ridges and marsh systems that were severed or destroyed during channel construction. Continued operation of the MRGO results in high rates of shoreline erosion from ship wakes, which destroy wetlands and threatens the integrity of the Lake Borgne shoreline and adjacent communities, infrastructure, and cultural resources. In addition, severe erosion of the MRGO channel continues to facilitate the transition of the upper Pontchartrain Basin estuary toward a more saline system.

Annual erosion rates in excess of 35 feet along the north bank of the MRGO result in the direct loss of approximately 100 acres of shoreline brackish marsh every year and additional losses of interior wetlands and shallow ponds as a result of high tidal ranges and rapid water exchange through the modified watercourse system. These vegetated habitats and shallow waters are important for estuarine biological resources and serve as critical habitat for the threatened Gulf sturgeon.

Erosion and saltwater intrusion are also impacting ridge habitat that is important for mammals, reptiles, and birds. The highest rates of erosion in the area occur along the north bank of the MRGO channel. The southern shoreline of Lake Borgne is eroding at approximately 15 feet per year resulting in the loss of 27 acres of wetlands per year. Continuing erosion along the channel and the shoreline of Lake Borgne is threatening to breach the lake/marsh rim, which would result in the coalescence of the two water bodies. A breach would accelerate marsh loss.

This near-term restoration feature involves the construction of shoreline protection measures, such as rock breakwaters, along the north bank of the MRGO and along important segments of the southern shoreline of Lake Borgne, as well as the investigation of various environmental restoration strategies requested in response to public concerns over the proposed plan to stabilize the MRGO navigation channel. The natural ridges along these selected shoreline segments are in danger of breaching in the very near future because of ship wakes along the channel and erosion from wind-driven waves along the lakeshore. Once these ridges are breached, the wetlands protected by these ridges become vulnerable to natural and man-made erosive forces that will quickly work to degrade the wetlands. Strategic placement of similar protective breakwaters has been effectively used along the MRGO in other locations to prevent bankline retreat and to protect large areas of estuarine wetlands from further erosion and degradation. The breakwaters may also facilitate future wetland creation using dedicated dredging and/or beneficial use of dredged material by serving as containment and protection for the restored wetlands. Additional ecosystem restoration features including marsh creation, freshwater introduction, barrier island restoration, and channel modification will be investigated to develop a suite of measures to stabilize and maintain important estuarine components.

The specific features proposed as part of the near-term MRGO environmental restoration plan include:

- Construct 23 miles of shoreline protection using rock breakwaters to prevent high rates of erosion that are occurring along the north bank of the MRGO.

- Construct 15 miles of rock breakwaters to protect critical points along the southern shoreline of Lake Borgne that are in peril of breaching in the near future.

These features would prevent the loss of 6,350 acres of marsh over the next 50 years. The estimated cost for designing and constructing critical rock breakwaters along the MRGO and selected sections of the southern Lake Borgne shoreline is $108.27 million (including monitoring). Details of this cost estimate are provided in the following tables:

Table MR 4-7 Summary of Costs for
MRGO Environmental Restoration Features
(June 2004 Price Level)

Lands and Damages	$	4,214,000
Elements:		
Bank Stabilization	$	80,000,000
Monitoring	$	842,000
First Cost	$	85,056,000
Feasibility-Level Decision Document	$	5,400,000
Preconstruction Engineering and Design (PED)	$	3,600,000
Engineering and Design (E&D)	$	4,614,000
Supervision and Administration (S&A)	$	9,600,000
Total Cost	**$**	**108,270,000**

Table MR 4-8 MRGO Environmental Restoration Features
FEDERAL AND NON-FEDERAL COST BREAKDOWN
(June 2004 Price Level)

Item	Federal	Non-Federal	Total
Decision Document (50%Fed-50%NFS)	$ 2,700,000	$ 2,700,000	$ 5,400,000
PED (65%Fed-35%NFS)	$ 2,340,000	$ 1,260,000	$ 3,600,000
LERR&D (100% NFS)	$ -	$ 4,214,000	$ 4,214,000
Ecosystem Restoration (65%Fed-35%NFS)	$ 54,739,100	$ 25,260,900	$ 80,000,000
Engineering and Design (E&D) (65%Fed-35%NFS)	$ 2,999,100	$ 1,614,900	$ 4,614,000
Supervision and Administration (S&A) (65%Fed-35%NFS)	$ 6,240,000	$ 3,360,000	$ 9,600,000
Monitoring (65%Fed-35%NFS)	$ 547,300	$ 294,700	$ 842,000
Total Construction	**$ 66,865,500**	**$ 36,004,500**	**$ 102,870,000**
TOTAL COST	**$ 69,565,500**	**$ 38,704,500**	**$ 108,270,000**
Cash Contribution	*$ 69,565,500*	*$ 31,790,500*	

In addition to these specific construction items, details of additional ecosystem restoration features would be developed during a study phase for purposes of estimating costs and benefits and for selecting the best set of projects to attain the ecosystem restoration goals for the area. This study effort would be conducted under the modification of the existing structures portion of the LCA proposed authorization. Under this approach, the MRGO channel is considered a structure for purposes of evaluating potential modifications to improve the environment.

Under this plan, large amounts of estuarine marshes would be protected from further shoreline erosion and other areas would be improved for the long-term benefit of the environment. In addition, other restoration features will be investigated that produce environmental benefits following the sequence established in the Coast 2050 plan to preserve wetlands and maintain the estuarine gradients established by the surrounding marshes. These habitats are significant for commercial and recreational fisheries as well as wildlife, and these areas serve as critical habitat for the threatened Gulf sturgeon.

The most important area of uncertainty associated with the near-term proposal is the future of the MRGO navigation channel as a deep draft-shipping route. A study is currently underway to reevaluate the economic benefits to the Nation of maintaining the channel. The scope of the reevaluation study covers a number of different alternative depth modifications and implementation timeframes for channel authorization changes. The outcome of that study has not been determined and, thus, the future status of the channel is unknown at this time. The possibility exists that some time in the future the status of the channel could be changed through a USACE study recommendation and a Congressional action to deauthorize the shipping canal. However, while some of the ecosystem losses occurring in the area are directly associated with the operation of the navigation channel, the need for shoreline protection on Lake Borgne and the channel will remain regardless of the future status of the channel. The need will remain because the background factors in Louisiana wetland losses will continue and some shallow draft navigation will likely continue to use the area waterways.

4.2.3.2.2 *Small diversion at Hope Canal*

The cypress-tupelo swamps south of Lake Maurepas represent an accumulation of decades of plant production and associated ecological complexity. Much (arguably, relatively more than even most other coastal ecosystems in Louisiana) will be lost if this ecosystem is degraded beyond the ability to restore it. Given the temporal considerations associated with replacing long-lived tree species, preventing the loss of such trees is preferable from both economic and ecological standpoints.

The ongoing degradation of the Maurepas Swamp can be attributed to two types of factors: the first being the relatively constant stress associated with the lack of riverine input and prolonged inundation, and the second being the effects of stochastic events, most notably increased salinities. A qualitative estimate of the ecosystem losses that could be prevented by contingent authorization must consider both types of these factors.

The ongoing, constant deterioration of the Maurepas Swamp results in reduced tree productivity and health, increased tree mortality, decreased soil integrity, and increased relative subsidence. At this same time, stochastic events (particularly salinity increases) have the potential to dramatically increase tree mortality, while further stressing the remaining trees. Delaying project implementation would result in a continuation of the constant ecosystem decline, while also exposing the existing ecosystem to the additional risks associated with increased salinities and other difficult to predict events. Therefore, under any scenario, expediting implementation of the Hope Canal project would prevent a range of potential adverse effects. Again, because the higher end of this range would represent unpredictable events, it would not be possible to accurately predict the full possible extent of such losses.

The potential adverse effects discussed above would include decreased habitat for important avian species (most notably the bald eagle) and could also adversely affect the populations of a variety of indigenous species, such as crawfish, alligator snapping turtles, blue crab, and channel catfish. Additionally, such losses would also contribute to an overall decline in swamp health, as measured by soil integrity, substrate elevation, and vegetative health and resilience.

The effectiveness of the Hope Canal project depends in large part upon enhancing the health and productivity of the existing trees, which would play a major role in restoring soil integrity and counteracting subsidence. As discussed above, delaying action on the Hope Canal project would result in increased tree mortality and decreased health in the remaining trees. It is very difficult to quantify the number of individual trees that would die or become severely stressed, but it is certain that the system as a whole will suffer without action. A delay would, therefore, most likely reduce the effectiveness of this restoration effort and/or require increased restoration inputs to achieve the same level of benefits.

Contingent authorization of the Hope Canal project is an appropriate and necessary way to meet the critical needs discussed above. Specifically, expediting the authorization process for this project has the potential to reduce tree mortality and decline in the overall health of the swamp; minimize exposure to stochastic risks, particularly increased salinities; reduce potential impacts to populations of indigenous fish and wildlife species; and minimize restoration costs and maintain restoration effectiveness.

The specific features proposed as part of the near-term Hope Canal Reintroduction plan include:

- Construct 2 10-foot x 10-foot box culverts in the Mississippi River levee with the invert set at an elevation to assure capability of essentially year-round water diversion.

- Build a receiving pond/settling basin with 100-foot x 100-foot dimensions, reinforced with 20 inches of riprap at the outfall of the culverts to slow velocities and remove heavy sand.

- Excavate a new leveed channel from the existing southern terminus of Hope Canal to the proposed reintroduction structure in the Mississippi River levee.

- Enlarge the cross section of Hope Canal to a width of 50 feet to accommodate the reintroduced river water. This channel would be a total of 27,500 feet long and run from the river to I-10.

- Implement outfall management measures to insure the water gets into the swamp.

- Install navigable constrictions in Hope Canal and gap an abandoned railroad embankment along Hope Canal north of I-10.

The Hope Canal project would restore approximately 36,000 acres of swamp. The estimated cost for designing and constructing the Hope Canal Reintroduction feature is $70.513 million (including monitoring). Details of this cost estimate are provided in the following tables:

Table MR 4-9 Summary of Costs for the Small Diversion at Hope Canal (June 2004 Price Level)

Lands and Damages	$	26,383,000
Elements:		
Relocations	$	22,384,000
Channels and Canals	$	4,125,000
Diversion Structures	$	6,520,000
Monitoring	$	594,000
First Cost	$	60,006,000
Feasibility-Level Decision Document	$	3,568,000
Preconstruction Engineering and Design (PED)	$	2,182,000
Engineering and Design (E&D)	$	1,189,000
Supervision and Administration (S&A)	$	3,568,000
Total Cost	**$**	**70,513,000**

Table MR 4-10 Small Diversion at Hope Canal FEDERAL AND NON-FEDERAL COST BREAKDOWN (June 2004 Price Level)

Item	Federal	Non-Federal	Total
Decision Document (50%Fed-50%NFS)	$ 1,784,000	$ 1,784,000	$ 3,568,000
PED (65%Fed-35%NFS)	$ 2,182,000	$ -	$ 2,182,000
LERR&D (100% NFS)*	$ -	$ 48,767,000	$ 48,767,000
Ecosystem Restoration (65%Fed-35%NFS)	$ 10,645,000	$ (25,336,250)	$ 10,645,000
Engineering and Design (E&D) (65%Fed-35%NFS)	$ 1,189,000	$ -	$ 1,189,000
Supervision and Administration (S&A) (65%Fed-35%NFS)	$ 3,568,000	$ -	$ 3,568,000
Monitoring (65%Fed-35%NFS)	$ 594,000	$ -	$ 594,000
Total Construction	**$ 18,178,000**	**$ 23,430,750**	**$ 66,945,000**
TOTAL COST	**$ 19,962,000**	**$ 25,214,750**	**$ 70,513,000**
Cash Contribution	*$ 47,082,250*	*$ (25,336,250)*	

*For the conditionally authorized feature, Small Diversion at Hope Canal, LERR&D exceeded 35% of the total project cost by $25,336,250, which is reimbursed to the non-federal sponsor.

To preserve swamps in the long-term, conditions must be reestablished that both allow survival of existing cypress and tupelo trees and allow at least periodic reproduction and recruitment of seedlings. In the Maurepas Swamp, non-stagnant water, accretion, and freshening are all needed to achieve these goals. From the perspective of sustainable ecosystem management, it is believed that implementation of a reintroduction project of appropriate size into the Maurepas Swamp is essential for bringing the area back toward environmental sustainability. Implementation of the proposed reintroduction would greatly increase flow through the project area, which would provide constant renewal of oxygen- and nutrient-rich waters to the swamps. (It is important to note that the proposed alternative would be operated such that reintroductions are reduced or stopped when climate and soil conditions are conducive to tree regeneration).

Benefits of the Hope Canal project would include measurable increases in productivity, which would help build swamp substrate and balance subsidence, as well as increases in growth of trees, reduced mortality, and an increase in soil bulk density. As accretion improves, there also is expected to be an increase in recruitment of new cypress and tupelo trees, required for long-term sustainability of the swamp. Anticipated sediment benefits to the swamp include direct contribution to accretion, as well as contribution to biological productivity through the introduction of sediment-associated nutrients, which also contributes to production of substrate. The sediment loading to the target swamps from the Hope Canal reintroduction is conservatively estimated to be >1,000 $g/m^2/yr$, or about twice the estimated quantity needed to keep up with subsidence.

The Hope Canal project has already been the subject of interagency review, numerous planning processes, considerable public review, and a range of environmental and engineering analyses. This review process has helped identify and address a number of potential questions/concerns, such as whether river reintroduction could cause flooding. While more information and evaluation will be needed to fully answer such questions, the information available to date indicates that such issues will either not occur or, if they could occur, are manageable and do not render the project infeasible or too risky. With respect to flooding in particular, the increased channel capacity in Hope Canal should provide greater ability to remove storm water from the existing drainage system, and the operation plan for the reintroduction project would be developed to accommodate such a use.

The Hope Canal project would offer an excellent opportunity to capitalize on existing environmental and engineering information to provide near-term environmental benefits to an area of critical need. Accordingly, it should be included in the contingent authorization category for the LCA Study.

4.2.3.2.3 *Barataria Basin barrier shoreline restoration*

The Louisiana barrier islands and shorelines are almost entirely uninhabited but are an essential ecosystem to the Louisiana coastal area since they include wetland habitats, essential fish habitat, and have high fish and wildlife value. The Louisiana barrier islands also protect interior coastal wetlands, which also have high fish and wildlife value within the Louisiana coast area.

The accelerated loss of Louisiana's coastal wetlands has been ongoing since at least the early 1900s with commensurate deleterious effects on the ecosystem and possible future negative impacts to the economy of the region and the Nation (USACE 2004 – Main Report). Contributing to these deleterious effects is the collapse of the Louisiana barrier islands and gulf coast shorelines. This Louisiana coastal area restoration feature is to restore or re-build the natural ecological function of the two coastal barrier shorelines, known as the Caminada Headland and Shell Island reaches.

The average rate of long-term (greater than 100 years) shoreline change along the Louisiana coast is a retreat of 19.9 ft/yr. The average short-term (less than 30 years) rate of shoreline change is a retreat of 30.9 ft/yr (USACE 2004 – Appendix D.3). Of the 505 miles of Louisiana gulf shoreline, 484 miles (96 percent) are eroding. The Barataria Basin Barrier Shoreline Restoration Project is one of three barrier island projects in the LCA Plan. All three of these barrier island projects are important; however, the Barataria Barrier Shoreline Restoration is considered critical due to the greatly degraded state of this shoreline and its key role in protecting and preserving larger inland wetland areas and bays. If this fragile area is not addressed quickly, restoration would be far more difficult and costly.

The Barataria Basin Barrier Island Restoration feature addresses critical ecological needs and would sustain essential geomorphic features for the protection of Louisiana's coastal wetlands and coastal infrastructure. The project is synergistic with future restoration by maintaining or restoring the integrity of Louisiana's coastline, upon which all future coastal restoration is dependent. The design and operation of the feature would maintain the opportunity for and support the development of large-scale, long-range comprehensive coastal restoration. The feature would also support the opportunity for resolution of scientific and technical uncertainties through incorporation of demonstration features and/or adaptive management.

The specific features proposed as part of the near-term Barataria Basin Barrier Island Restoration plan include:

<u>Caminada Headland</u>

- Dredge and place 9 to 10 million cubic yards of sand from Ship Shoal along 13 miles of shoreline to create a dune approximately 6 feet high and a 1,000-foot-wide shoreward berm. Plant the dune with native varieties of bitter panicum and sea oats for stabilization.
- Remove thirteen existing breakwaters that are failing.
- Approximately 2 million cubic yards of sand would be placed about every 10 years to periodically restore the dune and berm.
- Dredge and place about 6 million cubic yards of material to create a marsh area about 5 miles long and up to 1,200 feet wide. The created marsh would be planted with native vegetation, such as smooth cordgrass.
- Nourish existing eroding marsh in the area with a thin layer of dredged material.

Shell Island (west)

- Dredge and place 3.4 million cubic yards of material to create 139 acres of dune and berm and 74 acres of marsh.
- Plant the dune with native varieties of bitter panicum and sea oats for stabilization.
- Plant the marsh with smooth cordgrass, also a native variety.

Shell Island (east)

- Dredge and place 6.6 million cubic yards of material to create 223 acres of dune and berm and 191 acres of marsh. Contain material with geotubes on the gulf side and earthen dike on the bay side.
- Plant the dune with native varieties of bitter panicum and sea oats for stabilization.
- Plant the marsh with smooth cordgrass, also a native variety.

The Caminada Headland component would preserve 640 acres of dune and berm over the next 50 years and 1,780 acres of saline marsh. The Shell Island component would preserve 147 acres of barrier island habitat over the next 50 years. The estimated cost for designing and constructing these barrier shoreline restoration features is $247.204 million (including monitoring). Details of this cost estimate are provided in the following tables:

Table MR 4-11 Summary of Costs for
Barataria Basin Barrier Shoreline Restoration
(June 2004 Price Level)

Lands and Damages	$	15,558,000
Elements:		
Beach Replenishment	$	181,000,000
Monitoring	$	1,966,000
First Cost	$	198,524,000
Feasibility-Level Decision Document	$	10,200,000
Preconstruction Engineering and Design (PED)	$	6,800,000
Engineering and Design (E&D)	$	9,960,000
Supervision and Administration (S&A)	$	21,720,000
Total Cost	**$**	**247,204,000**

Table MR 4-12 Barataria Basin Barrier Shoreline Restoration
FEDERAL AND NON-FEDERAL COST BREAKDOWN
(June 2004 Price Level)

Item	Federal	Non-Federal	Total
Decision Document (50%Fed-50%NFS)	$ 5,100,000	$ 5,100,000	$ 10,200,000
PED (65%Fed-35%NFS)	$ 4,420,000	$ 2,380,000	$ 6,800,000
LERR&D (100% NFS)	$ -	$ 15,558,000	$ 15,558,000
Ecosystem Restoration (65%Fed-35%NFS)	$ 127,762,700	$ 53,237,300	$ 181,000,000
Engineering and Design (E&D) (65%Fed-35%NFS)	$ 6,474,000	$ 3,486,000	$ 9,960,000
Supervision and Administration (S&A) (65%Fed-35%NFS)	$ 14,118,000	$ 7,602,000	$ 21,720,000
Monitoring (65%Fed-35%NFS)	$ 1,277,900	$ 688,100	$ 1,966,000
Total Construction	**$ 154,052,600**	**$ 82,951,400**	**$ 237,004,000**
TOTAL COST	**$ 159,152,600**	**$ 88,051,400**	**$ 247,204,000**
Cash Contribution	*$ 159,152,600*	*$ 67,393,400*	

The Caminada Headland component of the Barataria Basin Barrier Shoreline Restoration should be constructed at the earliest possible date and include ecosystem restoration of the dune and berm as well as marsh creation. The overall goal of this feature is to maintain this headland reach, which would sustain significant and unique coastal habitats, help preserve endangered and threatened species, continue to transport sand to Grand Isle, and protect Port Fourchon and the only hurricane evacuation route available to the region.

The Shell Island component of the Barataria Basin Barrier Shoreline Restoration should be constructed at the earliest possible date and include beach restoration by use of containment to rebuild a vital link in the Louisiana barrier shoreline system. The overall goal is to prevent the intrusion of the Gulf of Mexico into the interior bays and marshes, which threatens fisheries and the regional ecology. The project would also help restore natural sand transport along this reach of the coast supporting the adjacent regional shorelines and various shoreline habitats. Numerous infrastructure elements such as highways, levees, ports, and oil and gas facilities located along the rim of the inland bays would incidentally benefit from this ecologic restoration.

The coastal resources at risk for the Barataria Basin Barrier Shoreline Restoration feature and the level of investigation in this area undertaken to date provides a high level of certainty in the appropriateness of the restoration feature and the range of alternative configurations that should be addressed in a final decision document. This project must be undertaken with a strong adaptive management approach due to the uncertainties of coastal processes and response to restoration. Monitoring- based project management would largely offset technical uncertainties. The current status of analyses and NEPA documentation also provides a high degree of confidence that the design and documentation for this restoration feature can be completed for approval and implementation on an expedited schedule.

4.2.3.2.4 *Small Bayou Lafourche reintroduction*

Bayou Lafourche occupies a central location in Louisiana's Deltaic Plain, between Terrebonne and Barataria Bays. This valuable estuarine complex is also Louisiana's most endangered, due in large part to the disruption of natural deltaic processes. Once a major distributary of the Mississippi River, Bayou Lafourche was a critical conduit for freshwater, nutrients, and sediment, which helped build and nourish marshes in the Barataria-Terrebonne estuary complex. Although flows down Bayou Lafourche declined as the river switched its course 800 to 1,000 years ago, the bayou continued to provide important riverine inputs until it was dammed in 1904 to alleviate flooding problems. While a limited amount of river flow (currently around 200 cfs) was subsequently restored to the bayou, there is an opportunity to use this natural distributary to increase freshwater, nutrient, and sediment inputs to coastal areas with critical restoration needs.

Approximately 2,000 years ago, the course of the Mississippi River began to occupy what is now Bayou Lafourche. This channel remained a primary distributary of the Mississippi River until about 800 to 1,000 years ago, when it was gradually replaced by the modern course of the river. While it was active, the Bayou Lafourche distributary built a large natural levee, with elevation ranging from over 20 feet NGVD near Donaldsonville, to approximately 1 foot near the mouth of the bayou.

In 1851 and 1858, discharge in Bayou Lafourche was measured at 6,000 to 11,000 cfs during high river stages. Thus, despite the shift in the river, Bayou Lafourche remained a major conduit by which freshwater, nutrients, and sediment were transported to coastal wetlands. During this time, the bayou was also extensively used for navigation.

Flows continued to decrease during the 19^{th} century and, by 1887, a bar had developed at the head of the bayou, which restricted flow and navigation. This led to annual dredging by the USACE. Additionally, the natural levee along the bayou was not sufficient to protect settled areas from flooding, and plantation owners gradually built up levees along most of the length of the bayou. Despite these levees, flood problems along Bayou Lafourche began to overshadow the usefulness of the channel for navigation. In 1902, Federal approval was given to construct a temporary dam across the head of the bayou. The dam was completed in 1904. The intent was to replace this dam with a lock, to allow for navigation. However, the dam was subsequently replaced by the Mississippi River flood control levee.

In 1906, a new problem arose: salt-water intrusion was recorded at Bush Grove Plantation just south of Lafourche Crossing. Agricultural, industrial, and domestic users recognized that fresh water would be necessary for their communities to continue to thrive. Also, damming the bayou contributed to dramatic salinity increases in the Barataria-Terrebonne estuary system. Anecdotal information gives evidence of the dramatic changes that resulted from the increased salinities. By 1910, for example, oysters were found growing in areas around

Leeville, and where orange orchards and rice fields had once flourished, saltwater seeped into the land, killing the oak groves and making the soil unsuitable for farming.

Responding to expanding industrial and residential demands, the Louisiana Legislature created the Bayou Lafourche Freshwater District in the 1950s. In 1955, a pump/siphon system with a capacity to reintroduce approximately 340 cfs was installed on the levee at Donaldsonville. No Federal funds were spent on that project. Because of channel constraints, this existing pump/siphon currently provides approximately 200 cfs of river water into the bayou. Approximately 80 percent of the current volume of water reintroduced to the bayou flows through the system, with approximately 20 percent being used for water supply (of which a relatively small amount is used for irrigation).

Today the bayou supplies fresh water to over 300,000 residents in four parishes: Ascension, Assumption, Lafourche and Terrebonne. In addition to residents and land-based businesses, Bayou Lafourche also provides potable water through Port Fourchon to offshore oil and gas facilities in the Gulf of Mexico. The bayou also provides aesthetic, recreation, drainage and navigation benefits to the numerous communities that have developed along its banks.

From 2000 to 2050, this estuary complex is predicted to lose approximately 231,000 acres of wetlands. This is 50 percent of the predicted loss in the entire state. In addition, approximately 465,000 acres have been lost in this complex over the past 50 years. The continued loss will further weaken an already stressed ecosystem that supports a wide range of resident and migratory animals. The highly diverse and numerous fish and shellfish populations in the complex would dramatically decline as land loss continues. In the future, there would be decreased habitat for neo-tropical migratory birds, furbearers, waterfowl, and threatened species such as the bald eagle.

Proposals to reconnect Bayou Lafourche as a restoration feature date back to at least 1992. At that time, coastal researchers from Louisiana State University's Center for Coastal Energy and Environmental Resources (CCEER; Currently LSU School of the Coast and the Environment) crafted a report that included reconnection of the former distributary as an innovative alternative to help address the land loss crisis in the Louisiana coastal zone. In the November 1993 Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) Main Report and Environmental Impact Statement (EIS) submitted to the U.S. Congress by the Task Force, reintroduction of Mississippi River water via Bayou Lafourche was listed as a major strategy for both the Terrebonne and Barataria basins.

The specific features proposed as part of the near-term Bayou Lafourche Reintroduction plan include:

- Upgrading existing pump/siphon facility to operate at the full 340 cfs capacity and constructing a 660 cfs new pump/siphon facility.

- Improving channel capacity to 1,000 cfs by eliminating the existing fixed weir at Thibodeaux, dredging of 6.7 million cubic yards of material over about 55 miles of the channel within its existing banks. If the dredged sediments are clean, they will be made available for local use and land application or sale. Any contaminated sediment will require special placement.

- Providing bank stability over three miles of the channel. The improved channel and bank stabilization would prevent flooding of bayou-side residents.

- Operating five monitoring stations to provide continuous information on water levels and other bayou conditions.

- Installing two adjustable weirs, one at Thibodeaux and another at Donaldsonville, to control water levels as necessary to eliminate current causes of bank instability, and to facilitate passage of storm runoff.

- Constructing a sediment trap at Donaldsonville to control siltation of the main channel and insure that flows are not impeded. This trap would be cleaned as needed.

As part of the CWPPRA process, the wetland benefits of the Bayou Lafourche project, with regard to providing habitat for a variety of fish and wildlife species, were calculated using Wetland Value Assessment (WVA) methodology. The benefit areas encompass 85,094 acres (nearly 49,000 acres of wetlands and 36,000 acres of water). Wetland benefits were determined primarily in terms of the projected reduction in marsh loss expected to occur as a result of the project. The mechanisms through which the diversion was expected to impact marsh loss in the seven areas were: (1) the reduction of salinity stress due to increased freshwater flows, and (2) the stimulation of organic production in emergent marshes as a result of the introduction of clay sediment and nutrients. Based on the 1998 WVA, it is estimated that at the end of 50 years there would be approximately 2,500 more acres of marsh than if the project had not been built. The WVA also credited this project with increasing submerged aquatic vegetation (SAV) that improves habitat for fish and waterfowl.

The estimated cost for designing and constructing the Bayou Lafourche Reintroduction is $144.116 million (including monitoring). Details of this cost estimate are provided in the following tables:

Table MR 4-13 Summary of Costs for Small Bayou Lafourche Reintroduction (June 2004 Price Level)

Lands and Damages	$	12,590,000
Elements:		
Relocations	$	14,720,000
Channels and Canals	$	52,156,000
Pumping Plants	$	16,230,000
Bank Stabilization	$	6,894,000
Monitoring	$	1,026,000
First Cost	$	103,616,000
Feasibility-Level Decision Document	$	13,500,000
Preconstruction Engineering and Design (PED)	$	9,000,000
Engineering and Design (E&D)	$	5,040,000
Supervision and Administration (S&A)	$	12,960,000
Total Cost	**$**	**144,116,000**

Table MR 4-14 Small Bayou Lafourche reintroduction
FEDERAL AND NON-FEDERAL COST BREAKDOWN
(June 2004 Price Level)

Item	Federal	Non-Federal	Total
Decision Document (50%Fed-50%NFS)	$ 6,750,000	$ 6,750,000	$ 13,500,000
PED (65%Fed-35%NFS)	$ 5,850,000	$ 3,150,000	$ 9,000,000
LERR&D (100% NFS)	$ -	$ 27,310,000	$ 27,310,000
Ecosystem Restoration (65%Fed-35%NFS)	$ 66,683,500	$ 8,596,500	$ 75,280,000
Engineering and Design (E&D) (65%Fed-35%NFS)	$ 3,276,000	$ 1,764,000	$ 5,040,000
Supervision and Administration (S&A) (65%Fed-35%NFS)	$ 8,424,000	$ 4,536,000	$ 12,960,000
Monitoring (65%Fed-35%NFS)	$ 666,900	$ 359,100	$ 1,026,000
Total Construction	**$ 84,900,400**	**$ 45,715,600**	**$ 130,616,000**
TOTAL COST	**$ 91,650,400**	**$ 52,465,600**	**$ 144,116,000**
Cash Contribution	*$ 91,650,400*	*$ 18,405,600*	

The wetlands being lost in the Barataria-Terrebonne estuary complex are of vast ecological importance. It has been estimated that nearly one fifth of the Nation's estuarine-dependent fisheries rely on the diverse habitats of Barataria-Terrebonne. Annual commercial fisheries landings have been estimated at more than $220 million, including oysters, shrimp, crabs, and various finfish. The wetlands and other habitats of the Barataria-Terrebonne estuary complex are also important for a wide range of resident and migratory birds. It is estimated that 353 species of birds are known to have occurred in Barataria-Terrebonne, of which 185 species are annual returning migrants. In total, approximately 735 species of birds, finfish, shellfish, reptiles, amphibians, and mammals spend all or part of their life cycle in the estuary.

By increasing the connection of the river to the bayou, the Bayou Lafourche project would nourish marshes, contribute to soil building through mineral sediment accretion and organic matter production, and combat saltwater intrusion during droughts or prolonged southerly winds. The associated increased vegetative health and vertical accumulation of the marsh surface would counterbalance subsidence and reduce future wetland loss in the area.

Although the WVA many attributes of estuaries that fish and wildlife rely upon, there would be unquantifiable benefits over the 49,000 acres of wetlands and 36,000 acres of estuarine waters, especially with a project such as this that is synergistic with other projects. It is possible that the acres preserved are underestimated. There would be benefits to threatened species such as the bald eagle and higher quality Essential Fish Habitat would be preserved. Waterfowl habitat would be improved.

Having undergone years of interagency and public review, the Bayou Lafourche project is well suited for conditional authorization within the LCA Plan. Since being selected by the CWPPRA Task Force in 1996, the Bayou Lafourche project has undergone considerable environmental and engineering review, including hydraulic modeling and environmental benefits assessment. Most recently, engineering and design and the National Environmental Policy Act process have been initiated as part of the ongoing CWPPRA process. The existing information provides greater certainty with respect to costs and environmental outcomes, and will help expedite completion of both the feasibility study and EIS.

4.2.3.2.5 *Medium diversion with dedicated dredging at Myrtle Grove*

Approximately 1,000 years ago, the Plaquemines Delta began to deposit sediment in the Myrtle Grove study area. Shallow water areas were filled with interdistributary and marsh deposits. The Mississippi River has been in its present location for the past 1,000 years, and the study area continued to receive fresh water and sediment from the Mississippi River and its distributaries.

With the development of the Mississippi River levee system over the last century, once frequent introductions of sediment and nutrients were disrupted. These introductions helped the area accrete sediment and detritus, and the marshes kept pace with subsidence. Another major factor was the dredging of oil and gas and navigation canals that allowed salt water to encroach far inland, resulting in a shift from intermediate marshes to slower-growing brackish marshes. The high subsidence rate combined with these factors resulted in a rapid degradation of the marshes in the area.

The project area is currently a sediment-starved system with little freshwater input. These factors have magnified the high subsidence in the area, resulting in massive land loss. To counteract this loss, the project area needs inputs of both sediment and water. The Davis Pond diversion provides freshwater input into the basin to the north, but local marshes are too far removed from the diversion structure to benefit directly from the introduction of nutrients, and the salinity regime would be more controllable with a freshwater input closer to the area of need.

The Medium Diversion with Dedicated Dredging at Myrtle Grove critical near-term feature addresses both the need to preserve long-term restoration opportunities and to bring significant reversal of the wetland loss trend. In preserving long-range restoration opportunities, implementation of this feature also supports several possible outcomes of proposed large-scale studies. The immediate restoration impact of the implementation of the Myrtle Grove feature is significant in addressing predicted future wetland loss in an ecologically critical zone of habitat transition in one of the most productive estuaries in the Nation. In addition, commercial and private development at the perimeter of this basin, located to take advantage of its productivity and to support local, regional, and National economic interests, would receive benefits from the restoration of these wetlands. These benefits would include continued sustainable biologic productivity in the estuary as well as the indirect benefit of reduction of storm-driven tidal stages.

The key components of the proposed feature include:

- A gated diversion structure with a capacity of approximately 5,000 cfs
- Inflow and outflow channels totaling approximately 16,000 feet
- Associated channel guide levees and infrastructure relocation
- Creating at least 6,500 acres of new marsh through dedicated dredging

This project is predicted to create/preserve 6,563 acres over the next 50 years. The estimated cost for designing and constructing the Myrtle Grove Diversion and Dedicated Dredging feature is $293.962 million (including monitoring). Details of this cost estimate are provided in the following tables:

Table MR 4-15 Summary of Costs for the Medium Diversion with Dedicated Dredging at Myrtle Grove (June 2004 Price Level)

Lands and Damages	$	78,990,000
Elements:		
Relocations	$	3,780,000
Ecosystem Restoration	$	96,970,000
Channels and Canals	$	24,150,000
Diversion Structures	$	21,800,000
First Cost	$	225,690,000
Feasibility-Level Decision Document	$	22,005,000
Preconstruction Engineering and Design (PED)	$	14,670,000
Engineering and Design (E&D)	$	8,215,000
Supervision and Administration (S&A)	$	21,125,000
Monitoring	$	2,257,000
Total Cost	**$**	**293,962,000**

Table MR 4-16 Medium Diversion with Dedicated Dredging at Myrtle Grove
FEDERAL AND NON-FEDERAL COST BREAKDOWN
(June 2004 Price Level)

Item	Federal	Non-Federal	Total
Decision Document (50%Fed-50%NFS)	$ 11,002,500	$ 11,002,500	$ 22,005,000
PED (65%Fed-35%NFS)	$ 9,535,500	$ 5,134,500	$ 14,670,000
LERR&D (100% NFS)	$ -	$ 82,770,000	$ 82,770,000
Ecosystem Restoration (65%Fed-35%NFS)	$ 142,920,000	$ -	$ 142,920,000
Engineering and Design (E&D) (65%Fed-35%NFS)	$ 6,339,750	$ 1,875,250	$ 8,215,000
Supervision and Administration (S&A) (65%Fed-35%NFS)	$ 16,509,750	$ 4,615,250	$ 21,125,000
Monitoring (65%Fed-35%NFS)	$ 1,467,050	$ 789,950	$ 2,257,000
Total Construction	**$ 176,772,050**	**$ 95,184,950**	**$ 271,957,000**
TOTAL COST	**$ 187,774,550**	**$ 106,187,450**	**$ 293,962,000**
Cash Contribution	*$ 187,774,550*	*$ 12,414,950*	

Currently authorized Federal environmental projects (in this specific case, the Davis Pond Freshwater Diversion project) have been designed to sustain and stabilize the present basin wide salinity regime. This outcome falls short of the broader restoration objectives, but existing projects can and will be incorporated or modified in the implementation of this and other future restoration efforts. In this manner, the proposed restoration feature would also support adaptive management and learning goals and provide a platform for additional learning through add-on demonstration projects.

The proposed restoration feature considers a diversion ranging from 2,500 to 15,000 cfs coupled with dedicated dredging for the creation of up to 19,700 acres of new wetlands. This combination would allow for rapid creation of wetland acreage and long-term sustainability. The diversion will allow the reintroduction of freshwater, sediment, and nutrients into the critically effected area of the basin in a manner similar to the rise and fall of the river's hydrologic cycle. The rate of reintroduction would be optimized according to the overall planning objectives of the LCA restoration effort to maintain hydro-geomorphic diversity and connectivity, as well as habitat diversity. The dedicated dredging component of the Myrtle Grove feature would allow immediate recovery of former wetland areas already converted to open water. The combination is also expected to maximize the amount of acreage created per yard of sediment placed by capitalizing on incremental accretion of diverted sediment.

A diversion from the Mississippi River would provide both resources, and would provide a relatively cost-effective way to recreate land in the project area. Nevertheless, the land accretion process is slow, and an introduction of material through dedicated dredging would provide for a marsh platform immediately. To balance the need for wetland acreage in the near-term with the ability to sustain the marshes over the long-term, various combinations of marsh creation through dedicated dredging and freshwater introductions through a river diversion would be examined.

The proposed restoration feature has the potential to prevent significant future land loss where currently predicted to occur in the central portion of the Barataria Basin. Ecologic modeling indicates that, in the next 50 years, all saline and brackish marsh and approximately 40 percent of the intermediate marsh in the Barataria Basin will be lost. This can be attributed to lack of sediment input, and continued soil subsidence. In addition to directly resulting in wetland loss, these factors are compounded by the low success of saline vegetation reestablishing on the highly organic soils established in fresh marshes. These combined factors, along with the projected hydraulic and ecologic trends in, and current make up of the area in the vicinity of Myrtle Grove, indicates that it is at particularly high risk.

The restoration of wetlands in this area would also protect and support socio-economic interests located in the central and upper portions of the Barataria Basin to capitalize on the fisheries productivity of the estuary. The communities of Lafitte and Barataria represent the southernmost development in the interior of the Barataria Basin and are located outside of any existing hurricane protection works. Loss of the existing wetland structure would have an immediate impact on the sustainability of these communities. In addition, industries located along the Mississippi River in the vicinity of Myrtle Grove would also become threatened with the loss of interior wetlands in this area. Currently, there is no Federal hurricane protection levee parallel to the river in this area. The absence of this protection is due, in part, to the historic presence of the wetlands.

The Medium Diversion with Dedicated Dredging at Myrtle Grove restoration feature addresses critical ecological needs in a sensitive area of the most highly productive estuarine systems in the Nation. The components of the feature create a synergy that would result in highly productive and sustainable outputs. The design and operation of the feature would maintain the opportunity for and support the development of large-scale, long-range comprehensive coastal restoration. The feature would also support opportunity for resolution of scientific and technical uncertainties through incorporation of demonstration projects and/or adaptive management.

4.2.3.3 Future Congressional Authorization for implementation of critical restoration features

The near term critical restoration features within the LCA Plan that are not conditionally authorized would be submitted to Congress for consideration of authorization in future WRDAs. Based on an analysis of the current LCA Plan schedule, components would have feasibility-level decision documents or Feasibility Reports completed and ready to submit to Congress through FY 2013, with construction starting no later than FY 2014.

4.2.4 Large-Scale and Long-Term Concepts Requiring Detailed Study

During plan formulation, the PDT identified several candidate large-scale and long-term concepts for potential incorporation into the LCA Plan. These restoration concepts exhibited a greater potential to contribute to achieving restoration objectives in 1) the subprovince within which they would be located, 2) adjacent subprovince(s), and/or 3) substantial portions of Louisiana's coastal ecosystem. Accordingly, the corresponding benefits and costs for these potential plan features should be further analyzed and confirmed to determine how best to incorporate them, if at all, with other plan features. Upon completion of detailed feasibility studies, recommendations for action would be documented in the manner specified for features that would be proposed for Congressional authorization, and would be subject to the standard review and authorization process for USACE water resources projects. Short descriptions of the large-scale, long-term concepts are included below.

4.2.4.1 Acadiana Bays Estuarine Restoration Study

The primary goal of this study is to evaluate the potential for reestablishing historic water quality conditions and viable estuarine fisheries in the Acadiana Bays system while maintaining a growing delta system in Atchafalaya Bay. The Acadiana Bays area of Louisiana consists of those bays in the central part of coastal Louisiana including from east to west, Four League, Atchafalaya, East Cote Blanche, West Cote Blanche, Weeks, and Vermilion Bays (**figure MR 4-3**).

During the last half of the 20th century, this estuary has experienced a freshening trend and increased turbidity. As a result, submerged aquatic vegetation densities and the viability of estuarine fisheries have declined. Several factors have led to these problems. In 1900, the Atchafalaya Basin received about 5 percent of the total of the Red River and Mississippi Rivers. By the 1950s, the Atchafalaya share had grown to 30 percent and has remained at that distribution with the construction of the Old River Control Structures in the early 1960s. Even though the flow distribution down the Atchafalaya has been stabilized, the basin has experienced significant changes in the twentieth century, resulting in greater efficiency to convey water and sediment to the estuary. Also, at one time, the bay complex reportedly contained the largest concentration of oyster reefs in the United States. The remnant reefs had limited wave action and storm impacts in the Acadiana Bays by providing a physical barrier to exchange; however these were largely destroyed by shell dredging prior to the mid-1980s. Removing this reef complex eliminated natural baffles between the Gulf of Mexico and Atchafalaya Bay, as well as Atchafalaya and West Cote Blanche Bays.

Figure MR 4-3: The Acadiana Bays, Louisiana.

The State of Louisiana has conducted initial engineering studies for restoration of the Acadiana Bays estuary. The large-scale study would expand on this effort by improving existing hydrodynamic models, using existing and new data to evaluate the salinity and turbidity levels in the Acadiana Bays system and ultimately determining the best course of action for restoration and maintenance of this estuarine system.

Several potential alternatives that have been proposed including construction of a rock jetty or a series of staggered reefs from Pt. Chevreuil to Marsh Island to impede the western flow of fresh water and sediment from Atchafalaya Bay, and shoreline stabilization and/or gap closures on the GIWW and the eastern shoreline of Freshwater Bayou Canal to minimize freshwater flow into the Acadiana Bays system.

The Acadiana Bays Estuarine Restoration Study would ultimately aid in defining the restoration plans of this ecologically important region of coastal Louisiana. This study has an anticipated start date of FY06 and an anticipated finish date of FY09, with an approximate cost of $7,110,000.

4.2.4.2 Upper Atchafalaya Basin Study

The study purpose is to conduct a system-wide comprehensive analysis of the problems and opportunities related to flood control, navigation, and ecosystem sustainability for the lower Red River, Old River, Mississippi River, and Atchafalaya River Basins.

This study relates primarily to the Mississippi River and Tributaries Project and, as such, would be funded under that project. It is discussed in this report because it would link closely with the Mississippi River Hydrodynamic Study (via the modeling to be developed) and because several proposed LCA features would either impact the operation of the ORCS and/or effect changes to the Atchafalaya Basin, the Mississippi River, and the coastal zone. As such, any potential LCA alternatives would have to assess the potential impacts to the existing river systems.

The primary objectives of the study are to:

1. Determine whether improvements are necessary to sustain the MR&T project's ability to pass project flow, maintain an efficient and safe navigation system, and maintain channel and bank stability.

2. Investigate the degradation of the Atchafalaya Basin and its ecosystem and develop solutions to stabilize and restore the system.

3. Investigate the sediment distribution needs and capabilities of the ORCS and determine the optimum distribution that is required to ensure adequate flood control, safe navigation, and ecosystem sustainability.

The secondary objectives of the study are to:

1. Investigate means to improve water quality and circulation in degraded areas of the Atchafalaya Basin that are not covered by the Water Management Units.

2. Investigate the ability of the system to transport sediment and freshwater to the Louisiana coastal area for delta building and marsh restoration purposes.

3. Investigate the potential of the system to further contribute to coastal ecosystem restoration.

This large-scale study would examine modifications to the ORCS operation to alter water circulation in the Atchafalaya Basin back swamps and associated lakes and bayous. Altering water circulation may achieve greater transport of sediment to coastal wetlands and reduced nutrient delivery to the Gulf of Mexico. Other potential benefits include enhanced water quality and aquatic ecosystem health in the upper Atchafalaya Basin Floodway. Adjustments to the operation of the ORCS may include daily and seasonal deviations from the 70/30-flow distribution while maintaining the flow distribution on an annual basis. Channel modifications within the upper basin would also be examined.

Increased sediment availability to coastal wetlands may act synergistically with other efforts to maximize the beneficial influence of these vital river resources through other elements of the near term LCA Plan. This includes the enhancement of Atchafalaya River/GIWW freshwater inflows into the central and eastern Terrebonne Basin, the operation of the Houma Navigation Canal Lock, and other water control features within the proposed Morganza to the Gulf Hurricane Protection Project for restoration purposes. The Atchafalaya River Diversion Study is expected to begin in FY04 and end in FY07.

4.2.4.3 Chenier Plain Freshwater and Sediment Management and Allocation Reassessment Study

The purpose of this study is to further develop a comprehensive management plan to restore the Chenier Plain's large-scale system hydrology and maximize the influence of the available sediment and fresh water. More efficient management of the existing limited water and sediment resources would stabilize and restore the wetlands of the region.

This study area is comprised of the Louisiana Chenier Plain, which extends from the western bank of Freshwater Bayou westward to the Louisiana-Texas border in Sabine Lake, and from the marsh areas just north of the Gulf Intracoastal Waterway (GIWW) south to the Gulf of Mexico in Vermilion, Cameron, and Calcasieu parishes. Although this system is linked to the Mississippi River Delta, the processes which governed its creation and subsequent degradation are different from those that affect the Deltaic Plain. The Chenier Plain wetland ecosystem developed primarily as a result of the interplay of three coastal plain rivers (Sabine, Calcasieu, and Mermentau Rivers), the intermittent mudstream from the Mississippi River outlets, and the Gulf of Mexico. During periods of active delta building in the western Mississippi Deltaic Plain, gulf currents transport fine-grained sediment west in a mudstream towards the Chenier Plain and form expansive mudflats. As Mississippi River Delta building switched to the east, this influence is removed and gulf processes rework the mudflats into beach ridges (cheniers). Subsequent westward shifts of the Mississippi River strand these cheniers inland, giving the Chenier Plain its defining characteristic.

Public works projects and other man-made and natural factors have altered the hydrology of the Louisiana Chenier Plain. In some areas, the estuarine character has been completely lost. In others, enhanced marine and tidal influences to sensitive areas have contributed to marsh degradation. Previous study efforts have indicated the technology currently applied to address the problems of the Louisiana Chenier Plain may be ineffective and insufficient to restore this region's landscape. A greater understanding of the availability of freshwater and sediment is necessary to plan appropriate ecosystem actions in the area.

Building on existing and ongoing modeling efforts, this study would help facilitate the development of a comprehensive restoration plan for the Chenier Plain ecosystem. Potential features to be analyzed may also include modification of existing authorized navigation and flood control projects, dedicated or beneficial use of dredged material, shoreline protection, modifications of land-use practices, and restoration of tidal influence to appropriate areas. The study is scheduled to begin in FY04 and conclude in FY07 at an estimated cost of $12 million.

4.2.4.4 Mississippi River Delta Management Study

The purpose of this study is to identify and evaluate features that would greatly increase the deposition of Mississippi River sediment in shallow coastal areas and restore deltaic growth in the Mississippi River Delta Plain. The study area is the Mississippi River Delta below Pointe a la Hache.

Every year, the Mississippi River transports millions of cubic yards of sediment to the delta at the mouth of the river. The District dredges approximately 31 mcy (2.4 million cubic meters) of sediment (sand) in the lower Mississippi. The river also transports a suspended sediment load (mostly silts) to the mouth of about 70 mcy (5.4 million cubic meters). Most of this material, as well as some of the sand load, is transported to deep waters of the Gulf of Mexico. However, little of this material is captured by the surrounding wetlands around the Mississippi River Delta. In addition, excess nutrients are diverted offshore instead of filtering through wetlands for assimilation, which leads to the annual development of a significant hypoxic zone in the northern Gulf of Mexico. The lack of sediment and nutrient input into the surrounding marshes has reduced regional soil building rates to a point where they are insufficient to offset effects of relative sea level change (RSLC), and massive land loss has resulted.

The District completed a Mississippi River Delta Reconnaissance Study in 1990 that indicated significant potential land building could be achieved by implementing diversion and channel projects, but environmental and economic analyses were insufficient to fully evaluate the NER/NED benefits and impacts. Recent investigations with a small-scale physical model have also indicated qualitatively that river diversions as well as alternative arrangements of navigation channels may contribute significantly to the restoration program. Environmental benefits would potentially include increased land building and maintenance and reduced hypoxia in the gulf.

This study would analyze two types of projects—large diversions (greater than 50,000 cfs [1,400 cms]) from the Mississippi River and alternative navigation channel alignments. The large- scale river diversions could potentially maximize the river's sediment and freshwater resources available for ecosystem maintenance. Diversion sites, capacities, and outfall management measures would also be assessed to help optimize diversion plans. Such massive diversions, however, may cause adverse impacts to the existing navigation channel; so alternative scenarios must be investigated to accommodate navigation needs. Alternate navigation scenarios include new channels to the east or west of the current river while providing navigation either in the new channel or by maintaining the existing navigation channel as a slack-water channel by the construction and operation of a lock system. In addition, the study would evaluate potential impacts of natural and man-made factors on the environment and economy. The study will run from FY06 through FY10 at an estimated cost of $15,350,000.

4.2.4.5 Mississippi River Hydrodynamic Study

Development of a Mississippi River Hydrodynamic Study, which would represent the existing Mississippi and Atchafalaya river systems below ORCS is necessary to properly assess the operation and parameters of the MR& river system with respect to water and sediment transport, flood control and navigation. The proposed study area encompasses the Mississippi and Atchafalaya Rivers from the ORCS to the Gulf of Mexico.

Although significant data has been collected on the amount of sediment, nutrients, and freshwater available in the river system, this information has not been assembled in a comprehensive modeling/study effort that would allow reliable estimates of the quantities of the total resources (water and sediment) that can be allocated for restoration purposes without compromising the river's existing navigation and flood control functions.

This study effort would include data collection, data synthesis, extension of existing modeling, and possibly new models. The comprehensive study would assist in determining the need, location, size, and seasonal variations for planned diversions and future restoration projects. Once a comprehensive model has been developed, calibrated, and verified for existing conditions, it would then be used to simulate a new base condition for the coastal area, one that represents/simulates the collective impacts of the near-term features and any other existing or planned projects that affect the river systems. As the average flow in the Mississippi/ Atchafalaya system is about 640,000 cfs (18,000 cms), the relatively small diversions in the near-term plan are unlikely to have a significant cumulative impact to the river system, but would become the base condition as these projects are implemented. The base condition model would then be used to evaluate the impacts of potential large-scale restoration features on the river system. In addition, the model would be used to evaluate adaptive management and potential adjustments to restoration features. This study is scheduled to begin in FY04 and end in FY07 at an estimated cost of $10,250,000.

4.2.4.6 Third Delta Study

The purpose of the Third Delta Study is to examine large-scale alternatives for the restoration of the lower areas of Terrebonne, Lafourche, and Jefferson parishes in the region of the Barataria-Terrebonne National Estuary. As proposed by Gagliano and van Beek (1999), this restoration concept involves constructing a conveyance channel parallel to Bayou Lafourche that would carry Mississippi River water and sediment to the western Barataria and eastern Terrebonne Basins in order to create two new deltas in this estuarine complex.

The Barataria-Terrebonne estuarine complex is bounded by the Mississippi and Atchafalaya Rivers. Bayou Lafourche separates this complex into two basins, Barataria Basin to the east, and Terrebonne Basin to the west. Bayou Lafourche was the main route of the Mississippi River until about 800 to 1,000 years ago. When the river changed course, Bayou Lafourche and the Lafourche delta gradually entered the final degradation phase of deltas. As such, flow from the Mississippi River down Bayou Lafourche gradually decreased until, by the mid-1800s, the bayou was a minor distributary. Prior to 1904, Bayou Lafourche maintained a hydrologic connection to the Mississippi River. Flows down the bayou were relatively small except during large floods on the Mississippi River, but helped to maintain some areas of the estuary. When the bayou was closed off from the Mississippi River in 1904 to provide flood protection along the bayou, water quality and quantity in the bayou decreased and no longer helped sustain the estuary. In the 1950s a pumping station was constructed at Donaldsonville, to divert up to 340 cfs (10 cms) from the Mississippi River into Bayou Lafourche to help improve water quality and provide water supply along the bayou (although channel conditions limited diversions to about 200 cfs [6 cms]). Conditions in the estuary, however, continued to deteriorate.

Today this area experiences the greatest rates of land loss along the entire Louisiana coast due to the numerous factors associated with coastal loss, including the disconnection of the estuarine system from the Mississippi River, the natural subsidence of the marsh, sea level change, oil & gas exploration, channelization, salinity intrusion, etc. This endangered ecosystem serves as valuable habitat for numerous species of birds, finfish, shellfish, reptiles, amphibians, and mammals that spend all or part of their life cycle in the Barataria-Terrebonne estuary, including several species that are categorized as either threatened or endangered. The vast acreage of marsh that is being eroded also serves to protect critical oil and gas infrastructure as well as the Louisiana Highway 1 corridor connecting Port Fourchon and Grand Isle to the rest of the state and Nation.

Restoration of the lower areas of Barataria-Terrebonne, and especially the eastern Terrebonne marshes on the western side of Bayou Lafourche, has been confounded by the long distances sediment must travel from the Mississippi River. The Third Delta concept proposed by Gagliano and van Beek (1999) involves creating a new delta between the Atchafalaya River and Mississippi River Birdfoot Deltas. The proposed two new deltas would be formed by sediment carried through a constructed conveyance channel. To reduce channel construction cost and increase availability of sediment in the created delta, a pilot channel would be constructed, and natural riverine processes would erode the conveyance channel to its final design width and discharge. The conveyance channel, as proposed, would follow the eastern slope of the natural Bayou Lafourche levee system, and split into two channels near Raceland. The eastern channel would terminate in Little Lake in Barataria Basin, and the western channel would cross Bayou Lafourche and carry sediment to Terrebonne Basin, ending near the Pointe au Chein Wildlife Management Area, north of Lake Felicity and Lake Raccourci (**figure MR 4-4**).

The State of Louisiana has conducted initial engineering studies of the Third Delta concept and concluded that the concept as proposed by Gagliano and van Beek (1999) could be engineeringly feasible, although serious concerns remain regarding the time scale and spatial extent of land building, the destruction of valuable swamps and marshes within the path of the conveyance channel, and the drastic alterations of the estuarine character of the receiving areas. In developing the feasibility study, the LCA Program would proceed with three additional phases: identifying alternatives to the proposed concept that would attain project goals, analyzing the significant environmental and economic effects of each alternative, and determining the economic feasibility of implementing the best project alternative. Potential alternatives include alternate diversion routes, the use of dedicated dredging, pipeline conveyance of sediment from the Mississippi River, and diverting water from the Atchafalaya River into Terrebonne Basin. As this study progresses, assessment tools developed under the

Mississippi River Hydrodynamic Study, previously discussed, would be used to evaluate the water and sediment transport capabilities of the alternative plans evaluated. Restoration of the Western Barataria-Eastern Terrebonne estuarine complex is challenging because of its remote location relative to the Mississippi and Atchafalaya Rivers. Yet, successfully restoring this region is crucial to the long-term sustainability not only of the coastal wetlands, but also to the sustainability of one of the world's most productive fisheries, and to protection of communities and infrastructure that is vital not only to the State of Louisiana, but also the Nation.

The study is currently underway through efforts funded by the State of Louisiana and would conclude in FY10, at an estimated cost of $15,290,000.

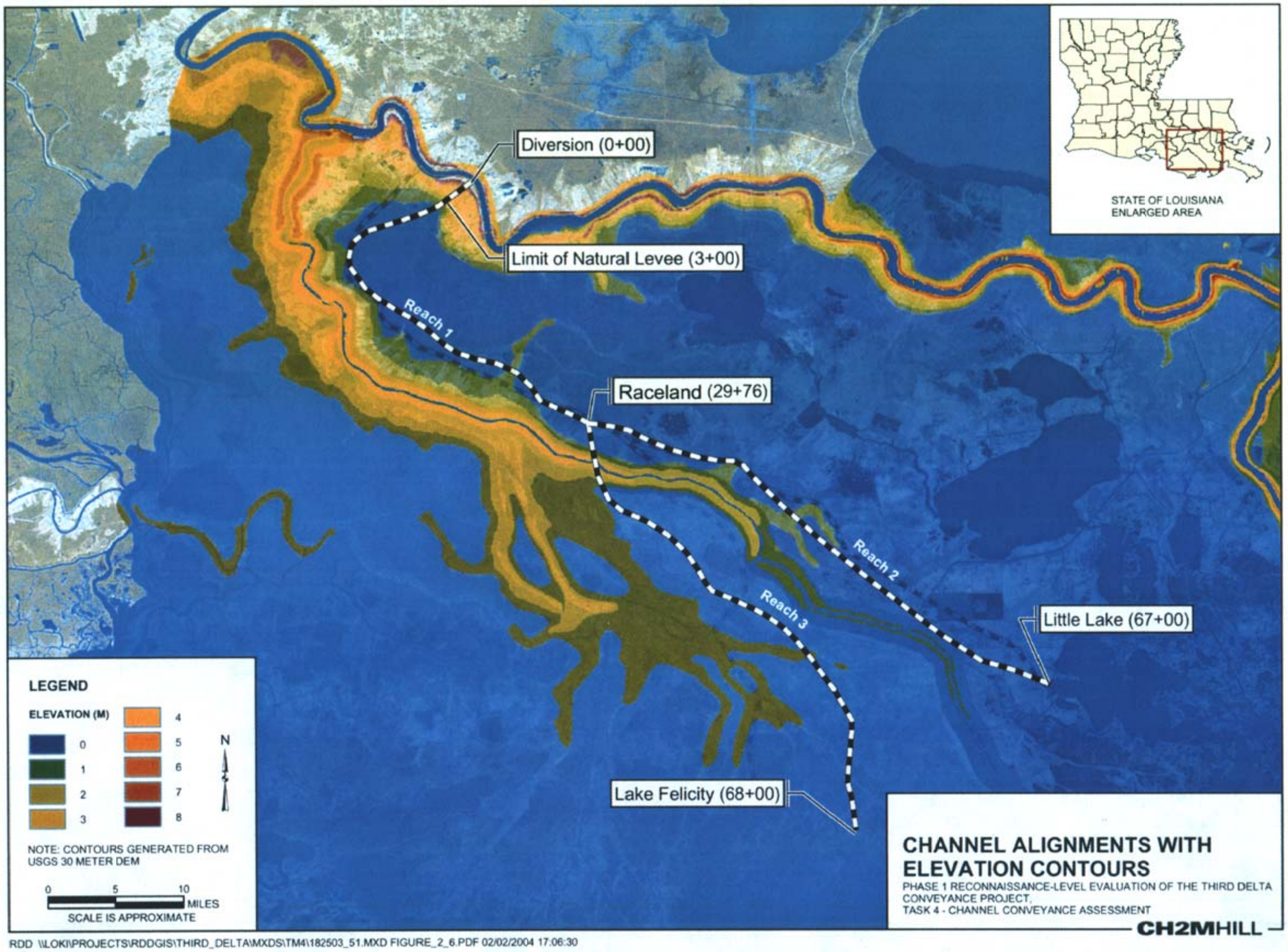


Figure MR 4-4 Location of proposed conveyance channel for the Third Delta Study (LDNR, 2004).

4.2.5 Science and Technology (S&T) Program

Section 3.1 PLANNING CONSTRAINTS detailed the key scientific uncertainties and engineering technology challenges in LCA implementation. Appendix A SCIENCE AND TECHNOLOGY PROGRAM details the proposed plan and program to resolve these challenges and facilitate effective implementation. It is proposed that a 10-year Science and Technology S&T (S&T) Program be funded as an authorized item subject to construction cost share percentages (65 percent Federal and 35 percent non-Federal would be applied for construction features and the S&T Program) at a total amount not to exceed $100 million. A major component of the S&T Program would be programmatic authorization for demonstration projects.

The LCA S&T Program would provide a strategy, organizational structure, and process to facilitate integration of science and technology into the decision-making processes of the Program Management and the Program Execution Teams. Implementation of this S&T Program would ensure that the best available science and technology are available for use in the planning, design, construction, and operation of LCA Plan features, as well as other coastal restoration projects and programs, such as CWPPRA. There are five primary elements in the S&T Program (outlined in the S&T Plan) and each element has a different emphasis and requirement. These include: (1) S&T Information Needs, (2) Data Acquisition and Monitoring, (3) Data and Information Management, (4) Modeling and AEAM, and (5) Research. Determining S&T needs requires a continuous process in place that solicits such needs from Program Managers, the PET, and scientists. Data Acquisition and Monitoring require standard operating procedures and rigorous adherence to those standards. Data and Information Management requires standards and procedures to assure data can be shared or compiled from a variety of sources. Modeling and AEAM requires broad interactions among scientists, Program Management, and the PET. Research requires clear hypothesis testing and a substantial degree of scientific independence but close coordination with the PET. A systematic process would be established to provide minimum standards for data quality and data management for information received and used by LCA.

The LCA S&T Program would perform the following:

- Work with LCA Program Management and the LCA PET to review and assess goals, objectives, and key documents of the LCA Program, Identify S&T needs to assist the LCA Plan in meeting those goals and objectives;
- Establish and maintain independent science and technology advisory and review boards;
- Manage and coordinate science projects for (1) data acquisition and monitoring, (2) data management, (3) modeling, and (4) research to meet identified scientific needs of the LCA Plan;
- Coordinate with other research efforts, such as CREST program; the Louisiana Governor's Applied Coastal Research and Development Program, and other state and Federal R&D entities;

- Incorporate lessons learned and experiences (pros and cons) of other large-scale ecosystem restoration science and engineering programs such as the Everglades, Chesapeake Bay, and Calfed;
- Conduct scientific evaluations, assessments and peer reviews to assure that the science implemented, conducted or produced by the S&T Program meets an acceptable standard of quality, credibility, and integrity;
- Establish performance measures for restoration projects and monitor and evaluate the performance of program elements;
- Improve scientific understanding of coastal restoration issues within the context of AEAM, infuse this improved information into planned or future restoration planning, projects and processes conducted by the PET;
- Prepare scientific documents including a periodic Science and Technology Report and conduct technical workshops and conferences; and
- Provide reports on science projects to support the Government Performance and Results Act (GPRA).

Monies allocated for the S&T Program would be used to:

- Establish and staff the S&T Office;
- Develop, implement and maintain a comprehensive data management structure and process;
- Establish, in concert with the CRMS, key monitoring stations to collect critical baseline data for planned projects and long-term monitoring of ecosystem status and trends;
- Identify key S&T uncertainties and focus efforts (e.g. monitoring and assessment, demonstration projects, research) to resolve them; and
- Develop analytical tools (i.e., hydrodynamic, ecological, and socioeconomic models) to help the Program Execution Team more effectively predict potential feature outcomes

Data collection and monitoring and assessment efforts to fully support the implementation of the LCA Plan and the S&T Program would require extensive collaboration between and funding support from Federal and state agencies, NGOs, and universities. Further details regarding the S&T Program can be found in appendix A: SCIENCE AND TECHNOLOGY PROGRAM.

4.2.6 Programmatic Authorization for Demonstration Projects

The purpose of LCA S&T Program demonstration projects is to resolve critical areas of scientific, technical, or engineering uncertainty while providing meaningful restoration benefits whenever possible. After design, construction, monitoring, and assessment of individual demonstration projects, the LCA Program would leverage the lessons learned to improve the planning, design, and implementation of other Louisiana coastal zone restoration projects.

There are numerous types of uncertainties to be addressed to support and improve LCA restoration efforts. Each uncertainty requires a different resolution strategy, based on the effects of the uncertainty on the program, degree of uncertainty, cost of addressing the uncertainty, and importance of reducing the uncertainty. Different strategies for resolving uncertainties may include, focused research projects, focused monitoring of existing projects or natural conditions, or demonstration projects.

Uncertainties may be related to basic understanding of the data availability, science, modeling, and other analytical tools, socio-economic impacts, implementation, technical methodology, resource constraints, cost, or effectiveness of restoration features. Uncertainties may also be related to development and refinement of forecasting tools. An uncertainty is considered critical if its resolution is vital to advancing the planning and implementation of the LCA Plan in the near-term. A role of the S&T Program is to identify and prioritize critical areas of uncertainty, to formulate the most appropriate means of resolving uncertainties, to ensure focused data collection aimed at resolving these areas of uncertainty, and to make recommendations to LCA Program Management regarding program and project refinements in light of the reduced uncertainty.

Critical areas of uncertainty identified by the PET, academics, or agency personnel would be proposed to the S&T Office Director. Proposed areas of uncertainty should be identified in relation to anticipated program activities. However, the S&T Office would not be constrained to targeting only these needs, and would be open to facilitating the pursuit of new technology, experimentation, and innovative ideas when suitable for the advancement of the LCA Program.

Areas of uncertainty would be prioritized based on the relative importance of resolution of the uncertainty to advancing the LCA Program. The S&T Office Director would be responsible for determining the significance of the uncertainties relative to the advancement of the LCA Program in coordination with Program Management and the PET.

Demonstration projects represent one of several strategies that the S&T Office would employ to reduce uncertainties. Demonstration projects may be necessary to address uncertainties not yet known and discovered in the course of individual project implementation or during the course of studies of large-scale and long-term restoration concepts. The Program Manager would review and approve requests from the S&T Director to prepare decision documents of potential demonstration projects. In addition to standard decision document information, the demonstration project decision documents would clearly identify major scientific or technological uncertainties to be resolved and a monitoring and assessment plan to ensure that the demonstration project would provide results that contribute to overall LCA Program effectiveness. Once the completed decision document is approved by the Secretary of the Army, construction could begin.

It is proposed that demonstration projects developed by the S&T Program be funded as a construction item at an amount not to exceed $100 million over 10 years, including a maximum cost of $25 million per project. The PDT developed five initial candidate demonstration projects, but these may be modified or replaced by demonstration projects of higher priority as determined by the S&T Director. In order to support continued development of the LCA Plan through AEAM, it is possible that additional and/or different demonstration projects would be needed.

The S&T Office would be responsible for defining and developing all demonstration projects to answer key ecological or technological uncertainties. A short description of some potential demonstration projects is provided below. The potential projects illustrate the general scope and purpose of the demonstration project's concept, but are not intended to represent the only demonstration projects that would be developed once the S&T Office is established.

4.2.6.1 Demonstration Project 1 – Marsh restoration and/or creation using non-native sediment

Uncertainty Addressed: This demonstration project would address the uncertainty involved in selecting sources of material for marsh creation, restoration of maritime forests, and restoration of cheniers. There is uncertainty regarding the efficacy of using saline mineral soils to support these habitats. Uncertainties regarding the time required for soil to leach out salts and increase organic matter content in order to make the soils suitable for the establishment of freshwater and terrestrial vegetation would need to be resolved prior to using this technique on a large scale. Other uncertainties include the cost of restoring cheniers and the potential benefits, such as habitat functionality.

Background: Coastal cheniers are critical habitats for many wildlife populations, especially migratory birds; however, these habitats are disappearing rapidly and are designated as critically imperiled by the Louisiana Natural Heritage Program. These chenier habitats provide upland habitat in very close proximity to marshes, which is instrumental in creating diverse upland/wetland assemblages. In addition to providing critical habitat, natural ridges, such as cheniers and natural distributary ridges, provide additional levels of flood protection. In spite of these potential benefits, coastal restoration programs in Louisiana have relatively little experience with chenier restoration.

Because marsh creation and chenier and maritime forest restoration are hampered by the availability of sediment that contains soil characteristics similar to the native soils (most available sediment is located in salt water offshore), it is important to determine the best methods of amending dredged sediment to create soils capable of sustaining this specialized habitat.

Description: This demonstration project could be located in the southwestern Barataria Basin, just north of Port Fourchon, in the "Chenier Unit" of the partially completed Barataria Basin Marsh Creation Study although the specific location of the project would not be selected until careful examination by the S&T Office in consultation with the Program Execution Team. This demonstration project would use different methods of soil modification and planting regimes to determine the quickest and most cost-effective, reliable means of attaining viable soils. A wide variety of variables selected by the S&T Office would be monitored to determine plant productivity, landform stability, and to evaluate impacts related to the acquisition of borrow material and its effect on the local ecosystem.

Anticipated Outputs: This demonstration project would provide insight into appropriate sources of available substrates, cost effective transport mechanisms, and time requirements for vegetation establishment on coastal cheniers. Documentation of impacts related to the acquisition of borrow materials and its effect on the affected area ecosystems would also be provided. This would enable more effective restoration of these habitat types in other areas of the coast.

4.2.6.2 Demonstration Project 2 – Marsh restoration using long-distance conveyance of sediment

Uncertainty Addressed: This demonstration project would address the uncertainty involved in marsh restoration through long distance conveyance of sediment via pipeline. Two major components of the demo will be examined: 1) most cost-effective mechanisms for long distance transport, and 2) most effective disposal of transported material to enhance land bridge and marsh construction. Concerns about the cost effectiveness of using conventional dredging techniques to transport large quantities of sediment long distances from sediment sources must be addressed. Conventional dredging equipment typically requires large pipelines for transport of sediment. However, there are uncertainties about how the material can be effectively transported efficiently over long distances and distributed. Variability in the sections of the restored marsh would facilitate monitoring to determine optimal final grade vs. design grade, dewatering periods, and potential water quality effects of transported materials. Tests may also be conducted to assess a two-tiered approach whereby large pipeline systems are used to convey high volumes of material but smaller dredges could be used to then disperse the material into final locations. Different mechanisms to distribute transported sediment within the marsh environment to minimize marsh damage and establish appropriate elevations for sustainable land bridge formation and marsh development would also be examined.

Background: Although modeling results indicate that very large diversions (e.g., 100,000 cfs [2,800 cms]) would build tremendous amounts of land; these results also indicate that such diversions would greatly alter the receiving basin's ecosystem. Furthermore, certain areas of the coastal zone that have experienced the greatest land loss may ultimately prove to be too far removed from the Mississippi or Atchafalaya Rivers for diversions to be a viable restoration technique. Long-distance sediment delivery via pipeline for marsh restoration is a promising alternative to very large diversions.

Dredged sediment is currently used for marsh creation; however, the scale is relatively small and the marsh creation sites are relatively close to the source of the material. Marsh nourishment is the concept of applying sediment to degrading marsh surfaces either by flowing low sediment concentration slurries over the surface or by direct spray disposal. These techniques have been shown to be effective on very small scales, but application to large areas is unproven and presents several challenges. These challenges include the logistics of moving material over and onto existing deteriorating marsh while minimizing damage, the need and methods to ensure vegetation colonization, and the cost-effectiveness of this restoration technique. Because marsh creation and nourishment have been shown to be successful on small, localized scales, the application of this technique on a larger scale makes it an excellent candidate for a demonstration project.

Description: This demonstration project would be located in the vicinity of a degrading land bridge. The specific location would be identified after the S&T Office is established. Techniques to be demonstrated may include spray disposal of dredged sediment to create marsh platforms in open water areas and application of thin sediment slurries over existing degrading marsh. Sources of material may be from offshore areas or from routine navigation channel maintenance dredging.

Anticipated Outputs: Results from this demonstration project would be used to determine the viability of transporting sediment slurries over long distances via pipeline for marsh restoration. Determination of cost-effectiveness would relate to the future use of these techniques. This project is further justified as a demonstration project because results can inform the appropriate design and cost estimates when these techniques are included as alternatives in large feasibility studies. Lessons learned from this demo project would be applicable to other dredging activities throughout the nation. Additionally, lessons learned from this demonstration project could be applied to improve the performance of beneficial use programs associated with the LCA Study and other efforts throughout the nation.

4.2.6.3 Demonstration Project 3 – Canal restoration using different methods

Uncertainty Addressed: This demonstration project would address uncertainties involved in restoration of canals. Canals, cut throughout the coastal marshes to support navigation, and oil and gas exploration needs, have resulted in fragmentation and accelerated erosion of many of the marshes. Considerable uncertainty exists and continues to be debated regarding the most effective approach to restoring existing canals. There are also uncertainties regarding the viability of restoration efforts and the timing of restoration.

Background: Many scientific papers suggest that these canals are one of the primary contributors to the land loss problem in coastal Louisiana. In addition to the direct removal of wetlands caused by their construction including dredged material banks, these canals have caused secondary indirect impacts by altering the natural hydrology of marshes and by accelerating erosion rates along the canal banks. The dredged material banks associated with these canals prevent the introduction of sediment and nutrients and cause artificially prolonged flooding. These effects combine to eliminate soil-building processes necessary to counteract subsidence. Additionally, canals provide avenues for higher salinity water to move into previously freshwater marshes, which ultimately leads to land loss. This demonstration project would address the many uncertainties related to canal restoration. The optimum method for closing these canals remains uncertain, but the intended outcome is known. In order to be sustainable, the linkage between wetlands and new sediment and nutrient sources must be reestablished. Thus, it must be demonstrated that the action taken is capable of attaining the desired ecological response by minimizing further erosion along the canal banks and by reestablishing historic hydrologic conditions.

Description: This demonstration project would be constructed in locations in both Barataria and Terrebonne basins, as these areas have some of the highest concentrations of canals. Different approaches to restoration should be examined and monitored including: 1) backfill with small hydraulic or mechanical dredge; 2) placing gaps in the excavated material disposal banks to restore natural hydrology; and 3) constructing plugs at canal entrances as stand alone features to reduce erosion within the canal. If backfill is used, impacts related to the acquisition of borrow material and its effect on the local ecosystem must also be addressed. The S&T Program may recommend additional restoration approaches to carry out this demonstration project or recommend further demonstration projects that build on or expand upon this demonstration project.

Anticipated Outputs: This demonstration project has implications for restoration throughout the entire coast of Louisiana. Once the most beneficial techniques have been identified and costs have been determined, these actions could be implemented as part of the restoration strategies for every subprovince. Any procedures for successful restoration of unused canals resulting from this demonstration project may be shared with regulatory agencies and departments for future permit actions.

4.2.6.4 Demonstration Project 4 – Shoreline erosion prevention using different methods

Uncertainty Addressed: This demonstration project would address uncertainties involved in restoration of eroding shorelines throughout the coastal area. Erosion along open bays and channels has lead to wetland losses across the coast. Different approaches to impede future erosion would be examined and monitored for long-term effectiveness, sustainability, and costs. Project monitoring would include comparative evaluations of settlement occurring within the various erosion protection/foreshore protection features.

Description: This demonstration project would be implemented through construction and monitoring of a variety of erosion protection/foreshore protection features in a variety of foundation conditions. This demonstration project would be constructed along several different reaches of shoreline subject to different wave energy regimes.

Anticipated Outputs: Results from this demonstration project would be used to determine the most efficient means of erosion protection/foreshore protection for different foundation conditions and wave energies. The findings from this demonstration project would be applicable to restoration efforts associated with shoreline erosion control. Once the most beneficial techniques have been identified and costs have been determined, these actions could be implemented as part of restoration strategies for the coastal areas

4.2.6.5 Demonstration Project 5 – Barrier island restoration using offshore and riverine sources of sediment

Uncertainty Addressed: This demonstration project would address uncertainties involved in restoration of barrier islands with offshore or riverine sources of sand. Focused research and restoration projects already completed in the LCA have contributed to an understanding about the most effective and sustainable island geometry design. However, several issues remain regarding the potential sources of the large quantities of sediment that would be required to re-establish or restore coastal barrier islands. Two sand sources already identified are Ship Shoal and the Lower Mississippi River. Uncertainties related to Ship Shoal are the quantity of available material and the cost-effectiveness of transporting this source relative to other sources. The sources of sands must be quantified and different transport mechanisms tested to determine a cost-effective approach to establishment. Demonstration project test sections would also vary in the types of sediment (percentage of sand/silt/clay) used for barrier islands and back barrier marsh creation. Monitoring would focus on vegetation growth and island stability.

Background: Barrier islands are critical land features in the Louisiana coastal area acting as the first line of defense from daily wave energies in the Gulf of Mexico and from less frequent hurricanes. The islands have been proved to reduce wave height and energy resulting in storm surge protection for coastal communities, but more importantly, the barrier islands provide protection from everyday wave activity; thereby promoting an environment that is conducive to marsh formation and sustainability. The islands also provide critical habitat to numerous species of wildlife, including specialized habitat required for rookeries of endangered brown pelicans. As barrier islands disappear, so do the invaluable services they provide.

Sediment resources located in the open Gulf of Mexico in shallow water are potentially major sources of high quality sand for barrier island restoration. Dredge equipment used for barrier island restoration is available primarily during the winter months. However, open gulf conditions in the winter months limit the ability of typical dredge operations in shallow conditions.

Costs and logistics of dredge operations on a busy commercial channel (the Mississippi) and the feasibility of pumping sediment long distances through a pipeline are difficult to estimate reliably. Other issues are associated with obtaining sediment, such as from Mississippi River point bars, including the renewability of the resource and the effects of removal from the point bars on river currents and navigation. This issue would be answered in part through the demonstration project directed at investigating the pipeline delivery of sediment. This demonstration project would more closely investigate methods associated with barrier island configuration, sediment placement, and habitat configurations (e.g. percent dune to marsh).

Description: This demonstration project would be constructed along sections of the Terrebonne and Barataria barrier islands.

Cost-effective techniques that would be feasible in difficult weather conditions need to be developed to capture and transport sediment from offshore sand bodies to a barrier island restoration site.

Construction of a sediment trap, potentially in the vicinity of the Head of Passes, may also be considered. This would potentially provide a renewable source of large-grained sediment, which could then be dredged and pumped through a pipeline delivery system to restoration sites. Initial construction of the sediment trap would also provide significant volumes of sand that could be used for restoration purposes. Second, sediment from point bars in the Mississippi River may be mined and pumped through a pipeline for delivery to restoration sites.

Anticipated Outputs: The expected output is to determine a viable source of large quantities of material and based on its source and composition the best method of use. Once uncertainties are resolved, these potential borrow sources would be incorporated more fully into future designs of restoration projects in both the Barataria and Terrebonne barrier shorelines.

4.2.7 Programmatic Authorization for the Beneficial Use of Dredged Material

The District has the largest annual channel O&M program in the USACE, with an annual average of 70 mcy (54 million cubic meters) of material dredged. Currently, approximately 14.5 mcy (11.1 million cubic meters) of this material is used beneficially in the surrounding environment with funding from either the O&M program itself or the Continuing Authorities Program (CAP) defined by the WRDA 1992 Section 204 for beneficial use of dredged material. Within the O&M program, beneficial use may be funded if the cost increment increase for the beneficial use transport and disposal is a minimal percentage increase above the O&M Base Plan for standard transport and disposal. The CAP Section 204 provides another funding source to "carry out projects for the protection, restoration, and creation of aquatic and ecologically related habitats, including wetlands, in conjunction with dredging for construction, operation, or maintenance by the Secretary [of the Army] of an authorized navigation project." Section 204 projects are completed in conjunction with existing O&M contracts and pay for the incremental cost above the Base Plan for the beneficial use alternative. The Base Plan is defined as "Disposal of dredged material … in the least costly manner consistent with sound engineering practice and meeting all Federal environmental requirements." Combined, the existing O&M program and the CAP Section 204 (with $15 million in annual funding spread throughout USACE) do not provide the resources for the District to take full advantage of the available sediment resources.

The LCA Plan would be enhanced by programmatic authorization for beneficial use of dredged material. This program would allow the District to take greater advantage of existing sediment resources made available by maintenance activities to achieve restoration objectives. Annualized, there is reasonable potential to use an additional 30 mcy (23 million cubic meters) of material beneficially if funding were made available. (A portion of the average annual material total of 70 mcy (54 million cubic meters) is not available for beneficial use because it is resuspended material from upstream maintenance; if taken out of the system upstream, it is not available for downstream beneficial use.) Other limitations within particular areas include threatened and endangered species operating restrictions; cultural resource site operating restrictions; and unfavorable maritime working conditions. The following list is a small subset of the many areas with significant opportunity for additional beneficial use of material in coastal Louisiana:

- The MRGO, LA, project;
- The bay reach of the Barataria Bay Waterway, LA project;
- The MR&T project, Head of Passes and Southwest Pass;
- The Atchafalaya River and Bayous Chene, Boeuf, and Black, LA, project;
- The inland reach of the Calcasieu River and Pass, LA, project; and
- The Houma Navigation Canal.

The LCA Plan recommends $100 million in programmatic authority to allow for the extra cost needed for beneficial use of dredged material. Funds from the Beneficial Use of Dredge Material Program would be used for restoration activities that are above and beyond what would otherwise be funded by the USACE O&M program. Approximately 15 percent would be used for feasibility studies, and the remaining $85 million would be used for placement of dredged material within the acquired disposal sites. Previous Section 204 projects have demonstrated an incremental cost of $1.00 per CY for placement. Additionally, these projects have demonstrated approximately 0.00025 acres per CY (0.0001 ha per CY) created. Based on the requested funds and a ten-year period of implementation, it is expected that the LCA beneficial use of dredged material could attain approximately 21,000 acres (8,500 acres) of newly created wetlands. This beneficial use program represents a vital opportunity to contribute to the attainment of the LCA objectives. Programmatic authority would allow for the application of funds appropriated for LCA for beneficial use of dredged material under guidelines established by the Secretary of the Army, which may be similar to the current guidelines specified for the Section 204 Continuing Authorities Program. Approval of individual beneficial use projects may be delegated by the Secretary of the Army and managed by Division based on the appropriated annual funds. Implementation would proceed with a more detailed analysis of the potential beneficial use disposal sites. Additional funds should not exceed $100 million over the initial 10 years of the LCA program and would greatly contribute to achieving restoration objectives by utilizing existing sediment resources from coastal zone navigation channels.

4.2.8 Programmatic Authorization for Investigations of Modifications of Existing Structures

Coastal Louisiana is a dynamic environment that requires continual adaptation of restoration plans. With this recognition, opportunities for modifying or rehabilitating existing structures and/or their operation management plans to contribute to the LCA ecosystem restoration objectives may be required in the future. Examples of existing structures include: Davis Pond, Bonnet Carre Spillway, MRGO, Bayou Sorrel Lock, and Leland Bowman Lock. Each of these structures may be modified to influence flow, stage, and/or water quality.

Initiation of investigations of modifications of existing structures requires advanced budgeting. Standard budget sequencing may limit responsiveness to recommendations made within the LCA Plan. As a result, the LCA Plan seeks programmatic authorities to initiate investigations of modifications of existing structures utilizing funds within the LCA appropriations, not to exceed $10 million.

4.2.9 Cost Estimates for Components of the LCA Plan

Estimated costs for each of component of the LCA Plan are shown in **table MR 4-17**. Cost estimates are based on June 2004 price levels.

The fully funded cost estimate of the five near-term critical restoration features are as follows:

- MRGO Environmental Restoration Features $121,736,000
- Small Diversion at Hope Canal $ 80,281,000
- Barataria Basin Barrier Shoreline Restoration $275,471,000
- Small Bayou Lafourche Reintroduction $167,582,000
- Medium Diversion with Dedicated Dredging at Myrtle Grove $340,311,000

The fully funded cost estimate for the LCA Plan is $2,323,653,000.

Table MR-4-17
LCA Plan Component Cost Estimates
(June 2004 Price Levels)

Item		Cost ($)	
MRGO environmental restoration features		$	80,000,000
Small diversion at Hope Canal		$	10,645,000
Barataria Basin Barrier shoreline restoration		$	181,000,000
Small Bayou Lafourche reintroduction		$	75,280,000
Medium diversion with dedicated dredging at Myrtle Grove		$	142,920,000
	SUBTOTAL	$	489,845,000
LERRD		$	178,619,000
First Cost	SUBTOTAL	$	668,464,000
Feasibility-Level Decision Documents		$	54,673,000
Preconstruction, Engineering, and Design (PED)		$	36,252,000
Engineering and Design (E&D)		$	29,018,000
Supervision and Administration (S&A)		$	68,973,000
Project Monitoring		$	6,685,000
Conditionally Authorized Cost	SUBTOTAL	**$**	**864,065,000**
Science & Technology Program Cost (10 year Program)		**$**	**100,000,000**
Demonstration Program Cost (10 year Program)*		**$**	**100,000,000**
Beneficial Use of Dredged Material Program*		**$**	**100,000,000**
Investigations of Modifications of Existing Structures		**$**	**10,000,000**
Total Authorized LCA Plan Cost		**$**	**1,174,065,000**
Multi-purpose operation of Houma Navigation Canal (HNC) Lock [#]		$	-
Terrebonne Basin Barrier shoreline restoration		$	84,850,000
Maintain Land Bridge between Caillou Lake and Gulf of Mexico		$	41,000,000
Small diversion at Convent / Blind River.		$	28,564,000
Increase Amite River Diversion Canal influence by gapping banks		$	2,855,000
Medium diversion at White's Ditch		$	35,200,000
Stabilize Gulf shoreline at Point Au Fer Island		$	32,000,000
Convey Atchafalaya River Water to Northern Terrebonne marshes		$	132,200,000
Modification of Caernarvon diversion		$	1,800,000
Modification of Davis Pond diversion		$	1,800,000
	SUBTOTAL	$	360,269,000
LERRD		$	208,100,000
First Cost	SUBTOTAL	$	568,369,000
Feasibility Level Decision Documents		$	47,529,000
Preconstruction, Engineering, and Design (PED)		$	36,027,000
Engineering & Design (E&D)		$	45,635,000
Supervision & Administration (S&A)		$	58,673,000
Project Monitoring		$	5,683,000
Approved Projects Requiring Future Congressional Authorization for Construction		**$**	**761,916,000**
Mississippi River Hydrodynamic Study		$	10,250,000
Mississippi River Delta Management Study		$	15,350,000
Third Delta Study		$	15,290,000
Chenier Plain Freshwater and Sediment Management and Allocation Reassessment Study		$	12,000,000
Acadiana Bays Estuarine Restoration Feasibility Study		$	7,110,000
Upper Atchafalaya Basin Study^		$	-
Large-scale and Long Term Studies Cost	SUBTOTAL	**$**	**60,000,000**
Total LCA Restoration Plan Cost		**$**	**1,995,981,000**

*Program total costs include any estimated Real Estate costs for these activities
[#] Feature of the Mississippi River and Tributaries, Morganza Louisiana to the Gulf of Mexico Hurricane Protection project
^ Study to be funded under the Mississippi River and Tributaries authority

4.3 PLAN MANAGEMENT

The purpose of the LCA Management Plan (Management Plan) is to maximize attainment of the planning objectives for restoration of Louisiana's coastal wetlands. This management plan and structure describe how various entities would be integrated into the planning and decision-making process during the LCA Plan implementation. This proposed management structure would also facilitate communication and coordination between the Federal and state agencies in the implementation of broader coastal restoration efforts and programs.

This section of the report describes the working relationships between the various entities and their respective roles and responsibilities to facilitate efficient management of coastal restoration activities. Due to the significance and magnitude of wetlands losses and the far-reaching national extent of the problems generated by coastal Louisiana land losses over the next 50 years, a Washington-level Task Force is needed to fully address the issues.

For each of the groups involved in the implementation of the LCA Program (**figure MR 4-5**), the purpose, structure, and roles and responsibilities are described. The groups include: Headquarters, a Program Management Team, a Program Execution Team, a proposed Task Force, the Assistant Secretary, a Regional Working Group, and a S&T Office. **Figure MR 4-5** depicts their overall relationship and the interaction that would be needed to achieve coastal restoration and consistency.

Management of the LCA restoration efforts would also include a decision support system that relies on clearly defined procedures to assess uncertainties and develop alternatives for the decision making process. The decision support system would be developed with and implemented by the program teams, and outputs from the system would be reported to the Program Management Team, who would be responsible for program-level decisions. The decision support system would be developed to explicitly identify constraints and tradeoffs among new projects, existing and backlogged projects and other planning and regulatory decisions made that affect the implementation and effectiveness of restoration efforts. Program planning efforts would support informed decision making in recognition of the interdependencies among actions and the tradeoffs in outcomes affecting the recreational and commercial uses of the working coast.

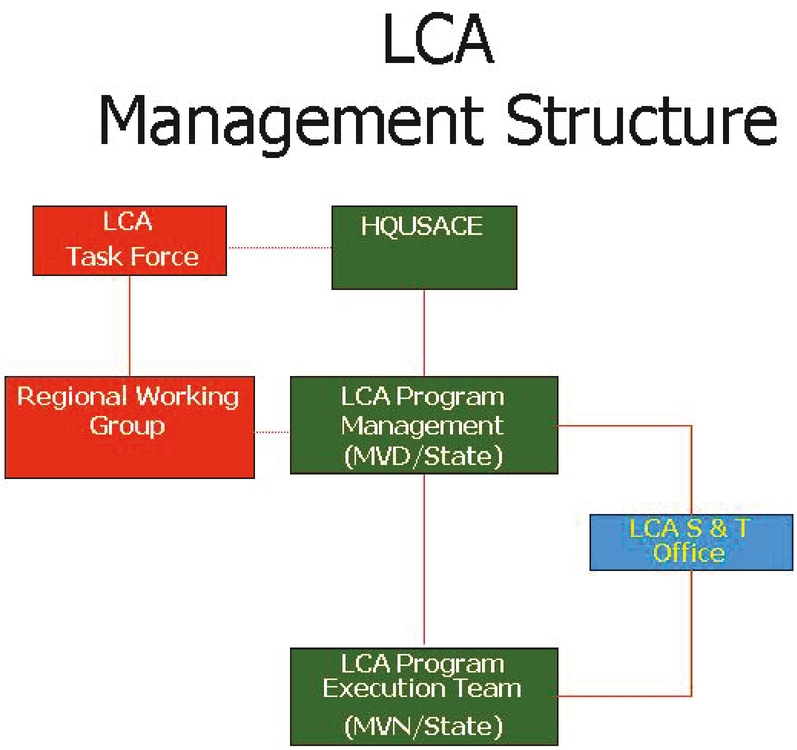


Figure MR 4-5. Coastal Restoration Management Structure.

4.3.1 Headquarters, US Army Corps of Engineers

Headquarters would provide leadership in policy review, compliance, and funding strategies for Louisiana coastal restoration. Headquarters formed an interdisciplinary regional integration team that would participate in the study, comprised of policy, planning, and programs staff. Headquarters would also:

- Expedite review and policy decisions;
- Coordinate with agencies at the Washington level;
- Provide leadership in the resolution of issues;
- Recommend approval to the Secretary of the Army for annual LCA budget requirements;
- Prepare Chief's reports for obtaining authorizations;
- Review requests for approval under programmatic authority; and
- Provide lead for administrative support to the Task Force.

4.3.2 Program Management Team

The Program Management Team would include representatives from Division, the State of Louisiana, and the S&T Office. With the support of the Program Management Team, the Program Manager (Commander, Mississippi Valley Division/President, Mississippi River

Commission) would manage the LCA program in close coordination with the State of Louisiana, and perform the following duties:

- Coordinate interagency program efforts through RWG forum;
- Complete upward reporting requirements to Headquarters;
- Submit the annual LCA program budget to Headquarters;
- Provide annual program funding to the Program Execution Team with program execution guidance;
- Review annual AEAM and program reports to develop future programmatic guidance;
- Approve S&T Office efforts in support of the LCA Program;
- Prioritize S&T Office efforts in support of on-going studies and construction;
- Support the District's need for technical resources within and outside the Division including independent technical review teams;
- Provide reports to the Task Force on LCA Program activities and execution;
- Participate in issue resolution conferences, alternative formulation briefings, teleconferences and other formal briefings;
- Provide leadership in ensuring quality assurance and policy compliance; and
- Establish program review teams as necessary.

4.3.3 Program Execution Team

The purpose of the Program Execution Team is to formulate, design, and implement the LCA Plan components. It would also provide a forum for the many Federal and state agencies working on coastal restoration efforts to interact and to share resources.

The District and the state (through LDNR) lead the Program Execution Team. The Program Execution Team would oversee and execute all project level coastal restoration activities. The overall Program Execution Team would include additional Federal and state agency members. The members of the team would efficiently and expeditiously manage studies and construction through appropriate implementation strategies. Each organization brings to the team a particular area(s) of expertise.

The Program Execution Team may make recommendations that it deems warranted to the District Engineer on matters that the Program Execution Team generally oversees and executes, including suggestions to avoid potential sources of dispute. The Government in good faith shall consider the recommendations of the Program Execution Team. The Government has the discretion to accept, reject, or modify the Program Execution Team's recommendations.

Team members would assist in the preparation of reports and the reports' submission to the Program Management Team. One specific reporting responsibility of the Program Execution Team would be the Program Report to Congress (RTC). The purpose of the RTC would be to provide Congress with 1) the status and progress of implementation of the LCA Plan, 2) any recommended changes to procedures for implementing the LCA Plan, 3) changes to the scope, cost, and structure of the LCA Plan, including the addition or removal of projects, 4) recommendations to improve the overall execution and management of the plan, and 5) any other information or recommendations regarding the plan. A RTC would be prepared by the Division and the District, in collaboration with the state, and would be approved by Headquarters and the Secretary of the Army prior to submittal to Congress.

The Program Execution Team would make recommendations to the District Engineer and the Program Manager for the following:

- Coordinate and conduct coastal consistency review of reports and documents for all District activities (i.e. feasibility reports) in the Louisiana coastal area;
- Prepare LCA Program Reports to Congress as required (for approval through the Program Manager;
- Prepare project cost share agreements for approval and execution by designated authority;
- Produce Project Management Plans (PMPs), Project decision documents/Feasibility Reports for approval and/or authorization of projects;
- Dialogue with the S&T Office during scoping of feasibility studies to identify S&T support requirements;
- Produce PED scope documents, Plans & Specifications (P&S), and environmental compliance documents;
- Review periodic AEAM monitoring reports, provide recommendations to the Program Manager, and implement guidance provided;
- Conduct all scoping meetings, public information meetings, and issue resolution activities;
- Prepare the Program Execution annual budget; and
- Submit the consolidated Program Execution and Science and Technology budget to the Program Manager.

4.3.4 Coastal Louisiana Ecosystem Protection and Restoration Task Force

The purpose of the proposed Task Force would be to facilitate coordination and collaboration among various agencies involved in implementation of major coastal restoration activities and provide recommendations to the Secretary of the Army. The Task Force would be formed by specific Congressional authorization.

The Task Force would include the following members or designees - in the case of a Federal agency, members or designees would be at the level of an Assistant Secretary:

- The Secretary of the Army, who shall serve as Chairperson;
- The Secretary of Interior;
- The Secretary of Commerce;
- The Administrator of the Environmental Protection Agency;
- The Secretary of Agriculture;
- The Secretary of Transportation;
- The Secretary of Energy;

- The Secretary of Homeland Security; and
- The Governor of the State of Louisiana

The Task Force would meet to discuss actions and recommendations to the Secretary of the Army regarding:

- Policies, strategies, plans, programs, projects, and activities for addressing the conservation, protection, restoration, and maintenance of the Coastal Louisiana Ecosystem;
- Integrated financial plans of the agencies represented on the Task Force. Such recommendations shall identity funds from available existing programs, and include recommendations for coordinated budget requests;
- Submission of a biennial report to Congress that summarizes the activities of the Task Force;
- Task Force actions to facilitate public participation, including providing advance notice of meetings, providing adequate opportunity for public input and comment, maintaining appropriate records, and making available a record of proceedings for public inspection.

4.3.5 Secretary of the Army

The Secretary of the Army, or his designee, would serve as the chair of the Task Force and would ultimately be responsible for recommendations to Congress on authorization and appropriation of funds. The Secretary's office includes the Principal Deputy Assistant Secretary of the Army (Civil Works), the Deputy Assistant Secretary of the Army (Policy and Legislation), the Deputy Assistant Secretary of the Army (Project Planning and Review), the Deputy Assistant Secretary of the Army (Management and Budget), and their staffs who would participate in policy determinations and reviews, and other activities related to Louisiana coastal restoration.

4.3.6 Regional Working Group

The RWG would support the Task Force and facilitate regional level collaboration and coordination with the LCA Program Management Team and with all Federal and state agencies involved in ecosystem restoration. The RWG membership mirrors the composition of the Task Force, but at the regional level.

The RWG would:

- Advise the Program Management Team;
- Identify opportunities for leveraging agency resources to support the S&T Program; and
- Coordinate with other on-going ecosystem restoration actions, such as CWPPRA and State Wetlands Authority projects.

4.3.7 Science and Technology Office

The S&T Office is the focal point for activities of the S&T Program. It provides a physical location and single point of contact for all agencies and individuals with interests in science and technology. It must communicate regularly and efficiently with the LCA Program Management and the Program Execution Team while maintaining a separate identity and independence from the day-to-day activities of implementation. While addressing the scientific needs of the LCA Program, the S&T Program would also strive to meet the technical needs of participating agencies within the context of their participation in the LCA Program. The S&T Office must also be responsive to the technical needs of the Program Execution Team and provide analytical tools responsive to the team (e.g., hydrodynamic and ecological models) and frequently assess the effectiveness of those tools through close communication. Funds would be allocated to the Science Program by the Program Manager to address science needs in support of the goals and objectives of the LCA Program. For example, funds could be used to: 1) develop necessary scientific data and information to implement features found in the LCA Plan; and 2) fund coastal restoration science and technology proposals to address uncertainties related to enhancing system-wide understanding, engineering concepts, and operational methods. Ongoing modeling efforts would continue as an integral component of the S&T Program to address uncertainties and assist in the implementation of the LCA Plan. The main structural elements of the LCA S&T Program and its relationship to program management are shown in **figure MR 4-6**.

The Director oversees the S&T Program, and is responsible for the operation and the conduct of all functions of the S&T Program. The Director is a member of the Program Management Team. Program budget requests are prepared by the Director in coordination with the Program Execution Team request and submitted to the Program Manager. A copy of the S&T budget request would also be provided to the Program Execution Team for consistency in submission of the program budget request to the Program Manager. The Director is a Federal employee under the S&T Office and should meet the qualifications set by the Program Manager. More specifically, the Director should have:

- Experience in managing complex interdisciplinary scientific programs,
- Undertaken substantial scientific research work in any field related to LCA,
- Experience managing environmental issues or advising high-level managers in methods for promoting science-based decision making, and
- A record of publication in the peer reviewed scientific literature.

Decision support describes the framework and process used to integrate analysis with decision-making, and represents the primary purpose of the S&T Program. The Program seeks to help decision makers to make the best possible decisions about the design and implementation of LCA Plan projects in the face of uncertainty, and to reduce uncertainty over time in order to improve future project planning and decision-making. The challenge for the S&T Program is to develop a decision support framework that incorporates scientific approaches directly into the LCA Plan planning and implementation process.

Within the S&T Program, the system synthesis model would be used to help identify and prioritize key scientific uncertainties and to select and configure demonstration projects and experiments to help reduce these uncertainties over time, following the principles of AEAM. In turn, the systems synthesis modeling team must have a clear process and capability to use what is learned in order to make model improvements over time.

The model would also take into account sensitivity analyses and assessments of uncertainties in data or relationships of variables. A systematic evaluation of these considerations would be included in the model framework. Where uncertainties and model performance issues cannot be addressed by collection of additional data or model testing, best professional judgment and data from published literature would be used in the model.

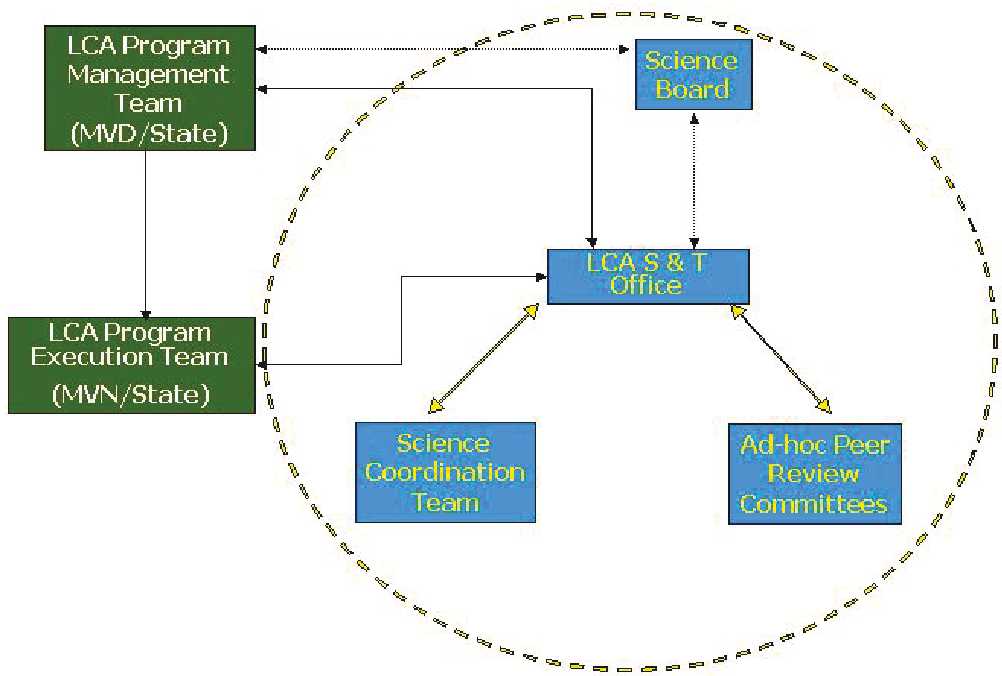


Figure MR 4-6. Relationship of the S&T Program with LCA Program Management and the Program Execution Team.

4.3.7.1 Science Board (SB)

The Science Board (SB) would be a small group that would meet periodically and would be knowledgeable of the ongoing activities of the program. The SB would consist of the appropriate number of members depending on scope of particular review, including:

- Several National Academy of Science-level academics (convened on a contract basis)
- A representative of the Corps of Engineers (Federal lead agency)

- A representative of the State of Louisiana (non-Federal lead)
- A representative of appropriate additional Federal agencies

Each member of the SB would have appropriate scientific credentials in an appropriate field of science or engineering and have experience in the science and technology issues surrounding coastal restoration.

The role of the SB would be to periodically review the S&T Program as well as the overall LCA Program, as it relates to use of science and technology, and prepare reports that provide recommendations and advice to the Program Management Team and the LCA S&T Office. The purpose of these reviews and reports would be to provide an independent assessment of the program. The Director of the S&T Office would keep regular communication with the SB between formal review sessions. Additionally, the SB would:

Review the LCA program to identify gaps in scientific information and AEAM tools and strategies,

- Recommend tools, processes, and methodologies from a review of current research to improve ongoing LCA restoration efforts,
- Work closely with the Director to review recommended changes that are needed in the applied science strategies of the restoration program,
- Possibly recommend establishing new science initiatives, innovative restoration tools, and other challenging research and development issues, and
- Report to Program Management and the Director of the S&T Office regarding the effectiveness of the S&T Program to meet the science and information needs of the restoration program.
- Provide recommendations to better incorporate the output of the S&T Program into the overall LCA Program.
- Provide reviews of how effectively the PMT is incorporating the output of the S&T Program and the recommendations of the SB into the overall LCA Program, and make recommendations to improve use of S&T Program results.

4.3.7.2 Science Coordination Team (SCT)

The SCT would provide the S&T Program with a mechanism for coordinating LCA Plan science initiatives with ongoing and planned work being undertaken in state and Federal agencies, other restoration efforts, and within the broader scientific community. An inventory of ongoing Federal and state agencies and academic institutions was initiated in 2004 to expedite this effort. The SCT members would assist with information transfer efforts, planning periodic science symposia, and would advise the S&T Office of new scientific developments and technological advances occurring within their agencies. The SCT would be an inclusive body with members representing Federal, state and local governmental agencies with scientific interests, NGOs, academic institutions, and private interests. The S&T Director would chair the SCT.

4.3.7.3 Ad hoc peer review committees

All scientific investigations and project studies would be subject to a peer review by an independent panel of experts as determined by the S&T Director. A panel of experts shall be composed of independent experts who represent a balance of areas of expertise suitable for the review being conducted. The peer review could include a review of the economic and environmental assumptions and projections, project evaluation data, economic analyses, environmental analyses, engineering analyses, formulation of alternative plans, methods for integrating risk and uncertainty, models used in evaluation of economic or environmental impacts of proposed projects, and any other work products of the project study.

4.4 CONSISTENCY AND COORDINATION BETWEEN DEVELOPMENT AND COASTAL RESTORATION AND PROTECTION EFFORTS

4.4.1 Consistency Between Coastal Restoration and Other Coastal Activities

From navigation improvements and hurricane protection to residential and commercial construction, development activities can affect the Louisiana coastal environment. Yet, such activities are critical for a healthy and vibrant economy in coastal Louisiana. The challenge, therefore, is to ensure that economic development does not undermine the sustainability of wetlands and coastal ecosystems that are also vital to long-term economic health of the region and Nation. The solution is neither a moratorium on growth in the coastal zone, nor "business as usual."

Project purposes such as hurricane protection, navigation, and economic development must be addressed in a way that is consistent with coastal restoration and protection efforts. Indeed, Section 303(d) of CWPPRA mandates consistency for some important activities:

> *Consistency--- (1) In implementing, maintaining, modifying, or rehabilitating navigation, flood control or irrigation projects, other than emergency actions, under other authorities, the Secretary* [of the Army]*, in consultation with the Director* [of the USFWS] *and the Administrator* [of the EPA]*, shall ensure that such actions are consistent with the purposes of the restoration plan submitted pursuant to this section.*

Despite efforts to address this important provision, it is acknowledged by many stakeholders that a more thorough and comprehensive effort is needed to ensure consistency across the coast. It is further recognized that the LCA Plan is the appropriate vehicle for initiating such an effort. In order to move towards such consistency, implementation of the LCA Plan would include:

- "Coastal Consistency" reviews by the LCA Program Execution Team of all District feasibility reports and significant regulatory actions;

- Early coordination between both the state and District on all projects in the Coastal Area that have potential impacts upon restoration activities;
- Adherence to the Coastal Zone Management Act Federal Consistency Regulations (15 CFR Part 930 Subpart C---Consistency for Federal Agency Activities, 16 U.S.C. 1451 et seq.)

These efforts to enhance internal and external coordination would build upon the significant progress that has already been made as a result of the formation of the interagency (Federal and state) collocated restoration team housed within the District. In implementing the LCA Plan, the state would also work towards consistency with their Coastal Zone Management Plan. A more detailed Consistency Action Plan is included in chapter 6 of the LCA FPEIS. The **figure MR 4-7** indicates the coordination that would be necessary to achieve coastal consistency. Most of these state and Federal programs involving coastal management are under the purview of the agencies represented on the Task Force.

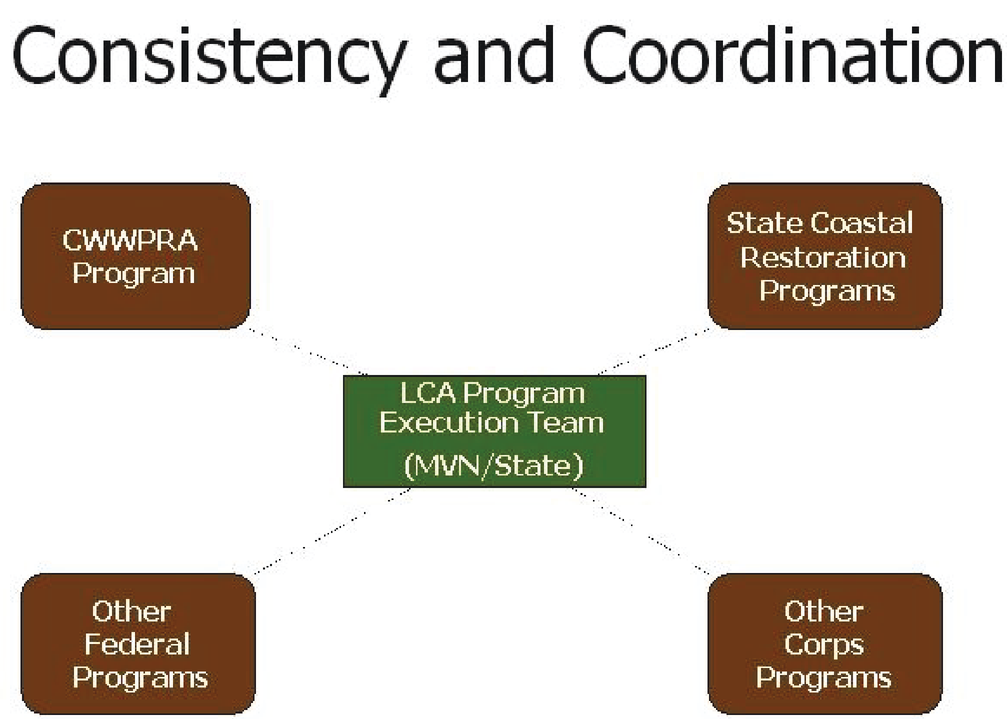


Figure MR 4-7. Consistency and Coordination.

4.4.2 Federal Agency Coordination

The U.S. Fish and Wildlife Service in their programmatic Fish and Wildlife Coordination Act Report (FWCAR) for the LCA Ecosystem Restoration Study has indicated concurrence with the findings of the study. The FWCAR recommendations state – "Given the substantial adverse future impacts to coastal wetlands and their associated fish and wildlife resources that are expected to occur under future without-project conditions, the USFWS strongly supports authorization and implementation of the TSP (LCA Plan) as it would provide the greatest level of sustainable benefits to Louisiana's Nationally significant coastal fish and wildlife resources." The Fish and Wildlife Coordination Act Report (FWCAR) is included as Appendix B6 to the FPEIS.

The reports In the September 17, 2004, Federal Register (volume 69, number 180), the U.S. Environmental Protection Agency rated the LCA Draft PEIS as LO - Lack of Objections. In addition the USEPA had no objections to the selection of the Tentatively Selected Plan (LCA Plan) of Action, and fully supported the primary restoration strategies.

The FWCAR also contained several recommendations for coordination and planning consistency under the LCA Plan. These recommendations are:

> **1.** *In accordance with the January 2003 Partnership Agreement for Water Resources and Fish and Wildlife between the Service and the Corps, sufficient continuous funding should be provided to the Service to fulfill our responsibilities under Section 2(b) of the Fish and Wildlife Coordination Act throughout post-authorization engineering and design studies for demonstration projects, participation in the Science and Technology Program, Near-Term Plan (NTP) projects, and planning and evaluation for long-term project feasibility studies. To facilitate that level of cooperation, the Service intends to negotiate an LCA-specific Memorandum of Agreement with the Corps (similar to that used for Florida's Everglades Restoration study) soon after the NTP is authorized.*

In accordance with the January 2003 Partnership Agreement for Water Resources and Fish and Wildlife between the USFWS and the USACE, the District would continue to provide funding required by the USFWS to enable their full participation throughout future detailed planning and post-authorization engineering and design studies, and to fulfill their reporting responsibilities for the LCA Plan component features under Section 2(b) of the Fish and Wildlife Coordination Act. Additionally, the District in cooperation with the USFWS, Lafayette Field Office, would draft and execute an LCA-specific Memorandum of Agreement detailing the operating guidelines for negotiating transfer funds (similar to those used for the Comprehensive Everglades Restoration Plan) and to facilitate and expedite the USFWS future involvement.

> **2.** *Under provisions of Section 7 of the ESA of 1973, as amended, the Service will also assist the Corps and any other Federal agencies responsible for funding or implementing selected projects and/or plans to ensure that they will neither jeopardize the continued existence of threatened and endangered species, nor adversely modify any designated critical habitat. The required consultations will be accomplished on a project-by-project basis, and will tier from the current programmatic consultation, details of which are*

contained in the Programmatic Environmental Impact Statement (PEIS) for the NTP. In keeping with the consultation requirements of the ESA, informal and formal (if needed) consultation must be completed before the Record of Decision for the NTP and PEIS can be signed. The Service (via the Department of the Interior's August 2004 letter) has concurred with the Corps' determination that the TSP is not likely to adversely effect any currently listed threatened or endangered species or designated critical habitat for which the Service has consultative jurisdiction.

Under provisions of the ESA, the District would continue to accomplish the required consultations on a project-by-project basis, and would tier from the current programmatic consultation, details of which are contained in the FPEIS for the LCA Plan. Further, in keeping with the consultation requirements of the ESA, informal and formal (if needed) consultation would be completed before the Record of Decision for the LCA Plan and PEIS can be signed.

3. *The Corps should coordinate closely with individual refuge managers prior to conducting any work on a National Wildlife Refuge, in conformance with the National Wildlife Refuge System Improvement Act of 1997. Such coordination will be essential to the timely completion of the Service's determination that the proposed work will/will not be compatible with the purposes for which those refuges were established, and to secure any appropriate permits that may be required. Likewise, LCA activities occurring on State-administered Wildlife Management Areas or refuges should also be fully coordinated with the Louisiana Department of Wildlife and Fisheries.*

Under provisions of the National Wildlife Refuge System Improvement Act of 1997, prior to initiating implementation of an LCA Project that would potentially affect any NWR, the District would, contact the appropriate Refuge Manager to determine if the proposed project constitutes a "refuge use" subject to a compatibility determination. If required to determine the anticipated impacts of any proposed use, the District would provide sufficient data and information to document any short-term, long-term, direct, indirect, or cumulative impacts on NWR resources. Compatibility determinations would include a public review and comment period before issuance of a final decision by the Service. To facilitate such contacts, the Louisiana Field Office would be contacted at (337) 291-3100. Likewise, the District would fully coordinate with the LDWF for those LCA Plan activities occurring on state-administered Wildlife Management Areas or refuges.

4. *Because of the uncertainties regarding some of the currently proposed habitat prediction methodologies, and because many details regarding the design, operation, and associated effects of the TSP are not yet available at the current programmatic level of planning, the USFWS cannot complete their evaluation of the individual TSP features' effects on fish and wildlife resources, nor can they entirely fulfill their reporting responsibilities under Section 2(b) of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) for each of those features. Therefore, extensive additional Service involvement during subsequent detailed planning, engineering, design, and construction of specific project measures, along with more-definitive project information that will be available during those planning phases, will be required so that we can fulfill our responsibilities under that Act. Additionally, improvements in the* *hydrologic and desktop models will be needed to predict environmental impacts and benefits of individual plan features, as indicated in our previous draft Fish and Wildlife Coordination Act Reports (Paille and Roy 2003, Grouchy and Paille 2004). Additionally, the USFWS states that the proposed Science and Technology Program should give high priority to refining the land gain/loss and habitat change models to enable determination of and evaluation of project-level effects and facilitate completion of FWCA reporting.*

The District intends to maintain the integrity of the collocated team which would afford the USFWS the ability to be intensively involved during subsequent detailed planning, engineering, design, and construction of specific LCA Plan restoration features, and provide more-definitive project information that would be available during those planning phases, in an effort to provide sufficient information to the USFWS to fulfill their responsibilities under Section 2(b) of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq). Additionally, the LCA S&T Program would give high priority to improvements in the hydrologic and desktop models that would better enable prediction of potential environmental impacts and benefits of individual plan features and the program manager would ensure that the S&T Office resolves any outstanding issue, or concerns regarding models or evaluation process in cooperation with the participating agency (including USFWS).

5. *The USFWS has actively participated throughout the formulation and evaluation of the LCA coastwide alternatives and the selection of near-term restoration features, the large-scale studies, and the potential demonstration projects that comprise the TSP. USFWS involvement and input includes the preparation of three previous draft Fish and Wildlife Coordination Act Reports (Paille and Roy 2003a, and 2003b, and Grouchy and Paille 2004); a letter listing threatened and endangered species within coastal parishes (Appendix A of the FWCAR); assistance in preparation of the draft Biological Assessment for Comprehensive Plan effects on threatened and endangered species; a May 11, 2004, letter affirming our continued participation as a Cooperating Agency in accordance with the implementing regulations of the National Environmental Policy Act of 1969; and concurrence with the District's programmatic "not likely to adversely affect" threatened and endangered species determinations (via an August 23, 2004, Department of the Interior letter). Those documents are incorporated into the FWCAR by reference, and should be considered as integral components of the administrative record for the forthcoming final PEIS and LCA Study Report.*

Under provisions of the NEPA, ESA, and the Fish and Wildlife Coordination Act, and because they are integral components of the administrative record, the District has included (in Appendix B of the FPEIS) the three previous draft FWCAR (Paille and Roy 2003a, and 2003b, and Grouchy and Paille 2004); the letter listing threatened and endangered species within coastal parishes (Appendix A of the FWCAR); the draft Programmatic Biological Assessment for the Comprehensive Plan effects on threatened and endangered species; the May 11, 2004, letter affirming the USFWS continued participation as a Cooperating Agency; the August 23, 2004, Department of the Interior letter of concurrence with the District's programmatic "not likely to adversely affect" threatened and endangered species determinations; and the October 6, 2004, FWCAR in appendix B6 of the FPEIS as integral components of the administrative record for the forthcoming FPEIS and LCA Main Report.

> **6.** *For purposes of maximizing synergistic wetland restoration benefits within the eastern Terrebonne Basin critical needs area, the post-authorization studies for the proposed Small Bayou Lafourche Diversion Project should, to the maximum extent possible, incorporate key Grand Bayou-area features of the Convey Atchafalaya River Water to Northern Terrebonne Basin Project.*

The District, working with other Federal and non-Federal agencies, would evaluate the synergistic effects of the LCA Plan's features as well as the synergistic effects of those features with other actions or projects during the specific feasibility level evaluation and make adjustments to project implementation accordingly.

The following Federal agencies are formal Cooperating Agencies for the LCA Study: MMS, NRCS, NMFS, USEPA, USFWS, and the USGS. The technical input from these agencies has greatly contributed to the completeness, effectiveness, and efficiency of the study. Continued cooperation and collaboration would greatly assist in effective plan implementation as well. With the exception of the Science Director, the S&T Office would be staffed in accordance with the level of effort and required tasks. It is probable that Federal and state agency scientists would be members of these teams on a case-by-case basis.

4.4.3 CWPPRA Task Force

As the lead decision maker for coastal projects pursued under CWPPRA, the CWPPRA Task Force would interact with the LCA Task Force. Primary interaction would be to ensure that efforts pursued under CWPPRA are complementary to efforts pursued under LCA. This interaction would include:

- CWPPRA Task Force members would be briefed on Task Force actions through their respective agency's chain of command;
- Attendance at Task Force quarterly meetings, as necessary; and
- Attendance at Governor's Advisory Commission meetings, as necessary.

Some of the features identified in the LCA Study as having the potential to address areas of critical ecological need already have some level of investigation and design effort completed under CWPPRA. Approval of the LCA Plan, especially the programmatically and conditionally authorized elements, would present an opportunity to expeditiously move towards implementation of some of these features that would take longer if they proceeded under the funding-constrained CWPPRA program. This would enable CWPPRA to potentially refocus or prioritize its program elements towards other important restoration efforts that complement LCA program elements. The CWPPRA features would continue to provide restoration benefits, as well as lessons learned to the larger-scale and longer-term restoration efforts undertaken within the Louisiana coastal area.

4.4.4 State of Louisiana Coastal Restoration Program Efforts

4.4.4.1 Louisiana Wetlands Conservation and Restoration Authority

The Louisiana Wetlands Conservation and Restoration Authority (State Wetlands Authority or Authority) is a cabinet level body legislatively established in 1989 (R.S. 49:213.1 et seq) within the Office of the Governor. Its functions include promulgation of policy with respect to coastal restoration, development of an annual coastal plan subject to the approval of the Louisiana legislature, and approval of funds proposed for appropriation from the Wetlands Conservation and Restoration Fund.

The Governor's appointed Executive Assistant for Coastal Activities serves as Chair of the Authority to develop procedures for the operation of the Authority, and to perform any tasks delegated to him by the Authority. The State Wetlands Authority is composed of the Governor's Executive Assistant for Coastal Activities, the director of the State Soil and Water Conservation Committee, the Commissioner of Administration and the Secretaries of the Departments of Natural Resources, Wildlife and Fisheries (LDWF), Environmental Quality (LDEQ), and Transportation and Development (LDOTD).

The Authority must approve any request by any state agency for funds to finance research, programs or projects involving coastal wetlands, except those to be funded from self-generating sources. Acting for the Authority, the Executive Assistant is responsible for overseeing and coordinating "all state departmental budget requests for programs and projects pertaining to coastal wetlands conservation and restoration, as well as all requests for funds to be appropriated from the Wetlands Conservation and Restoration Fund." Furthermore, the roles of the Executive Assistant include "review and reconcile state agency comments on federally sponsored water resource development projects" and "represent the policy and consensus viewpoint of the state at the Federal, regional, state and local levels with respect to wetlands conservation and restoration," and is expected to "report annually to the legislative committees on natural resources as to the progress of the projects and programs enumerated in the plan," providing such details as "estimated construction and maintenance costs, progress reports, and estimated completion timetables" (R.S. 49:213.1 et seq).

4.4.4.2 Louisiana Governor's Advisory Commission on Coastal Restoration and Conservation

Created within the Office of the Governor in the public interest, the Advisory Commission on Coastal Restoration and Conservation (the Commission) acts to advise the Governor of Louisiana and the Executive Assistant for Coastal Activities on coastal issues relative to the overall status and direction of the state's restoration program. The Governor's Office of Coastal Activities provides staffing functions for the Commission.

A broad range of groups and stakeholders comprise the 31-member Commission, representing numerous and diverse interests that live, work, and recreate in coastal Louisiana. Leaders in finance, banking and business, agriculture and farming, academia, non-governmental organizations and the conservation community, energy production and distribution, industry, political subdivisions, landowners, legislators, and commercial and recreational fishing are all represented on the Commission.

Commission meetings provide a forum for coordinating activities and exchanging information on the status of various state and Federal efforts affecting coastal preservation and conservation, fostering collaboration between various stakeholder groups and involved state and Federal agencies, identifying and resolving conflicts, and identifying potential sources of funding for coastal projects and programs.

4.5 ADAPTIVE ENVIRONMENTAL ASSESSMENT AND MANAGEMENT

As detailed in section 2.2 EXISTING AND FUTURE WITHOUT-PROJECT CONDITIONS, large coastal ecosystems like the Louisiana coastal area are dynamic systems that integrate terrestrial and marine processes nested in scale from global to local influences against a backdrop of historical conditions. The scientific and technological uncertainties outlined in section 3.1 PLANNING CONSTRAINTS, as well as watershed influences that affect delivery of water, sediment, and nutrients, and uncertainty in the timing and magnitude of infrequent, but high-energy events such as floods and storms, storms make response prediction within these large ecosystems inherently difficult. Integration of an AEAM system within the LCA Program would facilitate management of this complex system to best meet the planning objectives.

AEAM prescribes a management process wherein future actions can be changed as the efficacy of past actions on the ecosystem is determined through monitoring and other means to improve knowledge about the response of the system (Holling and Gunderson 2002). The AEAM approach recognizes that uncertainty is unavoidable in managing large-scale ecological systems. If properly planned and maintained, the feedback element can be used to sequentially improve management actions so that future system conditions become more consistent with program goals and objectives than past actions. AEAM allows development of an iterative and flexible approach to management and decision-making.

All organizations within the LCA Management Structure have a role in implementing AEAM. The LCA S&T Office would make AEAM recommendations to the Program Management Team and the PET based on assessment of monitoring data and the development of new tools or technologies. Specifically, the Program Manager is responsible for the overall program and issuing programmatic guidance to make necessary adjustments to better meet program objectives. The PET would implement changes directed by the programmatic guidance. **Figure MR 4-8** depicts this iterative process and the roles of the different groups. It is important to note that the scope of decisions presented in the "decision process" in **figure MR 4-8** would differ in scale. One way of expressing this is to distinguish between strategic decisions and tactical decisions. Strategic decisions comprise the decisions about the nature and timing of large projects and major policies related to the overall programmatic effort. Tactical decisions comprise those decisions about implementation and operation that are necessary for the projects and policies to succeed. The AEAM framework applies to both strategic and tactical decisions about coastal restoration. The key attribute of the decision process under AEAM is well-defined and effective communication. The AEAM within the LCA Program management would build upon lessons learned over the past several years in CWPPRA, along with CWPPRA-initiated tool development, such as the Coast-wide Reference Monitoring System (Steyer et al. 2003).

The structures and general process outlined in the LCA S&T Program provide the basic elements of an AEAM program. To make the AEAM effort most effective, it would be important to view the restoration effort as a learning process, with adaptation as required. Timely and effective communication of information to all participants would be instrumental in effectively implementing the AEAM process and to further attain program objectives. Examples of communication tools are project-specific assessment reports (report cards), annual programmatic AEAM report, and science symposia convened on an annual or biennial basis. Appendix A SCIENCE AND TECHNOLOGY PROGRAM expands on this general discussion of AEAM.

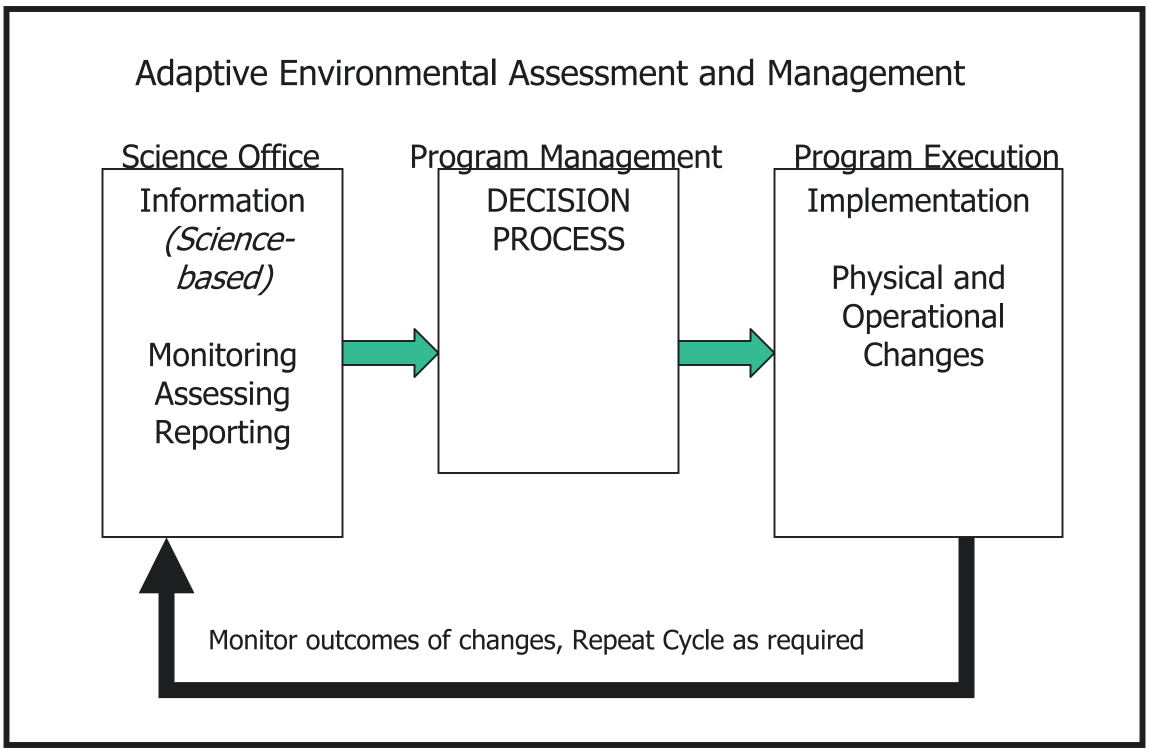


Figure MR 4-8. Adaptive Environmental Assessment and Management Process.

4.6 INSTITUTIONAL REQUIREMENTS

The WRDA of 1986 comprehensively reestablished and redefined the Federal interest in water resources development and, in recognition of the limitations on Federal financial resources, instituted requirements for proportionately greater non-Federal cost-sharing in USACE projects.

4.7 DIVISION OF RESPONSIBILITIES

4.7.1 Non-Federal Sponsor

The non-Federal sponsor is the State of Louisiana, acting through its LDNR. The LDNR would sponsor further planning studies, preparation of comprehensive plans and specifications developed during the detailed preconstruction engineering and design phase, and implementation of authorized projects under the LCA Program. The non-Federal sponsor has been made aware of and has expressed a complete understanding of the ultimate requirements for plan implementation.

4.7.2 Cost Sharing Requirements

The plan recommended in the report would require non-Federal cost-sharing for implementation. A standard cost share percentage of 65 percent Federal and 35 percent non-Federal would be applied for construction features, including demonstration projects and the S&T Plan, 75 percent Federal and 25 percent non-Federal would be applied for beneficial use of dredged material, 50 percent Federal and 50 percent non-Federal for general investigations, studies, and feasibility-level decision documents, and 100 percent of land, easements, rights of way, relocations, and disposals (LERRDs) and operations, maintenance, repair, rehabilitation, and replacement (OMRR&R) costs would be the responsibility of the non-Federal sponsor. These implementation costs are shown in summary and in detail in **tables MR 4-18** and **MR 4-19**, respectively.

As shown, the total cost consists of four major elements. The general investigations (GI) costs are those associated with preparation of the feasibility-level decision document. The PED phase is the phase during which the project design is finalized, plans and specifications are completed, and the construction contract is prepared for award. The construction cost includes all costs associated with project construction, as well as costs for monitoring and adaptive management. Operation and maintenance costs are those associated with operating and maintaining a project; this category includes costs of induced dredging.

4.7.3 Federal Obligations

1. Subject to receiving funds appropriated by the Congress of the United States and using those funds and funds provided by the non-Federal sponsor, expeditiously constructing the Project, applying those procedures usually applied to Federal projects, pursuant to Federal laws, regulations, and policies.

2. Affording the non-Federal sponsor the opportunity to review and comment on the solicitations for all contracts, including relevant plans and specifications, prior to the Government's issuance of such solicitations. The Government shall consider in good faith the comments of the non-Federal sponsor, but the contents of solicitations and award of contracts shall be exclusively within the control of the Government.

3. To the extent possible, affording the non-Federal sponsor the opportunity to review and comment on all contract modifications, including change orders, prior to the issuance to

the contractor of a Notice to Proceed. In those cases where providing the non-Federal sponsor with notification of the contract modification or change order is not possible prior to issuance of the Notice to Proceed, such notification would be provided in writing after the fact at the earliest date possible. The Government shall consider in good faith the comments of the non-Federal sponsor, but the execution of contract modifications, and issuance of change orders, shall be exclusively within the control of the Government.

4. To the extent possible, affording the non-Federal sponsor the opportunity to review and comment on all contract claims prior to resolution thereof. The Government shall consider in good faith the comments of the non-Federal sponsor, but the resolution of contract claims, and performance of all work on the Project (whether the work is performed under contract or by Government personnel), shall be exclusively within the control of the Government.

5. Throughout the period of construction, furnishing the non-Federal sponsor with a copy of the Government's Written Notice of Acceptance of Completed Work for each contract for the Project.

6. After the Government determines that construction of the Project, or functional portion of the Project, is complete: 1) notifying the non-Federal sponsor in writing of such determination; 2) furnishing the non-Federal sponsor with an Operation, Maintenance, Repair, Replacement, and Rehabilitation Manual; and 3) turning the Project, or functional portion of the Project, over to the non-Federal sponsor for operation, maintenance, repair, replacement, and rehabilitation.

7. Performing a final accounting to determine the contributions provided by the non-Federal sponsor, and to determine whether the non-Federal sponsor has met its obligations.

Table MR-4-18. Summary of LCA Plan Federal and Non-Federal Cost Share Responsibilities (June 2004 Price Levels)

Conditionally Authorized Features:		
Feasibility-level Decision and NEPA Documentation Cost:		
Federal (50%)	$	27,336,500
Non-Federal (50%)	$	27,336,500
Subtotal	$	54,673,000
Construction Cost (Including PED, E&D, S&A, Monitoring):		
Federal (65%)	$	500,768,550
Non-Federal (35%):		
LERRD*	$	178,619,000
Cash	$	130,004,450
Subtotal	$	809,392,000
Total	**$**	**864,065,000**
*For the conditionally authorized feature, Small Diversion at Hope Canal, LERRD exceeded 35% of the total project cost by $25,336,250, which is reimbursed to the non-federal sponsor.		
Programmatically Authorized Features:		
Science & Technology Program (10 year program)		
Federal (65%)	$	65,000,000
Non-Federal (35%)	$	35,000,000
Demonstration Program (10 year program)		
Federal (65%)	$	65,000,000
Non-Federal (35%)	$	35,000,000
Beneficial Use of Dredge Material Program		
Federal (75%)	$	75,000,000
Non-Federal (25%)	$	25,000,000
Investigations of Modifications of Existing Structures		
Federal (50%)	$	5,000,000
Non-Federal (50%)	$	5,000,000
Total	**$**	**310,000,000**
Conventionally Authorized Features:		
Feasibility-level Decision and NEPA Documentation Cost:		
Federal (65%)	$	23,764,500
Non-Federal (35%)	$	23,764,500
Subtotal	$	47,529,000
Construction Cost (Including PED, E&D, S&A, Monitoring):		
Federal (65%)	$	464,351,550
Non-Federal (35%)		
LERRD	$	208,100,000
Cash	$	41,935,450
Subtotal	$	714,387,000
Total	**$**	**761,916,000**
Large-scale, Long-term Studies for Future Congressional Authorization:		
Federal (50%)	$	30,000,000
Non-Federal (50%)	$	30,000,000
Total	**$**	**60,000,000**

Table MR 4-19
Detailed LCA Plan Cost Sharing Distribution
(June 2004 Price Levels)

Item	Federal Share	Non-Fed Share	Total Cost
Feasibility-level Decision and NEPA Documentation - (50/50)	$ 27,336,500	$ 27,336,500	$ 54,673,000
Near-term Feature First Construction Cost - (65/35)	$ 402,750,300	$ 61,758,450	$ 489,845,000
Preconstruction, Engineering, and Design (PED) - (65/35)	$ 24,327,500	$ 11,924,500	$ 36,252,000
Engineering and Design (E&D) - (65/35)	$ 20,277,850	$ 8,740,150	$ 29,018,000
Supervision and Administration (S&A) - (65/35)	$ 48,859,750	$ 20,113,250	$ 68,973,000
Project Monitoring - (65/35)	$ 4,553,150	$ 2,131,850	$ 6,685,000
LERRD - (0/100)	$ -	$ 178,619,000	$ 178,619,000
Conditionally Authorized Subtotal	**$ 528,105,050**	**$ 310,623,700**	**$ 864,065,000**
Cash Contributions	*$ 555,225,300*	*$ 130,004,450*	
Science & Technology Program (10 year Program) - (65/35)	$ 65,000,000	$ 35,000,000	$ 100,000,000
Demonstration Program (10 year Program) - (65/35)	$ 65,000,000	$ 35,000,000	$ 100,000,000
Beneficial Use of Dredge Material Program - (75/25)	$ 75,000,000	$ 25,000,000	$ 100,000,000
Investigations of Modifications of Existing Structures - (50/50)	$ 5,000,000	$ 5,000,000	$ 10,000,000
Programmatically Authorized Subtotal	**$ 210,000,000**	**$ 100,000,000**	**$ 310,000,000**
Cash Contributions	*$ 210,000,000*	*$ 100,000,000*	
Total Conditionally/Programmatically Authorized Subtotal	**$ 738,105,050**	**$ 410,623,700**	**$ 1,174,065,000**
Feasibility-level Decision and NEPA Documentation - (50/50)	$ 23,764,500	$ 23,764,500	$ 47,529,000
Near-term Feature First Construction Cost - (65/35)	$ 334,439,850	$ 25,829,150	$ 360,269,000
Preconstruction, Engineering, and Design (PED) - (65/35)	$ 31,417,550	$ 4,609,450	$ 36,027,000
Engineering and Design (E&D) - (65/35)	$ 40,662,750	$ 4,972,250	$ 45,635,000
Supervision and Administration (S&A) - (65/35)	$ 54,137,450	$ 4,535,550	$ 58,673,000
Project Monitoring - (65/35)	$ 3,693,950	$ 1,989,050	$ 5,683,000
LERRD - (0/100)	$ -	$ 208,100,000	$ 208,100,000
Conventionally Authorized Features Subtotal	**$ 488,116,050**	**$ 273,799,950**	**$ 761,916,000**
Cash Contributions	*$ 488,116,050*	*$ 65,699,950*	
Large-scale Studies - (50/50)	$ 30,000,000	$ 30,000,000	$ 60,000,000
Total Conventionally Authorized Subtotal	**$ 518,116,050**	**$ 303,799,950**	**$ 821,916,000**
Total LCA Plan Cost Share	**$ 1,256,221,100**	**$ 714,423,650**	**$ 1,995,981,000**
Total Cash Contributions	*$ 1,283,341,350*	*$ 325,704,400*	
Total Real Estate		$ 386,719,000	

*For the conditionally authorized feature, Small Diversion at Hope Canal, LERRD exceeded 35% of the total project cost by $25,336,250, which is reimbursed to the non-Federal sponsor.

4.7.4 Non-Federal Responsibilities

The non-Federal sponsor shall, prior to implementation, agree to perform all of the local cooperation requirements and non-Federal obligations. Local cooperation requirements and non-Federal sponsor obligations include, but are not necessarily limited to:

1. Provide a minimum of 50 percent of costs allocated to general investigations, studies, and feasibility-level decision documents.

2. Provide a minimum of 35 percent of total project costs allocated to ecosystem restoration/environmental protection project costs, including demonstration projects, a minimum of 25 percent of total project costs allocated to beneficial use of dredged material:

    a. Enter into an agreement which provides, prior to execution of the project cooperation agreement, 25 percent of design costs;

    b. Provide, during the first year of construction, any additional funds needed to cover the non-Federal share of design costs;

    c. Provide all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, and perform or assure the performance of all relocations determined by the Federal Government, in consultation with the non-Federal sponsor, to be necessary for the construction, operation, maintenance, repair, replacement, and rehabilitation of the project;

    d. Provide or pay to the Federal Government any additional funds needed to cover the cost of providing all retaining dikes, waste weirs, bulkheads, and embankments, including all monitoring features and stilling basins, that may be required at any dredged or excavated material disposal areas required for the construction, operation, maintenance, repair, replacement, and rehabilitation of the project;

    e. Provide, during construction, any additional funds necessary to make its total contribution attributable to ecosystem restoration/environmental protection equal to 35 percent of total project costs allocated to ecosystem restoration/environmental protection, and 25 percent of the total project costs allocated to beneficial use of dredged material;

4\. 3. Provide 35 percent of the costs allocated to the Science Program;

4. Provide the non-Federal share of that portion of the costs of mitigation and data recovery activities associated with historic preservation, that are in excess of 1 percent of the total amount authorized to be appropriated for the project;

5. Not use Federal funds to meet the non-Federal sponsor's share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is authorized;

6. Operate, maintain, repair, replace, and rehabilitate the project, or functional portion of the project, including mitigation, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and state laws and regulations and any specific directions prescribed by the Federal Government;

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

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

9. Perform, or cause to be performed, 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 the initial construction, periodic nourishment, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction;

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

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

12. Prevent obstructions of or encroachments on the project (including prescribing and enforcing regulations to prevent such obstruction or encroachments) which might reduce ecosystem restoration benefits, hinder operation and maintenance, or interfere with the project's proper function, such as any new developments on project lands or the addition of facilities which would degrade the benefits of the project;

13. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, and other evidence is required, to the extent and in such detail as would properly reflect total costs of construction of the project, 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;

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

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

16. 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 necessary for the initial construction, periodic nourishment, operation, and maintenance of the project, including those necessary for relocations, borrow materials, and dredged or excavated material disposal, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act.

4.8 REAL ESTATE

The purpose of this section is to discuss the real estate issues involved in pursuing the LCA Plan described in this report.

4.8.1 Estates

The following estates are proposed to be acquired over real property, as appropriate for particular project features. Each feasibility report/decision document would more particularly propose the exact estates to be acquired. The brackets indicate optional language for rights that may need to be acquired, if necessary for a project feature.

4.8.1.1 Fee excluding minerals (with prohibition on use of the surface)

This estate would be acquired, as needed for fee title, e.g., structures, barrier islands, and shoreline protection. Public access would generally be allowed on fee-owned sites, except where prohibited due to safety or security concerns or otherwise inconsistent with project purposes. Shoreline projects would include the right of public use of the shoreline below the ordinary high water mark.

4.8.1.2 Flowage easement (permanent flooding)

This estate would be acquired to secure the perpetual right to permanently overflow, flood and submerge lands and may allow existing and new camps within flowage areas, e.g., outlying areas over which the only project impact would be the overflow of water, such as the outermost areas affected by freshwater diversion.

4.8.1.3 Channel or channel improvement easement

This estate allows the perpetual right to construct, operate, and maintain a channel or channel improvement work, e.g., channels for freshwater and/or sediment diversion, relocated navigation channels, and improvements to existing channels. Habitable structures would not be allowed to remain. Although mineral interests would be reserved to the owner, mineral exploration and extraction would not be allowed on the surface.

4.8.1.4 Wetland creation and restoration easement

This estate would be acquired to secure the perpetual right to construct, operate and maintain the creation and/or restoration of wetlands and associated coastal habitats on the land; the right to deposit dredged material sediment or other beneficial materials thereon; to construct dikes and to install, alter, relocate, repair or plug cuts in the banks of dikes; to accomplish any alterations of contours; to clear, trim, cut, fell, and remove therefrom any or all *[*trees, timber*]*, underbrush, obstructions and any other vegetation, structures, or obstacles as required; to clear, borrow, excavate and remove therefrom all soil, dirt and any other materials; to construct, operate and maintain pipelines; to place, move and utilize machinery; to plant or cause the growth of vegetation; provided that existing habitable structures may remain, but new habitable structures may not be constructed on the land; excepting and excluding from the taking all minerals, in and under said land and all appurtenant rights for the exploration, development, production and removal of said minerals, but exploration or drilling on the surface requires prior written approval. This estate would be acquired for marsh creation, and other restoration features.

For those areas currently in State of Louisiana ownership where land is anticipated to be created as a result of the deposition of inorganic material from a diversion project, the right of public access would be provided by the State of Louisiana. However, in such areas, public access would not be allowed until the land has been created and stabilized.

4.8.1.5 Flowage and deposition easement

This estate would be acquired to secure the perpetual right to overflow, flood and submerge the land, including the right to deposit dredged or sediment material on, over and across the land; the right to clear and remove any brush, debris and natural obstructions; provided that existing habitable structures may be maintained on the land, and new structures may be constructed as long as they are consistent with the construction, operation and maintenance of the authorized project, provided prior written approval is obtained; excepting and excluding from the taking all minerals, in and under said land and all appurtenant rights for the exploration, development, production and removal of said minerals, but exploration or drilling on the surface requires prior written approval. This estate would be acquired in areas over which there may be overflow of water and deposition of sediment, e.g., ponding areas resulting from diversions of freshwater or sediment and /or placing gaps in canals.

4.8.1.6 Dredged material pipeline easement

This easement is a temporary and assignable easement and right-of-way in, on, over and across the land for the location, construction, operation, maintenance, alteration, repair and patrol of an [underground] [above ground] dredged material pipeline. This estate would be acquired if a pipeline would be used for the transport of dredged material.

4.8.1.7 Dredged material disposal easement

This easement allows perpetual rights to construct, operate, and maintain a dredged material disposal area on the land, [including the right to construct dikes]; to deposit dredged material thereon; [to accomplish any alterations of contours on said land for the purpose of accommodating the deposit of dredged material as necessary in connection with such works]; [to borrow, excavate and remove soil, dirt and other materials, including dredged material, from said land;] [to undertake any management practice designed to enhance use of or extend the life of said land for the deposit of dredged material]; to clear, cut, fell and remove any and all trees, timber, underbrush or other obstructions; provided that existing habitable structures may be maintained on the land, and new structures may be constructed as long as they are consistent with the construction, operation and maintenance of the project, provided prior written approval is obtained; excepting and excluding from the taking all minerals, in and under said land and all appurtenant rights for the exploration, development, production and removal of said minerals, but exploration or drilling on the surface must be consistent with the construction, operation and maintenance of the authorized project and requires prior written approval. This estate would be acquired for the disposal of dredged material and would allow management practices.

4.8.1.8 Dike (and/or weir) easement

This easement allows perpetual and exclusive right to construct, maintain, repair, operate, patrol and replace [an earthen] [a stone] dike and/or weir; provided that no habitable structures shall be constructed or maintained on the land; excepting and excluding from the taking all minerals, in and under said land and all appurtenant rights for the exploration, development, production and removal of said minerals, but without the right to enter upon or over the surface of said land for the purpose of drilling and extracting therefrom said minerals.

4.8.1.9 Levee and channel easement

This easement combines two estates and would be acquired to secure the perpetual and assignable right to construct, maintain, repair, operate, patrol and replace a levee, rock weir, drainage ditch, channel and/or channel improvement works; provided that no habitable structures shall be constructed, existing structures may be maintained on the land, no other habitable structures shall be constructed or maintained on the land; excepting and excluding from the taking all minerals, in and under said land and all appurtenant rights for the exploration, development, production and removal of said minerals, but without the right to enter upon or over the surface of said land for the purpose of drilling and extracting therefrom said minerals.

4.8.1.10 Access easement

The estate would be acquired to ensure access to project features. In appropriate areas, the estate would expressly include the right of public access, e.g., access to the shoreline and navigational elements of a project.

4.8.1.11 Canal alteration easement

This estate would be acquired to secure the right to deposit materials within and around the canal, to place plugs or fully close the canal, to cut gaps in the canal, or make other alterations to a canal, in order to restore the hydrology and /or to stabilize the spoil banks along the canal. In appropriate areas, it may include the right to remove from the canal any plug in order to accommodate passage through the canal, provided the user replaces the plug thereafter. The estate would expressly provide that the original canal (or pipeline) easement or right of way is subordinate to the canal alteration easement.

4.8.2 Non-Federal Sponsor

The non-Federal sponsor is the LDNR, acting on behalf of the State of Louisiana. As the non-Federal Sponsor, the LDNR must provide all real estate interests required for each project implemented under the plan, i.e., all lands, easements, rights of way, relocations, and any other interests, including suitable borrow and dredged or excavated material disposal areas (LERRDs). LDNR has indicated it would provide all lands, water bodies, and/or waterbottoms that are owned, claimed, or controlled by the State of Louisiana, including the voluntary acquisition of oyster leases but has requested the District to acquire other real estate interests on its behalf, including condemning such interests if necessary. The LDNR also has requested that the District perform all relocations and/or removals of public facilities and utilities, if required, except as said relocations and/or removals traverse State of Louisiana owned lands and/or water bottoms, in which the State of Louisiana would make every effort to resolve such actions.

The decision whether or not to acquire on behalf of a non-Federal sponsor is within the Government's discretion. Acquisition on behalf of the non-Federal sponsor would be discussed on a case-by-case basis in each decision document.

4.8.3 Non-Federal Sponsor-owned Real Property (LERRD's)

Given the time constraints for this report preparation, there was insufficient time for coordination with the Louisiana State Land Office to confirm State of Louisiana owned real property. For purposes of this report, the following position is adopted: the State of Louisiana is the owner of the bed and bottom of all waterways within the State that were navigable in fact, in 1812, when Louisiana was admitted to the United States. It is acknowledged that the State may have transferred ownership of certain water bodies to private interests. For planning purposes, it is assumed that the state owns the bed and bottoms of navigable waterways, including areas of open water, and that all land within the plan area is privately-owned. A detailed determination of ownership of the state, including any political subdivisions of the state, would be made for each particular plan.

4.8.4 Real Estate Cost Estimates

Cost estimates include the estimated value of the LERRD's. The Federal appraisal method has been used to estimate the value of the LERRD's, including oyster leases, as State law provides that "compensation for the taking of property rights affected by coastal wetlands conservation, management, preservation, enhancement, creation or restoration activities shall be governed by, and strictly limited to, the amount and circumstances required by the Fifth Amendment of the Constitution of the United States of America." La.R.S. 49:213.10.B. To account for changes in the future, the real estate cost estimates include a 50 percent contingency, which is found to be reasonable. The decision was based on the uncertainties associated with the study such as future design changes; areas that have not been identified yet such as mitigation areas; borrow sources beyond those of the Gulf of Mexico, the Mississippi River, and the Calcasieu River; and access locations for dredged material disposal pipelines; unforeseen severance damages; possible cemetery relocations; the impact, if any, of project footprints on mineral exploration and/or extraction rights; settlement of possible land reclamation rights, if allowed as project costs; and unknown court awards. In addition, the estimated number of the landowners is based on outdated ownership Tobin maps, many of which were last updated 40 to 60 years ago. Other costs included are contracting side-scan sonar for oysters, oyster report review, mapping by contractor, review of contractor mapping, title binders, intermediate certificates, final title insurance policy, temporary permits, review of plans and specifications, title review, appraisals and appraisal review, negotiations, field trips, meetings with landowners, reimbursement for relocation expenses for displaced persons, e.g., moving of personal property and reestablishment expenses for eligible businesses (PL 91-646), crediting, estimated percentage for condemnations, review of acquisitions by non-Federal sponsor, and administrative costs such as coordination with engineers, project management, contractors, and contracting division, drafting/mailing letters, estates, just compensation letters, deeds, etc.

4.8.5 Navigation Servitude

Derived from the Commerce Clause of the U.S. Constitution, article I, section 8, clause 3, the navigation servitude is the dominant right of the United States to use, control and regulate the navigable waters and submerged lands thereunder. The applicability of the navigation servitude depends on both legal and factual determinations. If the legal determination supports assertion of the navigation servitude, then the second step is to determine the geographical area over which the servitude can be asserted. In tidal areas, the servitude extends to all lands below the mean high water mark, whereas in non-tidal areas, the servitude extends to all lands within the bed and banks of a navigable stream that lie below the ordinary high water mark. For planning purposes, the real estate cost estimates do not consider the effect of the navigation servitude, given the extensive technical analysis required for such a factual determination. The navigation servitude would be asserted where restoration is related to navigation. This includes new restoration feature opportunities or projects as well as modifications to existing projects.

4.8.6 Public Law (PL) 91-646 Relocations

Title II of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, PL 91-646, as amended, would apply if the project displaces any residences, businesses, or farms. The assumption taken at the time of plan preparation was that minimal displacement would occur.

4.8.7 Habitable Structures

Historically, coastal Louisiana has a rich tradition of hunting, fishing, trapping, and waterfowl activity. Recreational type camps, often consisting of crude structures accessible only by water, are scattered throughout the marshes. Because of the low elevation, tidal influence, and susceptibility to hurricane damage, the camps are placed on stilts or otherwise raised. For many of the proposed plan areas, the restoration features, such as the flowage of water and sediment, study results indicate that the camps would not be adversely impacted, given the level of flowage in which case the existing camps within such areas may be allowed to remain. However, camps may not be able to remain in areas in which there are adverse impacts to the camps such as, but not limited to: camps located within the rights-of-way for channels, pipelines, or levees; camps that due to changes in elevation of the surface water become uninhabitable or unsafe; or camps that can no longer be accessed due to plan features. A case-by-case analysis of existing camps would be made prior to the initiation of real estate activities. For purposes of the real estate estimate, it is assumed that existing habitable structures, including camps, would be allowed to remain within the plan areas, except in areas where fee title must be acquired or where the habitable structures would be directly impacted by a plan feature, e.g., within a new channel or levee. New habitable structures may be allowed within the plan footprints, provided they do not interfere with the construction, operation or maintenance of the plan. Owners would need to obtain prior written approval from the U.S. and the non-Federal sponsor for construction of new camps/habitable structures in the plan area. In addition, all camps must comply with Federal, state, and local laws, e.g., section 404 permits under the Clean Water Act. Camp owners would also be required to hold the Government harmless from damage or injury relating to the plan.

4.8.8 Relocation of Roads, Bridges, Facilities/Utilities, Towns, and Cemeteries

Based on available information, a preliminary list of possible relocations has been prepared. Relocations consist of pipelines, roads, bridges, and utilities. Relocation of towns is not planned. It is not known if cemeteries would be within the rights-of-way of the plan. Determinations of compensability would be prepared for each report. For planning purposes, it is assumed that the facility owners would have compensable interests in their respective facilities. Costs associated with the subordination agreement are included in the real estate cost estimate.

4.8.9 Minerals

Under Louisiana law, a landowner does not own oil, gas, or other minerals "occurring naturally in liquid or gaseous form." However, the owner does have the exclusive right to explore and develop the land for the production of minerals. A landowner cannot transfer the mineral estate independent of the surface property, but the owner may lease the right to produce the minerals. The owner may also convey a mineral servitude to another, thereby giving that person the right to grant a mineral lease. It is common practice in Louisiana for a landowner to reserve a prescriptable mineral servitude for himself when he sells a tract of land to another. Between private parties, if a mineral owner does not exercise the right within ten years, the servitude is extinguished for "non-use," and reverts to the then surface owner. This "prescription of non-use" does not apply, however, in instances when the United States or the State of Louisiana, or any subdivision or agency of either, acquires property but reserves the mineral interests to the landowner. La R.S. 31:149. This statute allows the prior landowner to enjoy the right to minerals in perpetuity.

Mineral rights would not be acquired. The estates would expressly reserve to the landowner all mineral interests. Although the mineral interest owner would be allowed to continue ongoing mineral activities, in some areas there may be prohibitions or restrictions on future use of the surface of the property for mineral purposes. Alternative drilling methods may allow access to the minerals, e.g., via directional drilling. Specifically, in areas where fee title would be acquired and where permanent features would preclude surface access, e.g., channel or levee easements, the estates would expressly prohibit surface exploration or extraction. In other areas, the estates would restrict, rather than prohibit, the surface use, and would require prior written approval by the Corps and the non-Federal sponsor for mineral activities on the surface. Such approval would be granted if the surface activity does not interfere with the construction, operation, or maintenance of the project.

If it is not feasible for a landowner to use alternative methods to extract minerals, the landowner might try to assert a takings claim. This assertion might be contingent upon the size of the ownership and the area impacted by the project. At present, there are insufficient funds and time to identify possible locations of mineral deposits and the size of ownerships impacted by the plan. During the Feasibility Report Phase, when a more definitive plan footprint in known, ownership research would be conducted to determine the presence of existing mineral leases and to quantify the impact, if any, of the plan alignment upon those leases.

It is assumed that remote access to the minerals would be feasible, e.g., via directional drilling or other methods. However, as for any outstanding third party mineral interests, releases or subordinations would be secured from these mineral interest holders, to ensure acknowledgment of these future surface use restrictions. The real estate costs include sufficient funds to cover negotiations with outstanding third party mineral interest holders.

4.8.10 Ownership of Accreted and Emergent Lands and Mineral Rights

The State claims ownership over navigable water bottom, including areas over which land had historically been located but where such lands have been submerged through erosion or subsidence. Pursuant to Article IX, Section 3 of the Louisiana Constitution, owners of land contiguous to and abutting navigable waters, bays, arms of the sea, the Gulf of Mexico, and navigable lakes belonging to the State shall have the right to reclaim or recover land lost through erosion, compaction, subsidence, or sea level rise occurring on or after July 1, 1921. Such private efforts to reclaim or restore lost lands can be made at any time. Coastal restoration projects implemented pursuant to R.S. 49:214.1 et seq. (Act 6, Louisiana Wetlands Conservation and Restoration Act, 1989) might, if successful, impinge upon those private reclamation rights. Accordingly, R.S. 41:1702.D (2)(a) provides that LDNR may enter into negotiated boundary agreements with such disaffected landowners to address the anticipated loss of their ownership and reclamation rights in the area of the proposed plan where the creation of land is anticipated.

In most cases, the State is not asserting or claiming ownership in subsided interior marshes. As such, the appropriate estate(s) would be acquired in these areas to allow restoration and conservation activities over not only on the submerged lands, but also on any emergent lands.

By contrast, in other areas of open water, the state claims ownership of the water bottoms. The LDNR w provide the real estate interests necessary for construction, operation and, maintenance, repair, replacement, and rehabilitation of a project, including such water bottoms. In the event that land emerges from water bottoms claimed by the state, the state acknowledges that the previous landowner may attempt to claim that it was deprived of its reclamation rights to the emergent land. The state believes that the value of such a reclamation rights, if there is any, is too speculative to assess. If a landowner raises a reclamation issue, the state would handle such a claim on a case-by-case basis. The state has asserted that a specific claim may be denied on the basis of lack of evidence of value, or, if warranted by the circumstances, compromised pursuant to rather complex legal provisions. LDNR has proposed that it be afforded credit towards its cost share for any costs it might incur in asserting ownership over emergent lands. This proposal would have to be consistent with all of the obligations of the non-Federal sponsor, especially the LERRD and indemnification obligations. The real estate cost estimate does not consider these possible future costs.

4.8.11 Timber Activity

It is the general intent of the plan to reserve to the landowner the right to harvest timber. In areas where timber harvesting is prohibited, the market value of the timber is included as part of the overall estimate of land value based upon comparable sales of woodlands. Otherwise, the estimate of value includes an estimate of compensation for the adverse impact of the project on timber.

4.8.12 Row Crop Activity

It is assumed that landowners would be allowed to harvest mature crops prior to construction of the plan. In that instance, compensation would be for the impact of the easement on the value of the property. If time constraints do not permit the landowner to harvest crops, the landowner would also be compensated for the market value of the crops.

4.8.13 Valuation and Acquisition of Existing Oyster Leases

The construction and operation of the plan may require the acquisition of oyster leases in many areas throughout coastal Louisiana. The LDWF leases State of Louisiana water bottoms for oyster production for $2.00 per acre per year plus survey fees, for a 15-year initial term, which gives the leaseholder the exclusive right to harvest oysters within the leased area. There is no midterm termination clause. For oyster leases located within the projected impact area of a coastal restoration plan, at the end of its current lease term, a lease may be renewed for a term between 1 to 14 years as a bobtail lease under La R.S. 56:428.1. For an operational project, La R.S. 56:428.2 provides that an oyster lease may be renewed for a one-year term, if the leaseholder stipulates that the waterbottoms under lease are capable of producing oysters.

An oyster lease has been recognized as a real estate interest by both statute and case law. The state would therefore get LERRD credit for the acquisition of oyster leases within the plan impact area, including incidental costs, in accordance with the PCA and Chapter 12, ER 405-1-12.

The LDNR has indicated that for LCA it would acquire oyster leases anticipated to be adversely impacted by a project. With acceptance of payment for an affected lease, the lessee would execute a purchase agreement with the State of Louisiana and a receipt, release, indemnity and hold harmless agreement in favor of the United States, including the USACE, and the State of Louisiana, including LDNR and LDWF, indicating that full and fair compensation has been made in complete satisfaction of all claims against the state and the U.S., related to past, present, or future damages to the affected lease. The state shall be afforded credit in accordance with the PCA and Chapter 12 of ER 405-1-12.

Depending on the plan schedule, the oyster lessee may be allowed to harvest the oysters at his own expense. However, if the plan schedule prevents the oyster lessee from removing the oysters, then the lessee would be compensated for the oyster crop. The lessee would not be allowed to harvest the crop if payment has been made for the oysters. Under the Federal method, no payment would be made for loss of future crop. Compensation for the oysters would be limited to the contributory value of the crop. Real Estate costs include the costs associated with oyster lease acquisition.

The state would be obligated to provide real estates as necessary for the construction, operation, and maintenance, repair, rehabilitation, and replacement of a project. As such, the state must acquire existing oyster leases anticipated to be adversely impacted by a project, and the state must not enter into any new oyster leases or operational or bobtail leases within oyster impact areas.

4.8.14 Induced Flooding

If a taking is determined from increased water levels, a flowage easement would be acquired.

4.8.15 Zoning Ordinances

No application or enactment of zoning ordinances would be proposed in lieu of, or to facilitate, acquisition.

4.8.16 Acquisition Schedules

Acquisition schedules would be prepared for each feasibility report.

4.8.17 Landowner Concerns

Attitudes of landowners within the study areas would vary. Some landowners would be totally in favor of the plan, while others would be totally against it or components thereof. Public access over certain features may be an issue for private landowners. The most vocal group thus far has been the oyster fishermen. Although they understand that the project would be beneficial to the oyster industry in the long run, they are concerned about the impact of their individual businesses in the interim. Some fishermen have been in this business for generations and have invested much in their leased sites. Some landowners are also concerned about a plan's potential impact on existing camps and on new camp construction, as well as possible impacts on minerals.

4.8.18 Operation and Maintenance

The operation and maintenance for this plan would consist of OMRR&R of the structures, channels (other than existing navigation channels), and other project features. The non-Federal sponsor would have the OMRR&R responsibility.

4.8.19 Real Estate Costs

Table MR 4-20
Summary of Real Estate Costs for LCA Plan Components

Conditionally Authorized Features:	
MRGO Environmental Restoration Features	$ 4,214,000
Small Diversion at Hope Canal *	$26,383,000
Barataria Basin Barrier Shoreline Restoration, Caminada Headland, Shell Island	$15,558,000
Small Bayou Lafourche Reintroduction*	$12,590,000
Medium Diversion with Dedicated Dredging at Myrtle Grove*	$78,990,000
RE Subtotal:	$137,735,000
S&T Demonstration Program: (Costs captured within total $100 million program request)	
Marsh Restoration and/or Creation Using Non-Native Sediments	$3,300,000
Marsh Restoration Using Long Distance Conveyance of Sediments	$3,575,000
Canal Restoration Using Different Methods	$5,500,000
Shoreline Erosion Prevention Using Different Methods	$5,500,000
Barrier Island Restoration Using Offshore and Riverine Sources of Sediments	$5,500,000
Additional Demonstration Projects	$4,125,000
RE Subtotal:	$ 27,500,000
Beneficial Use of Dredged Material Program: (Costs captured within total $100 million program request)	$12,039,000
Congressionally Authorized Features	
Multi-purpose Operation of Houma Navigation Canal (HNC) Lock	$15,035,000
Terrebonne Basin Barrier Shoreline Restoration, E. Timbalier, Isles Dernieres (SP3)	$ 9,175,000
Maintain Land Bridge Between Caillou Lake & Gulf of Mexico	$ 892,000
Small Diversion at Convent/Blind River	$41,138,000
Increase Amite River Diversion Canal Influence by Gapping Banks	$ 1,494,000
Medium Diversion at Whites Ditch	$33,046,000
Stabilize Gulf Shoreline Stabilization at Pt. Au Fer Island	$ 272,000
Convey Atchafalaya River Water to Terrebonne Marshes	$38,598,000
Modification to Caernarvon diversion	$15,650,000
Modification to Davis Pond diversion	$52,800,000
RE Subtotal:	$208,100,000
LCA PLAN Total Real Estate (RE):	$385,370,000

* Diversion sizes: Small diversion: 1000 cfs - 5000 cfs; Medium diversion: 5001 cfs - 15000 cfs; Large diversion - > 15000 cfs

4.9 VIEWS OF THE NON-FEDERAL SPONSOR

The State of Louisiana has expressed an understanding of the current law and administration policy regarding implementation of Federal water resources projects. In a letter of intent dated June 3, 2004, Governor Kathleen Babineaux Blanco expressed the State of Louisiana's intention to share in the costs of implementing the recommendations of this report (attachment 4 NON-FEDERAL SPONSOR NOTICE OF INTENT). That letter referenced several outstanding issues that would need to be addressed prior to program implementation, and those issues are detailed in this section.

4.9.1 First Phase of Program Implementation

Because of the urgent need for Federal action to address the rate of land loss and the scale of effort necessary to sustain this vital landscape, the state believes that the near-term plan [course] of action presented in this report is a necessary first step in the restoration of the Coastal Louisiana Ecosystem. The state would like to emphasize, however, they see this first step in the context of a long-term, comprehensive effort that would require continuous Federal and non-Federal support. This first phase of implementation is an opportunity to begin construction of projects in areas of most critical need, to provide the sustained level of science and technology needed to support the scale and complexity of restoration activities, and to provide the tools and data required to support the continued effort. The state believes the plan should be updated as new circumstances arise, especially as long-term studies recommended in the report move toward completion and into the next phases of restoration.

4.9.2 Streamlined Implementation Processes

While it is important to maintain checks and balances to ensure wise and efficient use of resources, it is also important that program requirements do not preclude a timely response to this urgent problem. The state believes the USACE should develop procedures for preparation and submittal of streamlined decision documents. These procedures should include expedited mechanisms for incorporating projects that have undergone extensive engineering and design efforts under other state and Federal programs. These decision documents should provide adequate assurances that the projects would be effective and cost-efficient in meeting their objectives, but should not be traditional feasibility reports. In addition, these projects should be justified solely on National Ecosystem Restoration benefits; ancillary economic impacts and benefits should be reported.

The conditional authority recommended in this report for construction of five near-term critical projects is a good example of streamlined implementation. All of these projects meet the criteria specified in the President's FY 2005 Budget Request—they address some of the most critical needs in the Coastal Louisiana Ecosystem and are implementable in the very near-term. In addition, implementation of similar projects through other Federal and state programs has proven that the technology utilized is effective and cost-efficient in meeting the ecological goals of the restoration program. Incorporating and completing the extensive scientific and technological analysis already accomplished for these projects under other Federal and state efforts provides for the most expedient mechanism to address these identified critical needs. The state believes that the preparation of decision documents on these five projects has proceeded to the point where it is possible to begin budgeting construction funds for them, and urges the Corps to update their budget projections for Federal Fiscal Years 2006 and beyond to include sufficient funds to support timely implementation of the report recommendations.

4.9.3 Program Implementation Cost Share

Although current law requires a cost share ratio of 65 percent Federal, 35 percent non-Federal for construction of ecosystem restoration projects, with operations, maintenance, monitoring, repair, replacement and rehabilitation being 100 percent non-Federal responsibility, the state believes that alternative cost share scenarios are appropriate and justified. The state is requesting the non-Federal share of total program implementation be set at 25 percent, including operations, maintenance, monitoring, repair, replacement, and rehabilitation costs. Much of the need for restoration can be tied to disruptions of natural processes caused by implementation of existing Federally-authorized projects, which were built under different cost share ratios. Without modification of these projects, further decline of the coastal ecosystem is a certainty. In addition, the nation derives significant benefits from the coastal Louisiana ecosystem: protection for the production and transport infrastructure for about 30 percent of the nation's oil and gas supply; the Nation's second largest commercial fishery; and navigation and port facilities which together support America's number one port complex by tonnage. If the land loss is not addressed aggressively, there would certainly be National impacts as well, not the least of which is putting the country's energy security at increased risk. Past precedent also shows that Water Resources Development Act projects to restore the coastal Louisiana ecosystem have been implemented at a 25 percent non-Federal cost. In addition, similarly to provisions in the Comprehensive Everglades Restoration Program, the state believes that it should be allowed to deviate from its cost share percentage for individual program elements as long as the required share of total costs for program implementation is provided.

4.9.4 Credit for Non-Federal Work In-Kind

The State of Louisiana has developed extensive expertise in the planning, engineering, and design (PED) and construction of coastal restoration projects through the Coastal Wetlands Planning, Protection, and Restoration Act and other Federal programs. Current Federal law and policies, however, preclude allowances for work-in-kind (WIK) performed by the non-Federal sponsor in the PED and construction phases of project implementation. The state requests that the state be authorized to perform WIK during the PED and construction activities pursuant to implementation of the LCA Plan, including, but not limited to, S&T Program demonstration projects.

In addition, the state requests that WIK credit be allowed to carry over between LCA Program components, provided that provision of WIK, cash, and LERRDS fulfills the total non-Federal obligations. Both of these allowances would permit the state to better manage the non-Federal obligations and provide for expedited and flexible program implementation. The state believes these views are consistent with the programmatic rules and allowances currently governing implementation of the Comprehensive Everglades Restoration Program.

4.9.5 Monitoring and Adaptive Management

Monitoring of the overall functioning of the ecosystem would be needed to facilitate engineering, design, and operation of program features. This monitoring is different, and potentially more costly, than monitoring specific projects for performance. Under current USACE regulations, monitoring is limited to one percent of project cost and has a limit of five years, and adaptive management costs are limited to 3 percent of project costs. Both of these regulations are tied to implementation of specific projects, and may limit our ability to continually improve program and project outputs if applied to monitoring and adaptive management of the LCA Program. The state requests that these limitations not be applied to implementation of the LCA Program.

4.10 RECOMMENDED CREDIT FOR NON-FEDERAL WORK-IN-KIND

For ecosystem restoration projects, the non-Federal sponsor is afforded work-in-kind credit for studies, but not for planning, design, or construction. Given the scope and nature of the LCA Plan, the demonstrated successes resulting from the current collocation team at the District, and the opportunities to utilize the knowledge base in Louisiana, it is recommended that the non-Federal sponsor be afforded credit for the value of the following work-in-kind:

1. Feasibility level decision documents conducted for conditionally authorized features, estimated at 50 percent of study cost expended within the first ten years of authorization;

2. Academic and field research to support the Science and Technology (S&T) Program estimated to be 35 percent of the S&T Program costs within the first 10 years of authorization; and

3. Study costs associated with investigations, regarding the large-scale, long-term concepts identified in the LCA Plan as requiring detailed study, estimated to be 50 percent of the study costs within the first ten years of authorization.

Credit for such work-in-kind would require approval by the Secretary of the Army, based on the Secretary's determination that such work-in-kind is compatible and integral to the project and the costs of such work are allocable, allowable, and reasonable. The total amount of work-in-kind credit shall not exceed the relevant component non-Federal share, and there shall be no reimbursement for the value of work that may exceed the relevant component non-Federal share. Credit for work-in-kind granted for one component cannot be carried over or applied to a different component.

Crediting for the above items is allowable only for work-in-kind that occurs after the signing of the appropriate agreements.

When the non-Federal sponsor requests credit for work-in-kind services, the source of any funds not originating from the non-Federal sponsor must be identified.

Credit for work-in-kind would be evaluated based on the provision of documentation by the non-Federal sponsor. The non-Federal sponsor must identify all funding sources not originating from the non-Federal sponsor. All such documentation would be thoroughly reviewed by USACE to determine reasonableness, allocability and allowability of costs. Upon completion of this review, a financial audit would be conducted prior to granting final credit.

The credit afforded to the non-Federal sponsor would be limited to the lesser of the following: (1) actual costs that are auditable, allowable, and allocable to the relevant program or (2) USACE's estimate of the cost of the work allocable to the program had USACE performed the work.

This page intentionally left blank.

5.0 PUBLIC INVOLVEMENT

5.1 INTRODUCTION

Public involvement has been a critical component in the LCA study process and the development of the recommended LCA Plan. This section summarizes the public participation efforts during the LCA study process, and identifies future opportunities for public involvement and input as LCA Plan formulation transitions into plan implementation. Full documentation and discussion of public involvement and outreach efforts are included in the PEIS.

While the first official public meetings under the LCA Study occurred in April 2002, relevant public involvement and input regarding the study began in the late 1990s during the development of the Coast 2050 Plan. The extensive public participation and input during the development of that consensus-based report generated a coast wide vision for restoration efforts and identified numerous restoration strategies and specific restoration projects. The vision and strategies in the Coast 2050 Plan served as the basis for the 905 (b) reconnaissance report.

5.2 PHASED PUBLIC PARTICIPATION MEETINGS

Throughout public participation efforts in the LCA study process, the USACE and LDNR sought input from individuals, private entities, local governments, academia, and state and Federal agencies, in addition to other stakeholders such as environmental, navigation, commercial fishing, recreation, agricultural, and oil and gas interests. Meetings were held throughout the coastal region as well as in Texas, Mississippi, and Tennessee. Furthermore, the USACE and LDNR kept the public informed throughout the study process through the use of web sites, print and broadcast media, and radio interviews. Stakeholder groups, such as the Governor's Advisory Commission on Coastal Restoration and Conservation, also helped by keeping their constituents aware of changes or new developments during the study process.

The LCA Study included four sets of public participation meetings, two sets of public scoping meetings associated with the PEIS, and a series of USACE/LDNR-sponsored stakeholder meetings. The subject matter and date for each set of meetings held are as follows:

- Initial Scoping for LCA Study and PEIS – April 2002
- Update on Status of the LCA Study Process and Plan Formulation – February 2003
- LCA Subprovince Alternatives – May/June 2003
- Stakeholder Roundtable Discussions – July/August 2003
- Final Array of Alternative LCA Plans – August 2003
- Scoping for LCA Plan and PEIS – April/May 2004
- LCA Near Term Plan and Draft PEIS – July/August 2004

At each of the public participation meetings, the USACE sought to solicit public input on issues being addressed in the various phases of plan formulation. As part of that effort, background materials were provided to the public on a variety of issues. Materials to assist with various public participation activities included:

- Fact sheet on LCA Study and Coast 2050
- Fact sheet on Evolution of Coastal Restoration in Louisiana
- Fact sheet on Large-Scale Studies
- LCA Near-Term Sorting and Critical Needs Criteria Definitions
- LCA Study Public Involvement Fact Sheet
- Fact sheet on roles of various agencies/organizations
- Fact sheet on timeline, milestones, key decision points
- Fact sheet on sources of additional information (web site addresses, agency contacts, document titles, etc.)
- Brochure on Overview of the LCA Ecosystem Restoration Study Tentatively Selected Plan
- PowerPoint presentations
- Calendar of events/meetings
- Frequently Asked Questions
- Exhibits

The USACE employed several methods to facilitate input at public meetings. In all instances, the public was encouraged to provide written and oral comment on the particular study focus for each meeting through comment cards and through traditional public comment. In addition, USACE and LDNR representatives were present at each meeting to solicit input from individuals who preferred a one-on-one setting during "open-house" sessions. Some meetings provided the public an opportunity to become more intensively involved with plan formulation through the use of breakout sessions and worksheets. At each breakout session, individuals assembled into small groups and had the opportunity to express their concerns on a more individual and interactive level with study team members and other participants.

Using public input gathered from the April 2002 scoping meetings, the February and May/June 2003 public participation meetings, and the July/August 2003 stakeholder meetings, the PDT refined coast wide restoration strategies of plan alternatives and identified potential large-scale restoration concepts for inclusion in LCA Plan alternatives. For example, public comments identified a need to address freshwater management and allocation in the Chenier Plain as part of the LCA restoration effort. As a result of this input, the USACE included this restoration concept for evaluation in plan formulation, and ultimately recommended the inclusion of the Chenier Plain Freshwater Management and Allocation Reassessment Study as part of the LCA Plan.

In February 2004, study efforts were refocused to address critical ecosystem needs that require immediate attention over the next decade. At the April 2004 scoping meetings, the public was provided the opportunity to comment on the identification of sorting and critical needs criteria and to provide comment on the application of those criteria to the 79 restoration features identified in Phase V of plan formulation, described in section 3.3 PLAN FORMULATION.

In July and August 2004, the USACE conducted public meetings to solicit input on the draft LCA Plan, including comments on the recommended program components (e.g., near-term priority projects, large-scale studies, demonstration projects, etc.), as well as the recommended plan implementation procedures.

5.3 FUTURE PUBLIC INVOLVEMENT

Continued public participation will be a vital part of the efforts to refine, authorize, and ultimately implement the LCA Ecosystem Restoration Study, just as it has been at every step in the history of the endeavor to secure a sustainable future for coastal Louisiana.

Because of the scale and unprecedented nature of this undertaking, the formulation of a public participation plan must be characterized by a sense of urgency, purpose, and flexibility. In the context of the LCA Ecosystem Restoration Study, public participation must be understood to be more than a public information program or a public comment vehicle, though surely it includes those aspects. Rather, public participation is an integral part of plan formulation, project development, program implementation, and monitoring and evaluation.

As the LCA Ecosystem Restoration Study transitions from plan formulation to plan implementation, there will be future opportunities for public participation and input. The National Environmental Policy Act (NEPA) in USACE Restoration Activities provides for an early and open public process, called "scoping," for determining the scope of issues, resources, impacts, and alternatives to be addressed in draft Environmental Impact Statement (EIS). NEPA requirements will be addressed in all future planning and study efforts relative to the various aspects of the LCA Study for the next 10 years. Specific features associated with each LCA Ecosystem Restoration Study will include an EIS. Release of each study for public review and comments will comply with NEPA. The study will go above and beyond those requirements when and where appropriate.

During periods while not officially engaged in public or scoping meetings, the USACE, in coordination with the State of Louisiana, would keep open the lines of communication through web site interaction, speaking engagements, workshops, news releases, timeline awareness, frequently asked questions, fact sheets, and talking points. To that end, a Strategic Communications Plan would be established that clearly defines a proactive, consistent, and cohesive procedure for informing the public of the LCA study process.

The LCA team is currently funding a contract to produce a popular booklet, traveling exhibit, brochure and a PowerPoint presentation geared to a popular audience. Future public involvement initiatives include forming proactive partnerships with communities, providing information and interactive CDs to schools and libraries, hosting teacher workshops, and creating interpretive exhibits for local festivals, museums and visitor centers.

The following are additional objectives for the future LCA Public Involvement Plan:

Embedded Media: Major state newspaper reporters will be invited to spend two weeks each working and reporting from the collocated PDT office.
Exhibits: Portable exhibits are available, and others planned, for use at numerous exhibit opportunities around the state and Nationwide through conference participation.

Speakers Bureau: LCA Comprehensive Study team members will participate in an active Speakers Bureau program.

Outreach Tactics: The tools listed below are instrumental in educating the public (at a local and National level), an advantage that provides them the opportunity to fully engage in the study process (for example, determining the scope of issues, resources, impacts, and alternatives to be addressed for each individual project proposed for the next 10 years). The tools would provide a mechanism for the public to know, at any given time, the status of each study, from a science and technology standpoint (the uncertainties, research efforts underway), to the progress on the EIS, engineering and design, implementation and construction. All handouts would be posted in a consistent site on the web at www.lca.gov.

- Fact sheet of Frequently Asked Questions
- Fact sheet/brochure on LCA
- Fact sheet on roles of various agencies/organizations
- Fact sheet on timeline, milestones, key decision points
- Fact sheet on sources of additional information
- PowerPoint presentations geared toward multiple target audiences
- Calendar of events/meetings
- Newsletter – provide quarterly updates on study and construction
- Comment cards
- Host regularly occurring meetings with non-government agencies who act as a conduit to a larger audience.
- Contracts to develop a media writer and campaign
- Public radio announcements
- Engage focus groups
- Measure public knowledge through Department of Defense approved survey
- Exhibit or oral presence at National conferences
- Produce educational 10-minute animated videos

5.4 AREAS OF CONTROVERSY AND UNRESOLVED ISSUES

1. Conflict concerning the operation of the Mississippi River Gulf Outlet (MRGO).

The Mississippi River Gulf Outlet (MRGO), a channel connecting the Gulf of Mexico to the City of New Orleans, was completed in 1965 to provide a shorter, safer, and more efficient passage to New Orleans that would simultaneously boost the economy of St. Bernard Parish. Since the construction and operation of the MRGO land loss, soil erosion, habitat modification, and wildlife and fisheries losses have occurred in the surrounding area. Concerned citizens propose to "close" the MRGO, which would prohibit oceanic vessels with a draft of more than 12 feet from utilizing the canal. Along with eliminating deep draft vessels, the initial proposals call for water control structures including floodgates, locks, weirs and sills to be strategically built along the MRGO. The goal of these structures is to reduce water influx into the marshes and bayous from the MRGO channel, thus reducing the potential for storm surges and saltwater intrusion. Navigation stakeholders do not necessarily oppose the closure of the MRGO; however, they believe closure should be synchronized with construction of a new lock at the Inner Harbor Navigation Canal (IHNC) so commerce will not be disrupted. To resolve this conflict, the USACE/MVN is currently performing an economic analysis of the channel's efficiency. Residents are very concerned that this study will not lead to closure or significant modification of the MRGO.

2. Public concern that litigation from parties negatively impacted by restoration projects will make restoration prohibitively expensive.

Elements of the public expressed concern that restoration efforts, particularly projects that would involve freshwater diversions, would affect existing oyster beds via lowering salinity levels, thereby creating a situation where excessive compensation for potentially affected oyster leases would be necessary. As noted in Chapter 4 of the LCA main report, if oyster leases will be adversely impacted by a project, then such leases will be acquired and just compensation will be made. It is anticipated that this will reduce the potential liabilities in the future.

3. Concern about the priority of certain restoration projects.

- *Demand by Terrebonne and Barataria Basin residents for the immediate restoration of the Barataria-Terrebonne Estuary before other regions of the coastal ecosystem.*

Many residents of Terrebonne and Barataria Basins have expressed scoping concerns that this area has suffered the greatest land lost and ecological degradation and therefore should have immediate restoration efforts directed to address these problems. The Terrebonne and Barataria Basins are losing coastal wetlands more rapidly than anywhere else in Louisiana. Since these basins are in such dire need, there is strong public sentiment that these areas should be addressed first. Projects with considerable public support include the Bayou Lafourche reintroduction and the Third Delta Conveyance channel.

- *Public support for the construction of restoration projects in areas that will maximize the benefits to society, culture, and the regional economy.*

Nearly 2 million Louisiana residents live in the coastal zone, and the culture and socioeconomic structure of the population has evolved to depend on the presence and productivity of the wetlands. In general, the public is supportive of coastal restoration, but request project construction in areas that will maximize the benefit to Louisiana citizens. Restoration projects that will prevent flooding, storm surge, infrastructure damage, property damage, and damage to commercial and recreational fisheries are most desirable. In addition, the public wants restoration projects to coordinate with flood control projects, navigation activities, and other activities that preserve the local economy. Projects in isolated areas, with limited direct benefit for Louisiana residents are generally not supported by the public.

- *Public concern for additional salinity controls in the Chenier Plain and inclusion of additional restoration features for this subprovince in the implemented LCA Plan.*

Because of its distance from a major river, restoration opportunities in the Chenier Plain are hampered by the limited availability of "excess" freshwater and sediment. Thus, restoration projects constructed in this subprovince have attempted to capitalize on this limited excess freshwater through salinity control and hydrologic restoration measures. There is a great deal of public support for continued construction of such projects, as the belief is that they are effective means of combating saltwater intrusion and land loss in this region. However, members of the National Technical Review Committee (NTRC) as well as many other researchers and managers are concerned that such measures do not fully address the problem, and will not provide long-term sustainability in this region. Data indicate that the excess freshwater is very limited and is not available at times of the year when salinities are highest. Additionally, subsidence is not sufficiently offset using these measures, as they provide for very limited sediment redistribution. Fisheries access within and through this region is also hampered by the construction of these structures, creating another stress on valuable natural resources. To resolve this issue, the LCA Plan includes the Chenier Plain Freshwater and Sediment Management and Allocation Reassessment Study, in order to provide managers with the information needed to formulate the best restoration plan for Subprovince 4.

4. Concern with inaction and perceived lack of urgency with respect to restoration.

- *Public support for comprehensive, long-term restoration efforts beyond near-term restoration efforts.*

Members of the public expressed concern that the restoration of the Louisiana coastal ecosystem must include a long-term, comprehensive approach and commitment to significantly reverse the current trend of land loss and ecosystem degradation. While many members of the public acknowledged the need for a "near-term" effort, as embodied by the proposed LCA Plan, the majority viewed such an effort only as the initial step of the overall Louisiana coastal ecosystem restoration effort. Although the model results indicate that the LCA Plan would offset roughly 70 percent of the projected land loss in the future significant need still exists to offset the past loss of approximately 1.2 million acres and subsequent reduction in overall ecosystem quality.

Through meetings, the public has been informed of Federal guidance to focus on near-term restoration measures. The public was involved in the formulation of a comprehensive long-term restoration program and is certain a comprehensive program is the key to successful restoration. Many projects with considerable public support, including the restoration of the Bayou Chevreuil reef and additional salinity controls and other features in the Chenier Plain cannot be implemented in the near-term. However, the public feels these projects are essential to the restoration of coastal Louisiana; and consequently, they request a substantial long-term commitment from the Federal Government.

- *Public demand for the immediate construction of restoration actions versus requirements for conducting additional study of restoration problems.*

Members of the public expressed concern that the LCA Program's restoration effort will focus on the need for more studies rather than construction, operation and maintenance of restoration projects. In addition, it was expressed that immediate action should be taken to address Louisiana coastal ecosystem degradation issues, and that there are enough existing studies of the problem to warrant and justify that immediate action.

5. Concern about the necessity for sediment and water quality testing for each restoration feature.

Restoration measures call for riverine water and sediment to be redistributed into the surrounding coastal ecosystem. However, there is concern that these resources are sufficiently contaminated with nutrients and toxins such as mercury that restoration actions may intensify problems associated with eutrophication within the receiving areas, or compromise human health through consumption of contaminated fish and shellfish. Therefore, environmental groups have requested that sediment and water quality testing become a routine part of the project planning, engineering, and design phase. The Federal planning process requires that sediment and water quality be evaluated prior to implementation. If an issue arises during the evaluation, it will be addressed in a manner that is consistent with policy set by such acts as National Environmental Policy Act and Clean Water Act.

6. Conflicts may result when balancing economic interests with coastal restoration, especially when multiple stakeholders share common coastal resources.

- *Public concern that diversions will over-freshen receiving basins and concern that diversions could create widespread algae blooms in interior bays and lakes.*

Although there are many proponents of freshwater and sediment diversions, some members of the public are concerned about possible unintended consequences of implementing this type of restoration feature. Commercial and recreational fishermen are concerned that the change in the salinity regime often associated with a freshwater diversion, would cause loss or displacement of current recreational and commercially valuable fishery species. In addition to altering salinity, diversions may increase the amount of nutrients supplied to lakes and bays. Increased nutrients create the possibility of algal blooms, which are potentially detrimental to many aquatic organisms including fish, shellfish, and invertebrates, and may contribute to formation of hypoxic zones.

- *Concern with changing the existing operational scheme of the Old River Control Structure in regulating river flows in the Mississippi and Atchafalaya Rivers.*

Alterations in the operation of the Old River Control structure could increase sediment and freshwater in certain areas. The same concerns exist as with diversions. Change in the salinity regime often associated with a freshwater diversion, would cause loss of current recreational and commercially valuable fishery species. In addition to altering salinity, the features may increase the amount of nutrients supplied to a wetland. Increased nutrients create the possibility of algal blooms, which are potentially detrimental to many aquatic organisms including fish, shellfish, and invertebrates.

- *Concern that LCA Plan restoration features in Subprovince 3 would excessive amounts of water and sediment into the area.*

Overall, residents in Subprovince 3 are supportive of the proposed restoration features, however some citizens are concerned that an overabundance of water and sediment would result if the features are implemented. Concern is based on the thought that an excess of water and sediment could potentially displace many aquatic organisms, including fish, shellfish, and invertebrates. Additional concerns were raised that these sediments would accelerate infilling of the Atchafalaya Basin.

- *Real property rights issues including public access, mineral rights, and the perception that Federal monies would be spent to restore private properties.*

There are differing opinions regarding public access to restored areas and the extent to which mineral rights should be restricted within project areas. Also, some elements of the public are concerned that public monies will be used to benefit private land. Additional concerns were raised by private landowners that new rights for public access should not be created if private lands benefit from expenditures of public funds.

- *Concern with impediments to navigation and proposed re-routing of the Mississippi River and the Atchafalaya River Navigation channels.*

Members of the public, including Navigation interests, expressed concern that proposals to re-route portions of the Mississippi River and the Atchafalaya River Navigation channels could result in delays and restricted access, which could interrupt the transport of goods and commodities into and out of various ports in the Louisiana coastal area.

- *The effect of coastal restoration on flood control projects*.

Some members of the public are concerned that funding coastal restoration projects will reduce available funding for vital flood protection projects. Although the LCA program intends to be a complement, not a substitute, for flood protection projects, Federal funding shortages are a concern with any large-scale project.

6.0 RECOMMENDATIONS

As the District Engineer, I have considered the environmental, social, and economic effects, the engineering feasibility, and the comments received from other resource agencies and the public during this LCA Study effort and plan formulation. Based upon the sum of this information, I am recommending for implementation the LCA Ecosystem Restoration Plan (LCA Plan) that includes the highest priority actions from among those considered during plan formulation. I am convinced that the LCA Plan would begin to reverse the current trend of degradation of Louisiana's coastal ecosystem, support Nationally significant living resources, provide a sustainable and diverse array of fish and wildlife habitats, reduce nitrogen delivery to offshore gulf waters, provide infrastructure protection, and make progress towards a more sustainable ecosystem.

The LCA Plan I am recommending has seven components, with such modifications thereof as in the discretion of the Commander, HQUSACE, may be advisable.

A comparison of the cost effectiveness of the LCA Plan versus the final array of coastwide frameworks from which the LCA Plan was derived shows that the LCA Plan produces a lesser magnitude of output. However the efficiency of the LCA Plan is comparable to that of the larger frameworks in the final array. The comparison of the LCA Plan and the final array of coastwide frameworks is presented in **table MR 6-1**.

Table MR 6-1
LCA Plan and Final Array of Coastwide Frameworks

Plan	Subprovince Framework Codes	Average Annual Benefits ^	Average Annual Costs
LCA Plan		**2865**	**$ 55,921,000**
5610	S1M2, S2M3, S3R1	3094	171,479,754
5110	S1M2, S2R1, S3R1	3098	159,643,014
5410	S1M2, S2M1, S3R1	3110	185,416,495
10130	S1-3 N3*	3134	179,073,919
7610	S1E1, S2M3, S3R1	3166	193,662,284
7410	S1E1, S2M1, S3R1	3182	207,599,025
7002	S1E1, S2E3, S3M1	3202	542,511,742

*Plan developed by modification of plan 5110.
^Based on a composite of land building, habitat suitability, and nitrogen removal.

The ecologic model output for land building estimates that the LCA Plan would offset approximately 62.5 percent of the 462,000 acres projected to be lost within the Louisiana coastal area under the Future Without-Project condition. The estimated land building for Subprovince 1 exceeds projected Future Without-Project condition. In Subprovinces 2 and 3, the models estimated that the LCA Plan prevented almost 50 percent of the expected losses in each basin. These estimates do not include any projects in Subprovince 4.

The LCA Plan presents significant capacity for the prevention of future wetland loss with a smaller component of wetland building capacity. Although the LCA Plan acts significantly to reduce future loss of ecosystem structure and function, overall levels of environmental outputs will remain significantly reduced compared to historical conditions. This is especially true in Subprovince 4 where limited actions are recommended in the LCA Plan.

The cost of the five Near-Term Critical Restoration Features recommended for specific Congressional authorization, with implementation subject to Secretary of the Army review and approval of feasibility-level decision documents, (referred to as "Conditionally authorized" elsewhere in the report) is estimated at $864,065,000. The total cost of the Science and Technology Program, the Demonstration Projects, the Program for the Beneficial Use of Dredged Material, and Investigations of Modifications of Existing Structures is estimated at $310,000,000. The combined total cost of the previously stated components of the LCA Plan is estimated at $1,174,065,000. The total costs of Other Near-Term Critical Restoration Features Requiring Future Congressional Construction Authorization and Large-Scale and Long-Term Concepts Requiring Detailed Study is estimated to be $821,916,000. The total cost of the LCA Plan is estimated to be $1,995,981,000. Currently, the annual operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) costs are estimated at $7,883,000. OMRR&R costs are the responsibility of the non-Federal sponsor. These costs can be found in table **MR 6-3** through **MR 6-5**.

THE SEVEN COMPONENTS OF THE LCA PLAN

1. Near-Term Critical Restoration Features for Conditional Authorization. The LCA Plan includes 15 near-term critical restoration features (listed in tables **MR 6-2a** and **MR 6-2b**), five of which are recommended for specific Congressional authorization, with implementation subject to Secretary of the Army review and approval of feasibility-level decision documents. Implementation of these five restoration features would be subject to subsequent NEPA compliance, and appropriate decision documents. These decision documents would be constructed utilizing current policy and guidelines to provided a sound basis for decision makers at all levels. I recommend that Congress authorize implementation of the five near-term critical restoration features detailed below, with implementation subject to review and approval of the decision documents by the Secretary of the Army.

Studies or design of the five near-term features have been advanced to a state of readiness that suggest the feasibility-level decision documents can be completed prior to the next WRDA. In addition, initial analysis indicates that these five features address the most critical ecological needs of the coastal area in locations where delaying action would result in a "loss of opportunity" to achieve restoration and/or much greater restoration costs. These five critical near-term features present a range of effects essential for success in restoring the Louisiana coast. The benefits provided by these features include: sustainable reintroduction of riverine resources; rebuilding of wetlands in areas at high risk for future loss, the preservation and maintenance of critical coastal geomorphic structures; preservation of critical areas within the coastal ecosystem; and, the opportunity to begin to identify and evaluate potential long-term solutions. Based on a body of work both preceding and including this study effort, the PDT produced an estimate of average annual costs and benefits for these five features. This information shows that average annual environmental output for these five authorized features would be on the order of 22,000 habitat units at an average annualized cost of $2,700 per unit provided.

The five near-term critical restoration features that I recommend for specific Congressional authorization, with implementation subject to Secretary of the Army review and approval of feasibility-level decision documents are:

- MRGO Environmental Restoration Features
- Small Diversion at Hope Canal [1]
- Barataria Basin Barrier Shoreline Restoration
- Small Bayou Lafourche Reintroduction [1]
- Medium Diversion with Dedicated Dredging at Myrtle Grove [1]

2. Science & Technology (S&T) Program. I recommend that the LCA S&T Program be programmatically authorized and funded at an amount not to exceed $100 million over the initial 10 years of the LCA Program. This S&T Program would support all facets of program implementation by providing for acquisition of data, developing analytic tools, and providing recommendations to the LCA Program Manager within the adaptive management framework. Major benefits of the S&T Program would be reduced scientific and technological uncertainties and optimized attainment of LCA Program restoration objectives.

3. Science and Technology Program Demonstration Projects: I recommend that demonstration projects recommended by the S&T Program be programmatically authorized, with implementation subject to Secretary of the Army review and approval of feasibility-level decision documents, and funded as a construction item at an amount not to exceed $100 million over 10 years, including a maximum cost of $25 million per project. Demonstration projects would serve to reduce critical uncertainties and provide valuable lessons learned to improve overall program performance. I recommend that Congress authorize implementation of the $100 million demonstration program subject to review and approval of individual project feasibility-level decision documents by the Secretary of the Army. In addition to standard decision document information, the demonstration project documents would address:

- Major scientific or technological uncertainties to be resolved; and
- A monitoring and assessment plan to ensure that the demonstration projects would provide results that contribute to overall LCA Program effectiveness.

The purpose of the recommended LCA S&T Program demonstration projects is to resolve critical areas of scientific, technical, or engineering uncertainty while providing meaningful restoration benefits whenever possible. The types of uncertainty that are best resolved through implementation of appropriately scaled demonstration projects are the "Type 2" uncertainties introduced in section 3.1.1. After design, construction, monitoring, and assessment of individual demonstration projects, the LCA program will leverage the lessons learned to improve the planning, design, and implementation of other LCA restoration projects. Beyond

[1] Diversion / reintroduction sizes: Small diversion: 1000 cfs - 5000 cfs; Medium diversion: 5001 cfs - 15000 cfs; Large diversion - > 15000 cfs

serving to resolve the list of "Type 2" uncertainties detailed in this report, demonstration projects may be necessary to address uncertainties discovered in the course of individual project implementation or during the study of large-scale and long-term restoration concepts.

4. Programmatic Authorization for the Beneficial Use of Dredged Material. I recommend that Congress authorize $100 million over the initial 10 years of the LCA Program for execution of additional beneficial use of dredged material projects within the Louisiana coastal area. Based on the requested funds and a 10-year period of implementation, it is expected that this beneficial use program could contribute to the attainment of approximately 21,000 acres of newly created wetlands. I recommend that this program follow guidelines similar to the Section 204 Continuing Authorities beneficial use program that provides authority for the USACE to restore, protect, and create aquatic and wetland habitats in connection with construction or maintenance dredging of an authorized project.

5. Programmatic Authorization for Investigations of Modifications of Existing Structures. I recommend that Congress authorize $10 million over the initial 10 years of the program for use in studies of potential modification or rehabilitation of existing water resources structures and/or their operation management plans for the purpose of contributing to the attainment of LCA Plan restoration objectives. This authority would improve environmental performance within a project purpose by authorizing the use of LCA funds.

6. Near-Term Critical Restoration Features Recommended for Study and Future Congressional Authorization. In addition to the five critical near-term restoration features previously recommended and listed for Congressional authorization, with implementation subject to Secretary of the Army review and approval of feasibility-level decision documents, I recommend approval of funding for full development of feasibility reports for the other 10 LCA Plan features, for which the total study cost is $47,529,000. These features would be Congressionally authorized via future WRDA. The 10 features are:

- Multi-purpose operation of the Houma Navigation Canal Lock
- Terrebonne Basin barrier Shoreline Restoration
- Maintain land bridge between Caillou Lake and Gulf of Mexico
- Small diversion at Convent/Blind River
- Increase Amite River Diversion Canal influence by Gapping Banks
- Medium Diversion at White's Ditch
- Stabilize Gulf Shoreline at Point Au Fer Island
- Convey Atchafalaya River water to northern Terrebonne marshes
- Modification of Caernarvon Diversion
- Modification of Davis Pond Diversion

7. Large-Scale and Long-Term Concepts Requiring Detailed Study. I recommend development of studies that evaluate large-scale, long-term coastal restoration concepts. Investigations of the following six large-scale, long-term concepts will fully determine their potential for achieving restoration objectives beyond the critical needs, near-term focus of other

LCA Plan components. Upon completion of the studies, recommendations may be forwarded to Congress for consideration of authorization. The estimated cost of these studies is $60 million

- Mississippi River Hydrodynamic Study
- Mississippi River Delta Management Study
- Third Delta Study
- Chenier Plain Freshwater and Sediment Management and Allocation Reassessment Study
- Acadiana Bays Estuarine Restoration Study
- Upper Atchafalaya Basin Study

These studies and their resultant projects, if authorized and constructed, could significantly restore environmental conditions that existed prior to large-scale alteration of the natural system.

COST SHARING AND AGENCY RESPONSIBILITIES

I further recommend Federal and Non-Federal Sponsor responsibilities and cost sharing requirements as set forth in preceding Section 4.7 “Division of Responsibilities” and the credit for non-Federal work-in-kind as set forth in preceding Section 4.10 “Recommended Credit for Non-Federal Work-in-Kind.”

The recommendations contained herein reflect the information available at this time and current Department of the Army 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 sponsor, the state, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity for further comment.

Peter J. Rowan
Colonel, U.S. Army
District Engineer

Table MR 6-2a. Components of the LCA Plan.

Recommended for Conditional or Programmatic Authorization
1. <u>Near-term Critical Restoration Features</u> • MRGO Environmental Restoration Features • Small Diversion at Hope Canal • Barataria Basin Barrier Shoreline Restoration, Caminada Headland, Shell Island • Small Bayou Lafourche Reintroduction • Medium Diversion with Dedicated Dredging at Myrtle Grove 2. <u>S&T Program</u> 3. <u>Initial S&T Program Demonstration Projects</u> • Marsh Restoration and/or Creation Using Non-Native Sediment • Marsh Restoration Using Long-Distance Conveyance of Sediment • Canal Restoration Using Different Methods • Shoreline Erosion Prevention Using Different Methods • Barrier Island Restoration Using Offshore and Riverine Sources of Sediment 4. <u>Programmatic Authorization for the Beneficial Use of Dredged Material</u> 5. <u>Programmatic Authorization to Initiate Studies of Modifications to Existing Water Control Structures</u>

Table MR 6-2b. Components of the LCA Plan.

Recommended for Approval With Future Authorization *(Implemented with Congressional Approval Authority)*
6. <u>Other Near-term Critical Restoration Features</u> • Multi-purpose Operation of Houma Navigation Canal Lock • Terrebonne Basin Barrier Shoreline Restoration • Maintain Land Bridge between Caillou Lake and Gulf of Mexico • Small Diversion at Convent / Blind River • Increase Amite River Diversion Canal Influence by Gapping Banks • Medium Diversion at White's Ditch • Stabilize Gulf Shoreline at Point Au Fer Island • Convey Atchafalaya River water to Northern Terrebonne Marshes • Modification of Caernarvon Diversion • Modification of Davis Pond Diversion 7. <u>Large-scale and Long-term Concepts Requiring Detailed Study</u> • Mississippi River Hydrodynamic Study • Mississippi River Delta Management Study • Third Delta Study • Chenier Plain Freshwater and Sediment Management and Allocation Reassessment Study • Acadiana Bays Estuarine Restoration Feasibility Study • Upper Atchafalaya Basin Study

Table MR-6-3
LCA Recommended Component Cost Estimates
(June 2004 Price Levels)

Item			Cost ($)
MRGO environmental restoration features		$	80,000,000
Small diversion at Hope Canal		$	10,645,000
Barataria Basin Barrier shoreline restoration		$	181,000,000
Small Bayou Lafourche reintroduction		$	75,280,000
Medium diversion with dedicated dredging at Myrtle Grove		$	142,920,000
	SUBTOTAL	$	489,845,000
LERRD		$	178,619,000
First Cost	SUBTOTAL	$	668,464,000
Feasibility-Level Decision Documents		$	54,673,000
Preconstruction, Engineering, and Design (PED)		$	36,252,000
Engineering and Design (E&D)		$	29,018,000
Supervision and Administration (S&A)		$	68,973,000
Project Monitoring		$	6,685,000
Conditionally Authorized Cost	SUBTOTAL	**$**	**864,065,000**
Science & Technology Program Cost (10 year Program)		**$**	**100,000,000**
Demonstration Program Cost (10 year Program)*		**$**	**100,000,000**
Beneficial Use of Dredged Material Program*		**$**	**100,000,000**
Investigations of Modifications of Existing Structures		**$**	**10,000,000**
Total Authorized LCA Plan Cost		**$**	**1,174,065,000**
Multi-purpose operation of Houma Navigation Canal (HNC) Lock [#]		$	-
Terrebonne Basin Barrier shoreline restoration		$	84,850,000
Maintain Land Bridge between Caillou Lake and Gulf of Mexico		$	41,000,000
Small diversion at Convent / Blind River.		$	28,564,000
Increase Amite River Diversion Canal influence by gapping banks		$	2,855,000
Medium diversion at White's Ditch		$	35,200,000
Stabilize Gulf shoreline at Point Au Fer Island		$	32,000,000
Convey Atchafalaya River Water to Northern Terrebonne marshes		$	132,200,000
Modification of Caernarvon diversion		$	1,800,000
Modification of Davis Pond diversion		$	1,800,000
	SUBTOTAL	$	360,269,000
LERRD		$	208,100,000
First Cost	SUBTOTAL	$	568,369,000
Feasibility Level Decision Documents		$	47,529,000
Preconstruction, Engineering, and Design (PED)		$	36,027,000
Engineering & Design (E&D)		$	45,635,000
Supervision & Administration (S&A)		$	58,673,000
Project Monitoring		$	5,683,000
Approved Projects Requiring Future Congressional Authorization for Construction		**$**	**761,916,000**
Mississippi River Hydrodynamic Study		$	10,250,000
Mississippi River Delta Management Study		$	15,350,000
Third Delta Study		$	15,290,000
Chenier Plain Freshwater and Sediment Management and Allocation Reassessment Study		$	12,000,000
Acadiana Bays Estuarine Restoration Feasibility Study		$	7,110,000
Upper Atchafalaya Basin Study^		$	-
Large-scale and Long Term Studies Cost	SUBTOTAL	**$**	**60,000,000**
Total LCA Restoration Plan Cost		**$**	**1,995,981,000**

*Program total costs include any estimated Real Estate costs for these activities
[#] Feature of the Mississippi River and Tributaries, Morganza Louisiana to the Gulf of Mexico Hurricane Protection project
^ Study to be funded under the Mississippi River and Tributaries authority

Table MR-6-4. Summary of LCA Plan Federal and Non-Federal Cost Share Responsibilities (June 2004 Price Levels)

Conditionally Authorized Features:		
Feasibility-level Decision and NEPA Documentation Cost:		
Federal (50%)	$	27,336,500
Non-Federal (50%)	$	27,336,500
Subtotal	$	54,673,000
Construction Cost (Including PED, E&D, S&A, Monitoring):		
Federal (65%)	$	500,768,550
Non-Federal (35%):		
LERRD*	$	178,619,000
Cash	$	130,004,450
Subtotal	$	809,392,000
Total	**$**	**864,065,000**
*For the conditionally authorized feature, Small Diversion at Hope Canal, LERRD exceeded 35% of the total project cost by $25,336,250, which is reimbursed to the non-federal sponsor.		
Programmatically Authorized Features:		
Science & Technology Program (10 year program)		
Federal (65%)	$	65,000,000
Non-Federal (35%)	$	35,000,000
Demonstration Program (10 year program)		
Federal (65%)	$	65,000,000
Non-Federal (35%)	$	35,000,000
Beneficial Use of Dredge Material Program		
Federal (75%)	$	75,000,000
Non-Federal (25%)	$	25,000,000
Investigations of Modifications of Existing Structures		
Federal (50%)	$	5,000,000
Non-Federal (50%)	$	5,000,000
Total	**$**	**310,000,000**
Conventionally Authorized Features:		
Feasibility-level Decision and NEPA Documentation Cost:		
Federal (65%)	$	23,764,500
Non-Federal (35%)	$	23,764,500
Subtotal	$	47,529,000
Construction Cost (Including PED, E&D, S&A, Monitoring):		
Federal (65%)	$	464,351,550
Non-Federal (35%)		
LERRD	$	208,100,000
Cash	$	41,935,450
Subtotal	$	714,387,000
Total	**$**	**761,916,000**
Large-scale, Long-term Studies for Future Congressional Authorization:		
Federal (50%)	$	30,000,000
Non-Federal (50%)	$	30,000,000
Total	**$**	**60,000,000**

Table MR-6-5
Average Annual O&M Cost Estimates for the LCA Plan Features
(June 2004 Price Levels)

Item	O&M Cost ($/yr)
MRGO Environmental Restoration Features	$ 711,000
Small Diversion at Hope Canal	$ 120,000
Barataria Basin Barrier Shoreline Restoration	$ 500,000
Small Bayou Lafourche Reintroduction	$ 1,400,000
Medium Diversion with Dedicated Dredging at Myrtle Grove	$ 120,000
Total Conditionally Authorized Cost	$ 2,851,000
Multi-purpose Operation of Houma Navigation Canal Lock	$ -
Terrebonne Basin Barrier Shoreline Restoration E. Timbalier, Isle Dernieres	$ 2,760,000
Maintain Land Bridge between Caillou Lake and Gulf of Mexico	$ 745,000
Small diversion at Convent / Blind River.	$ 120,000
Increase Amite River Diversion Canal Influence by Gapping Banks	$ -
Medium Diversion at White's Ditch	$ 120,000
Stabilize Gulf Shoreline at Point Au Fer Island	$ 644,000
Convey Atchafalaya River Water to Northern Terrebonne Marshes	$ 643,000
Total Future Congressionally Authorized Cost	$ 5,032,000
Total Cost	**$ 7,883,000**

References

Barras, J.A., P.E. Bourgeois, and L.R. Handley. 1994. Land loss in coastal Louisiana 1956-90. National Biological Survey, National Wetlands Research Center Open File Report 94-01, 4 p., 10 color plates.

Barras, J., S. Beville, D. Britsch, S. Hartley, S. Hawes, J. Johnston, P. Kemp, Q. Kinler, A. Martucci, J. Porthouse, D. Reed, K. Roy, S. Sapkota, and J. Suhayda. 2003. Historical and projected coastal Louisiana land changes: 1978-2050: USGS Open File Report 03-334, 39 p.

Barrow, W.C., Jr., C. Chen, R.B. Hamilton, K. Ouchley, and T.J. Spengler. 2000. Disruption and restoration of en route habitat, a case study: the Chenier Plain. Studies in Avian Biology. 20:71-87.

Boesch, D.F., M.N. Josselyn, A.J. Mehta, J.T. Morris, W.K. Nutle, C.A. Simenstad, and D.J.P. Swift. 1994. Scientific assessment of coastal wetland loss, restoration and management in Louisiana. Journal of Coastal Research. Special Issue No. 20.

Cahoon, D.R., D.J. Reed, J.W. Day, Jr., G.D. Steyer, R.M. Boumans, J.C. Lynch, D. McNally, and N. Latif. 1995. The influence of hurricane Andrew on sediment distribution in Louisiana coastal marshes. J. Coast. Res. 21:280-294.

CENR. 2000. Integrated Assessment of Hypoxia in the Northern Gulf of Mexico. National Science and Technology Council Committee on Environment and Natural Resources, Washington, DC.

CH2MHill, 2004. Phase 1 Reconnaissance-level Evaluation of the Third Delta Conveyance Channel Project. Prepared for Louisiana Department of Natural Resources.

Coalition to Restore Coastal Louisiana. 1989. Coastal Louisiana, Here Today and Gone Tomorrow: A Citizen's Program for Saving the Mississippi River Delta Region to Protect Its Heritage, Economy and Environment. Baton Rouge, Louisiana.: Coalition to Restore Coastal Louisiana.

Colten, C.E 2001. Transforming New Orleans and Its Environs: Centuries of Change, University of Pittsburg Press. 210 pp.

Craig, J. J., R. E. Turner, and J. W. Day, Jr. 1979. Land loss in coastal Louisiana (U.S.A.). Environmental Management 3:133-144.

Doyle, W.H., Jr., 1972. Sediment transport in a Mississippi River distributary –Bayou Lafourche, Louisiana: U.S. Geological Survey Water Supply Paper 2008, 48 pp.

Dunbar, J.B., L.D. Britsch, and E.B. Kemp. 1992. Land loss rates: Louisiana Coastal Plain. Technical Report GL-92-3, U. S. Army Engineer Waterways Experiment Station, Vicksburg MS, 28 p.

Dunbar, J.B., Blaes, M, Dueitt, S. and Stroud, K. 1994. "Geological investigation of the Mississippi River deltaic plain, Report 2 of a Series," Technical Report GL-84-15, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Dunbar, J.B., Blaes, M, Dueitt, S. and May, J. 1995. "Geological investigation of the Mississippi River deltaic plain, Report 3 of a Series," Technical Report GL-84-15, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Fisk, H. N. 1944. “Geological Investigation of the Alluvial Valley of the Lower Mississippi River,” US Army Corps of Engineers, Mississippi River Commission, Vicksburg, Miss.

Fisk, H.N. 1952. Geological Investigation of the Atchafalaya Basin and Problems of Mississippi River Diversion, Vol. I and II, US Army Corps of Engineers, Mississippi River Commission, Vicksburg, MS.

Flynn, K. M., K. L. McKee, I. A. Mendelssohn. 1995. Recovery of freshwater marsh vegetation after a saltwater intrusion event. Oecologia 103:63-72.

Frazier, D. E. 1967. “Recent Deltaic Deposits of the Mississippi River: Their Development and Chronology,” Transactions Gulf Coast Association Geological Society, Vol. XVII, pp 287-315.

Gagliano, S.M. 1972. Environmental atlas and multi-use management plan for south-central Louisiana. (with S. Gagliano, et al.) *Center for Wetland Resources*, Louisiana State University, Baton Rouge, 17 pl.

Gagliano, S. and J. L. Van Beek. 1975. An approach to multiuse management in the Mississippi delta system, pp. 223-238. In, M. S. Broussard, (ed.), Deltas, models for exploration. Houston Geological Society, Texas. 555 pp.

Gagliano, S.M. and J.L. van Beek. 1993. A Long-term Plan for Louisiana's Coastal Wetlands. Louisiana Department of Natural Resources, Office of Coastal Restoration. Baton Rouge, LA.

Gagliano, Sherwood and J.L. van Beek, 1999. The TDCC Project. Proposed Mississippi River Diversion Channel and Sub-delta Building in the Barataria-Terrebonne Area of Coastal Louisiana. Section 6 in Appendix B of Coast 2050.

Gentner, B. M. Price and S. Steinbeck.. 2001. Marine Angler Expenditures in the Southeast Region, 1999. NOAA Technical Memorandum No. NMFS-F/SPO-48.

Helmers, D.L. 1992. Shorebird management manual. Western Hemisphere Shorebird Reserve Network, Manomet, MA. 58 pp.

Herke, W.H. 1993. Testimony before the Panel on Scientific Principles of Coastal Wetland Loss, Restoration and Creation in Louisiana, Baton Rouge, Louisiana, October 27, 1993.

Holling, C.S., and Gunderson, L.H. 2002. Resilience and Adaptive Cycles. In: Panarchy: Understanding Transformations in Human and Natural Systems. Gunderson, L.H. and C.S. Holling (Eds.). Island Press, Washington, D.C.

Keithly, W. 1991. Louisiana Seafood Industry Study: A Summary. New Orleans, Louisiana: Louisiana Seafood Promotions and Marketing Board, 32 pp.

Kesel, R.H., 1988. The decline in the suspended sediment load of the lower Mississippi River and its influence on adjacent wetlands. Environmental Geology and Water Science, 11, 271-281.

Kindinger J, Flocks J, Kulp M, Penland S and Britsh LD. 2001. Sand resources, regional geology, and coastal processes for the restoration of the Barataria barrier shoreline.

Kolb, C. R., and Van Lopik, J. R. 1958. "Geology of the Mississippi River Deltaic Plain, Southeastern Louisiana." Technical Report 3-483, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Kulp MA. 2000. Sand resources of Point Cheniere Ronquille to Grand Bayou Pass: Plaquemines Parish, Louisiana: In Sand resources and shoreline change analysis of Point Cheniere Ronquille to Grand Bayou Pass: Plaquemines Parish, Louisiana. Washington: National Marine Fisheries. Task Order 40-AA-NF-005575. 24 p.

LDNR, Wetlands Resources. 2003a. America's Wetlands: Energy Corridor to the Nation. Part 1 of 7: A proud History of Service to America's Energy Needs.

Louisiana Department of Natural Resources. 2003b. Coastal Restoration Annual Project Reviews December 2003.

May, J. R., 1984, Geological investigation of the Mississippi River deltaic plain: Technical Report GL-13-84, U. S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

McKee, K.L. and I.A. Mendelssohn. 1989. Response of a freshwater marsh plant community to increased salinity and increased water level. *Aquatic Botany*, 34, 301-316.

Mendelssohn, I.A., K.L. McKee, and W.H. Patrick. 1981. Oxygen deficiency in *Spartina alterniflora* roots: Metabolic adaptation to anoxia. *Science*, 214, 4329-441.

Michot, T.C. 1993. Testimony before the Panel on Scientific Principles of Coastal Wetland Loss, Restoration and Creation in Louisiana, Baton Rouge, Louisiana, October 27, 1993.

Minnello, T.J. and R.J. Zimmerman. 1991. The role of estuarine habitats in regulating growth and survival of juvenile penaeid shrimp. In: DeLoach, P., W.J. Dougherty, and M.A. Davidson. (eds.), *Frontiers in Shrimp Research*, Amsterdam: Elsevier Science Publishers, pp 1-16.

Mitsch, W. J. Day, J. W., Gilliam, W., Groffman, P. M., Hey, D. L., Randall, G. L., Wang, N. 2001 Reducing nitrogen loading to the Gulf of Mexico from the Mississippi River basin:Strategies to counters a persistent ecological problem. Bioscience 51:373-388

Penland, S. and R. Boyd. 1981. Shoreline changes on the Louisiana barrier coast. Oceans 91:209-219.

Penland S, Ritchie W, Boyd R, Gerdes RG, and Suter JR. 1986. The Bayou Lafourche delta, Mississippi River delta plain. Geological Society of America. Decade of North American Geology Field Guide (Southeastern section) pp. 447-452.

Penland, S.; Boyd, R., and Suter, J.R., 1988a. Transgressive depositional systems of the Mississippi delta plain: A model for barrier shoreline and shelf sand development. Journal of Sedimetnary Petrology, 58, 932-949.

Penland, S., K.E. Ramsey, R.A. McBride, J.T. Mestayer, and K.A. Westphal, 1988b Relative sea-level rise and delta-lain development in the Terrebonne Parish region: Louisiana Geological Survey, Coastal Geology Technical Report No. 4, pp. 121.

Penland, S., J.R. Suter and R.A. McBride. 1988c. Reconnaissance investigation of shoreface and inner shelf sand resources in Terrebonne Parish: Point Au Fer to Timbalier Island. Louisiana Geological Survey. 62 p.

Penland, S. and K.E. Ramsey. 1990. Relative sea-level rise in Louisiana and the Gulf of Mexico: 1908-1988. Journal of Coastal Research. 6(2):323-342.

Penland, S., L. Wayne, L.D. Britsch, S. Jeffress Williams, A.D. Beall, and V.C. Butterworth. 2000a. Process classification of coastal land loss between 1932 and 1990 in the Mississippi Delta Plain, southeaster Louisiana. (map). Sponsored by the Argonne National Laboratory, Gas Research Institute, U.S. Army Corps of Engineers, and the U.S. Geological Survey.

Penland S, Beall A, Connor P, Kulp M, Westphal K and Zganjar C. 2000b. Sand resources and shoreline change analysis of Point Cheniere Ronquille to Grand Bayou Pass: Plaquemines Parish, Louisiana. Washington: National Marine Fisheries Service. Coastal Wetland Planning, Protection, and Restoration Act. 37 p.

Rabalais, N.N., et al. 1999. Characterization of Hypoxia: Topic 1 Report for the Integrated Assessment on Hypoxia in the Gulf of Mexico. NOAA Coastal Ocean Program Decision Analysis Series No. 15. NOAA Coastal Ocean Program, Silver Springs, MD. 167 pp.

Reed, D.J. 1995. Status and Historical Trends of Hydrologic Modification, Reduction in Sediment Availability, and Habitat Loss/Modification in the Barataria and Terrebonne National Estuary Program, Thibodaux, LA.

Reed, D.J. 1989. Patterns of sediment deposition in subsiding coastal salt marshes, Terrebonne Bay, Louisiana. The role of winter storms. *Estuaries*, 12, 222-227.

Reed, D.J., N. De Luca and A.L. Foote. 1997. Effect of hydrologic management on marsh surface sediment deposition in coastal Louisiana. *Estuaries 20:301-311.*

Shlemon, R.J. 1972. Development of the Atchafalaya Delta, Louisiana, Report 13, Center for Wetland Resources, Louisiana State University, Baton Rouge, LA.

Smith, L.M., Dunbar, J.B., and Britsch, L.D. 1986. "Geomorphological Investigation of the Atchafalaya Basin, Area West, Atchafalaya Delta, and Terrebonne Marsh, Vol 1 and 2," Technical Report GL-86-3, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Steyer, G. D., Sasser, C.E., Visser, J.M., Swenson, E. M., Nyman, J. A., and Raynie, R. C. 2003. A proposed coast-wide reference monitoring system for evaluating wetland restoration trajectories in Louisiana. Environmental Monitoring and Assessment 81:107-117.

Stone P. Wang. 2000. A preliminary assessment of wave, current, and sediment interaction on the Louisiana shoreface adjacent to the Isles Dernieres. *Recent Research in Coastal Louisiana: 35-45.*

Stratton, D. P. and Westbrook, R. F. 1996. Louisiana's Timber Industry – An Assessment of Timber Product Output and Use.

Suter, J.R., S. Penland, and K. Ramsey, 1991. Nearshore Sand Resources of the Mississippi River Deltaic Plain: Marsh Island to Sandy Point, Coastal Geology Technical Report No. 8, Louisiana Geological Survey, Baton Rouge, Louisiana.

Swenson, E. M. And, R. E. Turner. 1987. Spoil banks: effects on coastal marsh water - level regime. Estuarine, Coastal and Shelf Science 24, 599-609.

Templet, P.H. and K.J. Meyer-Arendt. 1988. Louisiana wetland loss: Regional water management approach to the problem. *Environmental Management*, 12, 181-192.

Turner, R.E. 1979. Louisiana's fisheries and changing environmental conditions. In: J.W. Day Jr., D.D. Culley, R.E. Turner, and A.J. Mumphrey, eds., Proc. 3rd Coastal Marsh and Estuary Management Symposium, ppl 363-370. Div. Cont. Ed., Louisiana State University, Baton Rouge, LA.

Turner, R. E. 1997. Wetland loss in the northern Gulf of Mexico: multiple working hypotheses. Estuaries 20:1-13.

U.S. Army Corps of Engineers 1951. The Atchafalaya River Study, Vols. I, II, and III, Mississippi River Commission, Vicksburg, MS.

U.S. Army Corps of Engineers, New Orleans District. 1963. Hurricane Study for Morgan City, LA and Vicinity.

U.S. Army Corps of Engineers. 1983. Freshwater diversion to the Barataria and Breton Sound Basins. Main Report .

U.S. Army Corps of Engineers, New Orleans District. 1984. Louisiana Coastal Area, Louisiana. Freshwater Diversion to Barataria and Breton Sound Basins. Feasibility Study. Volume 2 Technical Appendixes A,B,C,D.

U. S. Fish & Wildlife Service. 2002. 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation - State Overview.

USGS-NWRC. 2004. Personal Communication. May, 2004.

Van Heerdan, I.L. and H.H. Roberts. 1988. Facies development of Atchafalaya Delta, Louisiana: a modern bayhead delta. The American Association of Petroleum Geologists Bulletin 72(4):439-453.

Waterborne Commerce Statistics Center, U. S. Army Corps of Engineers. 2003. Waterborne Commerce of the United States Calendar Year 2002.

Wang, F. C. 1987 Saltwater intrusion modeling: The role of manmade features. In: R.E. Turner and D. R. Cahoon (eds.). Causes of loss in the coastal central Gulf of Mexico. Volume II: Technical Narrative. Final report submitted to Minerals Management Service, New Orleans, LA. Contract No. 14-12-0001-30252. OCS Study/MMS 87-0120. 400 p.

Wang, F. C. 1988. Dynamics of saltwater intrusion in coastal channels. Journal of Geophysical Research 93.C6:6937-46.

Wang JD. 1987. Hurricane effects on surface Gulf Stream currents. Ocean Engr 14(3):165-180.

Williams, S.J., S. Penland, and A.H. Sallenger, Jr., editors. 1992. Louisiana Barrier Island Erosion Study: Atlas of shoreline changes in Louisiana from 1853 to 1989. Prepared by the U.S. Geological Survey in cooperation with the Louisiana Geological Survey. 103 p

This page intentionally left blank.

GLOSSARY

Acceptability – Adequate to satisfy a need, requirement, or standard. One of the USACE requirements for a project.

Adaptive Management – An interdisciplinary approach acknowledging our insufficient information base for decision-making; that uncertainty and change in managed resources are inevitable; and that new uncertainties will emerge. An iterative approach that includes monitoring and involves scientists, engineers and others who provide information and recommendations that are incorporated into management actions; results are then followed with further research, recommendations and management actions, and so on.

Aggradational Process of Plant Growth – Plant root material building elevation, usually in fresh marsh.

Air Quality Determination – The Louisiana Department of Environmental Quality ensures that projects do not adversely affect air quality through this determination as a requirement of the Clean Air Act.

Alternative Plan – A set of one of more management measures within a subprovince functioning together to address one or more objectives.

Amplitude – The maximum absolute value of a periodically varying quantity.

Anoxia – Absence of oxygen.

Anthropogenic – Caused by human activity.

Aquaculture – The science and business of farming marine or freshwater food fish or shellfish, such as oysters and crawfish, under controlled conditions.

Astronomical Tides – Daily tides controlled by the moon, as opposed to wind-generated tides.

Average Annual Habitat Unit (AAHU) – represent a numerical combination of habitat quality and quantity (acres) existing at any given point in time. The habitat unites resulting from the future without- and future with-project scenarios are annualized, averaged over the project life, to determine Average Annual Habitat Units (AAHUs).

Barbary Soils – Soils in swamps (with logs and stumps) that are level, very poorly drained, with a thin mucky surface layer and clayey underlying material.

Benefits – Valuation of positive performance measures.

Benthic – Living on or in sea, lake, or stream bottoms.

Biomass – The total mass of living matter (plant and animal) within a given unit of environmental area.

Bottomland Hardwood Forest – Low-lying forested wetlands found along streams and rivers.

Brackish Marsh (BRM) – Intertidal plant community typically found in the area of the estuary where salinity ranges between 4-15 ppt.

Chenier Plain – Western part of coastal Louisiana with little influence from Mississippi and Atchafalaya rivers characterized by chenier ridges.

Clean Water Act Section 404 (b) (1) – There are several sections of this Act which pertain to regulating impacts to wetlands. The discharge of dredged or fill material into waters of the United States is subject to permitting specified under Title IV (Permits and Licenses) of this Act and specifically under Section 404 (Discharges of Dredge or Fill Material) of the Act.

Coastal Zone Consistency Determination – The U.S. Environmental Protection Agency reviews plans for activities in the coastal zone to ensure they are consistent with Federally approved State Coastal Management Programs under Section 307(c)(3)(B) of the Coastal Zone Management Act.

Coast wide Plan – Combination of alternative plans assembled to address an objective or set of objectives across the entire Louisiana Coast.

Coast wide Framework – Combination of plan components assembled to address an objective or set of objectives across the entire Louisiana Coast.

Collocated Team – A collection of scientists and professionals from the U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, NOAA Fisheries, Natural Resources Conservation Service, U.S. Geological Survey, U.S. Environmental Protection Agency, Louisiana Department of Natural Resources, and Louisiana Department of Wildlife and Fisheries that are located at the USACE-MVN office and work together on the LCA Plan.

Compaction of Holocene Deposits – Deltaic mud that packs down under its own weight.

Completeness – The ability of a plan to address all of the objectives. One of the USACE four requirements for a project.

Comprehensive Plan – Same as coast wide Plan.

Conditional Authorization – authorization for implementation of a project subject to approval of the project feasibility-level decision document by the Assistant Secretary of the Army for Civil Works

Congressional Authorization – authorization for investigation to prepare necessary feasibility-level report to be recommended for authorization of potential future project construction by Congress

Connectivity – Property of ecosystems that allows for exchange of resources and organisms throughout the broader ecosystem.

Continental Shelf – The edge of the continent under gulf waters; the shallow Gulf of Mexico fringing the coast.

Control Structure – A gate, lock, or weir that controls the flow of water.

Discharge – The volume of fluid passing a point per unit of time, commonly expressed in cubic feet per second, millions of gallons per day, or gallons per minute.

Dissolved Oxygen – Oxygen dissolved in water, available for respiration by aquatic organisms. One of the most important indicators of the condition of a water body.

Direct Impacts – Those effects that result from the initial construction of a measure (e.g., marsh destroyed during the dredging of a canal). Contrast with "Indirect Impacts."

Diurnal – Relating to or occurring in a 24-hour period; daily.

Diversion – A turning aside or alteration of the natural course or flow of water. In coastal restoration this usually consists of such actions as channeling water through a canal, pipe, or conduit to introduce water and water-borne resources into a receiving area.

Dredged material embankments (Spoil Banks, Side-cast Banks, Excavated Material Banks) – Dredged material removed from canals and piled in a linear mound along the edge of canals.

Dynamic – Characterized by continuous change and activity.

Ecological – Refers to the relationship between living things and their environment.

Economic – Of or relating to the production, development, and management of material wealth, as of a country, household, or business enterprise.

Embankment – A linear mound of earth or stone existing or built to hold back water or to support a roadway.

Encroachment –Entering gradually into an area not previously occupied, such as a plant species distribution changing in response to environmental factors such as salinity.

Endangered Species – Animals and plants that are threatened with extinction.

Endpoints – see Objectives

Engineering News Record (ENR) – A magazine that provides news needed by anyone in or from the construction industry.

Enhance – To augment or increase/heighten the existing state of an area.

Entrenchment – Being firmly embedded.

Environmental Impact Statement (EIS) – A document that describes the positive and negative environmental effects of a proposed action and the possible alternatives to that action. The EIS is used by the Federal government and addresses social issues as well as environmental ones.

Federal Principals Group (FPG) –A collaboration among Federal agencies at the Washington level to facilitate the flow of information, to provide guidance and recommendations to the USACE and LDNR throughout the study process, and to facilitate resolution of any interagency issues that may be identified in the conduct of the study.

Final Array – The final grouping of the most effective coast wide plans from which a final recommendation can be made.

Foreshore Dikes – An embankment of earth and rock built to prevent floods or erosion that is built in the area of a shore that lies between the average high tide mark and the average low tide mark.

Framework Development Team (FDT) – A group of professionals from various Federal and state agencies, academia and the public formed to provide a forum for individual members to discuss LCA Comprehensive Study activities and technical issues and to provide individual comments to the Senior Management Committee.

Fresh Marsh (FAM) – Intertidal herbaceous plant community typically found in that area of the estuary with salinity ranging from 0-3 ppt.

Furbearer – An animal whose skin is covered with fur (mammal), especially fur that is commercially valuable, such as muskrat, nutria, and mink.

Geomorphic – Related to the geological surface configuration.

Geosynclinal Down-warping – The downward bend or subsidence of the earth's crust, which allows of the gradual accumulation of sediment

Geotropically – Downward growth in response to gravity, as in plant roots.

Glycophytes – A plant that cannot live in high salinity environments, most plants.

Goals – Statements on what to accomplish and/or what is needed to address a problem without specific detail.

Gradient – A slope; a series of progressively increasing or decreasing differences in a system or organism.

Habitat – The place where an organism lives; part of physical environment in which a plant or animal lives.

Habitat Loss – The disappearance of places where target groups of organisms live. In coastal restoration, usually refers to the conversion of marsh or swamp to open water.

Habitat Units (HUs) – represent a numerical combination of quality (HIS) and quantity (acres) existing at any given point in time. The HUs resulting from the future without- and future with-project scenarios are annualized, averaged over the project life, to determine Average Annual Habitat Units (AAHUs). The "benefit" of a project can be quantified by comparing AAHUs between the future without- and future with-project scenarios. The difference in AAHUs between the two scenarios represents the net benefit attributable to the project in terms of habitat quantity and quality.

Hazardous, Toxic, and Radioactive Wastes (HTRW) – Wastes that contain toxic constituents, or that may cause hazardous chemical reactions, including explosive or flammable materials, or radioactive wastes, which, improperly managed may present a hazard to human heath or the environment.

Headland – A point of land projecting into the sea or other expanse of water, still connected with the mainland.

Herbaceous – A plant with no persistent woody stem above ground.

Hydrodynamic – The continuous change or movement of water

Hydrology – The pattern of water movement on the earth's surface, in the soil and underlying rocks, and in the atmosphere.

Hypoxia – The condition of low dissolved oxygen concentrations.

Indemnification – Insurance against or compensation for loss or damage.

Indirect Impacts – Those effects that are not as a direct result of project construction, but occur as secondary impacts due to changes in the environment brought about by the construction. Contrast with "Direct Impacts."

Infrastructure – The basic facilities, services, and installations needed for the functioning of a community or society, such as transportation and communications systems, water and power lines, and public institutions including schools, post offices, and prisons.

Ingress – An entrance or the act of entering.
Inorganic – Not derived from living organisms; mineral; matter other than plant or animal.

Interdistributary Deposits – Sand and mud deposited between the river channels or between bayous.

Intermediate Marsh (INM) – Intertidal herbaceous plant community typically found in that area of the estuary with salinity ranging from 2-5 ppt.

Intertidal – Alternately flooded and exposed by tides.

Invertebrates – Animals without backbones, including shrimp, crabs, oysters, and worms.

Nursery – A place for larval or juvenile animals to live, eat, and grow.

Objectives – More specific statements than "Goals," describing how to achieve the desired targets.

Oceanic-dumping – The discharge of wastes or pollutants into offshore waters.

Organic – Composed of or derived from living things.

Oscillations – Fluctuations back and forth, or up and down.

Oxidation of Organic Matter – The decomposition (rotting, breaking down) of plant material through exposure to oxygen.

Oxygen-depleted – Situation of low oxygen concentrations where living organisms are stressed.

Petrochemical – Any compound derived from petroleum or natural gas.

Planning Scale – Planning term that reflects the degree to which environmental processes would be restored or reestablished, and the resulting ecosystem and landscape changes that would be expected over the next 50 years. This uppermost scale is referred to as "*Increase.*" No net loss of ecosystem function is "*Maintain.*" Reducing the projected rate of loss of function is "*Reduce.*" The lowest possible scale was no further action above and beyond existing projects and programs.

Point-Bar Deposit – The shallow depositional area on the inside bank of a river bend.

Post-larval – Stage in an animal's lifecycle after metamorphosis from the larval stage, but not yet full grown.

Potable Water – Water that is fit to drink.

Productivity – Growth of plants and animals.

Progradation – The phase during the deltaic cycle where land is being actively accreted through deposition of river sediments near the mouth.

Programmatic Environmental Impact Statement (PEIS) – and Environmental Impact Statement that supports a broad authorization for action, contingent on more specific detailing of impacts from specific measures.

Province – A major division of the coastal area of Louisiana. (e.g., Deltaic Plain and Chenier Plain).

Pulsing – Letting a diversion flow periodically at a high rate for a short time, rather than continuously.

Quantitative – Able to assign a specific number; susceptible to measurement.

Radiocarbon Age Determination –The use of the ratio of carbon isotopes to determine age.

Rebuild – To some extent build back a structure/landform that had once existed.

Reconnaissance Report – A document prepared as part of a major authorization that examines a problem or need and determines if sufficient methods and Federal interest exists to address the problem/need . If so, then a "Feasibility Report" is prepared, which details the solution and its impacts further.

Reduce – To diminish the rate or speed of a process.

Regional Working Group (RWG) – An inter-agency team formed to support the Washington-level Federal Principal's Group and to facilitate regional level collaboration and coordination on the LCA study.

Rehabilitate – To focus on historical or pre-existing ecosystems as models or references while emphasizing the reparation of ecosystem processes, productivity and service.

Relative Sea Level Change – The sum of the sinking of the land (subsidence) and eustatic sea level change; the change in average water level with respect to the surface.

Saline Marsh (SAM) – Intertidal herbaceous plant community typically found in that area of the estuary with salinity ranging from 12-32 ppt.

Stough soils – Yellowish brown coarse-loamy soil.

Strategy – Ecosystem restoration concept from the Coast 2050 Plan.

Stream Gaging Data – Records of water levels in streams and rivers.

Submergence – Going under water.

Subprovince – The divisions of the two Provinces (see "Province") into smaller groupings: 1) east of the Mississippi River; 2) west of the Mississippi River to Bayou Lafourche; 3) Bayou Lafourche to Freshwater Bayou; 4) Freshwater Bayou to Sabine River.

Subsidence – The gradual downward settling or sinking of the Earth's surface with little or no horizontal motion.

Sustain – To support and provide with nourishment to keep in existence; maintain.

Tarbert Flow – Stream gage data recorded at Tarbert's Landing on the Mississippi River.

Target – A desired ecosystem state that meets and objective or set of objectives.

Terrestrial Habitat – The land area or environment where an organism lives; as distinct from water or air habitats..

Third Delta – A proposed project that would divert up to 120,000 cubic feet of water per second from the Mississippi River near Donaldsonville, Louisiana down a conveyance channel to the marshes in southern Barataria and Terrebonne Basins.

Toxicity – The measure of how poisonous something is.

Transpiration – The process by which water passes through living plants into the atmosphere.

Trenasse – A small manmade trench through a swamp or marsh allowing travel by small boats.

Turbidity – The level of suspended sediments in water; opposite of clarity or clearness.

Unique Farmland – Land other than Prime Farmland (see "Prime Farmland") that is used for the production of specific high-value food and fiber crops, such as citrus, tree nuts, olives, cranberries, fruits, and vegetables.

Upconing – The tendency of underground salt water to move closer to the surface in the vicinity of a well as it fills the areas where freshwater is drawn out.

Upland (UPL) – A general term for non-wetland elevated land above low areas along streams or between hills.

Water Resource Units (WRU) – Stage-damage data developed as part of the Flood Damage Estimation System (FDES) in 1980 for the Mississippi River and Tributaries (MR&T) project were used to estimate the flood damages that are expected to occur in Subprovinces 1, 2, and 3. The data collected for the FDES were delineated into geographic areas with homogenous physical and hydraulic characteristics. These geographic areas were numerically coded and designated as Water Resource Units (WRUs). Within each WRU, land-use elements (structures, cropland, roads, bridges, railroads, etc.) were categorized by location, value, and corresponding depth-damage relationship. The structural damage categories included: residential, commercial, industrial, public, and farm buildings.

Water Resources Development Act (WRDA) – A bill passed by Congress that provides authorization and/or appropriation for projects related to the conservation and development of water and related resources.

Weir – A dam placed across a canal or river to raise, divert, regulate or measure the flow of water.

This page intentionally left blank.

ACRONYMS

AAHU – Average Annual Habitat Unit
ACHP – Advisory Council on Historic Preservation
ACM – Articulated Concrete Mat Revetment
AEAM – Adaptive Environmental Assessment and Management
ARS – Local Rate of Subsidence
ASA (CW) – Assistant Secretary of the Army (for Civil Works)
BAT – Best Available Technology Economically Achievable
BCT – Best Conventional Pollutant Control Technology
BMP – Best Management Practices
BPD – Barrels Per Day
BRM – Brackish Marsh
BTNEP – Barataria-Terrebonne National Estuary Program
BTU – British Thermal Units
BU – Benefits Units
CDP – Census Designated Places
CE/IC – Cost Effectiveness and Incremental Cost
CE/ICA – Cost Effectiveness and Incremental Cost Analysis
CELSS – Coastal Ecological Landscape Spatial Simulation
CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act
CFR – Code of Federal Regulations
CFS – Cubic Foot Per Second
COM – Compaction Fraction
CP – Conceptual Plan
CRT – Coastal Restoration Team
CSVR – Contents-to-Structure Value Ratio
CWA – Clean Water Act
CWPPRA – Coastal Wetland Planning, Protection Restoration Act
CY – Calendar Year
CYR – Cubic Yards Per Year
D – Water Depth
dbl – decibels
DD – Decision Documents
DEQ – Department of Environmental Quality
DM – Decision Makers
DO – Dissolved Oxygen
E&D – Engineering and Design
EIS – Environmental Impact Statement
EMAP – Environmental Monitoring and Assessment Program
ENR – Engineering News Record
EP – Engineering Pamphlet
FAM – Fresh Marsh
FDES – Flood Damage Estimation System
FDT – Framework Development Team

FEMA – Department of Homeland Defense – Federal Emergency Management Agency
FHWA – Federal Highway Administration
FPG – Federal Principals Group
FCSA – Feasibility Cost Share Agreement
FTL – Functional Team Leader
FWA – Future With The Alternative
FWO – Future Without Project
FY – Fiscal Year
GIWW – Gulf Intracoastal Waterway
GIS – Geographic Information System
H&H – Hydrology and Hydraulics
HSI – Habitat Suitability Index
HSIQL – Habitat Suitability Index That Reflects Quality of Habitat
HTRW – Hazardous, Toxic, or Radioactive Waste
HQU – Habitat Quality Units
HQUSACE – Headquarters, United States Army Corps of Engineers
HUD – Housing and Urban Development
IHNC – Inner Harbor Navigation Canal
INM – Intermediate Marsh
INT – Interspersion
IPT – Interdisciplinary Planning Team
ITR – Independent Technical Review
IWR – Institute for Water Resources
LABR – Lower Atchafalaya Basin Reevaluation
LAR – See LABR
LCA – Louisiana Coastal Area
LDNR – Louisiana Department of Natural Resources
LDOTD – Louisiana Department of Transportation and Development
LDWF – Louisiana Department of Wildlife and Fisheries
LERRD – Land, Easements, Rights of Way, Relocation, and Disposal
LNG – Liquefied Natural Gas
LPDES – Louisiana Pollution Discharge Elimination System
LPMS – Lock Performance Management System
LPP – Locally Preferred Plan
LSU – Louisiana State University
MCACES – Microcomputer Aided Cost Estimating System
MCFS – Marsh Creation Feasibility Study
MPO – Metropolitan Planning Organization
MR&T – Mississippi River and Tributaries
MRC – Mississippi River Commission
MRGO – Mississippi River Gulf Outlet
MS4s – Municipal Separate Storm Sewer Systems
MVD – Mississippi Valley Division
MVN – Mississippi Valley New Orleans District
NE – Northeast
NED – National Economic Development

NEPA – National Environmental Policy Act
NER – National Ecosystem Restoration
NG – Natural Gas
NGVD – National Geodetic Vertical Datum
NHPA – National Historic Preservation Act
NMFS – Department of Commerce – National Marine Fisheries Service
NOAA – National Oceanic and Atmospheric Administration
NPDES – National Pollutant Discharge Elimination System
NRC – National Research Council
NRCS – Department of Agriculture – Natural Resources Conservation Service
NRHP – National Register of Historic Places
NTRC – National Technical Review Committee
NW – North West
NWR – National Wildlife Refuge
OMRR&R – Operating, Maintaining, Repairing, Replacing, and Rehabilitating
OSI – Overall Suitability Index
O&M – Operations and Maintenance
OPEC – Organization of Petroleum Exporting Countries
P&G – Principles & Guidelines
PBMO – Plan that Best Meets Objectives
PCA – Project Cost Agreement
PDT – Project Delivery Team
PED – Preconstruction, Engineering, and Design
PEIS – Programmatic Environmental Impact Statement
PIERS – Port Import Export Reporting Service
PIR – Project Implementation Report
PMT – Project Management Team
PPM – Parts Per Million
Q – Discharge
RET – Retention Fraction
RR – Railroad
RSLR – Relative Sea Level Rise
RV – Recreational Vehicle
RWG – Regional Work Group
S&A – Supervision and Administration
SAM – Saline Marsh
SELA – Southeast Louisiana
SHPO – State Historic Preservation Officer
SL – Sediment Load
SLU – Southern Louisiana University
SPR – Strategic Petroleum Reserve
SS – Scrub Shrub
SUB – Local Subsidence Amount
SW – Southwest
SWF – Swamp
SWPPP – Storm Water Pollution Prevention Plan

TMDL – Total Maximum Daily Limit
TSP – Tentatively Selected Plan
TVA – Tennessee Valley Authority
ULL – University of Louisiana at Lafayette
UNO – University of New Orleans
UPL – Upland
USACE – United States Army Corps of Engineers
USACE-MVN – United States Army Corps of Engineers – Mississippi Valley New Orleans District
USACE-OVEST – United States Army Corps of Engineers – Office of the Chief of Engineers Value Engineering Study Team
USEPA – United States Environmental Protection Agency
USFDA – United States Food and Drug Administration
USFWS – Department of Interior – U.S. Fish and Wildlife Service
USGS – Department of Interior – United States Geological Survey
VE/ITR – Value Engineering/ Independent Technical Review
VT – Vertical Team
WAT – Water
WCSC – Waterborne Commerce Statistics Center
WEFA – Wharton Economic Forecasting Associates
WLO – Wax Lake Outlet
WRDA – Water Resource Development Act
WRU -- Water Resource Units
WVA – Wetlands Value Assessment
WW – Waterway

CONVERSIONS

METRIC SYSTEM[1]					
LENGTH					
Unit	*Abbreviation*	*Number of Meters*	*Approximate U.S. Equivalent*		
kilometer	km	1,000	0.62 mile		
hectometer	hm	100	328.08 feet		
dekameter	dam	10	32.81 feet		
meter	m	1	39.37 inches		
decimeter	dm	0.1	3.94 inches		
centimeter	cm	0.01	0.39 inch		
millimeter	mm	0.001	0.039 inch		
micrometer	µm	0.000001	0.000039 inch		
AREA					
Unit	*Abbreviation*	*Number of Square Meters*	*Approximate U.S. Equivalent*		
square kilometer	sq km *or* km^2	1,000,000	0.3861 square miles		
hectare	ha	10,000	2.47 acres		
are	a	100	119.60 square yards		
square centimeter	sq cm *or* cm^2	0.0001	0.155 square inch		
VOLUME					
Unit	*Abbreviation*	*Number of Cubic Meters*	*Approximate U.S. Equivalent*		
cubic meter	m^3	1	1.307 cubic yards		
cubic decimeter	dm^3	0.001	61.023 cubic inches		
cubic centimeter	cu cm *or* cm^3 *also* cc	0.000001	0.061 cubic inch		
CAPACITY					
Unit	*Abbreviation*	*Number of Liters*	*Approximate U.S. Equivalent*		
			cubic	*dry*	*liquid*
kiloliter	kl	1,000	1.31 cubic yards		
hectoliter	hl	100	3.53 cubic feet	2.84 bushels	
dekaliter	dal	10	0.35 cubic foot	1.14 pecks	2.64 gallons
liter	l	1	61.02 cubic inches	0.908 quart	1.057 quarts
cubic decimeter	dm^3	1	61.02 cubic inches	0.908 quart	1.057 quarts
deciliter	dl	0.10	6.1 cubic inches	0.18 pint	0.21 pint
centiliter	cl	0.01	0.61 cubic inch		0.338 fluid ounce
milliliter	ml	0.001	0.061 cubic inch		0.27 fluid dram
microliter	µl	0.000001	0.000061 cubic inch		0.00027 fluid dram

MASS AND WEIGHT			
Unit	*Abbreviation*	*Number of Grams*	*Approximate U.S. Equivalent*
metric ton	t	1,000,000	1.102 short tons
kilogram	kg	1,000	2.2046 pounds
hectogram	hg	100	3.527 ounces
dekagram	dag	10	0.353 ounce
gram	g	1	0.035 ounce
decigram	dg	0.10	1.543 grains
centigram	cg	0.01	0.154 grain
milligram	mg	0.001	0.015 grain
microgram	µg	0.000001	0.000015 grain

Attachment 1

Relevant Authorizations for Coastal Restoration Efforts

1. Caernarvon Freshwater Diversion project (authorized by the Flood Control Act of 1965 (PL 89-298), the WRDA of 1974 (PL 93-251), and WRDA 1986 (PL 99-622)).

2. Davis Pond Freshwater Diversion project (authorized by the Flood Control Act of 1928 (PL 70-391) and the Flood Control Act of 1965 (PL 89-298); the project was further amended by WRDA 1986 (PL 99-622) and WRDA 1996 (PL 104-303)).

3. Section 103 of the 1962 River and Harbor Act - Hurricane and Storm Damage Reduction. Section 103 of the 1962 River and Harbor Act provides authority for the USACE to develop and construct projects to protect the shores of publicly owned property by constructing revetments, groins, and jetties, to include periodic sand replenishment. Each project is limited to a Federal cost of not more than $3 million.

4. Section 1135 of WRDA 1986 - Project Modifications for Improvement to the Environment. Section 1135 of the 1986 WRDA provides authority to restore degraded ecosystems, if the construction or operation of a USACE project contributes to the degradation of the quality of the environment. Measures for restoration through modifications of the structure or operation of the structure can be undertaken. Measures at other locations affected by the construction or operation of the project can also be undertaken if they do not conflict with the authorized project purposes.

5. The Coastal Wetland Planning, Protection and Restoration Act (PL-101-646, Title III), (CWPPRA), enacted in November 1990, provided the first Federal statutory mandate for restoration of Louisiana's coastal wetlands.

6. The Barataria-Terrebonne National Estuary Program (BTNEP) was established in 1990 under the U.S. Environmental Protection Agency 's (USEPA) National Estuary Program. BTNEP established a partnership between the USEPA and the State of Louisiana to study natural and man-made causes of environmental degradation in the Barataria-Terrebonne watershed and to protect the watershed from further degradation.

7. Section 204 of the 1992 WRDA - Ecosystem Restoration Projects in Connection with Dredging. Section 204 of the 1992 WRDA provides authority for the USACE to restore, protect, and create aquatic and wetland habitats in connection with construction or maintenance dredging of an authorized project.

8. Section 206, 1996 WRDA - Aquatic Ecosystems. Section 206, of the 1996 WRDA provides authority for the USACE to restore degraded ecosystems. This authority is similar to Section 1135, but a USACE project need not be a contributor to the degradation of the quality of the environment.

This page intentionally left blank.

Attachment 2

Prior Studies, Reports, and Existing Water Projects

Additional information regarding restoration actions with respect to the LCA study authority can be found in the section 1 INTRODUCTION (found on page MR-14).

A number of studies and reports on water resources development in the study area have been prepared by the USACE, other Federal, state, and local agencies, research institutes, and individuals. Previous studies established an extensive database for this study. Historical trends and existing conditions were identified to provide insight into future conditions, help isolate the problems, and identify the most critical areas. Those projects not fully described in section 1 are summarized here.

The more relevant studies, reports, and projects are described as follows:

1. In November 1993, The Louisiana Coastal Wetlands Restoration Plan was prepared, by the Louisiana Coastal Wetlands Conservation and Restoration Task Force as part of the Federal Coastal Wetlands Planning Protection and Restoration Act (CWPPRA) established in 1990 (Public Law 101-646, title III). This plan is a product of communication, coordination, and cooperation among the designated participants from the state and Federal agencies, and through formal and informal involvement of numerous local government agencies, the academic community, private environmental and business groups, and countless motivated individuals. There are two important findings that form the core of the Restoration Plan.

   1. First, by phasing in an adequate investment now, it is technically feasible to significantly slow or reverse coastal wetlands loss and thereby protect, sustain, and increase the most valuable environmental and economic assets of the region.
   2. Second, the no-action alternative condemns the Nation to a far more expensive course of uncoordinated and increasingly futile emergency efforts to protect existing investments in the economic infrastructure without hope of achieving sustainability.

   Under the authority of CWPPRA, the Task Force has actively pursued its mission, fulfilling a second CWPPRA directive of submitting a series of annual Priority Project Lists. CWPPRA projects include gulf and inland shoreline protection, sediment and freshwater diversions, terracing, vegetative plantings, marsh creation, and barrier island projects.

2. In 1994, the Governor's Office of Coastal Activities Science Advisory Panel prepared a plan entitled An Environmental –Economic Blueprint for Restoring the Louisiana Coastal Zone: The State Plan for the Wetlands Conservation and Restoration Authority (State Wetlands Authority), constituted under Act 6 (R.S. 49:213.1 et seq.). At about the same time, other plans were developed, as the need for action became widely apparent.

3. In April 1995, a report was presented entitled A White Paper-The State of Louisiana's Policy for Coastal Restoration Activities. This White Paper represents the State of Louisiana's appraisal of the present conditions and the ongoing challenges in the restoration and protection efforts of our state's coastline. Equally important, this paper outlines strategies for a 20-year coastal restoration plan based on a partner-supported, unified plan of action. In this paper, the State calls upon its partners: the USACE, the U.S. Departments of Agriculture, Commerce, and Interior, and the U.S. Environmental Protection Agency, along with other Federal, state/local agencies, user groups, concerned citizens, and private interests to support and endorse the strategies outlined there in. The paper presents the State's desire to improve coordination with all local governments and Federal agencies, as well as our Congressional delegation.

4. The December 1998 report Coast 2050: Toward a Sustainable Coastal Louisiana presents a coast wide plan developed through a joint effort of the CWPPRA Task Force and the State Wetlands Authority. The Coast 2050 plan was subsequently adopted by the State Wetlands Authority as their official plan. The plan combines elements of all previous efforts, along with new initiatives from private citizens, local governments, state and Federal agency personnel, and the scientific community. The plan integrates coastal management and coastal restoration approaches, and adopts a multiple-use approach to restoration planning. Among other contributions, the Coast 2050 Plan provides new quantitative techniques for projecting land loss patterns into the future, a coast wide assessment of subsidence rates and patterns, and a comprehensive consideration of changes in fish and wildlife populations. The Coast 2050 plan establishes regional and coast wide common strategies and programmatic recommendations. The coast wide strategies were updated in January 2001 and include beneficial use of dredged material and dedicated dredging to create, restore, or protect wetlands; herbivory control; stabilization of the width and depth of major navigation channels and other water bodies at their point of intersection; maintenance of gulf, bay, and lake shoreline integrity; management of pump and gravity-flow outfall for wetland benefits; vegetative planting; maintaining, protecting, or restoring coastal ridge function; terracing; off-shore and riverine sand and sediment resources; diversions and riverine discharge; and management of diversion outfall for wetland benefits. Programmatic recommendations include: coordinate wetland mitigation, provide appropriate relocations costs and flood control for impacts related to wetland restoration, expedite coastal restoration permitting, impose and enforce boat wake limits, implement measures to improve wetlands and aquatic habitats, improve land rights acquisition procedures, increase wetlands through incentive based programs, identify funding sources to adequately address coastal land loss problems in Louisiana, prevent negative effects of shell dredging, mitigate water hyacinth problems, minimize losses due to permitted activities, develop and sustain a comprehensive barrier shore/island initiative, and provide for better coordination among agencies regarding coastal issues.

5. In May 1999, a report entitled Section 905(b) (WRDA1986) Analysis Louisiana Coastal Area, Louisiana --Ecosystem Restoration was prepared by USACE. This reconnaissance level effort evaluated the Coast 2050 Plan as a whole and expressed a Federal interest in proceeding to the feasibility phase.

Previous partial responses to the Louisiana Coastal Area Study Authorization of 1967 that have been completed at the present time are summarized as follows:

6. In 1984, a feasibility report entitled Mississippi and Louisiana Estuarine Areas was prepared by USACE. The report recommended the diversion of Mississippi River water into the Lake Pontchartrain Basin and Mississippi Sound to increase habitat conditions and improve fish and wildlife resources. The project was authorized by the Water Resources Development Act of 1988.

7. In September 1984, an initial evaluation study entitled Louisiana Coastal Area Louisiana, Shore and Barrier Island Erosion reports investigative findings which indicate that Louisiana's beaches and barrier islands act as buffers for coastal marshes and communities, absorbing much of the wave action from the Gulf of Mexico. The problems addressed in this study concerns shoreline and barrier island erosion caused by both man-induced and natural forces. The study identified that increased wave energy and altered water circulation would increase turbidity and salinity, replacing the highly productive estuarine environment with a less productive marine environment.

8. In June 1990, the USACE conducted a reconnaissance study under the Louisiana Coastal Authority entitled Mississippi River Delta Study. The purpose of this study was to determine the feasibility of realigning the lower Mississippi River channel to increase its marsh-building capacity. The general study finding was that there are no economically justified alternatives for making realignments to the Mississippi River.

9. In September 1984, an initial evaluation report Louisiana Coastal Area, Louisiana, Water Supply was prepared by USACE which investigated the advisability of improvements or modification of existing improvements, in the interest of water supply, in the coastal area of Louisiana. The report recommended that five of the six problem areas identified be further investigated in the cost-shared feasibility phase of the study.

10. In March 1989, the reconnaissance report Louisiana Coastal Area, Hurricane Protection investigated hurricane induced storm surges associated with anticipated future losses of coastal wetlands and barrier islands in Louisiana. The USACE prepared a report, certified in March 1989, recommending that the study proceed into the cost shared feasibility phase.

11. In April 1990, a report entitled Land Loss and Marsh Creation, St. Bernard, Plaquemines, and Jefferson Parishes, Louisiana was published by USACE under the LCA Authority. The report presents the findings of feasibility phase investigations for utilizing Mississippi River water and sediment through diversions and direct placement to address the loss of vegetated wetlands in coastal Louisiana.

Other pertinent studies, reports, and projects not prepared under the LCA Study authority are as follows:

There are numerous existing projects within the study area that have been created under various congressional authorizations. These projects include navigation related projects under the Rivers and Harbors Act, Mississippi River & Tributary Project (Flood Control Act 1928) and hurricane protection/ flood controls (Flood Control Act of 1965).

12. In 1942, a report entitled Louisiana-Texas Intracoastal Waterway, New Orleans, Louisiana to Corpus Christi, Texas was published as House Document No. 230, 76th Congress, 1st Session. The report and prior River and Harbor Acts provide for the construction of a 384.1-mile channel 12 ft deep by 125 ft wide from the mouth of the Rigolets to the Sabine River. The project was authorized for construction by the River and Harbor Act of 23 July 1942. The main stem of the project was completed in 1944.

13. In 1945, a report entitled Mississippi River, Baton Rouge to the Gulf of Mexico, Louisiana was published as House Document 215, 76th Congress, 1st Session. The report recommended a navigation channel 35 ft to 40 ft deep by 800 ft to 1,000 ft wide. Construction of the channel was completed in 1963. The General Design Memorandum Supplement No. 2, dated April 1984, provides for the restoration of deteriorated bank lines below Venice, Louisiana, and along Southwest Pass with rock foreshore dikes and hydraulic fill to reduce shoaling.

14. In 1951, a report entitled A Report on the Relationship of Agricultural Use of Wetlands to the Conservation of Wetlands in Cameron Parish, Louisiana was published by the USDA-Soil Conservation Service. This report contained information on the relationship of agricultural wetland uses and wetland conservation efforts in Cameron, Parish Louisiana.

15. In 1951, a report entitled Relationship of Wildlife to Agricultural Drainage and Economic Development of Coastal Marshes in Cameron Parish, Louisiana was published by the USFWS. This report contained information on the wildlife and agricultural drainage/economic development relationship for coastal marshes in Cameron Parish.

16. In 1959, L.M. McBride and Edmund McIlhenny authored a report entitled Survey and Report of Vermillion Corporation in Opposition to Project (Fresh Water Bayou Canal Project).

Mississippi River. The locally constructed back levee from City Price to Venice, Louisiana, on the west bank would be brought up to grade. The General Design Memorandum Supplement No. 5, dated October 1983, provides for the creation of 297 acres of marsh in the Delta-Breton National Wildlife Refuge as mitigation for marsh loss caused by the levees. Construction is approximately 80 percent complete with estimated completion in 2017.

19. In 1964, a report on the Mississippi River and Tributaries project, published as House Document No. 308, 88th Congress, 1st Session, recommended construction of the Mississippi Delta Region project. The project provided for four salinity control structures to introduce freshwater into the delta region. These improvements were authorized by the Flood Control Act of 1965.

20. In 1965, the Lake Pontchartrain, LA, and Vicinity Hurricane Protection Project (LP&V-HPP) was authorized by the Flood Control Act of 1965; additional authorization was given through the Water Resources Development Acts of 1974, 1986, 1990, and 1992. The project provides for hurricane protection for the metropolitan New Orleans area by constructing hurricane protection levees and appurtenant features. Construction was initiated in 1967 and is ongoing with over-all project completion scheduled for 2013.

21. In 1965, the Larose to Golden Meadow Hurricane Protection Project was authorized by Flood Control Act of 1965, House Document 184, 89th Congress, Public Law 89-298. The Larose to Golden Meadow Project is located along Bayou Lafourche in south Louisiana. It consists of a 43-mile ring levee that provides hurricane protection and approximately 8 miles of low interior levees that regulate intercepted drainage for lands on both banks of the bayou from Larose south to Golden Meadow. There are two floodgates, one at the upper bayou crossing and another at the lower bayou crossing, that maintain navigation in Bayou Lafourche. The first levee lift was completed in 1975. The final levee lift to the 100-year elevation is scheduled for completion in 2003.

22. In 1973, an eighteen report series, Hydrologic and Geologic Studies of Coastal Louisiana, and the final report entitled Environmental Atlas and Multi-Use Management Plan for South-Central Louisiana were prepared by the Center for Wetland Resources, Louisiana State University under a contract with USACE. The studies examined and identified trends in the coastal area resulting from natural processes and human activities, identified significant environmental parameters, determined the fresh water required to implement changes for fish and wildlife enhancement, and developed management and structural approaches to problem-solving in the estuarine environment.

23. In 1978, Barney Barrett et al. authored a technical bulletin entitled Study of Louisiana's Major Estuaries and Adjacent Offshore Waters LDWF – Seafood Div., Technical Bulletin No. 27.

24. In 1979, a report sponsored by the USFWS entitled An Ecological Characterization Study of the Chenier Plain Coastal Ecosystem of Louisiana and Texas was published. This

report contains information on the biological, physical, and social parameters in the Chenier Plain of Louisiana and Texas.

25. In 1980, the USFWS produced a report entitled Mississippi Deltaic Plain Region Ecological Characterization. The report supplies information about the biological, physical, and social parameters in the Mississippi Deltaic Plain region of Louisiana. Portions of the USFWS report were used in the present study.

26. In June 1980, the Grand Isle and Vicinity, Louisiana, Phase II General Design Memorandum was issued by USACE. The report contains detailed studies of a combined beach erosion and hurricane protection plan for the shore of Grand Isle. Design features include beach fill, vegetated dunes, and a jetty

27. In 1981, a report entitled New Orleans-Baton Rouge Metropolitan Area, Louisiana was completed by USACE. The report contains a comprehensive plan for development and conservation of water and related land resources in a 21-parish area. The report includes 10 parishes in the current study.

28. In 1981, a report entitled Deep-Draft Access to the Ports of New Orleans and Baton Rouge, Louisiana was prepared by USACE. The report recommended deepening the Mississippi River to a project depth of 55 ft from the Gulf of Mexico to the Ports of New Orleans and Baton Rouge. Dredged material would be placed in subsiding areas east and west of the river below Venice to create 11,600 acres of marsh over a 50-yr period. The project was authorized by the 1985 Supplemental Appropriations Act of 1986, dated 17 November 1986. Construction of Phase I of the project, a 45-ft channel to mile 181 Above Head of Passes, was completed in December 1988.

29. In June 1982, a report entitled Louisiana's Eroding Coastline: Recommendations for Protection was published by Coastal Environments, Inc., through a contract with LDNR. The report recognizes that future losses of coastal wetlands are unavoidable and will require either retreat of development from the coastal region of increasingly greater levels of protection. Areas with erosion problems were identified and ranked according to severity. The report recommends a number of pilot projects using water and sediment diversions, dredged material placement, and planted vegetation as ways to reduce erosion. A study to determine future coastal conditions including changes in shoreline configuration and impacts on developed areas is also recommended. Information on erosion and shoreline changes was used in defining problem areas and evaluating alternative plans.

30. In 1982, the USFWS published the Proceedings of the Conference on Coastal Erosion and Wetland Modification in Louisiana: Causes, Consequences, and Options, edited by D.F. Boesch. The proceedings provide a current compendium of information on the natural and man-induced causes of land loss, their impacts on natural resources production and man's use of the area, and possible means of reducing land loss.

31. In April 1994, a report entitled Mississippi River and Tributaries - Morganza, Louisiana to the Gulf of Mexico Reconnaissance Report was published by the USACE. The reconnaissance analysis used available data and preliminary field investigations to establish existing conditions, determine the extent of flooding problems, and develop a wide array of alternative solutions. The USACE, the Terrebonne Levee and Conservation District (TLCD), and the public, through the regulatory process, generated numerous flood protection alternatives for a large study area extending from the East Atchafalaya Basin Protection Levee (EABPL) to the western Mississippi River guide levee. The proposals connected existing and permitted forced drainage levees and utilized existing pump stations and flood control structures where possible. In addition, the proposals included new floodgates and water control structures of varying sizes to form a comprehensive system of flood protection, drainage, navigation, and environmental enhancement in Terrebonne Parish. Four flood protection alternatives were determined to be economically feasible and environmentally acceptable. Congress authorized the multipurpose feasibility study in the Energy and Water Development Act of 1995.

32. In January 1996, the Louisiana Barrier Shoreline Feasibility Study was authorized by the CWPPRA Task Force and conducted to assess and quantify wetland loss problems linked to protection provided by barrier formations along the Louisiana coast. The study identified solutions to these problems, attached an estimated cost to these solutions, and determined the barrier configuration that will best protect Louisiana's significant coastal resources from saltwater intrusion, storm surges, wind/wave activity, and oil spills. These resources include, but are not limited to, oil and gas production and exploration facilities, the Strategic Petroleum Reserve, pipelines, navigable waterways, and fragile estuarine and island habitats.

33. In July 2000, the Mississippi River Sediment, Nutrient and Freshwater Redistribution Feasibility Study was conducted under the CWPPRA authority. The purpose of this study was to: (1) determine means to quantify and optimize the available resources of the Mississippi River to create, protect, and increase coastal wetlands and dependent fish and wildlife populations in coastal Louisiana; and (2) to plan, design, evaluate, and recommend for construction projects utilizing the natural resources of the Mississippi River in order to abate continuing measured loss of this habitat and restore a component of wetland growth.

34. The NRCS has published soil surveys on all of the coastal parishes. These provide detailed soils information in addition to uses and limitations of land use as a result of these soils. Cooperative River Basin Studies have also been published by the NRCS. These contain current and historic descriptions of basins and provide detailed management alternatives of hydrologic units within these basins. The published coastal reports include: Lafourche-Terrebonne, 1986; East Central Barataria, 1989; Calcasieu-Sabine, 1994;Mermentau, 1997; Teche-Vermilion, 1999.

35. In October 2003, a preliminary draft reevaluation report and environmental impact statement entitled Mississippi River & Tributaries, Atchafalaya Basin, Louisiana – Lower Atchafalaya Basin Reevaluation (LABR) Study was submitted by the New Orleans

District of the U.S. Army Corps of Engineers to the Mississippi Valley Division for review and comment. The recommended plan presented in the LABR preliminary draft reevaluation study would involve continued implementation of the authorized features of the Atchafalaya Basin Floodway System, Louisiana Feasibility Study dated January 1982, with the exception of three features that were no longer necessary. These features are 1) enlargement of the Wax Lake Outlet Overbank Structure, 2) channel training works below Morgan City, and 3) no further implementation of a controlled flow distribution between the Wax Lake Outlet and the Lower Atchafalaya River. Additionally, the draft recommendations include the request for further investigations into the feasibility of replacing the Avoca Island Levee Extension feature with the Levees East of Morgan City feature. This further study will include hydrologic and hydraulic analysis, hydraulic modeling, surveys, fisheries studies, and the necessary environmental studies. The Levees East of Morgan City feature, as presented in the LABR preliminary draft report, will included a lock and pump station (12,000 cfs) at Amelia, LA; a pump station (3,000 cfs) at the Elliot Jones Canal and the appropriate levee and floodwall system. During the development of the LABR preliminary draft report, several investigations were conducted to determine if a jetty extending from Point Chevreuil into the Gulf of Mexico was required as a mitigation feature of the MR&T project. Through these investigations it was determined that such a feature is not a mitigation feature of the MR&T projects. However, it was determined that such a feature could have sufficient environmental benefits to justify construction. The preliminary draft recommendations included in the LABR study indicate that this feature should be fully investigated under an environmental authority. The LDNR is currently engaged in a preliminary study to examine the engineering feasibility and environmental impacts of constructing this feature. These efforts will be included in future LCA detailed studies.

36. The <u>Atchafalaya River and Bayous Chene, Boeuf, and Black, Louisiana Feasibility Study</u> is currently underway. The study is a multi-purpose study, with emphasis on examining the feasibility of deepening the channel to the Morgan City/Amelia Industrial Area and maximizing coastal restoration and delta development opportunities. The study was initiated in May 2002 and is scheduled for completion in May 2005. This study will examine in detail, different alternatives (including channel diversions) for maximizing the use of river sediments (both dredged and un-dredged) to restore eroding coastal areas in conjunction with providing improvements to the navigation channels. The ecosystem restoration components contained in this study may be included in future LCA detailed studies and implemented as a part of the LCA Plan.

<u>Other Federal projects within the study area include:</u>

37. <u>Old River complex</u>. The Old River complex consists of three structures: the low sill structure, the auxiliary structure, and the overbank structure. The low sill and overbank structures were completed in 1963. The low sill structure was damaged during the 1973 flood. Rehabilitation of the structure was undertaken, but the integrity of the structure to function as designed during future high water events was questionable. Consequently, construction of an auxiliary structure to supplement the low sill structure was completed in 1986. The privately owned Sidney A. Murray, Jr. Hydroelectric Power Station

(completed in 1989) is located just upstream of the over bank structure, and pursuant to a certain Memorandum of Agreement, dated December 13, 1989 between the United States of America and the Town of Vidalia and the Catalyst Old River Hydroelectric Limited Partnership, significant portions of the Old River flows are presently being diverted to the Atchafalaya River through the plant for power generation instead of passing through the federal structures. Among other things, daily operation of the Old River complex consists of regulating the low sill structure, the auxiliary structure, and the power station so that of the total flow from the Red and Mississippi Rivers at the latitude of Old River, 30 percent passes down the Atchafalaya River and 70 percent down the Mississippi River on a yearly basis. The overbank structure has been used during high water events. The maximum design capacity for the complex during a project flood is 620,000 cfs. The Old River lock, which allows navigation between the Mississippi and Atchafalaya Rivers, is located approximately 10 miles downstream of the Old River complex.

This page intentionally left blank.

Attachment 3

Non-Federal Sponsor Financial Capability

A breakdown of the Federal and non-Federal cost sharing for the project is displayed in table MR 6-4, of the Main Report. The State of Louisiana has been an active participant throughout the development of the LCA Plan and has reviewed a preliminary draft of the cost-sharing agreement. It has also provided the District with a letter of intent indicating that the State understands the responsibilities incumbent on the non-Federal sponsor. The State intends to enter into a binding agreement with the USACE for each element at the appropriate time. This agreement, called the Project Cost Sharing Agreement (PCA), would include a statement of financial capability and a financing plan, each of which would be prepared by the State and signed by an appropriately authorized state official. The financing plan would specifically identify the source of project funding and the annual revenues generated from this source in order to ensure that sufficient funds are available on a cash-flow basis to meet non-Federal cost-sharing responsibilities for each fiscal year. Also included in the PCA would be a Commander's Assessment of the non-Federal Sponsor's Ability to Cost Share, which would be prepared and signed by the USACE-MVN District Engineer.

This page intentionally left blank.

Attachment 4

Non-Federal Sponsor Notice of Intent

Col. Rowan
Page 2
June 3, 2004

I would like to express my personal support for continuing this important work. A long-term, comprehensive approach to the sustainable restoration and rehabilitation of our coastal ecosystem is of vital importance to the state of Louisiana and to the nation as a whole. As we embark on this first phase of implementation, I look forward to working with you as we move toward achieving that goal.

Sincerely,

Kathleen Babineaux Blanco
Governor
State of Louisiana

Attachment 5

Additional Information on Five Near-Term Critical Restoration Features for Conditional Authorization

Mississippi River - Gulf Outlet Environmental Restoration Features

Small Diversion at Hope Canal

Barataria Basin Barrier Shoreline Restoration, Caminada Headland, Shell Island

Small Bayou Lafourche Reintroduction

Medium Diversion with Dedicated Dredging at Myrtle Grove

This page intentionally left blank.

Mississippi River - Gulf Outlet Environmental Restoration Features

A Near-Term Critical Feature for the Louisiana Coastal Area Plan

Mississippi River - Gulf Outlet Environmental Restoration Features
A Near-Term Critical Feature for the Louisiana Coastal Area Plan

Introduction

This near-term restoration feature involves the construction of shoreline protection measures such as rock breakwaters along the north bank of the MRGO and along important segments of the southern shoreline of Lake Borgne, as well as the investigation of various environmental restoration strategies requested in response to public concerns over the proposed plan to stabilize the MRGO navigation channel. The natural ridges along these selected shoreline segments are in danger of breaching in the very near future because of ship wakes along the channel and erosion from wind-driven waves along the lakeshore. Once these ridges are breached, the wetlands protected by these ridges become vulnerable to natural and man-made erosive forces that will quickly work to degrade the wetlands. Strategic placement of similar protective breakwaters has been effectively used along the MRGO in other locations to prevent bankline retreat and to protect large areas of estuarine wetlands from further erosion and degradation. The breakwaters may also facilitate future wetland creation using dedicated dredging and/or beneficial use of dredged material by serving as containment and protection for the restored wetlands. Additional ecosystem restoration features including marsh creation, freshwater introduction, barrier island restoration, and channel modification will be investigated to develop a suite of measures to stabilize and maintain important estuarine components.

Although current operation and maintenance (O&M) practices along the navigation channel include bankline stabilization, that task is executed primarily to reduce future maintenance dredging activities by reducing the amount of material sloughing from the bankline and shoaling in the navigation channel. However, the channel O&M program’s purpose and funding is not designed to address the critical environmental protection and restoration needs of the area. The New Orleans District Operations Division has evaluated test sections and developed several plans for bank protection along the MRGO utilizing rock breakwaters and articulated concrete mats. Cost estimates for this proposed restoration feature are based on previously constructed rock breakwaters; however, articulated concrete mats or other bankline stabilization methods could be used depending on localized conditions and opportunities.

The MRGO is currently undergoing a reevaluation of the economic viability of the existing MRGO navigation channel for deep-draft navigation. The outcome of this study will provide the direction for MRGO ecosystem restoration options based upon whether or not the channel should be maintained for ship traffic. Additional investigations will be conducted under the LCA Plan to develop a plan that not only addresses navigation needs, but also addresses various environmental restoration strategies, including evaluation of freshwater reintroductions into the Central Wetlands, possible channel depth modifications, and construction of a navigation/water control structure to restore the Bayou la Loutre Ridge. As long as the MRGO remains authorized to provide deep-draft navigation, ecosystem protection measures are critically needed to minimize further wetland loss and to preserve the opportunities for future restoration. This includes preventing erosion of the MRGO channel banks from ocean-going vessel wakes. Wave wash and drawdown caused by deep-draft vessel traffic are responsible for much of the bank erosion along the channel. Shallow draft barge traffic, commercial fishing vessels, and recreational watercraft also contribute to bank erosion along the waterway. Continued operation of the channel will result in further bank erosion and loss of adjacent coastal wetlands. Also, if not quickly addressed, the continuing erosion of the southern Lake Borgne shoreline from wind-driven waves could cause breaching of the shoreline in several locations, threatening the integrity of marshes between the lake and the MRGO. Without action, critical landscape components that make up the estuarine system would be lost and future restoration efforts would be much more difficult and costly. In certain cases, failure to act to protect these areas would likely result in the permanent loss of ecosystem structural components that cannot be replaced using existing restoration techniques.

Critical action points to avoid near-term (3 to 5 years) threats of shoreline and bayou breaches are located at Bayou Bienvenue, Bayou Mercier, Proctor Point, Alligator Point, Bayou Biloxi, Bayou Magill, and Antonio's Lagoon. These sites face significant risk of losing the integrity of bayou banks along the lake shoreline and potential major breaches of the navigation channel into the lake. Loss of bayou bankline stability would result in higher rates of erosion and destruction of limited and diverse habitats that offer fish and wildlife refuge from open lake conditions. A breach between the lake and the MRGO navigation channel would result in rapid wetland loss as storm waves from the lake and ship wakes from the channel impact sensitive interior wetlands and submerged grass beds in protected ponds. Further impacts from breaches would occur as scarce sediment is exported into deeper water and out of the wetland system.

The specific features proposed as part of the near-term MRGO environmental restoration plan include:

- Construct 23 miles of shoreline protection using rock breakwaters to prevent high rates of erosion that are occurring along the north bank of the MRGO.
- Construct 15 miles of rock breakwaters to protect critical points along the southern shoreline of Lake Borgne that are in peril of breaching in the near future.

A second phase of the MRGO Environmental Restoration Features (conducted under the "Modifications to Existing Structures" element of the LCA Plan) would take into consideration the navigation authority, but could recommend future ecosystem restoration activities that include closure or modification of the MRGO channel or channel relocations necessary to meet restoration goals. This phase would investigate and develop additional ecosystem restoration features including dedicated dredging and beneficial use of dredged material for marsh creation, freshwater introduction, barrier island restoration, and channel modification to develop a suite of measures to stabilize and maintain important estuarine components.

Description of Area/Background

The study area is located in Orleans, St. Bernard, and Plaquemines Parishes in southeastern Louisiana. The area is generally bounded by Lake Pontchartrain on the north, the Mississippi River on the south and west, and Lake Borgne, Breton Sound, and the Gulf of Mexico on the east and south (see **figure 1**). The study area includes the wetlands surrounding

Lake Pontchartrain and parts of the City of New Orleans, St. Bernard Parish, and Plaquemines Parish. The area potentially affected by change in navigation depth includes the navigation channels and related land areas in the study area and in the inland waterway system on the Gulf Intracoastal Waterway (GIWW) and the Mississippi River.

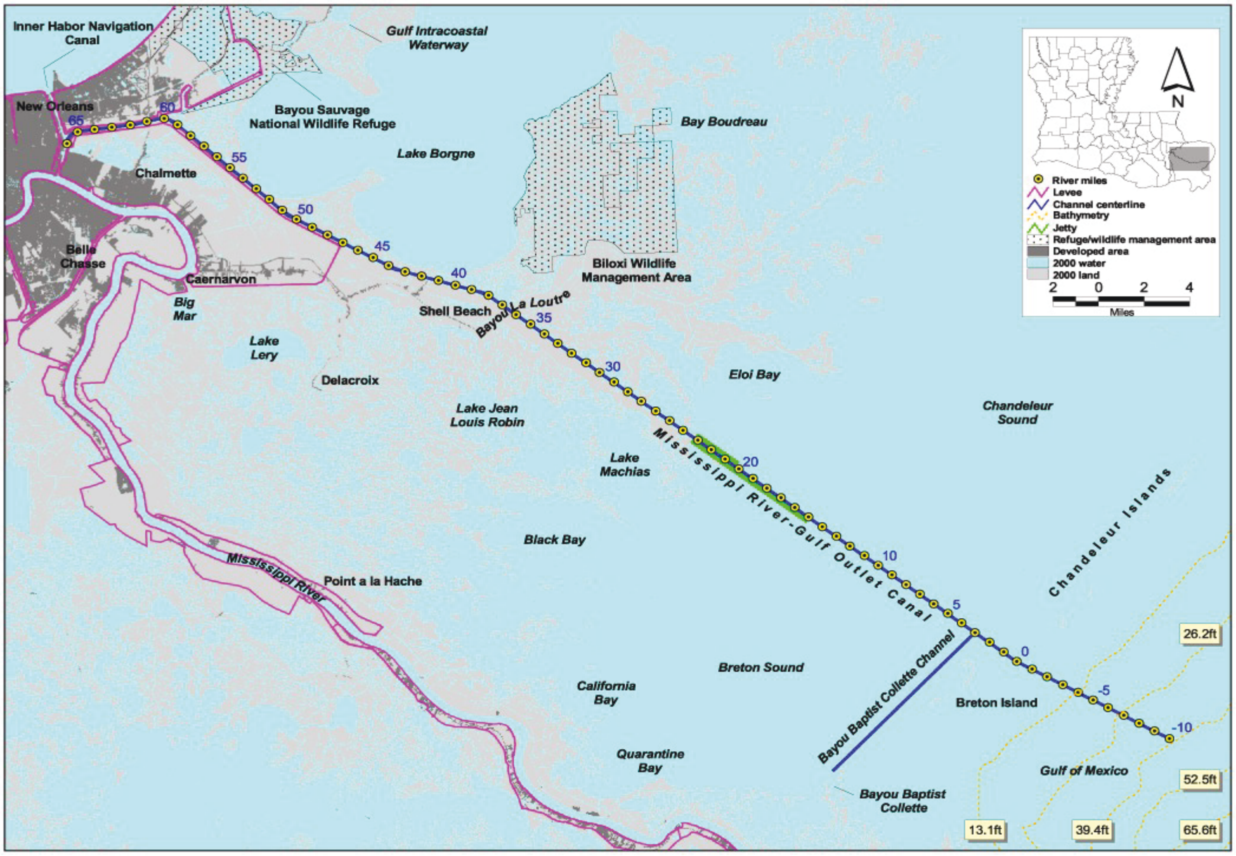


Figure 1. Mississippi River-Gulf Outlet Project Area

The Rivers and Harbors Act of 1956 and the Water Resources Development Acts of 1976, 1986, and 1996 authorized the MRGO as a 36-foot deep by 500-foot wide and 76-mile long channel. The MRGO extends from the Inner Harbor Navigation Canal (IHNC) in New Orleans to the 38-foot depth contour in the Gulf of Mexico (see **figure 1**). Dredging for channel construction began in 1958 and the channel was opened for deep-draft maritime traffic in 1968.

Dredged through shallow bays, coastal marshes, ridges, and cypress swamps, the channel was constructed to provide an outlet from the Mississippi River in the interest of National defense, general commerce, and to provide a safer and shorter route between the Port of New Orleans and the Gulf of Mexico. Business interests in Orleans and St. Bernard parishes, the State of Louisiana, the Board of Commissioners of the Port of New Orleans, and the navigation industry all supported construction of the channel. Construction of the MRGO caused widespread wetlands loss and damages to estuarine habitats from the outer barrier islands in the lower Chandeleur chain up to cypress forests and tidal fresh marshes in the western reaches of the Lake Borgne Basin.

The MRGO also connects to the Michoud Canal, which is a private deep-draft navigation canal in operation, unrelated to the public actions of the Port of New Orleans. A new lock at the IHNC is a Congressionally authorized project currently under construction and scheduled for completion in 2017. The lock will replace an existing structure that was built in the late 1920s.

Congressional appropriations for the MRGO navigation project are approximately $12.5 million annually for O&M activities. However, analysis of actual channel maintenance costs indicates that the average annual maintenance expenditures between 1995-2004 were $18.4 million per year. The majority of this funding is spent on maintenance-dredging actions that occur at varying time intervals, depending upon need, along the length of the MRGO. Increases in maintenance costs occur following tropical storm and hurricane events that impact the shoaling rates in the channel.

Maintenance-dredging activities provide opportunities for using material beneficially for the creation of coastal habitat. It is estimated that 285 acres of coastal habitat could be created each year with the full beneficial use of maintenance-dredged material under the current channel authorization. As long as the channel is authorized it is anticipated that similar opportunities will remain available as part of the channel O&M plans. However, current O&M funding limitations and uncertainties prohibit the district from maximizing the beneficial use of maintenance-dredged material.

Maintenance dredging occurs annually in the bar channel (Mile -4 to Mile -9.38) with materials disposal in the approved Ocean Dredged Material Disposal Site (ODMDS) in the Gulf of Mexico. About every two to three years, maintenance dredge-occurs in the reach from Mile 3.4 to Mile -2, with beneficial use of the dredged materials under the O&M Program to restore habitat on Breton Island. When available, Section 204 funding is applied to place dredged materials from Mile -2 to Mile 4 on Breton Island. Otherwise, the materials are placed in the ODMDS. The reach from Mile 23 to Mile 3.4 is dredged about every other year, with the dredged materials beneficially placed in single point discharge (SPD) locations within the designated open water disposal site in Breton Sound for aquatic habitat enhancement. Materials from Mile 23 to Mile 14 are placed in SPDs for wetland creation behind the north and south jetties.

When Continuing Authorities Program Section 204 funds are available, the maintenance-dredged materials from Mile 14 to Mile 12 are also placed behind the north and south jetties near Breton Sound and Gardner's Island for wetland creation. The reach from Mile 27 to Mile 23 is dredged about every three years, with materials placement behind the north and south jetties in SPD locations for wetland creation. Dredging of the inland reaches (Mile 66 to Mile 27) of the channel occurs about every five to eight years, and is conducted by using environmental best management practices (BMPs) for the creation of wetlands. The majority of the inland reach dredged material is placed in marsh creation sites located between the north bank of the channel and the south shore of Lake Borgne.

Over the next 50 years, it is anticipated that the following actions associated with dredging for operations and maintenance of the MRGO will occur:

- Inland reach (mile 66 to mile 27) dredging of 0.723 million cubic yards per year with beneficial use marsh creation of an estimated 85 acres of wetlands per year.
- Jetty reach (mile 27 to mile 12) dredging of 1.308 million cubic yards per year with beneficial use marsh creation of an estimated 115 acres of wetlands per year.
- Open water reach (mile 12 to mile -4) dredging of 1.136 million cubic yards per year with beneficial use marsh creation of an estimated 85 acres of wetlands per year.
- Bar channel (mile –4 to mile –9) dredging of 0.579 million cubic yards per year placed in the ODMDS.

The USACE has developed several plans for bank protection along the MRGO as part of the channel O&M plan. These plans have been linked to reductions in the annual volume of maintenance-dredged material that must be removed. The program has demonstrated that installing bank protection reduces the amount of shoaling in the protected reaches and thus reduces the amount of maintenance dredging that is required. The investment return on bank protection performed along the inland reach is aimed at attaining cost savings on maintenance dredging into the future, as well as to provide greater environmental sustainability along the waterway by protecting adjacently residing coastal habitats. There are plans at present under the O&M Program for future bank protection using traditional foreshore rock protection along the north bank, as well as continued maintenance of the existing bankline protection along the inland reach. The O&M bank protection program includes scheduled foreshore and dredged materials retention rock between Mile 24 to Mile 28 on the south bank, and Mile 43 to Mile 45.5 on the north bank. Additional plans over the next 50 years include installing bank protection at channel Mile 29 to Mile 30 on the south bank, and Mile 29 to Mile 32 and Mile 57 to Mile 59 on the north bank (see **figure 1**).

Alternative bank protection measures have been investigated along the south bank of the channel. A series of articulated concrete mattress (ACM) test sections were placed directly on the bankline. The installed test sections have performed very well in preventing bankline erosion along the channel and are forecast to require very little to no subsequent maintenance. Plans over the next 50 years include installing ACM along the southern bank of the channel between approximate Mile 27 and Mile 46 as part of the channel O&M actions.

Problems and Needs

Construction and maintenance of the MRGO caused widespread wetland loss and damage to estuarine habitats from the outer barrier islands in the lower Chandeleur chain up to cypress forests and tidal fresh marshes in the western reaches of the Lake Borgne Basin. During construction of the MRGO, dredging and filling destroyed more than 19,000 acres of wetlands, and an important hydrologic boundary was breached when the channel cut through the ridge at Bayou la Loutre.

After the MRGO was completed, significant habitat shifts occurred because the impacted area converted to a higher salinity system with the influx of saltwater through ridges and marsh systems that were severed or destroyed during channel construction. Continued operation of the MRGO results in high rates of shoreline erosion from ship wakes, which destroy wetlands and threaten the integrity of the Lake Borgne shoreline and adjacent communities, infrastructure, and cultural resources. In addition, severe erosion of the MRGO channel continues to facilitate the transition of the upper Pontchartrain Basin estuary toward a more saline system.

Annual erosion rates in excess of 35 feet along the north bank of the MRGO result in the direct loss of approximately 100 acres of shoreline brackish marsh every year and additional losses of interior wetlands and shallow ponds as a result of high tidal ranges and rapid water exchange through the modified watercourse system. These vegetated habitats and shallow waters are important for estuarine biological resources and serve as critical habitat for the threatened Gulf sturgeon.

Erosion and saltwater intrusion are also impacting ridge habitat that is important for mammals, reptiles, and birds. The highest rates of erosion in the area occur along the north bank of the MRGO channel. The southern shoreline of Lake Borgne is eroding at approximately 15 feet per year resulting in the loss of 27 acres of wetlands per year. Continuing erosion along the channel and the shoreline of Lake Borgne is threatening to breach the lake/marsh rim, which would result in the coalescence of the two water bodies. A breach would accelerate marsh loss.

Prior to construction of the MRGO, tidal flow into Lake Borgne was dominated by flow from Mississippi Sound because the tidal flow from the Breton Sound area was reduced as it moved northwest across the marshes and wetlands through bayous and ponds toward Lake Borgne. Construction of the MRGO caused a reversal of the former circulation pattern, with the dominant tidal flow into Lake Borgne now coming from the Breton Sound area directly via the MRGO. Before construction, habitats in the area were aligned along salinity gradients and reflected the varied landscape and interspersed watercourses.

A number of factors have contributed to the alteration of circulation patterns and water quality since the completion of construction of the MRGO. The MRGO is a deep channel that provides a more direct flow of more saline, higher density water inland into Plaquemines, St. Bernard, and eastern Orleans parishes. The channel provides a direct passage for tidal exchange and allows any freshwater surpluses to exit at low tide and be replaced by the inflow of more saline water at high tide.

Dredged material from the construction dredging of the MRGO channel was deposited in a 4,000-foot wide continuous strip along the channel's southwestern side, interrupting the circulation patterns of the natural waterways that transected the length of the channel and connecting a solid upland to form the southern portion of the Lake Borgne watershed. This dredged material disposal area covers approximately 25 square miles of former vegetated wetlands and shallow estuarine waters. Creation of the dredged material area resulted in the disruption of water flow and semi-impounded wetlands on the southwestern side of the spoil bank causing water quality problems and affecting the quality and integrity of the marsh habitat.

The alteration of salinity levels in waters along the MRGO channel and outward into adjacent areas was first observed in studies conducted immediately following construction of the channel. The influx of more saline water into these areas resulted in a continual increase in salinity until a new equilibrium was reached. The MRGO is a straight and deep channel in comparison with the natural meandering shallow lagoons and characteristically sluggish water movement found in the area. Greater volumes, more rapid mixing, and deeper penetration of saltwater are responsible for higher salinities in surface waters and marsh areas adjacent to the MRGO and in Lake Pontchartrain.

An investigation of various combinations of depth and width reductions in relation to salinity changes titled "Salinity Changes in Pontchartrain Basin Estuary, Louisiana, Resulting from Mississippi River-Gulf Outlet Partial Closure Plans with Width Reduction" was published by the USACE, Engineering Research and Development Center (ERDC) in August 2002. The study includes a base condition of the authorized channel and the results clearly show the impacts of elevated salinity throughout the MRGO influence area.

The ERDC report data indicates that area salinity is lowest in the late spring and highest in the summer and fall. This is reflective of the seasonal variations in the fresh-water inflows from the major rivers and streams into the basin. The salinity in Lake Pontchartrain generally ranges from 2 to 15 parts per thousand (ppt) and is influenced greatly by Pearl River discharges and inflows from the Rigolets and Chef Pass. Higher salinity water from the MRGO enters the western regions of Lake Borgne through breaks in the marshes between the two water bodies and then enters Lake Pontchartrain through the opening of the Industrial Canal at the Seabrook Bridge and the Chef Pass and the Rigolets.

The analyses of the salinity data indicate that there was an increase in monthly average salinity for all months after 1963. This increase falls directly after the partial completion of the MRGO in 1963, which provided a major access for salt water to enter Lake Maurepas, Lake Pontchartrain, and Lake Borgne. No other major events occurred at that time to cause such an increase in the salinity.

Monthly summaries of salinity for pre- and post-MRGO indicate that salinity has increased on the average by the following amounts:

- 0.4 ppt at Pass Manchac near Pontchatoula.
- 1.1 ppt at Lake Pontchartrain, North Shore (St. Tammany Parish).
- 1.9 ppt at Lake Pontchartrain, Little Woods (New Orleans lakefront).
- 2.3 ppt at Chef Menteur Pass near Lake Borgne (Orleans and St. Bernard Parish).
- 4.5 ppt at Bayou LaLoutre, Alluvial City.

The salinity in the region has stabilized, and no significant increase in average annual salinity is projected in the foreseeable future for Lake Maurepas or Lake Pontchartrain. Salinity is expected to increase in the western Lake Borgne region and surrounding marshes due to land loss in the area (see **table 1**).

Table 1. Mean monthly salinity pre- and post-MRGO 1951 to 1963 & 1963 to 1977

Month	Pass Manchac ppt		North Shore ppt		Little Woods ppt		Chef Menteur Pass ppt		Alluvial City ppt	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
January	1.1	1.5	3.0	4.0	3.9	5.0	3.8	5.7	6.8	9.8
February	1.0	1.5	2.5	3.0	3.0	6.5	2.9	4.8	6.4	9.7
March	1.0	1.2	1.9	2.6	2.3	4.4	2.2	4.3	6.3	10.4
April	0.8	1.3	1.9	2.6	2.4	4.0	2.2	4.0	7.0	10.0
May	1.0	1.1	2.4	2.7	2.2	3.9	2.6	4.0	9.5	10.2
June	1.0	1.5	3.6	3.0	2.2	3.8	3.3	4.2	9.0	12.3
July	1.0	1.6	3.0	4.6	2.1	4.4	3.2	6.3	7.9	16.0
August	1.2	1.7	4.6	5.6	2.5	4.8	4.8	7.5	8.6	16.1
September	1.7	2.0	5.4	7.5	4.5	6.2	6.0	8.5	8.2	12.9
October	1.8	2.2	4.7	7.3	4.9	6.8	5.2	8.4	7.6	13.8
November	1.8	2.1	4.6	6.7	4.8	6.8	5.2	8.0	8.0	13.1
December	1.2	1.8	4.5	5.4	4.7	6.2	4.2	7.0	8.0	12.5
Average	1.2	1.6	3.5	4.6	3.3	5.2	3.8	6.1	7.8	12.2
Salinity Increase		0.4		1.1		1.9		2.3		4.5

Salinity data collected in Lake Eloi, Stump Lagoon, Lena's Lagoon and Lake Borgne from 1960 through 1968 show net increases in salinity following construction of the MRGO. The degree of the increases appears to depend on the initial salinity of a given area prior to construction as well as on the area's distance from the MRGO channel. Lake Eloi, located along the southeastern region of the channel, has shown minimal changes in salinity over time due to its proximate location to the saline waters of Breton Sound and the maintenance of its original circulation patterns. In contrast, the observed salinity increases at Stump Lagoon and Lena's Lagoon are the result of the influx of more saline waters into these areas.

Recent salinity data collected from the Louisiana Department of Environmental Quality (LDEQ) monitoring stations at Lake Eloi located near Mile 25 appear consistent with the data collected following construction of the MRGO. Recent LDEQ data collected from Lake Borgne continues to display fluctuations in salinity that appear more strongly influenced by rainfall and tidal flow unrelated to the construction of the channel. It is likely that the increased salinities observed in Stump Lagoon and Lena's Lagoon following construction of the MRGO will continue because of the influx of high salinity water from the MRGO into these areas. Construction of the MRGO has resulted in steep increases in salinity along its route due to the influx of more saline waters inland along the deepened channel passageway. Recent salinity data from LDEQ monitoring stations, where available, indicate that the influence of the channel in these areas remains today. The inland reduction of salinity in areas along the channel appears to be primarily determined by distance from the more saline source waters.

Habitat change between 1956 and 2000 in the MRGO region has been substantial. In that time, 27,784 acres of marsh habitat have been converted to open water (see **table 2**). Some of this loss is attributable to direct impacts of construction of the MRGO and the continued erosion of the channel banks. However, measured salinity increases associated with the MRGO have contributed to this habitat conversion and land loss.

Table 2. MRGO Habitat Change 1956-2000

Total acreage for the study area in 1956 was 359,123 acres
Total water acreage for the study area in 1956 was 159,518 acres
Total land acreage for the study area in 1956 was 199,605 acres
Total acreage for the study area in 2000 was 359,123 acres
Total water acreage for the study area in 2000 was 187,302 acres
Total land acreage for the study area in 2000 was 171,821 acres
27,785 acres of marsh habitat were converted to open water between 1956 and 2000
16,726 acres of fresh marsh were converted to open water or a different habitat between 1956 and 2000
5,927 acres of nonfresh marsh habitat were converted to open water or a different habitat between 1956 and 2000
36,454 acres of brackish marsh habitat were converted to open water or a different habitat between 1978 and 2000
10,141 acres of open water or marsh habitat was converted to intermediate marsh between 1978 and 2000
19,592 acres of open water or marsh habitat was converted to saline marsh between 1978 and 2000

Construction and operation of the MRGO navigation project resulted in significant changes and damages to habitats in the Lake Pontchartrain, Lake Borgne, and Breton Sound estuaries. Environmental changes and damages associated with the project can be classified into three categories covering construction damages, immediate post-construction hydrologic changes, and long-term operational impacts.

Dredging to construct the channel destroyed wetlands via both the digging and disposal of these sediments. Cutting the channel through marshes, swamps, ponds, bayous, and ridges resulted in modification of natural tidal movement and allowed a direct conduit for high salinity water to move into the inner parts of the estuary.

The influx of saltwater through the MRGO channel caused basin-wide losses of fresh and intermediate marshes as well as cypress-tupelo swamps. The saltwater influx produced an estuary-wide shift in habitat types and associated biological communities to those associated with higher salinity regimes.

Shoreline erosion is occurring along both the north and south banks of the MRGO. Wave wash and drawdown caused by deep-draft vessel traffic is responsible for much of the shoreline erosion along the channel. Shallow draft barge traffic, commercial fishing vessels, as well as recreational watercrafts contribute to bank erosion along the waterway. The erosion rate is approximately 35 feet per year along the north bank and approximately 15 feet per year along the south bank. Continued operation of the channel will result in further erosion and loss of coastal wetlands over a wide area.

Critical Need

Rapid action is required to protect the integrity of the southern Lake Borgne shoreline and marshes and to prevent continued erosion of the MRGO channel banks. Without action, critical landscape components that form the backbone of the Lake Borgne, Lake Pontchartrain, and Breton Sound estuaries would be lost and future efforts to restore other parts of the ecosystem would be much more difficult and expensive. These important landscape components include marshes, ridges, bayous, ponds, submerged grassbeds, and lake shorelines. The rapid rate of shoreline retreat indicates that extensive breaching between the channel and lake will occur over the next ten years. As previously stated, loss of bayou and lake ridges will accelerate this loss and threaten interior marshes that are vulnerable to high rates of erosion when exposed to high-energy wave environments. Protection of the shoreline and channel banks is critical to insuring restoration success in the future.

This feature, including shoreline protection and ecosystem restoration measures, has been identified as a critical need in the ongoing MRGO reevaluation study and should be implemented regardless of any potential changes to the channel authorization. In addition, stabilization of the north bank of the MRGO and maintaining the shorelines of Lake Borgne are identified in the Coast 2050 Report as a near-term (1 to 5 years) regional strategy. Closing the MRGO to deep-draft navigation and various other environmental restoration strategies for the area were also identified in the Coast 2050 report.

Land loss data during five time intervals between the 1930s and 2001 is shown in **figure 2** with each color representing wetlands lost during a specific time interval. Areas identified as loss were mapped by comparing a 1930s' base map to aerial photography flown in 1956-58, 1974, 1983, 1990, and 2001. The original mapping was done at a scale of 1:62,500 (15-min.) during a three-year period and is described in more detail by Britsch and Kemp (1990) and Dunbar, Britsch, and Kemp (1992). This map represents a composite 1930s' base map showing the land loss from individual 15-min. maps reduced for printing purposes. The map is intended to present a regional overview of the distribution and magnitude of land loss and the time periods in which it occurred. The scale at which the data is presented precludes any detailed measurements from the map.

This recent data analysis reveals an alarming trend in land loss rates in the estuarine wetland areas in and around the MRGO corridor. The data indicates that land loss rates have accelerated since 1990 and that the rate of wetlands loss now exceeds the rates experienced in the area during the period of MRGO channel construction. Researchers have noted that the increasing loss rate trend is pervasive throughout the system and not necessarily directly related to the use of the channel. Indications are that widespread wetlands losses are occurring throughout the area and that these losses may represent impacts associated with system-wide causes similar to events occurring in other subprovinces.

Additional factors, not directly associated with the construction, operation, and maintenance of the MRGO channel, contribute to wetland losses. These include subsidence, tropical storms and hurricanes, cold fronts, hydrologic modification, flood control of the Mississippi River, human development, and oil and gas exploration and production. Combined, the systemic wetland loss factors and the channel operation and maintenance are resulting in a widespread decline in habitat quantity and quality in the Lake Borgne and Pontchartrain basins and surrounding aquatic ecosystems. Due to these factors a near-term critical plan must include measures that address factors other than the direct loss of shoreline wetlands from the passage of deep-draft vessels on the MRGO channel.

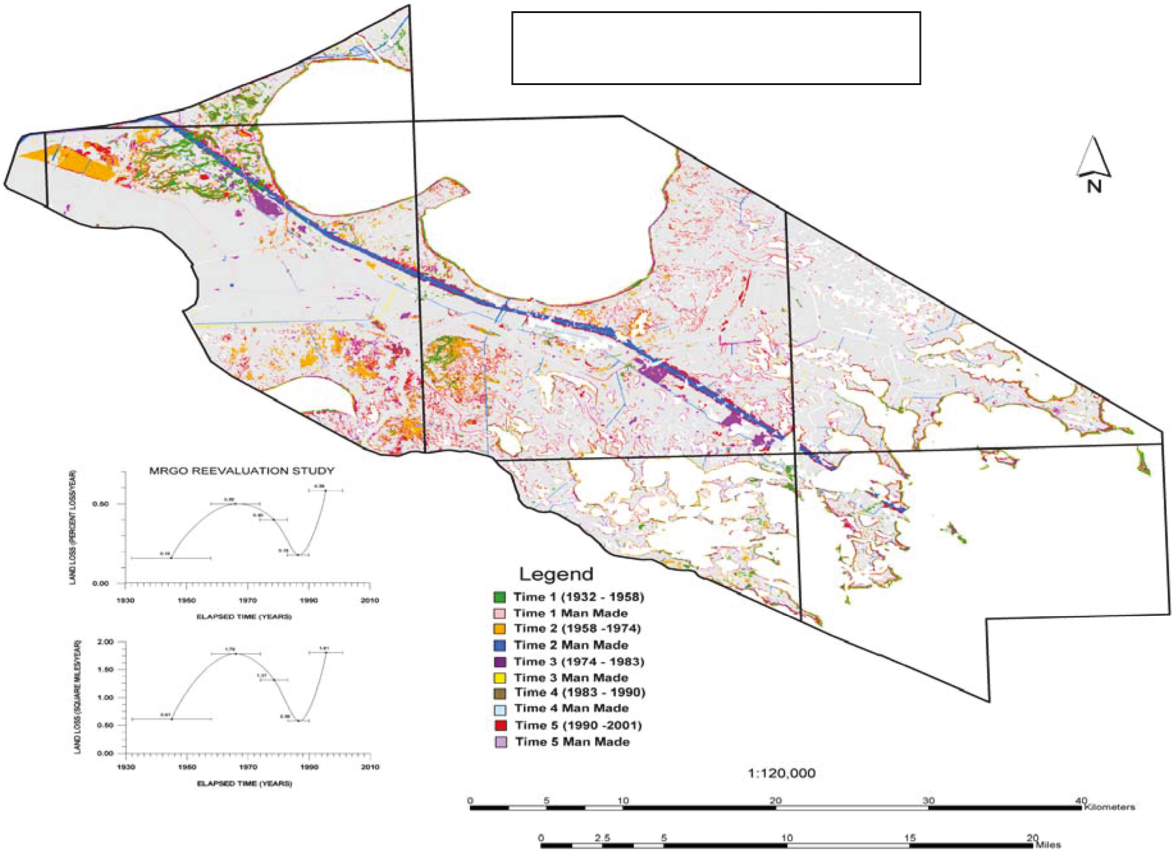


Figure 2. MRGO Study Area Land Loss 1930s - 2001

Table 3. MRGO Project Area Land Loss Rates by Time Period

Time Interval	Total Acres Lost	Total % Land Loss	% Loss/yr	acres/yr	sq.miles/yr
1932-1958	10099	4.2	0.16	388	0.6
1958-1974	18302	8	0.5	1144	1.8
1974-1983	7552	3.6	0.4	397	1.3
1983-1990	2616	1.3	0.18	374	0.6
1990-2001	12727	6.4	0.58	1157	1.8

Without Project Conditions

Shoreline erosion is occurring along both the north and south banks of the MRGO. Wave wash and drawdown caused by deep-draft vessel traffic is responsible for much of the shoreline erosion along the channel. Shallow-draft barge traffic, commercial fishing vessels, as well as recreational boats contribute to bank erosion along the waterway.

Continued operation of the channel will result in further shoreline erosion and loss of adjacent coastal wetlands. The rate of shoreline retreat is approximately 35 feet per year along the north bank and approximately 15 feet per year along the south bank. Modification of the natural hydrology of the area during channel construction has resulted in large-scale shift in the salinity regime of the project area estuaries. Long-term trends indicate that salinity levels will remain high and could continue to increase over time with the deterioration of surrounding habitats creating more direct links to offshore areas containing higher salinity waters.

Table 4. MRGO Bankline Erosion Rate (average feet per year).

Reach by Channel Mile	North Bank (left-descending)	South Bank (right-descending)
65.1 to 59.8	8.7	12.8*
59.7 to 53.0	27.4	
52.9 to 37.8	28.7	
37.7 to 29.1	38.0	
29.0 to 26.8	35.6	
26.7 to 23.1	27.8	
* The erosion rate along the south bank is nearly consistent for the entire inland reach of the navigation channel.		

The southern shoreline of Lake Borgne is eroding at approximately 15 feet per year resulting in the loss of 27 acres of wetlands per year. Continuing erosion along the channel and the shoreline of Lake Borgne is threatening to breach the lake marsh rim. A breach of the wetlands between Lake Borgne and the MRGO is projected to rapidly accelerate marsh loss rates in the area. These breaches would lead to the coalescence of the two water bodies exacerbating land loss problems and contributing to the continuing decline of this estuarine system.

Annual erosion rates along the MRGO results in the direct loss of approximately 100 acres of shoreline brackish marsh every year and additional losses of interior wetlands and shallow ponds as a result of high tidal ranges and rapid water exchange. These vegetated wetland habitats and shallow waters are important for estuarine biological resources and serve as critical habitat for the threatened Gulf sturgeon. Erosion and saltwater intrusion are also impacting ridge habitat that is important for mammals, reptiles, and birds that reside in the system or use the area during life cycle migrations.

Alternatives Investigations

In general, few cost-effective alternative methods are available for shoreline protection efforts in the generally poor soil conditions found in the MRGO project area. Demonstration projects to investigate the field performance of alternative methods for shoreline protection have proven the alternatives to be less effective than traditional rock breakwater designs.

Several techniques and designs have been employed in the MRGO area to protect eroding shorelines. These designs include foreshore protection dikes, rock breakwaters, ACM, and geotubes. Experience indicates that the rock breakwater designs are the most certain in terms of performance, benefits, and costs.

Engineering and Design Considerations.

Information has been collected in the area as part of planning and design efforts for operations and maintenance actions and several projects authorized under the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) program. These design efforts included the collection of water level, wind, and geotechnical information that is important for consideration of engineering performance requirements to meet project goals. This information is project site specific and should not be assumed to be applicable to all projects in the MRGO area. However, as indicated in the data, soil conditions investigated under the CWPPRA efforts were found to be some of the poorest in coastal Louisiana and thus design consideration of this fact would characterize those designs as conservative because of the site conditions.

Lake Borgne has an irregular shape 18 miles long and 16 miles wide as shown in **figure 1**. The south shore of the lake has been eroding due to a combination of land subsidence and wave action from northerly winds. Strong northerly winds frequently occur in the area during the passage of winter cold fronts. Strong winds associated with tropical storms and hurricanes are infrequent events in the area but can cause extensive erosion and habitat damages.

Hydraulic engineers use geographic and environmental information to establish the parameters necessary to achieve the project design goals of stopping shoreline erosion. These efforts involve analyzing historic water level and wind information to develop design elevations, slopes and materials requirements for constructing rock dikes for protecting the project area shorelines.

A water level gage in the vicinity of the project areas was investigated to obtain data for use in the hydraulic design analysis. The gage is located at Shell Beach, Louisiana, along Bayou Yscloskey near its intersection with the MRGO, and is identified as Water Elevation Station 85800.

Figure 3 shows historical water elevations for Shell Beach, near the project sites, corrected to NAVD 88. From the gage, annual mean sea level (MSL) at Shell Beach is 0.76 feet NAVD 88, however there is a strong seasonal variance. MSL from January through July is 0.61 feet NAVD 88 and MSL in September and October is 1.30 feet NAVD 88. The graph shows a seasonal variation in stage that reflects some of the annual variation of mean gulf elevations.

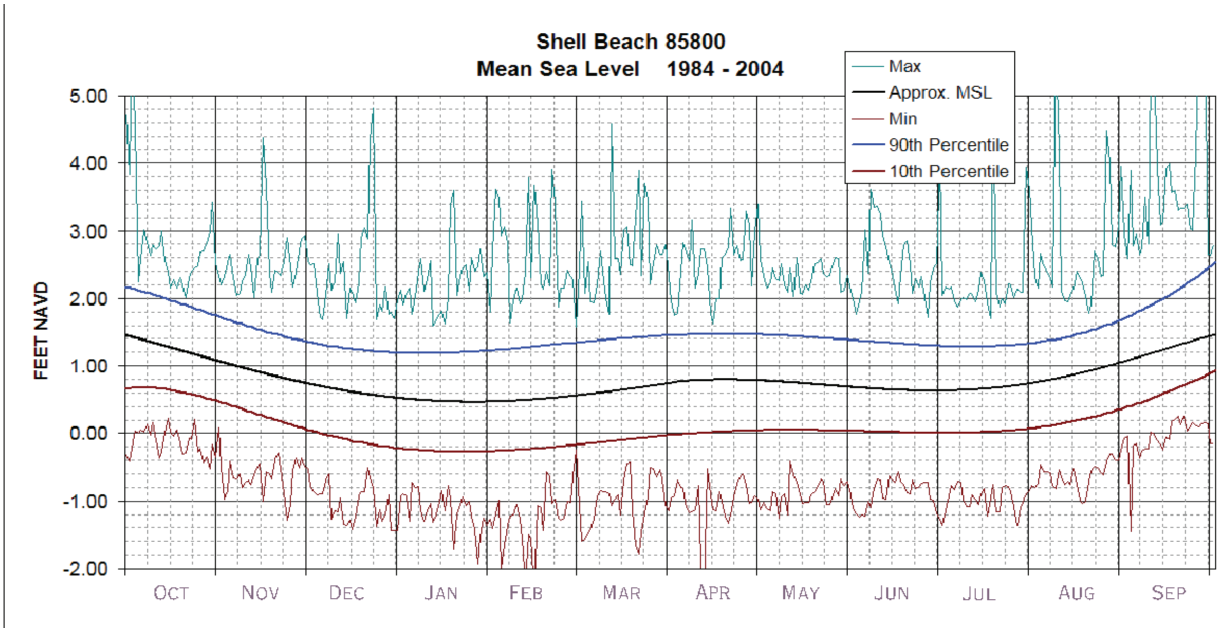


Figure 3. Mean Sea Level at Shell Beach Gage

The Coastal and Hydraulics Laboratory at Vicksburg, Mississippi reconstructed wind records from 1990 to 1999 for various stations along the Gulf coast. Wind data from station 142 at 29.83N 88.67W (70 miles east of Lake Borgne) shows that winds are about twice as likely to come from the east as from the west but that northerly and southerly winds occur about equally. High winds however, usually come from the north. The reconstructed maximum wind speed was 62.4 MPH at 64 degrees true. A statistical presentation of northerly wind speeds is shown in table 5. From these, a design wind equal to the 90th percentile speed of 24.2 MPH was chosen for this project.

Lake Borgne is relatively wide and shallow. With a 25-mile fetch and average depth of 9 feet, the expected wind setup from the maximum wind will be 5.5 feet. The setup from the 90th percentile wind is 0.9 feet using the Bretschneider equation and 0.5 feet using the Shell Beach gage historical data.[1] An average of these two measurements (0.7 feet) was used.

Using the Coastal Engineering Design and Analysis System (CEDAS) software, version 2.01g developed by personnel at the Waterways Experiment Station in Vicksburg, Mississippi and at Veri-Tech, the corresponding maximum wave height was found to be 3.0 feet.

[1] Project area water level data was analyzed for wind-induced surge or computed separately using the Bretschneider equation from USACE data at Lake Okeechobee (Bretschneider 1966).

Table 5. North Winds and Waves at Lake Borgne, Louisiana*

Percent Less Than	Wind Meters/Sec	Wind Miles/Hr	Waves CM	Waves Feet	Setup CM	Setup Feet
MAX	27.9	62.4	122	7.0	168	5.5
95%	12.0	26.8	67	3.6	34	1.1
90%	10.8	24.2	64	3.0	27	0.9
75%	9.0	20.1	55	2.3	18	0.6
50%	6.6	14.8	43	1.4	12	0.4
25%	4.5	10.1	31	0.8	6	0.2

* From 300° to 60°

The wind field was transferred from 70 miles offshore without any reduction for terrestrial friction and is very likely higher than what might be expected over Lake Borgne. The data table consists of 88,627 entries with only the winds from 300° to 60° being used to compute the 90th percentile design wind suggested in the report. A narrower range from say 10° to 30° would have produced slightly higher winds. A broader range would have produced lower winds as shown in the comparative **table 6** below. Our selection criterion was a reasonably high wind that is typical of the area.

Table 6. Wind Direction and Velocity Comparisons

	ALL WINDS			**WINDS FROM 300° – 60°**			**WINDS FROM 10° - 30°**	
	Wind			Wind			Wind	
	Meters /Sec	Miles/ Hr		Meters/ Sec	Miles/Hr		Meters/Sec	Miles /Hr
MAX	27.9	62.4	MAX	27.9	62.4	MAX	22.4	50.1
95%	11.0	24.6	95%	12.0	26.8	95%	12.2	27.3
90%	9.8	21.9	90%	10.8	24.2	90%	11.0	24.6
75%	7.8	17.4	75%	9.0	20.1	75%	9.4	21.0
50%	5.8	13.0	50%	6.6	14.8	50%	7.2	16.1
25%	4.2	9.4	25%	4.5	10.1	25%	4.9	11.0
10%	3.0	6.7	10%	3.1	6.9	10%	3.3	7.4
5%	2.4	5.4	5%	2.4	5.4	5%	2.6	5.8
MIN	0.2	0.4	MIN	0.2	0.4	MIN	0.2	0.4

Breakwater stone weight can be computed using Hudson's equation:

$$W_{50} = \frac{\gamma_r H^3}{K_D \left(\frac{\gamma_r}{\gamma_w} - 1 \right)^3 \cot\theta}$$

where: γ_r = unit weight of rock, 155 lbs/cubic feet
γ_w = unit weight of water, 64 lbs/cubic feet
H = height of design wave, 2.1 feet
$\cot\theta$ = slope of rock, 1.5h:1v
K_D = stability coefficient, 2.41

which yields a mean rock size of 138 pounds. Stone with a mean size of 138 pounds are on the lower edge of the CEMVD standard for 24-inch riprap. Even though 24-inch riprap meets the minimum requirements, it was decided for economy of scale to use 36-inch riprap for the Lake Borgne dike.

The top elevation of the construction lift of the breakwater along Lake Borgne should be set as follows:

Mean water elevation	0.80 ft NAVD 88 (Shell Beach gage)
Wind setup (90%)	(0.5+0.9)/2 = 0.7 feet
Wave height (90%)	(3.0/2) = 1.5 feet
Future settlement (construction lift)	1.0 feet .
Top of breakwater	+4.0 feet NAVD 88

Engineer Manual 1110-2-1601, section 3-3, recommends that rubble-mound breakwaters have face slopes of no more than 1v:1.5h. Top widths of one stone diameter have been built but they were usually made of very large rock. To reduce damage from waves larger than the 90% design wave, the top width should be at least two stone diameters. There is concern, but no empirical evidence supporting the need for scour protection on the lakeside of the breakwater. Engineer Manual 1110-2-1614, section 2-19, suggests making the blanket thickness equal to the incident wave height and the width equal to about 3.5 times the thickness. However, the design team has considered the immediate displacement of soils during construction, the 5-foot crown width and the rapid initial settlement, and has recommended that the design section not include a berm.

Recommended Plan

The specific features proposed as part of the near-term MRGO environmental restoration plan include:

- Construct 23 miles of shoreline protection using rock breakwaters to prevent high rates of erosion that are occurring along the north bank of the MRGO.
- Construct 15 miles of rock breakwaters to protect critical points along the southern shoreline of Lake Borgne that are in peril of breaching in the near future.

MRGO Bank Breakwaters.

The designs presented in the Section 206 Preliminary Restoration Plan for South Shores of Lake Borgne, Louisiana and the CWPPRA PO-32 Lake Borgne – MRGO Shoreline Protection were used. The proposed dike is aligned along the –2 ft. contour. The crown width is 5 feet and the top is set at elevation +4.0 ft NGVD. The dike is 6 feet high with a 5-foot wide crown and 1V on 2H side slopes. Similar designs are being considered for a CWPPRA project in the area that is in the preconstruction engineering and design phase.

Lake Borgne Breakwaters

The designs presented in the Section 206 Preliminary Restoration Plan for South Shores of Lake Borgne, Louisiana were used. The proposed dike is aligned along the –2 ft. contour. The crown width is 5 feet and the top is at +4.0 ft NGVD. The dike has 1V on 2H side slopes.

Additional Ecosystem Restoration Study

Details of additional ecosystem restoration features would be developed during a study phase for purposes of estimating costs and benefits and for selecting the best set of projects to attain the ecosystem restoration goals for the area. This study effort would be conducted under the Modification of the Existing Structures portion of the LCA proposed authorization. Under this approach, the MRGO channel is considered a structure for purposes of evaluating potential modifications to improve the environment.

Input from area residents, resource managers, Federal and state agencies, and USACE personnel have identified a number of options that could produce ecosystem benefits under a modification scenario. These options include marsh creation using dredged sediments, freshwater introduction to maintain salinity gradients, barrier island reconstruction and protection, and constriction of the MRGO channel. The ecosystem restoration measures would follow the strategies identified in the Coast 2050 Plan.

Alternatives for protecting ecosystem components have been evaluated in previous studies of projects in the area. These studies were conducted as part the CWPPRA program. The restoration plan developed by the Louisiana Coastal Wetlands Conservation and Restoration Task Force calls for protecting the shorelines of Lake Borgne and the MRGO from ongoing erosion. Various projects to protect segments of the lake shoreline and MRGO banks were included on the annual priority project lists for the program in 2000, 2002, and 2003. These projects are currently in the preconstruction engineering and design phase. Additional alternatives were identified in the Coast 2050 Plan and other suggestions for shoreline protection actions continue to be recommended during public meetings hosted by the Louisiana Coastal Wetlands Conservation and Restoration Task Force.

Benefits

Benefits to the environment resulting from this recommended critical action plan are particularly important to system integrity. Specifically, the bankline erosion rate, along both sides of the navigation channel, continues at an extremely high rate that requires immediate attention (see table 1). Although operation and maintenance of the navigation channel includes bankline stabilization, this task is executed primarily to reduce future maintenance dredging activities by reducing the amount of material sloughing off of the bankline and shoaling in the navigation channel. However, there are instances where bankline stabilization provides a containment barrier for the placement of dredged material for the purposes of wetland nourishment or creation in proximity to the navigation channel.

The benefits of the proposed shoreline protection features include:

- preserving large amounts of wetlands designated as Essential Fish Habitat,
- protecting critical habitat in Lake Borgne for the Federally-listed threatened Gulf sturgeon,
- avoiding significantly higher long-term restoration costs,
- protecting critical infrastructure (pipelines and oil and gas wells),
- storm surge buffering, and
- providing opportunities for value-added wetland restoration in conjunction with other ongoing programs (CWPPRA and O&M).

Another method of calculating benefits is the Wetlands Valuation Assessment (WVA). The Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) program has conducted WVAs for the PO-30/31 and PO-32 projects. These projects are designed to protect segments of shoreline along the southern rim of Lake Borgne and along the north bank of the MRGO. Specifically, the PO-30/31 project would construct breakwaters to protect Lake Borgne shoreline segments near Shell Beach and Bayou Dupre and the PO-32 project will protect several miles of the MRGO north bank and the southern shore of Lake Borgne between Doullut's Canal and Jahncke's Ditch. The WVA is a comparative differential model that produces benefit estimates in units known as Average Annual Habitat Units (AAHU).

For CWPPRA projects the period of evaluation for a WVA is twenty years. The CWPPRA PO-31a project is in the advanced stages of design for a 17,700-foot breakwater in Lake Borgne that would generate 73 AAHUs over twenty years. The PO-31b project is in the advanced stages of design for a 14,784-foot breakwater in Lake Borgne that would generate 29 AAHUs over twenty years. The CWPPRA PO-32 project is in the advanced stages of design for an 18,500-foot breakwater in Lake Borgne and 14,250-foot breakwater along the MRGO that combined would generate 70 AAHUs over twenty years. These estimates were used to generate reliable estimates of the AAHUs that would be generated by the proposed MRGO features of the LCA report. Converting shoreline lengths to miles and then dividing by the number of project AAHUs produces an estimate of AAHUs per mile. Combined the three projects have an average benefit of 13.9 AAHUs per mile. Applying this number to the proposed LCA feature generates 528 AAHUs over twenty years.

By stopping shoreline erosion, the feature would benefit approximately 100 acres per year along the MRGO channel and an additional 27 acres per year along the southern shoreline of Lake Borgne producing an estimated 528 AAHU. In addition, several critical points along both the channel and lake shoreline are threatening to breach in the near-term and could result in rapid acceleration of interior marsh loss. Over the next 50 years, the feature would protect approximately 6,350 acres of wetlands that are threatened from shoreline erosion along the MRGO and the lake.

Also, the features of the near-term plan for MRGO have been evaluated in the context of other ecosystem restoration needs in the area and across the greater coast and found to be consistent with the goals of the overall plan. Further, the features are deemed critical for the near-term success of the plan because of high benefits and the protection of important structural components of the surrounding estuaries.

Costs

The estimate of total project costs is based upon a schedule of project expenditures that was provided for each year of the project. This schedule represents incremental, or "un-inflated," costs. Expenditures include future planning, engineering and design (PED) costs; construction costs; and monitoring costs. O&M costs are reported separately. As with any single USACE project, individual expenditures are either compounded or discounted to a given base year, defined as that year in which the project is generating all of the outputs intended by its design. The project cost estimate is derived through summing the compounded/discounted values to yield the present value of costs that is correlated to the corresponding base year. This figure is then annualized using the Federal discount rate (5-3/8 percent for fiscal year 2005) and a 50-year project life to yield an estimate of average annual project costs.

The estimate of total project costs and its average annual equivalent on a "fully-funded" basis is derived in exactly the same manner as described above, except that the schedule of project costs previously reported as incremental costs are adjusted to include inflation. The factors that are used to inflate project costs are those provided in the Fiscal Year 2006 Budget Engineering Circular.

The project designs were based on conventional and proven existing designs and/or supplemented with engineering experience. Shoreline protection was estimated based on conventional stone structures. Bank protection design was based on the MRGO North Bank foreshore dike designs. Measure lengths were developed by sketching in preliminary alignments atop Digital Ortho-Quarter-Quad (DOQQ) image files using MicroStation I/RAS C image processing software and measuring the feature lengths.

The area was divided into reaches and geotechnical estimates of construction losses for each reach were provided. **Table 7** shows measure, estimated length, and the construction losses used for estimating purposes.

Table 7. Assumed Length and Construction Loss for Measures

Measure	Linear Feet	Construction Loss
Lake Borgne/MRGO Land Bridge	89,000	40%
MRGO North Bank Mile 56.0 to 60.0	21,120	40%
MRGO North Bank Mile 50.9(51.1) to 49.8(49.5)	5,808	40%
MRGO North Bank Mile 48.5(48.5) to 44.9(44.9)	19,008	40%
North Bank Mile 36.5(36.5) to 36.1 and Mile 35.5 to 33.9(33.8)	10,560	40%
North Bank Mile 32.5(32.6) to 26.7	30,624	40%
North Bank Mile 24.4 to 23.2	6,336	40%

Feature costs are based upon completed construction of similar projects funded under the New Orleans District's channel O&M maintenance program. Approximately 12 miles of rock breakwaters were constructed under this program as part of a best management plan for channel maintenance dredging. Experience documented in the construction completion reports and the as-built surveys of those projects has been valuable for the design of other similar projects in the area.

Additional cost information has been developed from ongoing preconstruction engineering and design work conducted in the CWPPRA for a rock breakwater project located near Shell Beach, Louisiana. Information from these design and construction efforts indicates that rock breakwaters constructed for shoreline protection range from $1 million to $4 million per mile depending upon soil conditions and other site specifics.

These features would prevent the loss of 6,350 acres of marsh over the next 50 years. The estimated cost for designing and constructing critical rock breakwaters along the MRGO and selected sections of the southern Lake Borgne shoreline is $108.27 million (including monitoring). Details of this cost estimate are provided in the following tables:

Table 8. MCACES Cost Estimate, MRGO Environmental Restoration

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
01-	LANDS AND DAMAGES						
	Lands and Damages (Includes Influence Area)						
01B	Acquisitions						
01B20	By Local Sponsor (LS)				5,000	2,500	7,500

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
01B30	By Govt on Behalf of LS				1,264,503	632,323	1,896,826
01B40	Review of LS				1,560	780	2,340
01C	Condemnations						
01C30	By Govt on Behalf of LS				62,000	31,000	93,000
01E	Appraisal						
01E40	By Govt on Behalf of LS (Contract)				175,200	87,600	262,800
01E50	Review of LS				58,400	29,200	87,600
01G	Temporary Permits/Licenses/Rights-of-Entry						
01G10	By Government				87,934	43,970	131,904
01N00	Facility/Utility Relocations (Subordination Agreement)				1,080	540	1,620
01R	Real Estate Payments						
01R1	Land Payments						
01R1C	By Govt on Behalf of LS				1,095,000	547,500	1,642,500
01R2	PL 91-646 Assistance Payments						
01R2C	By Govt on Behalf of LS				8,650	4,330	12,980
01T	LERRD Crediting						
01T20	Administrative Costs (By Govt and LS)				10,450	5,230	15,680
51	Operations & Maintenance During Construction						
51B	Real Estate Management Services				2,000	1,000	3,000
51B20	Outgrants (Over 5 Years)				15,000	7,500	22,500
51B30	Disposal/Quitclaim				22,500	11,250	33,750
01--	Subtotal: Lands And Damages (Includes Influence Area)						2,809,277
	Contingencies						1,404,723
01--	Subtotal: Lands And Damages (Includes Influence Area)						4,214,000
01--	TOTAL: LANDS AND DAMAGES						
16--	BANK STABILIZATION						
16--	Lake Borgne/MRGO Land bridge						
	Mob and Demob	3	EA	70,000	210,000	73,500	283,500
	Stone (2,200 lb max.)	710,000	TN	26	18,460,000	6,461,000	24,921,000
	Core Material	260,000	CY	35	9,100,000	3,185,000	12,285,000

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
	Geotextile	770,000	SY	2.50	1,925,000	654,500	2,579,500
	Marker Plates	1,900	EA	500	950,000	323,000	1,273,000
	Flotation Channel	1	LS	1,112,500	1,112,500	378,500	1,491,000
16--	Subtotal: Lake Borgne/MRGO Land bridge						31,757,500
	Contingencies						11,075,500
16--	Subtotal: Lake Borgne/MRGO Land bridge						42,833,000
16--	North Bank Mile 50.9 (51.1) to 49.8 (49.5)						
	Mob and Demob	1	EA	70,000	70,000	24,500	94,500
	Stone (2,200 lb max.)	31,000	TN	26	806,000	282,100	1,088,100
	Core Material	7,000	CY	35	245,000	85,750	330,750
	Geotextile	42,000	SY	2.50	105,000	36,750	141,750
	Marker Plates	70	EA	5000	35,000	12,250	47,250
	Flotation Channel	1	LS	76,250	76,250	26,400	102,650
16--	Subtotal: North Bank Mile 50.9 (51.1) to 49.8 (49.5)						1,337,250
	Contingencies						467,750
16--	Subtotal: North Bank Mile 50.9 (51.1) to 49.8 (49.5)						1,805,000
16--	North Bank Mile 48.5 (48.5) to 44.9 (44.9)						
	Mob and Demob	1	EA	70,000	70,000	24,500	94,500
	Stone (2,200 lb max.)	94,000	TN	260	2,444,000	855,500	3,299,500
	Core Material	40,000	CY	35	1,400,000	490,000	1,890,000
	Geotextile	174,000	SY	2.50	435,000	152,250	587,250
	Marker Plates	390	EA	500	195,000	68,250	263,250
	Flotation Channel	1	LS	250,000	250,000	87,500	337,500
16--	Subtotal: North Bank Mile 48.5(48.5) to 44.9 (44.9)						4,794,000
	Contingencies						1,678,000
16--	Subtotal: North Bank Mile 48.5(48.5) to 44.9 (44.9)						6,472,000
16--	North Bank Mile 39.9 (39.9) to 37.2 (37.2)						
	Mob and Demob	1	EA	70,000	70,000	24,500	94,500

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
	Stone (2,200 lb max.)	71,000	TN	26	1,846,000	646,000	2,492,000
	Core Material	30,000	CY	35	1,050,000	367,500	1,417,500
	Geotextile	131,000	SY	2.50	327,500	114,625	442,125
	Marker Plates	290	EA	500	145,000	50,750	195,750
	Flotation Channel	1	LS	187,500	187,500	65,625	253,125
16--	Subtotal: North Bank Mile 39.9 (39.9) to 37.2 (37.2)						3,626,000
	Contingencies						1,269,000
16--	Subtotal: North Bank Mile 39.9 (39.9) to 37.2 (37.2)						4,895,000
16--	North Bank Mile 36.5 (36.5) to 36.1 and mile 35.5 to 33.9 (33.8)						
	Mob and Demob	1	EA	70,000	70,000	24,500	94,500
	Stone (2,200 lb max.)	51,000	TN	26	1,326,000	464,437	1,790,437
	Core Material	22,000	CY	35	770,000	269,500	1,039,500
	Geotextile	95,000	SY	2.50	237,500	83,125	320,625
	Marker Plates	220	EA	500	110,000	38,500	148,500
	Flotation Channel	1	LS	146,250	146,250	51,188	197,438
16--	Subtotal: North Bank Mile 36.5 (36.5) to 36.1 and mile 35.5 to 33.9 (33.8)						2,659,750
	Contingencies						931,250
16--	Subtotal: North Bank Mile 36.5 (36.5) to 36.1 and mile 35.5 to 33.9 (33.8)						3,591,000
16--	North Bank Mile 32.5 (32.6) to 26.7						
	Mob and Demob	1	EA	70,000	70,000	24,500	94,500
	Stone (2,200 lb max.)	151,000	TN	26	3,926,000	1,379,250	5,305,250
	Core Material	65,000	CY	35	2,275,000	796,250	3,071,250
	Geotextile	280,000	SY	2.50	700,000	245,000	945,000
	Marker Plates	620	EA	500	310,000	108,500	418,500
	Flotation Channel	1	LS	410,000	410,000	143,500	553,500
16--	Subtotal: North Bank Mile 32.5 (32.6) to 26.7						7,691,000
	Contingencies						2,697,000
16--	Subtotal: North Bank Mile 32.5 (32.6) to 26.7						10,388,000

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
16--	North Bank Mile 24.4 to 23.2						
	Mob and Demob	1	EA	70,000	70,000	24,500	94,500
	Stone (2,200 lb max.)	39,000	TN	26	1,014,000	344,887	1,358,887
	Core Material	17,000	CY	35	595,000	202,300	797,300
	Geotextile	73,000	SY	2.50	182,500	63,875	246,375
	Marker Plates	160	EA	500	80,000	28,000	108,000
	Flotation Channel	1	LS	76,250	76,250	26,688	102,938
16--	Subtotal: North Bank Mile 24.4 to 23.2						2,017,750
	Contingencies						690,250
16--	Subtotal: North Bank Mile 24.4 to 23.2						2,708,000
16--	North Bank Mile 56.0 to 60.0						
	Mob and Demob	1	EA	70,000	70,000	24,500	94,500
	Stone (2,200 lb max.)	102,000	TN	26	2,652,000	901,680	3,553,680
	Core Material	52,000	CY	35	1,820,000	618,800	2,438,800
	Geotextile	165,000	SY	2.50	412,500	143,645	556,145
	Marker Plates	430	EA	500	215,000	75,250	290,250
	Flotation Channel	1	LS	277,500	277,500	97,125	374,625
16--	Subtotal: North Bank Mile 56.0 to 60.0						5,447,000
	Contingencies						1,861,000
16--	Subtotal: North Bank Mile 56.0 to 60.0						7,308,000
16--	TOTAL: BANK STABILIZATION						80,000,000
30--	ENGINEERING AND DESIGN						
	Design Documentation (Feasibility)				4,500,000	900,000	5,400,000
	PED				3,000,000	600,000	3,600,000
	E&D				3,840,000	774,000	4,614,000
	Monitoring				842,000	170,000	1,012,000
30--	Subtotal: Engineering And Design						12,182,000
	Contingencies						2,444,000

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
30--	TOTAL: ENGINEERING AND DESIGN						14,626,000
31--	CONSTRUCTION MANAGEMENT						
	Supervision and Administration (S&A)				8,000,000	1,600,000	9,600,000
31--	TOTAL: CONSTRUCTION MANAGEMENT						9,600,000
	TOTAL PROJECT COST						108,270,000

Monitoring the performance of project features will be conducted as part of the construction portion of the plan. The purpose of including monitoring in the project is to document the performance of the structures in terms of meeting the goals of the environmental project. Monitoring will assess the engineering performance of the designs to aid in decisions regarding operations and maintenance needs and to feed information into an adaptive management program for the coast.

All of the structural components of this feature will require operations and maintenance to sustain engineering performance and achieve long-term project environmental goals. In general, the maintenance requirements are driven by the rate of subsidence of the rock breakwaters constructed. This rate will vary depending upon the specific subsurface soil conditions along the alignments. Typical O&M actions will include engineering inspections of the breakwaters and construction events to maintain the necessary elevations to stop shoreline erosion. These Operations, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) actions will be the responsibility of the local sponsor. The estimated average annual O&M cost is $711,000.

Table 9 provides a summary of the first costs for the initial phase of the MRGO Environmental Restoration Features project.

Table 9. Summary of Costs for the LCA Plan

MRGO Environmental Restoration Features (June 2004 Price Level)		
Lands and Damages	$	4,214,000
Elements:		
Bank Stabilization	$	80,000,000
Monitoring	$	842,000
First Cost	$	85,056,000
Feasibility-Level Decision Document	$	5,400,000
Preconstruction Engineering, and Design (PED)	$	3,600,000
Engineering, and Design (E&D)	$	4,614,000
Supervision and Administration (S&A)	$	9,600,000
Total Cost	$	108,270,000

A detailed breakdown of cost accounts between Federal funds and the share of the local sponsor is provided in **table 10**.

Table 10. MRGO Environmental Restoration Features

FEDERAL AND NON-FEDERAL COST BREAKDOWN
(June 2004 Price Level)

Item	Federal	Non-Federal	Total
Decision Document (50%Fed-50%NFS)	$ 2,700,000	$ 2,700,000	$ 5,400,000
PED (65%Fed-35%NFS)	$ 2,340,000	$ 1,260,000	$ 3,600,000
LERR&D (100% NFS)	$ -	$ 4,214,000	$ 4,214,000
Ecosystem Restoration (65%Fed-35%NFS)	$ 54,739,100	$ 25,260,900	$ 80,000,000
Engineering and Design (E&D) (65%Fed-35%NFS)	$ 2,999,100	$ 1,614,900	$ 4,614,000
Supervision and Administration (S&A) (65%Fed-35%NFS)	$ 6,240,000	$ 3,360,000	$ 9,600,000
Monitoring (65%Fed-35%NFS)	$ 547,300	$ 294,700	$ 842,000
Total Construction	**$ 66,865,500**	**$ 36,004,500**	**$ 102,870,000**
TOTAL COST	**$ 69,565,500**	**$ 38,704,500**	**$ 108,270,000**
Cash Contribution	*$ 69,565,500*	*$ 31,790,500*	

Implementation Plan

Initial Project Management Plan (PMP) and scoping efforts to address the appropriate level of engineering detail required for the follow-up feasibility-level decision document for the MRGO environmental restoration features are currently underway. The PMP is expected to be negotiated by the end of December 2004 and will form the basis for assigning tasks between the USACE and the sponsor, Louisiana Department of Natural Resources (LDNR), as well as, detail the conduct of the feasibility-level analyses. Development of the decision document is anticipated to begin in January 2005, with completion estimated in two years (January 2007). Pre-construction engineering and design (PED) efforts to finalize the detailed design and ready the project for construction would initiate once a design agreement is negotiated with LDNR to define the scope, schedule and cost of the design. Preparations of plans and specifications for construction could commence in January 2007 and are forecasted for completion in two years (January 2009). Construction of the features could begin following PED with approval and execution of a Project Cooperation Agreement (PCA). The current schedule would allow for construction to begin as early as January 2009, with construction completion estimated for the end of calendar year 2012.

These accelerated schedules are important for the implementation of the LCA Plan. Experience in designing and constructing similar features in coastal Louisiana indicates that these schedules are attainable and that a high degree of coordination and funding will be required to achieve the goals and objectives of the plan and address the critical needs facing coastal Louisiana.

National Environmental Policy Act (NEPA)

Since early 1999, there has been considerable public and agency involvement and input concerning the future of the MRGO through the efforts of the U.S. Environmental Protection Agency (USEPA), and others. The USEPA and the LDNR sponsored an effort to plan for the "Timely Modification of the MRGO." To that goal, committees composed of representatives from government agencies, local governments, environmental groups, and shipping interests have met on numerous occasions to discuss and plan for modifications to the MRGO. These efforts have assisted in preparation of alternatives descriptions and NEPA documentation.

A notice of intent to prepare an Environmental Impact Statement (EIS) for an MRGO reevaluation study was published in the *Federal Register* on Tuesday, August 7, 2001. Scoping meetings were held on August 30, 2001, in Chalmette, Louisiana, and on September 5, 2001, in New Orleans, Louisiana. A draft EIS is being prepared to accompany the draft reevaluation study report. The draft General Reevaluation Study report is scheduled for submittal to USACE-Mississippi Valley Division for review in late calendar year 2004.

A draft Environmental Assessment for the CWPPRA-sponsored "Lake Borgne – Mississippi River Gulf Outlet Shoreline Protection" was released for public comment in September 2004. The document outlines plans and impacts for two proposed rock breakwaters along segments of lake and channel shoreline for the purposes of preventing wetlands erosion.

Special provisions in the draft EA have been incorporated into project designs and construction plans to protect threatened and endangered species and to conserve estuarine fish habitat.

The environmental impacts of the near-term features recommended in the LCA authorization are covered in the Programmatic Environmental Impact Statement (PEIS) for the study. In addition, each specific project recommended will proceed through feasibility study for approval requiring project specific review under NEPA through a Supplemental Environmental Impact Statement (SEIS) or Environmental Assessment (EA). These environmental compliance actions will be completed in decision documents to be reviewed and approved by the Secretary of the Army.

During the plan formulation process the LCA Project Delivery Team assessed the impacts of various specific restoration techniques, the specific subprovince restoration frameworks, the identified final array of coast wide frameworks, the alternative plans for best meeting the study objectives, and the tentatively selected plan. The PEIS identified and discussed these impacts by specific and cumulative natural and human environmental effects for the alternative plans carried over for detailed analysis. The PEIS provided a consistent basis for initiating NEPA documentation of individual restoration features in the context of larger systemic coastal needs and functions.

Uncertainties/Risks

Previous efforts to protect eroding shorelines have successfully utilized rock breakwaters along the MRGO to prevent marsh loss. However, extremely poor soil conditions in the project area require high cost O&M events to maintain the level of protection from large vessel wakes and high-energy storm and wind-driven waves. Detailed engineering investigations help reduce the risk associated with constructing and maintaining rock dikes in areas of poor soil conditions. In addition, some promise exists from demonstrations in the area of alternative shoreline protection methods. These methods may allow more cost-effective solutions to the high rates of shoreline erosion in the area. Feasibility level investigations will produce detailed designs that recognize these limitations and opportunities and recommend the appropriate solutions to the ongoing shoreline erosion problems in the area. In general, project design risks are considered minimal and likely to be reduced even further with the conduct and completion of feasibility investigations and detailed engineering and design work.

Subject to Feasibility

The most important area of uncertainty associated with the near-term proposal is the future of the MRGO navigation channel as a deep-draft shipping route. A study is currently underway to reevaluate the economic benefits to the Nation of maintaining the channel. The scope of the reevaluation study covers a number of different alternative depth modifications and implementation timeframes for channel authorization changes. The outcome of that study has not been determined and, thus, the future status of the channel is unknown at this time. The possibility exists that some time in the future the status of the channel could be changed through a USACE study recommendation and a Congressional action to deauthorize the shipping canal.

However, while some of the ecosystem losses occurring in the area are directly associated with the operation of the navigation channel, the need for shoreline protection on Lake Borgne and the channel will remain regardless of the future status of the channel. The need will remain because the background factors in Louisiana wetland losses will continue and some shallow-draft navigation will likely continue to use the area waterways. The completion of the channel reevaluation study and the undertaking of the feasibility investigations for the near-term measures will require close coordination because of the interrelation of the matters.

Contingent Authorization/Demos/S&T

Protecting critical ecosystem structural components in the area will provide extensive direct and indirect benefits. Several opportunities exist to investigate potential alternative designs and techniques to improve project performance and cost effectiveness. Certain advanced geotechnical improvement technologies are being used throughout the world to build structures in poor soil settings. The application of these advanced engineering methods to restoration plans could produce better project performance for rock breakwaters built in the coastal wetlands of Louisiana. In particular, these methods could produce substantial cost savings in the MRGO area through the reduction of O&M requirements associated with the construction losses, subsidence and settlement of the breakwaters. Investigation of these engineering methods for application to MRGO environmental restoration could involve the construction of test sections to evaluate project performance improvements. These test sections would demonstrate the effectiveness of the engineering improvements and would identify technologies for broader application in this environmental restoration effort.

Recommendations/Summary

The Lake Borgne estuarine complex is deteriorating and recent analysis indicates that the rate of wetland loss in the area is accelerating. Rapid action is required to protect the integrity of the southern Lake Borgne shoreline and to prevent continued erosion of the MRGO channel banks from ocean going vessel wakes. Additional ecosystem restoration features are required to address serious ecological problems developing in the surrounding parts of the estuary. Without action, critical landscape components that make up the Lake Borgne estuary would be lost and future efforts to restore other parts of the ecosystem would be much more difficult and expensive if not impossible.

While the MRGO Environmental Restoration Features were not specifically evaluated for cost-effectiveness, it was found to be a critical feature of seven feasible and cost-effective, coast wide restoration frameworks. In addition, the feature addresses an identified, imminent, and critical need for restoration. It is recommended for implementation based on the sequencing rule that identifies features at potential risk for loss of opportunity if near-term action is not taken. The identification of critical ecological solutions in the ecosystem does not necessarily equate to identification of cost effective solutions. However, in this case, action now will save critical structural components of the estuary that cannot be replaced if they are lost.

Critical action points to avoid near-term (3 to 5 years) threats of shoreline and bayou breaches are located at Bayou Bienvenue, Bayou Mercier, Proctor Point, Alligator Point, Bayou Biloxi, Bayou Magill, and Antonio's Lagoon. These sites face significant risk of losing the integrity of bayou banks along the lake shoreline and a potential major breach of the navigation channel into the lake. Loss of bayou bankline stability would result in higher rates of erosion and destruction of limited and diverse habitats that offer fish and wildlife refuge from open lake conditions. A breach between the lake and the MRGO navigation channel would result in rapid wetlands loss as storm waves from the lake and ship wakes from the channel impact sensitive interior wetlands and submerged grass beds in protected ponds. Further impacts from breaches would occur as scarce sediments are exported into deeper water and out of the wetland system.

This critical restoration feature proposes to construct 23 miles of rock breakwaters along the north bank of the MRGO and 15 miles along important segments of the southern shoreline of Lake Borgne that are projected to breach in the near future. Strategic placement of similar protective breakwaters has been effectively used along the MRGO to prevent shoreline retreat. Under this plan, large amounts of estuarine marshes would be protected from further shoreline erosion and other areas would be improved for the long-term benefit of the environment. In addition, other restoration features will be investigated that produce environmental benefits following the sequence established in the Coast 2050 plan to preserve wetlands and maintain the estuarine gradients established by the surrounding marshes. These habitats are significant for commercial and recreational fisheries as well as wildlife, and these areas serve as critical habitat for the threatened Gulf sturgeon.

Finally, details of additional ecosystem restoration features would be developed during a study phase for purposes of estimating costs and benefits and for selecting the best set of projects to attain the ecosystem restoration goals for the area. This study effort would be conducted under the modification of existing structures portion of the LCA proposed authorization. Under this approach the MRGO channel is considered a structure for purposes of evaluating potential modifications to improve the environment.

Small Diversion at Hope Canal
A Near-Term Critical Feature for the Louisiana Coastal Area Plan

Introduction

The Maurepas Swamp is an area of considerable ecological, socio-economic, and cultural importance. Since the construction of the Mississippi River flood control levees, large portions of the Maurepas Swamp have largely been cut off from freshwater, sediments, and nutrients. Due to this disruption in natural processes, soil building in the swamp has been insufficient to keep up with subsidence. Consequently, much of the swamp is persistently flooded, the existing trees are highly stressed, and there is little to no natural regeneration of cypress and tupelo trees, which are the dominant vegetation in this swamp ecosystem. These factors, combined with increasing occurrences of high salinities, have resulted in a highly degraded swamp system, which is at great risk of conversion to open water.

The Hope Canal project would reintroduce 1,000 to 2,000 cubic feet per second (cfs) of Mississippi River water into the southern portion of the Maurepas Swamp, thereby increasing the flow of freshwater, nutrients, and fine-grained sediment to an area in the swamp that is highly stressed and in need of restoration. The Hope Canal project is fully consistent with both the strategies used to develop the draft LCA restoration plan and the critical needs criteria for identifying near-term restoration opportunities.

The purpose of the Hope Canal project is to restore and protect the health and productivity of the swamps south of Lake Maurepas through reintroduction of Mississippi River water. The specific objectives of the project concept are to:

- Prevent habitat conversion and land loss;
- Restore and maintain characteristics of natural swamp hydrology;
- Retain and preferably increase overstory cover;
- Decrease the mortality rate of tupelo trees;
- Increase the primary productivity of trees;
- Reduce salinity levels in the swamp;
- Increase sediment loading to the swamp;
- Increase nutrient loading to the swamp;
- Increase dissolved oxygen concentrations in swamp water;
- Ensure that reintroduction of river water does not result in increased nuisance algal blooms in Lake Maurepas; and
- Reduce nutrient loading from the Mississippi River to the Gulf of Mexico.

Having undergone years of interagency and public review, the Hope Canal project is in a good position to move forward expeditiously within the LCA Plan. Since being selected by the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) Task Force as the "Mississippi River Reintroduction into Maurepas Swamp" in January 2002, for engineering and design work, the Hope Canal project has undergone considerable environmental and engineering review, including hydrologic modeling; baseline vegetation, soils, and water quality monitoring;

preliminary alternatives analysis; and environmental benefits assessment. A number of public hearings and outreach activities have also been conducted. Most recently, engineering and design and the National Environmental Policy Act (NEPA) process have been initiated as part of the ongoing CWPPRA process for this project. Some of the major actions conducted to date are:

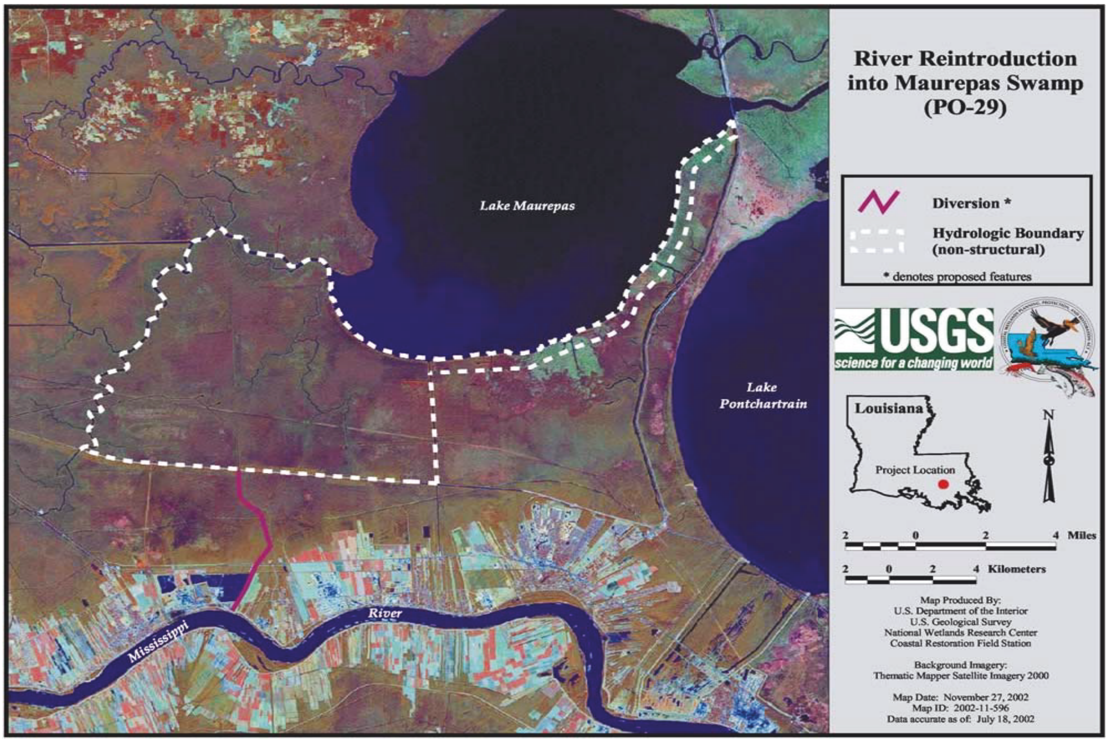
- Channels (canals and bayous) have been surveyed.
- Swamp elevation data have been obtained.
- A one-dimensional hydrologic model (UNET) was developed, and existing conditions, various reintroduction options, and project features have been simulated.
- Water level data have been collected for over two years.
- Swamp vegetation has been characterized.
- Productivity (growth) of swamp trees and other vegetation has been measured for over two years.
- Sediment accumulation in the swamp has been measured for over two years.
- Nutrient concentrations in canals and bayous have been measured for two years.
- Alternative reintroduction alignments have been evaluated.
- Real estate and relocation costs have been estimated.
- LIDAR data (swamp elevation) have been acquired.
- Several public meetings have been held.
- Interagency coordination meetings on drainage issues have been held including EPA, USACE, St. John Parish, and their drainage master plan contractor.
- A cooperative agreement between EPA and the Louisiana Department of Natural Resources (LDNR) has been in place for over two years, supporting Phase 1 engineering and design work, including some of the above activities.

Description of Area/Background

The Maurepas Swamp is located in LCA Subprovince 1, west of Lake Pontchartrain and north of the I-10 corridor (**figure 1**). The Maurepas Swamp is one of the largest remaining tracts of coastal freshwater swamp in Louisiana. Including Lake Maurepas, the Maurepas Swamp area is approximately 232,928 acres, most of which is swamp with some isolated areas of bottomland hardwood forest and fresh marsh.

The Maurepas Swamp is important habitat for a range of fish and wildlife species, including crawfish, alligator snapping turtles, blue crab, and channel catfish. The Maurepas Swamp also provides valuable habitat to a number of avian species, including neo-tropical migratory songbirds and waterfowl. Two threatened species (the bald eagle and Gulf sturgeon) are found in this area. Bald eagles typically nest in cypress trees near fresh to intermediate marshes or open water. There were 16 active and 7 inactive bald eagle nests in this area during the 2003-2004 breeding season. The Gulf sturgeon is a threatened species found in Lake Maurepas.

The Maurepas Swamp serves as a buffer between the open water areas of Lakes Maurepas and Pontchartrain and developed areas along the I-10/Airline Highway corridor. Development along the I-10/Airline Highway corridor in this area includes residential, commercial, and industrial. The Maurepas Swamp is used for fishing, hunting, and other recreational activities, and as a large contiguous tract of cypress/tupelo swamp near the New Orleans metropolitan area, has considerable cultural significance.



1. Map showing the general location of Maurepas Swamp, proposed Hope C conveyance route, and project hydrologic boundary.

Since the construction of the Mississippi River flood control levees, the Maurep Swamp has been virtually cut off from any freshwater, sediment, and nutrient input. Thus, the only soil building has come from organic production within the wetlands, and vegetative productivity may be substantially depressed compared to normal conditions. Subsidence in this area is classified as interm

In addition, the existing trees are highly stressed, which decreases productivity, increases mortality, and increases susceptibility to herbivory and parasites. Saltwater intrusion has increased, at least in part due to a progressive combination of net subsidence and the lack of riverine freshwater inputs. Saltwater intrusion events observed in 1999 and 2000 caused greater than 97 percent mortality of tens of thousands of cypress seedlings planted in the northwestern portion of the Maurepas Swamp. Salinity can be an important factor contributing to swamp deterioration, especially combined with other stressors (e.g., flooding, herbivory). Herbivory appears to be another potentially important stressor in the Maurepas Swamp. Tupelo trees are susceptible to grazing by tent caterpillars and cypress by leaf rollers, which can result in almost total defoliation in the spring. Caterpillar grazing can reduce production of litter by about 13.5 percent. Young cypress and tupelo are both very susceptible to grazing by nutria, deer, and crawfish.

Problems and Needs

The combination of little to no tree regeneration and more frequent incidence of higher than tolerable salinities place the Maurepas Swamp at high risk of conversion to open water. Recent tropical storm events, occurring at a rate of one to two per year, have produced measurable spikes in salinity in the area. With subsidence, the lack of substrate accretion, and reduced organic productivity, this area is at high risk for the type of die-off that is already occurring in lake rim areas in western Lake Pontchartrain. With the increasing water depth in these areas, it is highly likely that swamp habitat will be converted to open water rather than intermediate marsh.

The ability to restore flows of Mississippi River waters to the Maurepas Swamp represents an important opportunity to respond to the restoration needs of this valuable and endangered coastal Louisiana wetland ecosystem. In addition to the ecosystem benefits the Hope Canal project could provide, there would also be indirect benefits such as an increased knowledge of swamp ecosystem restoration and the logistical and engineering aspects of river reintroduction projects. Capitalizing on this ecosystem restoration opportunity could increase the efficiency and effectiveness of subsequent reintroduction measures, particularly those dealing with swamp ecosystems.

Critical Need for the Project

The cypress-tupelo swamps south of Lake Maurepas represent an accumulation of decades of plant production and associated ecological complexity. Much (arguably, relatively more than even most other coastal ecosystems in Louisiana) will be lost if this ecosystem is degraded beyond the ability to restore it. Given the temporal considerations associated with replacing long-lived tree species, preventing the loss of such trees is preferable from both economic and ecological standpoints.

The ongoing degradation of the Maurepas Swamp can be attributed to two types of factors: the first being the relatively constant stress associated with the lack of riverine input and prolonged inundation, and the second being the effects of stochastic events, most notably increased salinities. A qualitative estimate of the ecosystem losses that could be prevented by contingent authorization must consider both types of these factors.

The ongoing, constant deterioration of the Maurepas Swamp results in reduced tree productivity and health, increased tree mortality, decreased soil integrity, and increased relative subsidence. At this same time, stochastic events (particularly salinity increases) have the potential to dramatically increase tree mortality, while further stressing the remaining trees. Delaying project implementation would result in a continuation of the constant ecosystem decline, while also exposing the existing ecosystem to the additional risks associated with increased salinities and other difficult to predict events. Therefore, under any scenario, expediting implementation of the Hope Canal project would prevent a range of potential adverse ffects. Again, because the higher end of this range would represent unpredictable events, it would not be possible to accurately predict the full possible extent of such losses.

The potential adverse effects discussed above would include decreased habitat for important avian species (most notably the bald eagle), and could also adversely affect the populations of a variety of indigenous species, such as crawfish, alligator snapping turtles, blue crab, and channel catfish. Additionally, such losses would also contribute to an overall decline in swamp health, as measured by soil integrity, substrate elevation, and vegetative health and resilience.

The effectiveness of the Hope Canal project depends in large part upon enhancing the health and productivity of the existing trees, which would play a major role in restoring soil integrity and counteracting subsidence. As discussed above, delaying action on the Hope Canal project would result in increased tree mortality and decreased health in the remaining trees. It is very difficult to quantify the number of individual trees that would die or become severely stressed, but it is certain that the system as a whole will suffer without action. A delay would, therefore, most likely reduce the effectiveness of this restoration effort and/or require increased restoration inputs to achieve the same level of benefits.

Contingent authorization of the Hope Canal project is an appropriate and necessary way to meet the critical needs discussed above. Specifically, expediting the authorization process for this project has the potential to:

- Reduce tree mortality and decline in the overall health of the swamp;
-

Alternatives Analysis

The Small Diversion at Hope Canal project has been approved by, or is consistent with a number of major planning efforts for coastal Louisiana, including Coast 2050, CWPPRA priority project list (PPL) 11, and five of the seven cost-effective, coast wide restoration frameworks developed as part of the LCA process. In addition, the cost effectiveness/incremental cost analysis of the Mississippi River, Sediment, Nutrient, and Freshwater Redistribution Study identified a reintroduction (as large as 2,000 cfs) in the vicinity of Hope Canal as a cost-effective means of utilizing Mississippi River resources for restoration. Given this history, as well as the current LCA Plan, it is highly likely that the Hope Canal project would be a component of any comprehensive plan developed in the future.

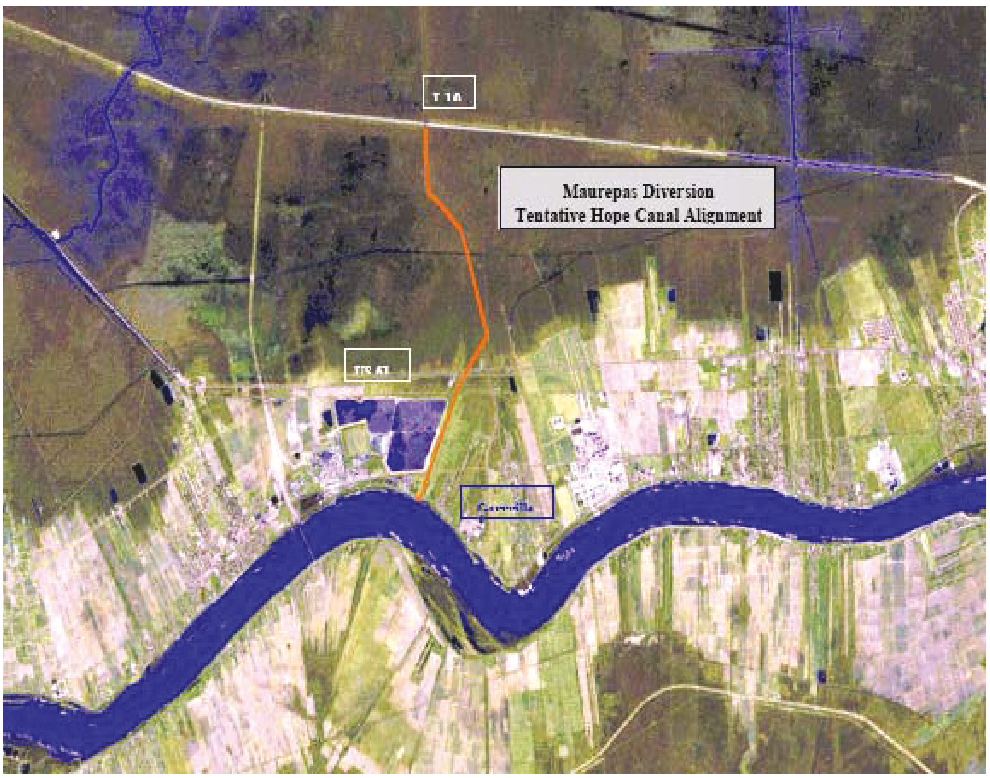


Figure 2. Proposed Hope Canal alignment.

In addition to the studies and planning efforts referenced above, a preliminary alternatives analysis has been conducted under the CWPPRA process. This alternatives analysis reviewed four different locations (or conveyances) for reintroduction of Mississippi River water into the Maurepas Swamp. The four reintroduction locations reviewed were Reserve Relief Canal, Hope Canal, Convent, and Romeville. The alternatives analysis examined major factors that are either important to imparting benefits to the swamp or to avoiding unacceptable human conflicts or excessive costs, including any potentially irresolvable conflicts that could represent "fatal flaws" to project implementation.

While not necessarily eliminating other alternatives as potentially suitable options, the alternatives analysis indicated that Hope Canal provides distinct advantages with respect to cost, logistics, complexity, and potential environmental benefits. In short, Hope Canal was found to be the most promising alternative. Among other advantages, it was found that the Hope Canal site is located such that water reintroduced there has the potential to flow directly into the swamps where benefits are needed, while at the same time minimizing potential conflicts with the existing development. The proposed conveyance channel would traverse largely undeveloped land, thereby reducing conflict with existing development. Additionally, the dimensions of the existing channel north of I-10 is a benefit, as it facilitates outfall management and maximizes the amount of diverted water that would be introduced into sheet-flow through the swamp. (**table 1** provides a summary of the preliminary analysis of alternative reintroduction sites with respect to potential swamp benefits.)

Table 1. Alternative Reintroduction Sites

	Sites			
Issue	Romeville	Convent	Hope Canal	Reserve Relief Canal
Distribution of Diverted Water Through Swamp	Water diverted to headwaters of Blind River; most expected to move in channel flow directly to Lake Maurepas, with minimal overland flow in swamps. Would require discharge 2-3 times larger in magnitude and/or additional structures to introduce water into the desired area of the swamp. This would add cost, interference with boat traffic.	Water diverted to headwaters of Blind River; most expected to move in channel flow directly to Lake Maurepas, with minimal overland flow in swamps. Would require discharge 2-3 times larger in magnitude and/or additional structures to introduce water into the desired area of the swamp. This would add cost, interference with boat traffic.	Easiest to manage for complete overland flow of diverted water, good network of channels for distribution through swamp. Require the least amount of outfall structures, thus less cost and interference with boat traffic.	Easier to get water out of canal than Blind River, but still expect primarily channel flow directly to lake; lesser network of channels for distribution than Hope Canal. Would require additional channel construction to direct water back to desired area of the swamp. This would add cost, interference with boat traffic.
Character of Target Swamps and Relative Benefits to Swamp Areas	Receiving swamp is stressed, but not as severely as the swamps closer to and south/southwest of Lake Maurepas. Unless extensive channel structures are built, there would be minimal benefits, because diverted water delivered to Blind River headwaters, remains in channel with minimal overland flow through swamps.	Receiving swamp is stressed, but not as severely as the swamps closer to and south/southwest of Lake Maurepas. Unless extensive channel structures are built, there would be minimal benefits, because diverted water delivered to Blind River headwaters, remains in channel with minimal overland flow through swamps.	Receiving swamp is stressed; some areas of moderately stressed swamps adjacent to Hope Canal at I-10, but large areas of highly stressed swamps near Tent and Mississippi Bayous. Greatest benefits, due to maximum distribution of diverted water through greatest area of needy swamp.	Relatively high level of stress in receiving swamps. Moderate benefits - not as easy to distribute diverted water as Hope Canal, slightly smaller area of target swamps.

It is important to note again that this alternatives analysis did not necessarily eliminate other alternatives as potential means for addressing environmental concerns in the Maurepas Swamp; rather, it suggests that Hope Canal offers the optimal first step in restoring the swamp. The Hope Canal project will not benefit the entire Maurepas Swamp; therefore, further restoration will be needed, particularly the other two measures included in the TSP (i.e., Amite River Diversion Canal and Small Diversion at Convent/Blind River).

The past and ongoing work described above has helped demonstrate the necessity, appropriateness, cost-effectiveness, and feasibility of the project, and can provide valuable information that would help expedite study and implementation under contingent authorization.

Recommended Plan

The selected project's main structural features will include 2 10-foot x 10-foot box culverts in the Mississippi River levee with the invert set at an elevation to assure capability of essentially year-round diversion (see **figure 2**). A receiving pond/settling basin with 100-foot x 100-foot dimensions, reinforced with 20 inches of riprap, would be built at the outfall of the culverts to slow velocities and remove heavy sand. It would be necessary to excavate a new leveed channel from the existing southern terminus of Hope Canal to the proposed reintroduction structure in the Mississippi River levee. Additionally, the cross section of Hope Canal would need to be enlarged to a width of 50 feet to accommodate the reintroduced river water. This channel would be a total of 27,500 feet long and run from the river to I-10. Outfall management would be necessary to insure the water gets over the swamp. There will be navigable constrictions in Hope Canal and an abandoned railroad embankment will be gapped along Hope Canal north of I-10. Results from a UNET model were used to develop the project features above.

The State of Louisiana represented by the LDNR will perform all operation and maintenance and rehabilitation. Operation and maintenance activities would consist of structure operation, channel maintenance, grass cutting, etc. No specific year is scheduled for rehabilitation at present time, but this will be determined during future engineering and design.

Monitoring

Water levels, salinity patterns, swamp productivity, accretion, nutrient assimilation and other associated responses will be monitored. The data from monitoring will be used to adaptively manage this project. Knowledge gained from monitoring will also be applied to the planning and operation of other reintroductions into swamps.

Synergy with Other Restoration Projects

Reintroduction of river water at Hope Canal would complement LCA near-term projects to restore other parts of the Maurepas Swamp (i.e., Small Diversion at Convent/Blind River and Amite River Diversion). Hope Canal would restore the lower end of the Maurepas swamp system while the other two projects would preserve the upper and central areas.

As noted above, implementation of the Hope Canal project would also provide indirect restoration benefits in terms of increased knowledge on the scientific and logistical aspects of river reintroduction, knowledge that would be valuable for future reintroduction projects. In particular, implementation of this reintroduction project would provide information that would further our understanding of cypress swamp restoration and would be useful to both the near-term Maurepas projects mentioned above as well as cypress swamps in the upper Barataria Basin (Subprovince 2).

Benefits

To preserve swamps in the long-term, conditions must be reestablished that both allow survival of existing cypress and tupelo trees and allow at least periodic reproduction and recruitment of seedlings. In the Maurepas Swamp, non-stagnant water, accretion, and freshening are all needed to achieve these goals. From the perspective of sustainable ecosystem management, it is believed that implementation of a reintroduction project of appropriate size into the Maurepas Swamp is essential for bringing the area back toward environmental sustainability. Implementation of the proposed reintroduction will greatly increase flow through the project area, which will provide constant renewal of oxygen- and nutrient-rich waters to the swamps. (It is important to note that the proposed alternative would be operated such that reintroductions are reduced or stopped when climate and soil conditions are conducive to tree regeneration.)

Benefits of the Hope Canal project will include measurable increases in productivity, which will help build swamp substrate and balance subsidence, as well as increases in growth of trees, reduced mortality, and an increase in soil bulk density. As accretion improves, there also is expected to be an increase in recruitment of new cypress and tupelo trees, required for long-term sustainability of the swamp. Anticipated sediment benefits to the swamp include direct contribution to accretion, as well as contribution to biological productivity through the introduction of sediment-associated nutrients, which also contributes to production of substrate. The sediment loading to the target swamps from the Hope Canal reintroduction is conservatively estimated to be >1,000 $g/m^2/yr$, or about twice the estimated quantity needed to keep up with subsidence.

Results of a CWPPRA "Phase 0" study show the Maurepas Swamp is almost certainly nutrient limited. Other studies provide the expectation that the addition of nutrients with diverted water would at least double growth rates of the dominant swamp trees. An important adjunct to this is that it is estimated that nutrients added with diverted river water would be essentially completely taken up within the swamp (i.e., prior to discharge to Lake Maurepas). The addition of nutrients and associated increase in production will contribute substantially to the buildup of swamp substrates (accretion) through organic contribution, which will help counterbalance subsidence. Therefore, nutrient additions will directly improve the health of the trees and conditions of the swamp, and in the long run also will help generate a condition more conducive to sprouting and recruitment of cypress and tupelo seedlings.

Previous study also shows the impacts of saltwater intrusion on the cypress-tupelo swamps, including mortalities of cypress, tupelo, red maple and ash, and suppression of tree productivity in the areas of highest salinity. Saltwater intrusion in the Maurepas Swamp is impacting swamp vegetation already stressed by excessive flooding. The proposed re-introduction project is expected to directly ameliorate increasing salinities in the Maurepas Swamp, as well as in the lake itself. This is expected to largely prevent the high mortalities previously observed in the project area. More persistently freshwater conditions are also expected to help increase tree and herbaceous productivity, which along with the flow-through of oxygen-, sediment- and nutrient-rich waters, will contribute to stronger (higher bulk density) substrates and increased accretion. Beyond direct benefits to the swamps, it is expected that there could be a positive indirect impact on Lake Maurepas freshwater fisheries, along with freshwater-related wildlife species.

The inner continental shelf of the Gulf of Mexico off Louisiana currently experiences widespread hypoxia (low dissolved oxygen conditions) during the summer, attributed to direct introduction of nutrient-rich water from the Mississippi River. It has been recommended that wetlands and shallow water bodies be used to process river water before it enters the Gulf, to reduce the magnitude of this hypoxic zone as well as help restore the wetlands. Nutrient studies conducted as part of the CWPPRA process show that approximately 94 percent to 99 percent of the nutrients introduced in diverted water will be processed and retained by the Maurepas Swamp. Therefore, it can be assumed that contribution of this Hope Canal project toward amelioration of Gulf hypoxia would be proportional to the magnitude of flow of the reintroduction compared to that of the Mississippi River. Because the volume of the proposed Maurepas reintroduction project is small compared to average flows in the river, by itself this reintroduction would not have a measurable impact on the size of the hypoxic zone. But the proposed reintroduction should be viewed as a functional component of a potentially larger system of river reintroductions that together could reduce nutrient delivery to the Gulf. It should be noted, however, that reintroductions alone could not solve the problem of Gulf hypoxia. It will be necessary to implement a suite of other measures designed to reduce nutrients at their sources, as well as to implement similar riverine wetland restoration efforts throughout the Mississippi/Atchafalaya River Basin.

WVA Benefits

The procedure for evaluating the benefits of CWPPRA projects to swamp habitats, the Wetland Value Assessment (WVA) swamp model, uses a series of variables that are intended to capture the most important conditions and functional values of a swamp. Values for these variables are estimated for existing condition,; conditions projected into the future if no restoration efforts are applied, and conditions projected into the future if the proposed diversion project is implemented. This procedure provides an index of "quality" of the swamp for the given time period. The quality index is then combined with the acres of swamp to get a number that is referred to as "habitat units." Expected project benefits are estimated as the difference in habitat units between the futures with and without the project. To allow comparison of WVA benefits to costs, total benefits are averaged over a 20-year period, with the result reported as Average Annual Habitat Units (AAHUs).

The Hope Canal project would restore approximately 36,000 acres of swamp. The total WVA benefits estimated for the project are 8,486 AAHUs, which is the highest estimated AAHU score for any CWPPRA project to date.

It is important to note that the CWPPRA institutional constraint of considering project benefits only over 20 years is widely understood to underestimate benefits in a swamp because cypress and tupelo trees are very long-lived, and their response (positively or negatively) to environmental change may take many decades to be realized. In particular, a diversion now could prevent catastrophic loss of swamp areas 30 or 40 years in the future. Thus, the merits of a reintroduction into the Maurepas Swamp have probably been underestimated and the above estimates provide a very conservative measure of the expected outputs over the 50-year period-of-analysis.

Costs

The estimate of total project costs is based upon a schedule of project expenditures that was provided for each year of the project. This schedule represents incremental, or "un-inflated," costs. Expenditures include future planning, engineering and design (PED) costs; construction costs; and monitoring costs. Operations and maintenance (O&M) costs are reported separately. As with any single USACE project, individual expenditures are either compounded or discounted to a given base year, defined as that year in which the project is generating all of the outputs intended by its design. The project cost estimate is derived through summing the compounded/discounted values to yield the present value of costs that is correlated to the corresponding base year. This figure is then annualized using the Federal discount rate (5-3/8 percent for fiscal year 2005) and a 50-year project life to yield an estimate of average annual project costs.

The estimate of total project costs and its average annual equivalent on a "fully-funded" basis is derived in exactly the same manner as described above, except that the schedule of project costs previously reported as incremental costs are adjusted to include inflation. The factors that are used to inflate project costs are those provided in the Fiscal Year 2006 Budget Engineering Circular.

The estimated cost for designing and constructing the river reintroduction at Hope Canal is $70.513 million (including monitoring). Details of this cost estimate are provided in the following tables:

Table 2. MCACES Cost Estimate, Hope Canal (Maurepas Swamp) Diversion

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
01-	LANDS AND DAMAGES						
	Lands And Damages (Including Influence Area)						
01B	Acquisitions						
01B20	By Local Sponsor (LS)				5,000	2,500	7,500
01B30	By Govt on Behalf of LS				189,078	94,788	283,866
01B40	Review of LS				1,560	780	2,340
01C	Condemnations						
01C30	By Govt on Behalf of LS				8,276	4,140	12,416
01E	Appraisal						
01E40	By Govt on Behalf of LS (Contract)				20,400	10,200	30,600
01E50	Review of LS				6,800	3,400	10,200
01F	PL 91-646 Assistance						
01F30	By Govt on Behalf of LS				11,300	5,650	16,950

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
01G	Temporary Permits/Liscenses/Rights-of-Entry						
01G10	By Government				10,278	5,140	15,418
01N00	Facility/Utility Relocations (Subordination Agreement)				8,650	4,330	12,980
01R	Real Estate Payments						
01R1	Land Payments						
01R1C	By Govt on Behalf of LS				17,212,000	8,606,000	25,818,000
01R2	PL 91-646 Assistance Payments						
01R2C	By Govt on Behalf of LS				79,500	39,750	119,250
01T	LERRD Crediting						
01T20	Administrative Costs (By Govt and LS)				8,650	4,330	12,980
51	Operations & Maintenance During Construction				2,000	1,000	3,000
51B	Real Estate Management Services				15,000	7,500	22,500
51B20	Outgrants (Over 5 Years)				10,000	5,000	15,000
51B30	Disposal/Quitclaim						
01--	Subtotal: Lands And Damages (Including Influence Area)						17,588,492
	Contingencies						8,794,508
01--	Subtotal: Lands And Damages (Including Influence Area)						26,383,000
01--	TOTAL: LANDS AND DAMAGES						26,383,000
02--	RELOCATIONS						
02--	Roads, Railroads, Utilities and Pipelines	Lump Sum	LS	20,349,000.00	20,349,000	2,035,000	22,384,000
02--	TOTAL: RELOCATIONS						22,384,000
09--	CHANNELS AND CANALS						
09--	Channels						
	Channel Work	1,032,300	CY	3.10	3,200,130	320,970	3,521,100
	Sediment Basin	Lump Sum	LS	549,000.00	549,000	54,900	603,900
	Subtotal: Channels						3,749,130
	Contingencies						375,870
	Subtotal: Channels						4,125,000
09--	TOTAL: CHANNELS AND CANALS						4,125,000
15--	DIVERSION STRUCTURES						
15--	Hope Canal (Maurepas Diversion)						

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
	2 10'x10' Box Culverts	Lump Sum	LS	4,858,377.00	4,858,377	485,503	5,343,880
	72" Flapgate	4	EA	20,000.00	80,000	8,000	88,000
	Pipe For Culverts	280	FT	65.00	18,200	1,820	20,020
	Site Prep For Culverts	Lump Sum	LS	20,000.00	20,000	2,000	22,000
	Riprap I-10 Bridge	25,000	TN	25.00	625,000	62,500	687,500
	Rock For Channel Construction	10,000	TN	25.00	250,000	25,000	275,000
	Spoil Bank Gapping	Lump Sum	LS	76,000.00	76,000	7,600	83,600
15--	Subtotal: Maurepas Diversion						5,927,577
	Contingencies						592,423
15--	Subtotal: Maurepas Diversion						6,520,000
15--	TOTAL: DIVERSION STRUCTURES						6,520,000
30--	ENGINEERING AND DESIGN						
	Design Documentation (Feasibility)				2,973,000	595,000	3,568,000
	PED				1,818,000	364,000	2,182,000
	E&D				991,000	198,000	1,189,000
	Monitoring				594,000	119,000	713,000
30--	Subtotal: Engineering And Design						6,376,000
	Contingencies						1,276,000
30--	TOTAL: ENGINEERING AND DESIGN						7,652,000
31--	CONSTRUCTION MANAGEMENT						
	Supervision and Administration (S&A)				2,973,000	595,000	3,568,000
31--	Subtotal: Construction Management						2,973,000
	Contingencies						595,000
31--	TOTAL: CONSTRUCTION MANAGEMENT						3,568,000
	TOTAL PROJECT COST						70,513,000

All of the structural components of this feature will require operations and maintenance to sustain engineering performance and achieve long-term project environmental goals. In general, the maintenance requirements are driven by the need to manage the freshwater introduction. Management will vary depending upon the specific flows in the Mississippi River that are variable from year to year. Typical operations and maintenance actions will include engineering inspections of the pipes and minor construction events to maintain the performance of outfall management measures. These OMRR&R actions will be the responsibility of the local sponsor. The estimated annual O&M cost is $120,000.

Table 3 provides a summary of the first costs for the reintroduction of Mississippi River water into Hope Canal and the Maurepas Swamp project.

Table 3. Summary of Costs for the LCA Plan Small Diversion at Hope Canal (June 2004 Price Level)		
Lands and Damages	$	26,383,000
Elements:		
Relocations	$	22,384,000
Channels and Canals	$	4,125,000
Diversion Structures	$	6,520,000
Monitoring	$	594,000
First Cost	$	60,006,000
Feasibility-Level Decision Document	$	3,568,000
Preconstruction Engineering, and Design (PED)	$	2,182,000
Engineering, and Design (E&D)	$	1,189,000
Supervision and Administration (S&A)	$	3,568,000
Total Cost	$	70,513,000

A detailed breakdown of cost accounts between Federal funds and the share of the local sponsor is provided in **table 4**.

Table 4. Small Diversion at Hope Canal FEDERAL AND NON-FEDERAL COST BREAKDOWN (June 2004 Price Level)			
Item	**Federal**	**Non-Federal**	**Total**
Decision Document (50%Fed-50%NFS)	$ 1,784,000	$ 1,784,000	$ 3,568,000
PED (65%Fed-35%NFS)	$ 2,182,000	$ -	$ 2,182,000
LERR&D (100% NFS)*	$ -	$ 48,767,000	$ 48,767,000
Ecosystem Restoration (65%Fed-35%NFS)	$ 10,645,000	$ (25,336,250)	$ 10,645,000
Engineering and Design (E&D) (65%Fed-35%NFS)	$ 1,189,000	$ -	$ 1,189,000
Supervision and Administration (S&A) (65%Fed-35%NFS)	$ 3,568,000	$ -	$ 3,568,000
Monitoring (65%Fed-35%NFS)	$ 594,000	$ -	$ 594,000
Total Construction	**$ 18,178,000**	**$ 23,430,750**	**$ 66,945,000**
TOTAL COST	**$ 19,962,000**	**$ 25,214,750**	**$ 70,513,000**
Cash Contribution	*$ 47,082,250*	*$ (25,336,250)*	

*For the conditionally authorized feature, Small Diversion at Hope Canal, LERR&D exceeded 35% of the total project cost by $25,336,250, which is reimbursed to the non-federal sponsor.

Implementation Plan

Initial Project Management Plan (PMP) and scoping efforts to address the appropriate level of engineering detail required for the follow-up feasibility-level decision document for the Small Diversion Hope Canal features are currently underway. The PMP is expected to be negotiated by the end of December 2004 and will form the basis for assigning tasks between the USACE and the sponsor (LDNR) as well as detail the conduct of the feasibility-level analyses. Development of the decision document is anticipated to begin in April 2005, with completion estimated in two and a half years (January 2007). Pre-construction engineering and design (PED) efforts to finalize the detailed design and prepare the project for construction would initiate once a design agreement is negotiated with LDNR to define the scope, schedule, and cost of the design. Preparations of plans and specifications for construction could commence in January 2007 and are forecast for completion in October 2008. Construction of the features could begin following PED with approval and execution of a Project Cooperation Agreement (PCA). The current schedule would allow for construction to begin as early as October 2008, with construction completion estimated for spring in the year 2013.

These accelerated schedules are important for the implementation of the LCA Plan. Experience in designing and constructing similar features in coastal Louisiana indicates that these schedules are attainable given the necessary level of coordination and funding that will be required to achieve the goals and objectives of the plan to address the critical needs facing coastal Louisiana.

National Environmental Policy Act (NEPA)

The NEPA process has been initiated as part of the ongoing CWPPRA effort on the Hope Canal project. The work conducted thus far as part of the NEPA process would be applicable to the EIS that would be prepared as part of the LCA contingent authorization process. Similarly, the engineering and environmental information developed thus far under CWPPRA would expedite development of both the EIS and the feasibility study.

atement (PEIS) for the
ecommended will proceed through feasibility study for
pproval requiring project specific review under NEPA through a Supplemental Environmental

rmy.

During the plan formulation process, the LCA PDT assessed the impacts of various storation techniques, the specific subprovince restoration frameworks, the identified final array of coast wide frameworks, the alternative plans for best meeting the study objectives, and the LCA Plan. The PEIS identified and discussed these impacts by specific and cumulative natural and human environmental effects for the alternative plan carried over for detailed analysis. The PEIS provides a consistent basis for initiating NEPA documentation of individual restoration features in the context of larger systemic coastal needs and functions.

Uncertainties/Risks

All major environmental restoration projects come with uncertainties and risks. Thorough study and review prior to project implementation is critical for minimizing such risks and uncertainties. Effective monitoring and adaptive management (included as part of the LCA Study) is key for managing unforeseen consequences and maximizing project effectiveness.

As outlined above, the Hope Canal project has already been the subject of interagency review, numerous planning processes, considerable public review, and a range of environmental and engineering analyses. This review process has helped identify and address a number of potential questions/concerns, such as whether river reintroduction could cause flooding, and what would occur if there were a hazardous substance spilled in the river near the reintroduction structure. While more information and evaluation will be needed to fully answer such questions, the information available to date indicates that such issues will either not occur or, if they could occur, are manageable and do not render the project infeasible or too risky. With respect to flooding in particular, the increased channel capacity in Hope Canal should provide greater ability to remove storm water from the existing drainage system, and the operation plan for the reintroduction project would be developed to accommodate such a use.

Recommendations/Summary

The Hope Canal project offers an excellent opportunity to capitalize on existing environmental and engineering information to provide near-term environmental benefits to an area of critical need. Accordingly, it should be included in the contingent authorization category for the LCA Study.

Sources

Lake Pontchartrain Basin Foundation, New Orleans, LA. U.S. Geological Survey Open File Report 02-206. *Environmental Atlas of the Lake Pontchartrain Basin*: http://pubs.usgs.gov/of/2002/of02-206/

U.S. Environmental Protection Agency, Region 6. June 2001. Diversion into the Maurepas Swamp: A Complex Project Under the Coastal Wetlands Planning, Protection, and Restoration Act.
www.epa.gov/region6/6wq/ecopro/em/cwppra/maurepas/a_maur_report2.pdf

Barataria Basin Barrier Shoreline Restoration, Caminada Headland, Shell Island

A Near-Term Critical Feature for the Louisiana Coastal Area Plan

Barataria Basin Barrier Shoreline Restoration, Caminada Headland, Shell Island
A Near-Term Critical Feature for the Louisiana Coastal Area Plan

Introduction

The accelerated loss of Louisiana's coastal wetlands has been ongoing since at least the early 1900s with commensurate deleterious effects on the ecosystem and possible future negative impacts to the economy of the region and the Nation (USACE 2004 – Main Report). Contributing to these deleterious effects is the collapse of the Louisiana barrier islands and gulf coast shorelines. This Louisiana coastal area restoration feature is to restore or rebuild the natural ecological function of the two coastal barrier shorelines, known as the Caminada Headland and Shell Island Reaches.

The Louisiana barrier islands and shorelines are almost entirely uninhabited but are an essential ecosystem to the Louisiana coastal area since they include wetland habitats, essential fish habitat, and have high fish and wildlife value. The Louisiana barrier islands also protect interior coastal wetlands, which also have high fish and wildlife value within the Louisiana coastal area.

The average rate of long-term (greater than 100 years) shoreline change along the Louisiana coast is a retreat of 19.9 feet per year. The average short-term (less than 30 years) rate of shoreline change is a retreat of 30.9 feet per year (USACE 2004 – Appendix D.3). Of the 505 miles of Louisiana gulf shoreline, 484 miles (96 percent) are eroding. The Barataria Basin Barrier Shoreline Restoration Project is one of three barrier island projects in the LCA Plan of the LCA. All three of these barrier island projects are important; however, the Barataria Barrier Shoreline Restoration Project is considered critical due to the greatly degraded state of this shoreline and its key role in protecting and preserving larger inland wetland areas and bays. If this fragile area were not addressed quickly, restoration would be far more difficult and costly.

The Barataria Basin Barrier Shoreline Restoration feature was selected for contingent authorization due to its criticalness to the coast and because it is capable of being accelerated for construction. This project addresses the 15.5 miles of Louisiana coast deemed to be in critical need of restoration due to the condition of the barrier headland or gulf shoreline, and due to significant broader impacts of these coastal reaches to the Louisiana coastal area, while also being achievable on an accelerated schedule. An implementation schedule alternative is included in the Main Report and specifically for this feature later in this document.

As Louisiana's barrier islands disappear and shorelines retreat, once protected inland bays experience substantially higher waves and storm surges. These water conditions resemble those of the open Gulf of Mexico and they threaten the entire inland estuarine ecosystem. In addition the barrier island and gulf shorelines provide habitats for migratory birds, wildlife, finfish, shellfish, and other aquatic organisms including threatened or endangered species (USACE 2004 – FPEIS). Restoration of the coast is thus an essential step for the long-term health of south Louisiana (USACE 2004 - Appendix D.3). The Barataria Basin Barrier Shoreline Restoration (Caminada Headland and Shell Island Reaches) project is deemed the most critical because it maintains the integrity of the gulf shoreline and protects the interior coast from further deterioration.

Aside from supporting coastal habitats, the coastal barrier chains in Louisiana are the first line of defense for protecting wetlands, inland bays, and mainland regions from the direct effects of wind, waves, and storms. The barrier systems serve multiple defensive purposes to:

- reduce coastal flooding during periods of storm surge;
- prevent direct ocean wave attack, which would accelerate rates of erosion and degradation of marshes and other wetlands; and
- help maintain gradients between saline and freshwater, thereby preserving estuarine systems.

The morphology and integrity of barrier islands along Louisiana's shoreline are directly related to the supply of sediment contributed to the coast and the physical processes operating in this region. The Louisiana coastal area is one of the most dynamic environments that exist in nature (see USACE, 2004 - Appendix D.2). Extensive science and engineering design technology and modeling can be used to overcome this challenge for the Barataria Basin Barrier Shoreline Restoration Project (USACE, 2004 – Appendix D.9 and D.5).

The Caminada Headland has suffered loss of wetland habitat and diminished function within the gulf shoreline. Ecologic restoration would sustain the rare coastal habitats and maintain the character and function of this critical headland. Headlands in Louisiana are ancient distributaries of the Mississippi River, which are prominent wetland areas of the coast containing ridges that give significant structural integrity to the coastal landscape. Headlands are integral landforms to both adjacent interior marshes and to the lateral gulf shoreline. In this case, Bayou Lafourche and its associated ridge are a defining landform for 80 miles through interior marshes of the coast terminating at the Caminada Headland. Louisiana Highway 1 was built on this ridge **(figure 1)**. At the headland, natural processes redistribute sediment along the Gulf shoreline as far away as Grand Terre Island, 20 miles distant. It is noteworthy that Port Fourchon and the only hurricane evacuation route available to the region are on this headland and would incidentally benefit from this ecologic restoration feature **(figure 2)**. Without ecologic restoration, Caminada Headland would lose most, if not all, of its function as a headland.

Shell Island, south of the port of Empire (**figure 1**), was once a single barrier island aligned along the gulf coast but it is now fragmented into several, much smaller islands displaced from the adjacent gulf shorelines. The loss of the barrier island habitat and the opening of this shoreline to the Gulf are both dramatic losses, which pose even greater potential loss to interior habitat of marsh and bays by the intrusion of the Gulf of Mexico into the coastal estuary. Ecologic restoration would rebuild two segments of the former barrier island to reestablish continuity with the adjacent gulf shorelines, which would protect the coastal estuary. Without ecologic restoration large-scale change would occur due to the encroachment of the Gulf into the coastal wetlands.

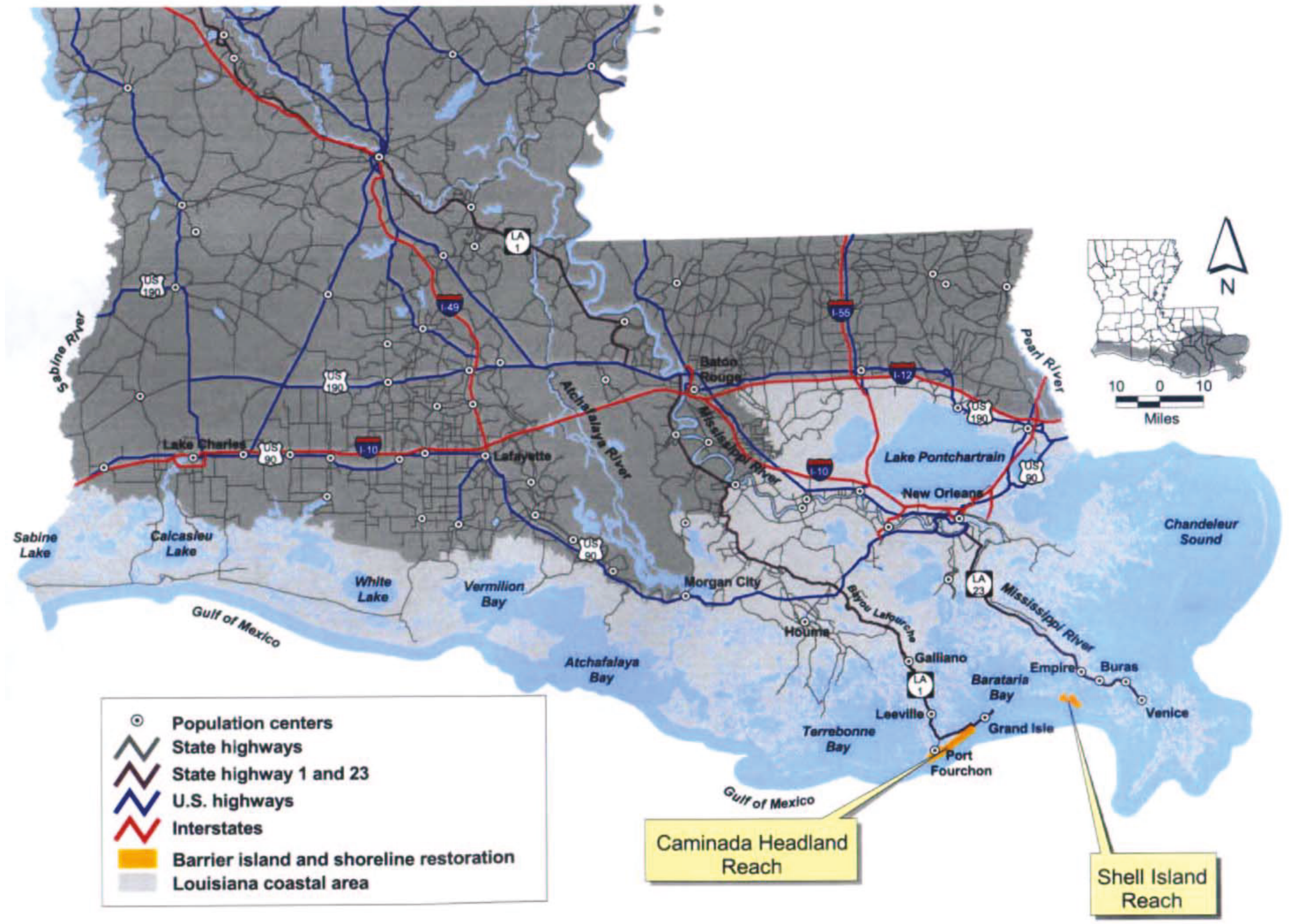


Figure 1. Map of Louisiana coast showing location of Barataria Barrier Island

Description of Area/Background

<u>Description of Area – Caminada Headland</u>

The Caminada Headland lies at the mouth of Bayou Lafourche and is defined as the area south of Highway 1 between Raccoon Pass and Caminada Pass **(figure 2)**. The beach from Belle Pass to Highway 3090 is known as Fourchon Beach. The beach at the eastern end of the island is known as Elmer's Island. This headland is unique for many reasons:

- It is the only attached erosional headland on the Louisiana coast.
- It has the highest shoreline retreat rate in the Barataria system, except for Shell Island.
- The headland has the longest uninterrupted sandy beach in the Barataria system.
- The central and eastern areas are a system of parallel abandoned beach ridges locally known as chenieres. These are covered with a rare cheniere maritime forest.

- The central portion of the headland supports the largest black mangrove "forest" in coastal Louisiana.
- Port Fourchon is located near the western portion of the headland.

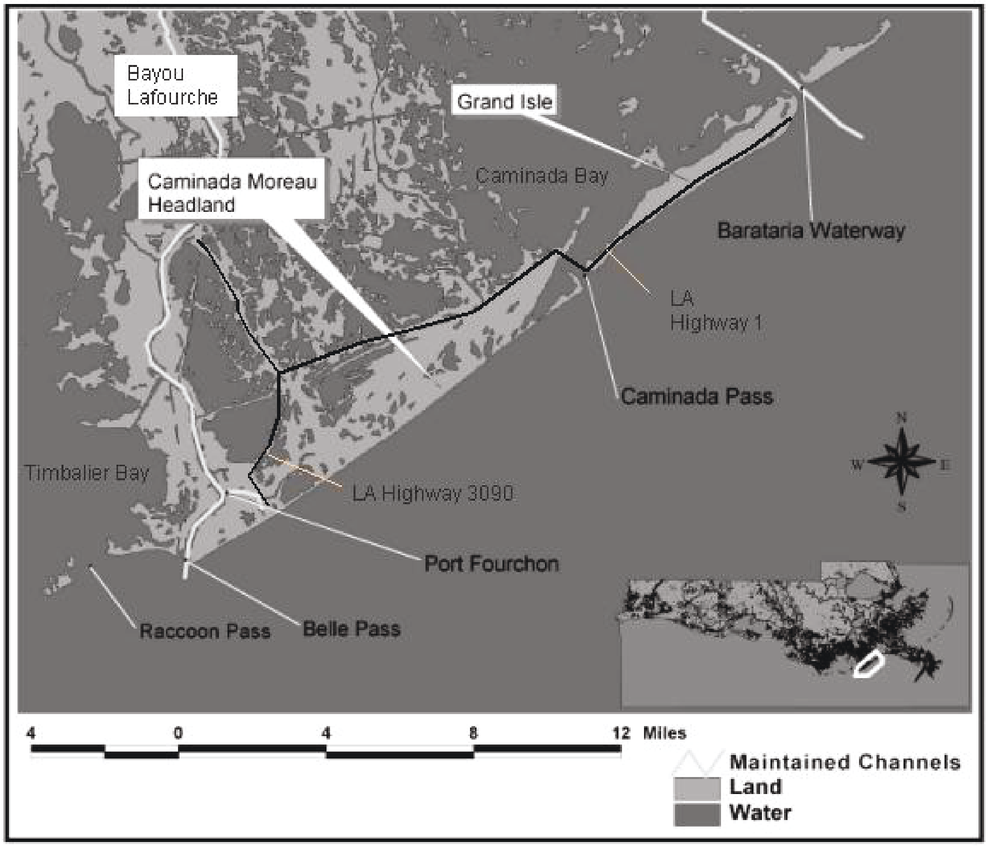


Figure 2. Map of Grand Isle and Caminada Headland with associated inlets/passes.

Physical Characteristics

The Caminada Headland formed due to the reworking and winnowing of sediments after Bayou Lafourche abandoned its delta-building phase about 800-2,500 years ago. A new delta, the Plaquemines-Belize, started forming where there was a shorter, more efficient route to the gulf. The headland is separated from East Timbalier Island to the west by Raccoon Pass and from Grand Isle to the east by Caminada Pass. Spits have formed at either end of the headland. The 13-mile long beach is quite narrow and has numerous storm overwashes. The headland has been supplying sand to East Timbalier Island and Grand Isle over the last 300 years. The area is known as a headland because it is still attached to the mainland. The next stage in this process from a delta to a headland to barrier islands to shoals is the detachment of the headland from the mainland. It then fragments into a chain of barrier islands.

Caminada Headland had a sand dune that was about 5 feet high in 1990 **(figure 3**), a beach berm with a 1 on 35 slope and a back-barrier slope of 1 on 110. The back-barrier marshes have a slope of 1 on 300 and consist of fine sediments. Back-barrier lagoons include Bay Champagne, the area behind Caminada Spit, and several irregular shaped ponds. Numerous small bayous wind through the back barrier wetlands and there are also several man-made pipeline canals. The BP Canal is parallel to the shore, only about 1,200 feet inland from the Gulf **(figure 4)**, and runs nearly the entire length of the headland. There are also 13 locally constructed offshore breakwaters partially in front of and west of Bay Champagne.

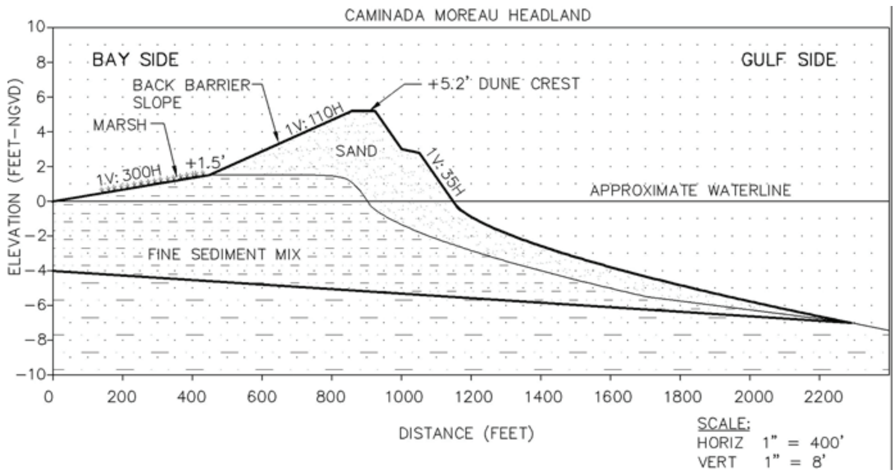


Figure 3. Diagrammatic sketch showing primary dimensional components, boundaries, sediments, and operational slopes for the Caminada Headland. Measurements originated from the cross-sections presented by Ritchie et al. (1990). The figure is vertically exaggerated 50 times for display purposes.

Bayou Lafourche, a navigable waterway with a depth of 24 feet and bottom width of 300 feet, cuts through the western portion of the headland. Rock jetties at its mouth, known as Belle Pass where the waterway is 27 feet deep, reduce the amount of maintenance dredging in the bar channel. The jetties also interrupt longshore transport to the west. Thus the eastern jetty is accreting sand and there is an erosional shadow next to the western jetty. Raccoon Spit lies immediately west of Belle Pass and historically has had some of the highest erosion rates in the state, 82 feet per year from 1887-2002, partially due to the shadow effect. However, between 1988 and 2002 the rate slowed to 21 feet per year. This was because the USACE beneficially used the material dredged from Belle Pass and its bar and placed it near Raccoon Spit to help compensate for the erosional shadow.

Figure 4. The Caminada Headland Reach illustrating a small sand beach, interior lagoons and BP Canal.

Shoreline retreat is very severe on the Caminada Headland. As can be seen in 2001 aerial photography, there were numerous washovers, especially in front of Bay Champagne in the erosional shadow of the breakwaters **(figure 5)**. There are numerous overwash areas east of what remains of Bayou Moreau near Bayou Thunder von Tronc **(figure 4)**. Most of the erosion and sand transport takes place during frontal passages and tropical storms or hurricanes. During these storms, sand is moved offshore and stored on the shoreface. Between storm events, some of the sand may be transported onshore in the form of nearshore bars. However, in general there has been a net export of material from the headland. Relative subsidence rates have been measured and the rate on the headland is approximately 3 feet per century, one of the highest in the Barataria barrier system.

Longshore transport along the Caminada Headland Reach is predominantly to the east. There is a nodal point approximately two miles east of the Belle Pass entrance. This area has had the highest retreat rates and has been the focus of numerous attempts at limiting the retreat because of valuable infrastructure behind the shore. These attempts essentially hardened the shoreline. The first was the use of soil-cement filled bags (geotubes) on the shoreline. These were locally referred to as “boudin bags.” They were placed along 5,000 feet of shoreline in 1985-1986 after Hurricane Juan severely eroded the shoreline and opened Pass Fourchon to the Gulf. About 1,800 feet were protected with armor matting to prevent undermining of the bags.

This effort did not stop the sand in front of the boudin bags from being eroded. Hurricane Andrew destroyed the unprotected bags and caused damage to the 1,800 feet of protected bags, moving many back into the marsh.

The next attempt at controlling erosion was by private oil companies who built an offshore breakwater by sinking 13 old barges in 6 to 8 feet of water and filling them with stones **(figure 5)**. Beach erosion has stopped locally and sand has accreted in the lee of the four western barges. The remaining nine appear to have had no positive effect on the beach. However, there is an erosional shadow to the east of the barges where the beach has thinned and several overwash fans can be seen, including some on the beach in front of Bay Champagne. There were multiple breaches in the overwash shadow during the 2002-2003-hurricane season, In addition, the offshore side of the barges has suffered toe scour up to 2 to 4 feet and the barges are in danger of settling. If the scour continues in front of the barges, as it probably will, these barge breakwaters may fail, perhaps in the next storm. This could present a navigation hazard for small boats and the barges would be less effective at retarding erosion.

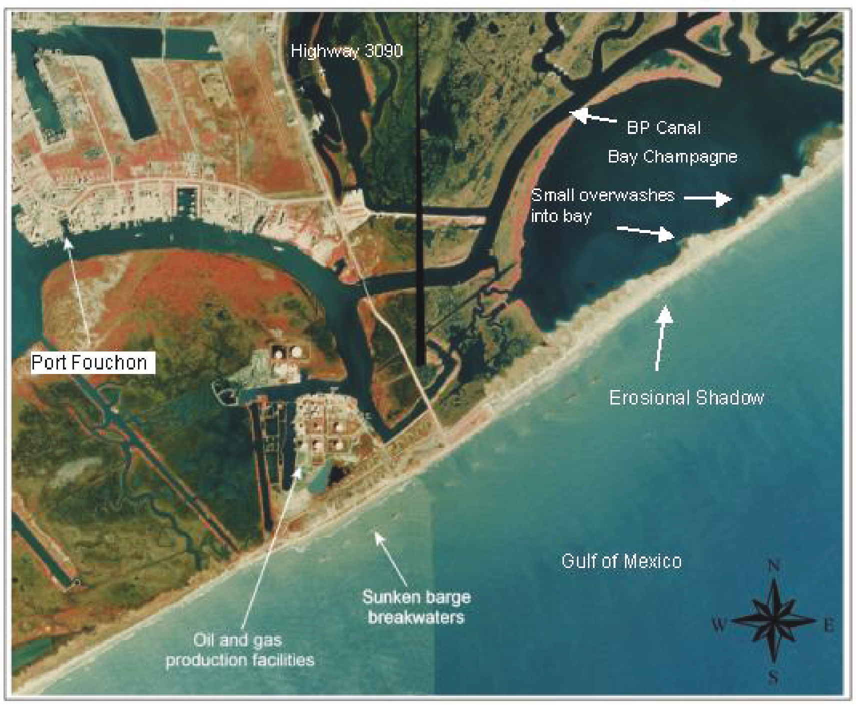


Figure 5. The coast at the northwestern segment of the Caminada Headland showing sunken barge breakwaters (center), a small downdrift erosional feature with small overwashes (top right), and the presence of industrial infrastructure and the Port Fourchon (center and top left) oil and gas production facilities.

Biological Characteristics

The 13-mile-long beach is valuable habitat for several species of shorebirds. Numerous recreationally and commercially valuable fish and shellfish such as spotted seatrout, Florida pompano and blue crabs inhabit the surf zone. Gulls, terns, pelicans and skimmers fish in the area (as well as recreational fishers). The low dunes are generally well vegetated around the base with grasses and herbs. Behind the dunes lies a unique area of parallel cheniere ridges interspersed with saline marsh, linear ponds and small lagoons. The tops of the ridges are covered with a rare cheniere maritime forest consisting of live oaks and hackberries. This community functions as an important habitat for small mammals and hawks. The trees are a vital resting area for trans-gulf migrating birds. Numerous species of birds use these cheniere forests as a stopover point to rest and refuel on their migration north and as their last stop before returning south in the fall. Both dabbling and diving ducks use waterbodies on and near the headland.

At the edges of these chenieres and north of Fourchon Beach, there are coastal mangrove thickets dominated by black mangroves. The extensive root system of this shrub helps stabilize the pond shoreline, the cover and food they provide creates an excellent nursery area for fish and shellfish, and they are heavily utilized by birds as nesting, resting or foraging areas. Some of the higher portions of the headland are covered with patches of rare coastal dune shrub thicket. This area has fairly dense stands of wax myrtle, marsh elder, groundsel bush and tooth-ache tree and is heavily used by birds and mammals. The saline marshes on the headland provide nursery grounds for many recreationally and commercially important fish and shellfish and foraging for wading birds and shorebirds. The linear ponds are rich in submerged aquatic plants. The Barataria Basin is one of the most biologically productive areas in the nation.

Several threatened and endangered species utilize the headland and adjacent waters. The threatened piping plover winters on the intertidal beach, which is designated as critical wintering habitat. The endangered brown pelican forages in the Gulf and lagoons and rests on the headland. The endangered Kemp's Ridley sea turtle forages in the nearshore area or in bays behind the headland. The threatened Gulf sturgeon potentially winters in the passes near and on the headland.

In summary, the Caminada Headland is one of the most biologically diverse areas along the Louisiana coast, due to the unusual juxtaposition of archetypal cheniere ridge habitat combined with classic high-productivity salt marsh of the Mississippi Delta Plain.

Social Characteristics

The most important infrastructure is Port Fourchon, a bustling multipurpose port, home to 125 companies, just northwest of the breakwaters and about a mile inland from the gulf **(figure 5).** The port provides land-based support for about 75 percent of the deepwater oil and gas activity in the gulf. LOOP has its land-based facilities at the port. The pipelines come ashore from the offshore docking area and booster pumps send the oil further north to a salt-dome storage area east of Galliano. The port is also a hub of the growing charter fishing industry.

There is a heliport at the port with accommodation for several helicopters. Free public facilities include a dock for commercial fishermen, a public boat launch with restroom facilities and an oilfield service dock for boats not under contract.

There are oil and gas producing facilities immediately behind the beach and south of Port Fourchon. The Port Fourchon Laboratory is a state-owned facility under the auspices of the Louisiana Universities Marine Consortium. It is available to all state universities and public and private schools. There are numerous private camps north and east of Bay Champagne.

Louisiana Highway 1 is the only land access onto the Caminada Headland. It runs south along Bayou Lafourche and then turns eastward toward Grand Isle at the point where the headland joins the mainland. At that same point, Louisiana Highway 3090 extends southwestward from Highway 1 to Port Fourchon, providing the only land access to the port. Highway 1 averages 10,000 vehicles per day, 1,000 of which are cargo trucks carrying supplies for oil and gas platforms in the Gulf of Mexico. Highway 1 is the only hurricane evacuation route for the town of Grand Isle, Port Fourchon and Leeville. Due to a near continuous development of interesting and historic fishing communities along Highway 1, the highway has been designated as the Lafourche/Terrebonne Scenic Byway by the state. With a population of 1,541 (2000 census data), Grand Isle is the only developed barrier island in Louisiana and supports the oil and gas industry, a residential community, tourism, the International Grand Isle Tarpon Rodeo, and a state park.

The state-leased, 21,600-acre Wisner Wildlife Management Area lies immediately north and partially on the Caminada Headland and is protected from the Gulf of Mexico by the eastern end of the headland. This wildlife management area is under conservation management while also providing public access to hunting for rabbit and waterfowl; and to fishing for species such as speckled trout, redfish, flounder, shrimp and crab.

Fourchon Beach is a public beach on the western end of the headland with vehicle access to the beach and camping. Surf fishing and crabbing are popular. For many years Elmer’s Island, at the east end of the Caminada Headland, was a heavily used private beach. Elmer’s Island was open to the public for a small daily fee. After the death of the owner a few years ago, the property was put up for sale. There is significant public pressure for the state to purchase some or all of Elmer’s Island for conservation and public recreational use.

Project Area Background - Shell Island Reach

Shell Island is part of the Plaquemines barrier shoreline, which is approximately 30 miles long, and extends from Sandy Point to West Grand Terre Island **(figure 6).** This section of the coast is located approximately 25 miles west of the modern Mississippi River delta and approximately 50 miles south-southeast of New Orleans.

The Plaquemines barrier shoreline has a complicated geological framework because it is associated with different phases of deltaic evolution during the Holocene. Ritchie et al. (1990) indicate that the western margins of the islands lie within the old Lafourche delta lobe, which was active until about 300 years before present (YBP). The central area lies within the St. Bernard delta complex, which was active from 1600 to 1800 YBP. The central and eastern coastal segments (which contains the Shell Island Reach) are associated with the Plaquemines delta lobe, abandoned about two centuries ago.

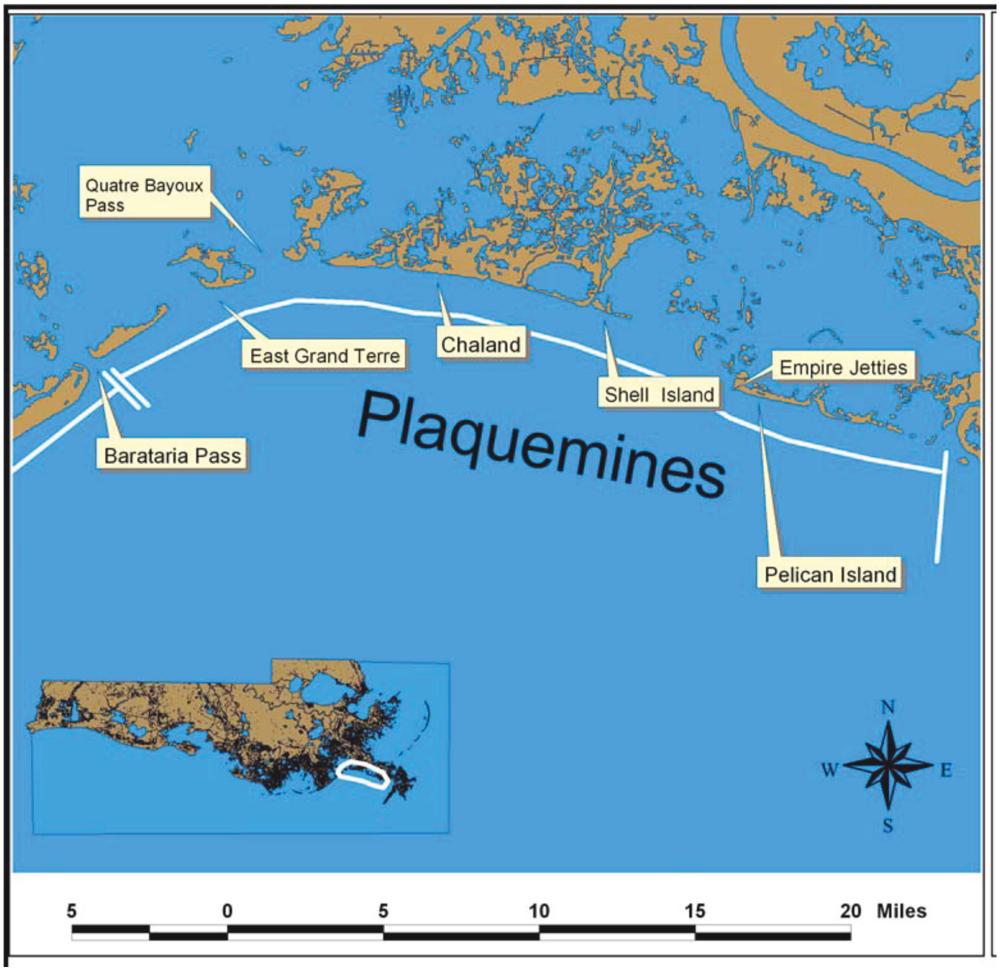


Figure 6. Map of the Plaquemines shoreline.

The Shell Island Reach stretches approximately 2.5 miles, from Fontanelle Pass to Grand Bayou Pass. Bayou Fontanelle and its Pass is the largest headland in the eastern portion of the Barataria Basin. In 1884, Shell Island formed a barrier island that appeared semi-permanently attached to Bayou Fontanelle. Longshore sediment transport appeared to be northwest toward Grand Bayou Pass. In 1884 Shell Island (also known as Launax Island) enclosed and protected Shell Island Bay. Immediately to the west of the 1884 Launax Island was a smaller barrier island only 1.2 miles in length that enclosed Bastian Bay and was attached to Grand Bayou Pass **(figure 7)**. The Shell Island Reach is currently highly fragmented into small, shallow shoals and islands, which represent only a fraction of the once continuous shoreline. The remaining shoals and islands have migrated northward into Shell Island Bay.

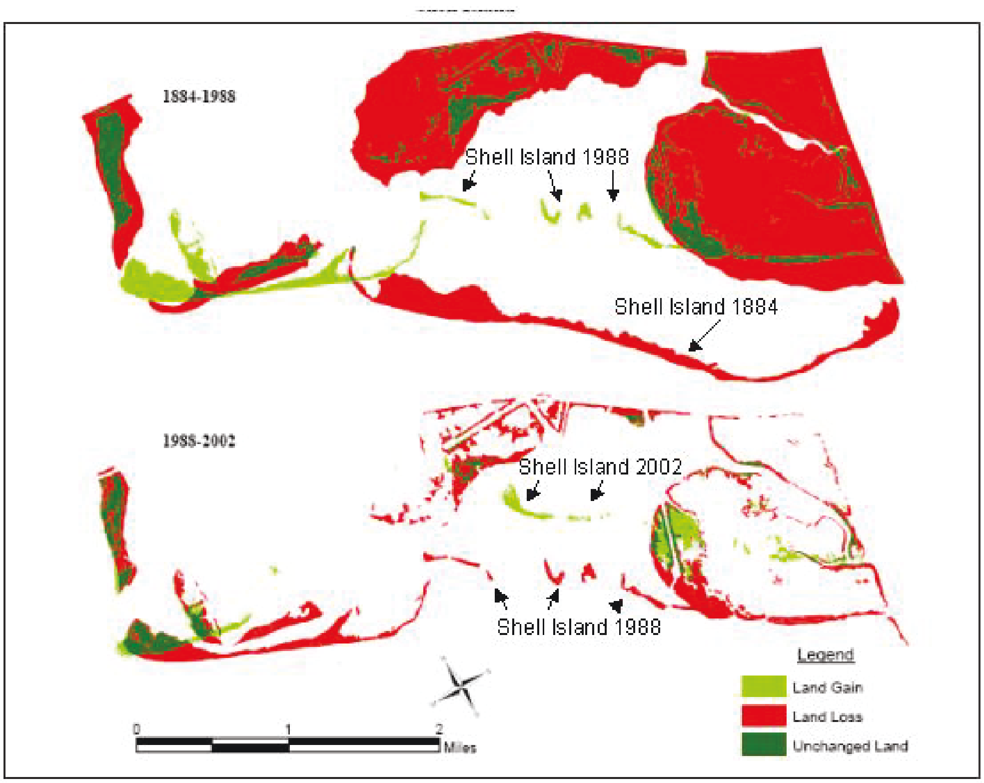


Figure 7. Map illustrating the erosional history of Shell Island 1884 to 1998 and 1988 to 2002. Note the dramatic breakup and shift of Shell Island inland.

Problems and Needs

General Problems

The natural processes of subsidence and erosion have combined with human-caused effects leading to significant shoreline retreat on barrier islands and headlands. Construction of levees along the Mississippi River to prevent flooding has effectively stopped the nourishment of the wetlands with nutrients and sediments. Confinement of the Mississippi has also caused the bedload to be deposited in progressively deeper waters of the Gulf of Mexico. In addition the sediment load of the river has declined by over 50% due to flood control works and bank stabilization upstream. The latter two factors have prevented the Mississippi River sediments from nourishing the downdrift barrier islands and headlands.

Specific Problems on Caminada Headland (Future Without-Project)

The Caminada Headland has some of the highest shoreline erosion rates in Louisiana. Bay Marchand, a small historic bay adjacent to Belle Pass, is now part of the Gulf of Mexico due to shoreline retreat. A similar fate is occurring to nearby Bay Champagne **(figure 8)**. Over the last 100 years erosion has averaged about 45 feet per year. From the 1970s to 1988 it also averaged about 45 feet per year. Then, from 1989 to 2002, the rate was only 9 feet per year. However, in 2003, Tropical Storm Bill eroded the beaches back as far as 60 to 80 feet. Since Louisiana is impacted by tropical storms and hurricanes once every 1.2 years, it is likely that the 40+ feet per year erosion would continue. Thus, for this report, the 45 feet per year rate from the 1970s to 1988 would be used.

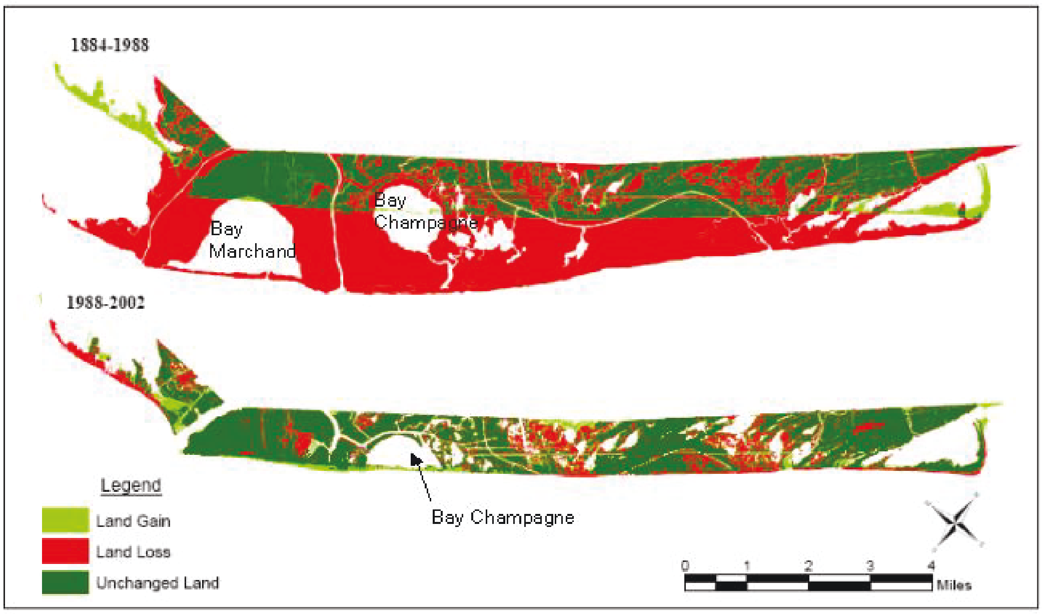
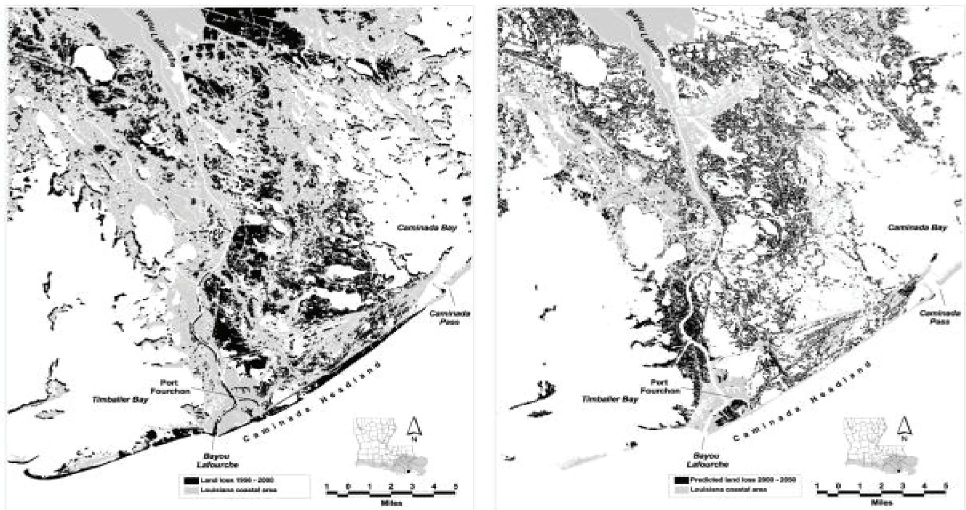


Figure 8. Map of the Caminada Headland illustrating historic land losses from 1884 to 1988 and 1988 to 2002. Note complete loss of Bay Marchand by 1988 and the continued loss of Bay Champagne by shoreline erosion.

An important factor in the retreat of the Caminada Headland is the existence of the BP canal **(figure 4)**. This canal is approximately 1,200 feet from the shoreline. If no action is taken and shoreline erosion continues, the beach would reach this canal. When this happens the sand of the shoreline would fall into the canal as happened at Shell Island. At this point, the barrier shoreline ceases to function as a barrier and recession rates would increase dramatically. Using the average shoreline recession of 45 feet per year, this could occur in about 27 years (or far sooner if a near-miss or direct hit from a hurricane occurs). When the shoreline reached the canal at Shell Island, the recession rate jumped seven-fold from 20 feet per year to 138 feet per year. It is unlikely that such a dramatic increase would occur at Caminada Headland since there is much less open water behind the BP canal than there was at Shell Island. However, in 30 years there will be much more open water than there is now. It is probable that the increase would be about half of what was seen at Shell Island. This means that the rate would jump to 132 feet per year and thus, in 50 years, the shoreline could well be 4,200 feet inland from where it is now, just assuming a linear erosion rate.

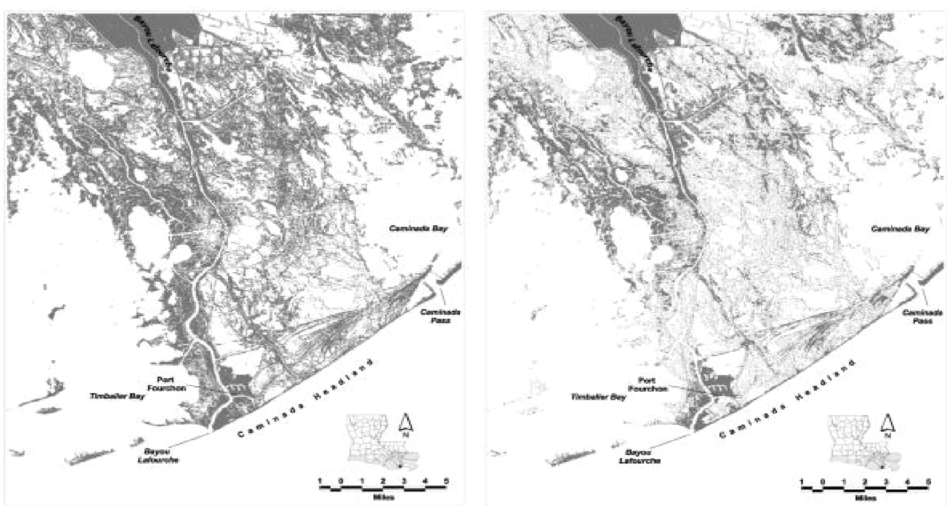
There is an erosional shadow to the east of the 13 barges where the beach has thinned and several overwash fans can be seen, some on the beach in front of Bay Champagne. There were multiple breaches in the overwash shadow during the 2002-2003 hurricane season. It is likely that within the next 5 to 10 years this erosional shadow could cause a significant breach in the beach in front of Bay Champagne. The northeastern shore of this bay is very fragile due to numerous intersecting canals. It is highly probable that the headland could fragment somewhere over a nearly two-mile area from the western shore of Bay Champagne to the remnant Bayou Moreau ridge and back to or past Highway 3090. This breach would change the western portion of the headland into Fourchon "Island". Much of the rare mangrove and the coastal dune shrub thickets would be destroyed, increasing stress on birds, mammals and fish that rely on these areas for food, nesting and resting. It is this scenario that makes the Caminada Headland a candidate for a near-term project.

Additional evidence indicates that with no intervention, the Caminada Headland will not remain as it is now (**figure 9)**. This figure is from an interagency land loss model led by USGS and prepared for the LCA Study. Map A depicts the past loss from 1956 to 2000 and Map B depicts the predicted loss between 2000 and 2050. During that time period, 3,750 acres are predicted to be lost from the headland and 14,780 acres from an area between Bayou Lafourche and Caminada Bay and about 12 miles north of the headland.



A. B.

Figure 9. Caminada Headland region showing land loss (USGS 2004).



A. B.

Figure 10. Caminada Headland region showing remaining land (USGS 2004).

Figure 9 illustrates the land distribution in 2000. **Figure 10** illustrates the predicted remaining lands by considering the projected losses from 2000 to 2050. It shows only a skeleton framework of wetlands remaining in 2050. The model does not project the loss of the gulf shoreline, but in actuality it would likely be far north of where it is shown in **figure 10**. The area around Port Fourchon would be further isolated from the remaining mainland, and could become a detached small barrier island.

Most of the land depicted in 2000 in **figures 9 and 10** is predicted to convert to open water due to subsidence, sea level rise, and erosion. These areas of open water would increase the tidal prism through the existing passes, especially Raccoon, and any new breaches. This would enlarge the cross sectional area of these passes. It is highly possible that sometime within the next 5 to 20 years the shoreline would breach near Bayou Thunder von Tronc. As this breach widens and continues northward, Elmer’s Island would truly become an island.

The central portion of what is now a headland would probably become a barrier island well before 2050. The loss of the cheniere ridges due to subsidence, erosion, and the influence of salt spray would be devastating to neotropical migrants. The oaks would join the other “ghost” oak forests in the coastal zone. Forested areas and scrub shrub are disappearing rapidly from the Barataria Basin and these areas are vital as resting and refueling areas for both north and south migrations. This loss could further impact these migratory birds who also are being stressed by loss of wintering habitat in the south and nesting habitat in the United States.

There would still be a surf zone but the protected saline ponds and lagoons, which are now heavily used by fish and shellfish, would be much smaller (Bay Champagne and Elmer’s Lagoon would be gone). In addition, there would be about 24,000 fewer acres of marsh in the Barataria Basin every 10 years. At some point the present-day prolific estuarine-dependent fishery could collapse as the marsh that fuels it disappears. The exact timing of this devastating event is unknown, but it could occur during the next 10 to 30 years. When the fishery crashes, the brown pelican, Kemp’s Ridley sea turtle and the Gulf sturgeon would all be adversely affected. As the barrier islands and headlands are lost, there would be less critical wintering habitat for the piping plover and this could eventually impact the national population.

The loss of the only chenieres in the Deltaic Plain, the largest black mangrove thickets in the state, and the coastal dune shrub thickets would dramatically decrease habitat diversity in this basin. This would have the snowballing effect of reducing numbers and diversity of the birds and mammals that presently utilize these areas.

If no action is taken to prevent this retreat of the western end of the Caminada Headland and the formation of Fourchon “Island”, the many critical infrastructure facilities could be seriously threatened in the near future (the next 5 to 20 years). Maintaining the headland shoreline would help avoid future damage to Port Fourchon, the largest oil and gas base in coastal Louisiana, the largest coastal fishing port, major oil and gas infrastructure, two hurricane evacuation routes, and the LOOP onshore terminal.

With the severe ecological problems delineated above, the overriding need is to preserve the Caminada headland and prevent the devastating habitat losses. It is more cost effective to protect this last erosional headland before it becomes barrier islands. Pumping sand and marsh fill onto an existing framework of dunes, remnant ridges, marshes and shallow ponds is far more efficient than pumping material into a more fragmented and deeper area. Delaying the project would allow further deterioration of this foundation, which would result in higher costs and could preclude some restoration element.

The LCA Plan has three critical needs. The first is to prevent future land loss where it is predicted to occur. Preserving this headland certainly meets this need since it is highly likely to continue the transgressive process and fragment into three islands in the next 5 to 50 years. If the headland is preserved, it is possible that 10 percent of the predicted loss in the marshes to the north could be prevented. The second LCA Critical Need is to preserve endangered, critical geomorphic structure. This headland is highly endangered since it is in the process of becoming barrier islands, a process which would destroy its biological diversity. It is critical to the stabilization of the western terminus of the Barataria Basin. As a headland, it preserves lower salinities in the lakes and bays to its north. It also provides protection to interior marsh to its north. The third LCA critical need is to protect vital local, regional and national infrastructure. This critical need is not an ecological benefit and thus cannot be used to justify this project. However, it is a definite incidental benefit of headland restoration. Since Port Fourchon supports such a large portion of the Nation's energy supply from the Gulf of Mexico, the loss of the port would have significant consequences to the parish, state, and Nation. The headland also protects Highways 1 and 3090, the hurricane evacuation routes for residents of southern Lafourche Parish, the community of Grand Isle and 6,000 offshore workers.

Problems and Needs - Shell Island Reach

The long-term erosion rate for this reach is -38.5 feet per year with a range of –8.0 to –101.5 feet per year. **Figure 7** depicts the long-term erosional history of the Shell Island area. Historically, Launax or Shell Island migrated onshore and merged with the small barrier island at Grand Bayou Pass. By 1956, Bayou Fontanelle had been jettied and Launax Island or Shell Island migrated onshore and attached to the new Empire jetties. An erosional shadow extended from the western Empire Pass jetty. The erosional shadow began affecting Shell Island because western longshore transport along the Plaquemines shoreline was disrupted. The erosion rates along Shell Island accelerated from –8feet per year to –79.5 feet per year. Shell Island narrowed rapidly and Hurricane Bob, in 1979, breached Shell Island forming Coupe Bob. The shoreline erosion rates accelerated further to –101.5 feet per year, exposing Shell Island Bay to marine processes. This pattern of barrier island degradation continued with the enlargement of Coupe Bob and by 2003 Bastion Bay was also exposed to the forces of the open Gulf.

The Shell Island Reach is important in terms of its location in the Plaquemines shoreline. The Bayou Fontanelle Headland/Shell Island system establishes the geologic framework for the orientation of the downdrift barrier shorelines of Bay Joe Wise, Chaland Island, and Cheniere Ronquille. For the management of the Plaquemines barrier shoreline it is important to understand that the longshore sediment transport is towards the northwest along this shoreline. In its present state, the Shell Island Reach represents a gap in the already minimal barrier system. This gap prevents the natural movement of sediment alongshore, resulting in a reduction of sediment to the 10 miles of barrier shoreline to the northwest. Without this downdrift nourishment, the sustainability of the barrier island system is reduced.

The restoration and maintenance of the Shell Island Reach is critically important now. Restoration of Shell Island would reestablish a linkage between island segments of the Plaquemines horeline. Historic longshore sediment transport patterns would be restored and downdrift barrier islands would benefit. The Shell Island Reach also separates the open Gulf from the back-barrier estuarine environments, helping to maintain the salinity gradients important to estuarine species. Loss of the Shell Island Reach has contributed to changes in the hydrologic patterns, allowing more saline waters to enter the estuary. In habitats with restricted variation in conditions, such as those with extreme salinity, species diversity is reduced. Since the source of salinity in coastal Louisiana is the Gulf of Mexico, salinity levels exist along a gradient, which declines as the saltwater moves inland. A zonation of plant species that differ in salinity tolerance exists along that gradient, with the species diversity of those zones increasing from salt to fresh environments (Chabreck 1972b). Numerous studies have shown that elevated salinity can negatively affect all wetland species (Chabreck and Linscombe 1982; McKee and Mendelssohn 1989). These changes in salinity gradient have reduced the productivity of this ecosystem and negatively impacted the wildlife species that depend on this habitat.

Shell Island Bay and Bastion Bay are some of the most productive oyster habitat and have traditionally supported important fisheries. The oyster fishery was lost when Shell Island was washed away by a combination of the disruptive updrift Empire Pass jetties, Hurricane Bob in 1979, and subsequent storms in the following years. Restoration of the Shell Island Reach would help bring back these important fisheries.

The Shell Island Reach is a critical storm and hurricane protection buffer that acts to reduce wave energy and tidal surge in the area north of the reach. It reduces the loss rate of the interior wetlands. The tropical storms and hurricanes in 2002 and 2003 demonstrated the importance of restoring the Shell Island Reach. These storms validated the concept that historic storms of the same strength were having a greater and greater impact as the barrier islands and back barrier marshes erode away.

Restoration of the Shell Island Reach would address two critical needs immediately. It would 1) prevent future land loss where it is predicted to occur and 2) restore geomorphic structure. A third critical need is to protect vital infrastructure. This critical need is not an ecological benefit and thus cannot be used to justify this project. However, it is a definite incidental benefit of Shell Island restoration.

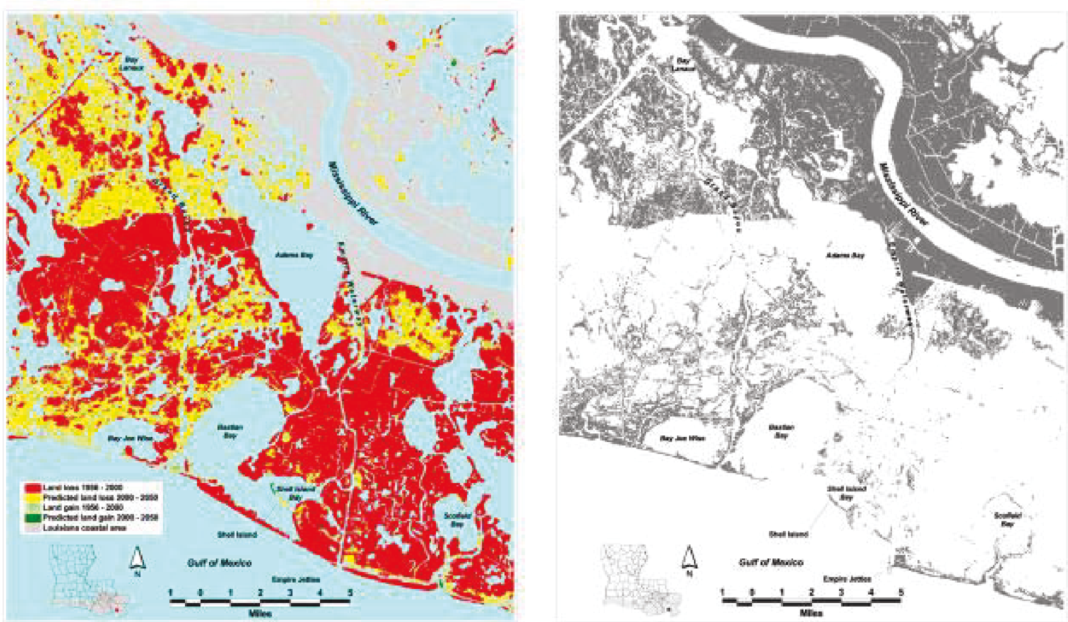
Without Project Conditions

Caminada Headland

Without human intervention this headland could fragment within the next 5-20 years and transgress to a detached chain of three or more barrier islands. It would be much like the condition we now find at Shell Island with equal or greater ecological consequences. Some of the last remaining stopover areas for neotropical migrants would be gone as the maritime forests on the chenieres are lost. This would increase stress on these small birds that are already highly stressed in their wintering and nesting areas. Salinities would increase in lakes and bays to the north. Some critical wintering habitat for the threatened piping plover would be lost. As the headland fragments into islands, it would provide less protection to marshes to the north.

Shell Island Reach

Delay in the Shell Islands Reach jeopardizes the remaining framework of the barrier shoreline and interior bays north of the Shell Islands Reach. Shell Island Bay north of Shell Islands Reach is nearly open into the adjacent Bastian Bay **(figure 11).** A single hurricane event may trigger the collapse of the interior bay system and is a compelling reason that this project should be accelerated and that contingent authorization is warranted. A direct hurricane or tropical storm impact can be expected in less than seven years. Complete opening of the bays would nearly double open water and fetch within these bays, decreasing their ecologic value. North of Bastian Bay, only a few marsh islands and small ridges separate it from the much larger Adams Bay. Coalescence of the three bays would continue and accelerate without this project. Without the project, a large sound would develop between Empire and the Gulf of Mexico. This sound would have a profound impact on the entire region. Ecologic changes would occur and storm surges would increase requiring greater levels of flood and wave erosion protection. As this coastal reach progressively collapses northward and allows intrusion of the Gulf of Mexico, restoration would become progressively more expensive and difficult to implement.



A. B.

Figure 11. Shell Island Reach Land Loss (USGS 2004)

Figure 11 illustrates extreme land loss in this area and the 1,770 acres of land that are projected to be lost in the next 50 years north of the Shell Island Reach. This area is bounded by the north shore of Adams Bay on the north, the Shell Island Reach on the south, Grand Bayou on the west, and the Empire Waterway on the east. This area is approximately 22,000 acres in size. The window of time available is uncertain since the next direct strike of a hurricane cannot be predicted, but if barrier island restoration bypasses the window, the post-storm restoration would be for an entire bays system rather than a few miles of barrier island. That is the risk of missing this window and the risk of not having contingent authorization.

Synergy with Other Restoration Projects - Caminada Headland

Restoration of the Caminada Headland would function synergistically with the Modification of the Davis Pond diversion project for marsh creation and with the Small Bayou Lafourche Reintroduction. The headland would provide some protection to the marshes that these projects preserved. The restoration of the Caminada Headland would also function synergistically with the proposed Third Delta Study, which would build a delta over time in Little Lake to the north. If the headland were preserved, it would provide protection to the developing delta from tides and saline waters. In turn, the nutrient-rich river water would nourish the marshes on the headland. If the headland is not preserved and becomes breached as described above, it could not serve these synergistic functions.

The Caminada Headland would also provide some protection to any deltas that would develop if the management of the Birdsfoot Delta would create marsh to the west.

Synergy with Other Restoration Projects - Shell Island Reach

The restoration of the Shell Island Reach is a necessary element for any future barrier shoreline restoration strategies aimed at restoring the ecosystem functions of coastal barriers. It would function synergistically with the Medium Diversion at Myrtle Grove with Dedicated Dredging. The restoration of the shoreline gap at Shell Island would help preserve the marsh created and preserved by the Myrtle Grove project. The Shell Island Reach would also provide some protection to deltas that develop if management of the Birdsfoot Delta leads to creation of marsh to the west.

Alternatives Investigation

Caminada Headland

Three alternatives were considered for this headland. Alternative 1 was construction of a dune only, approximately 1,000 feet wide. Alternative 2 consisted of construction of a 1,000-foot wide dune and creation of 177 acres of marsh in a few areas behind the dune. Alternative 3 was building the same dune, but creating a 385-acre strip of marsh between the dune and the BP Canal so nearly the whole length was filled. In addition all the remaining 1,200 acres of marsh in this area would be nourished. **Table 1** indicates the benefits of the three alternatives for the Caminada Headland:

Table 1. Benefits of Caminada Headland Alternatives

Alternative	AAHU	Acres
1	535	2,052
2	621	2,229
3	732	2,437

Monitoring of existing barrier shoreline projects by the SST indicates that a wide marsh platform on a barrier shoreline helps significantly to preserve the shoreline. Thus alternative 3 was chosen which provides the maximum amount of marsh for the dune to roll back on. The cost per marsh acre is essentially the same for alternatives 2 and 3, so alternative 3 was chosen since it would provide greater longevity for the whole headland.

Shell Island Reach

The Louisiana Gulf shoreline and its barrier islands are continuously modified by fair weather wave and wind conditions, but hurricanes and tropical storms generate the most dramatic and less predictable modifications (See Uncertainties and Risk). Alternatives were considered to reduce the impact of storm events. Three basic alternatives were considered at the start of the 2002 Barrier Shoreline Study. The first was to modify the Empire Waterway jetties to avoid the downdrift shadow. This alternative was discarded because it would take several years to begin to restore the Shell Island area and maintenance dredging costs could increase. The second alternative was creation of about 12 miles of artificial ridges or reefs, ranged in parallel rows. This was not chosen because it provided no terrestrial habitat and would not significantly reduce wave height in the interior bays. The third and selected alternative was restoration of Shell Island. This plan was selected because it would create dune and marsh habitat for wildlife and fisheries, would reduce wave height in the interior bays that would help prevent the coalescence of these bays and protect interior marsh.

Hurricanes can be expected to impact the Louisiana coast once every 1.2 years. From 1901 to 1996, seven tropical storms and eight hurricanes directly impacted this region of the coast (Stone et al. 1997), which equates to an event once every 6.4 years. This breach of the coast is expected to be impacted by multiple events by 2050. Each storm poses the risk of breaching through existing islands whether they are in their natural state or have undergone restoration. Breaches through the islands may close by natural process so the island is able to “heal” itself. However some breaches become permanent and ultimately segment the island. This process leads to decline of the entire gulf shoreline as separation between islands grows. Segmented islands may eventually shrink and ultimately be lost as they become submarine shoals. Island breaching therefore is, in general, deleterious to the gulf shoreline and prevention of breaching is a primary design consideration for barrier island restoration.

The historical nature of island breaches west of the Mississippi River was investigated and it was determined that a primary control on the occurrence and location of historical island breaches was island width. **Figure 12** is a graph of barrier length (dimension measures parallel to the coast) and the island width (dimension measured perpendicular to the coast). Both the average width and the local width of the island at a particular breach are plotted (y-axis) against the island length (x-axis). It is apparent that when Louisiana barrier islands breach, it is consistently at locally narrow widths of the island. **Figure 12** demonstrates this relationship as seen in the distinct populations of local island widths and the average island widths. The appropriate (stable) island form implied by the history of Louisiana barrier islands is that island widths less than 4.5 percent of the island length have a much greater probability of breaching. As a design consideration island widths should exceed 4.5% of the island length to avoid breaching. After restoration, sediment may be lost and the island width would decrease. So construction in excess of 4.5 percent should, in general, extend the life of the island without breaching.

For the Shell Island east restoration feature, four alternatives were developed that utilized various widths and geotube configurations that best complemented the existing configuration of land. Alternative 1 had a dune/berm width of 1,000 feet and a triangular marsh with both the gulf and bay sides contained by large geotubes, approximately 300 feet apart. Alternative 2 differed only in that it was contained with small geotubes on the bay side. Alternative 3 was characterized by large geotubes on the Gulf and a temporary earthen fill dike on the bay side. Alternative 4 had a wider dune and berm of 1,150 feet and the Gulf side contained by two large geotubes that would be removed after construction.**Table 2** indicates the benefits of the Shell Island (east) Alternatives.

Table 2. Benefit Estimates

Alternative	AAHU	Acres
1	122	71
2	147	62
3	230	55
4	207	55

Alternative 3 was selected since it would ultimately have the greatest efficiency to contain placement material with lower cost than a second geotube and provide the most benefits. The width of this configuration, including marsh creation, is 1,100 feet to 2,000 feet with a length of 18,500 feet. The width ranges from 5.9 percent to 10.8 percent of the length and exceeds the 4.5 percent threshold. This reach would not have the full effect of the gulf since it is positioned within the embayment at Shell Island Reach. This overall configuration was selected due to the favorable dimensions of the footprint and because of its position within the embayment at Shell Island Reach.

For Shell Island (west) the restoration template was dictated by the remaining island configuration. A single alternative configuration was considered. This includes shoreline and dune restoration to 1,000-foot width. Including marsh creation the width is 1,100 to 2,400 feet with a length of 7,000 feet. This smaller reach would have a width 15.7% to 34.2 percent of its length. This alternative exceeds the 4.5 percent threshold. Since this island would have the full effect of the gulf and also has an open bay behind it, the additional width ratio is warranted.

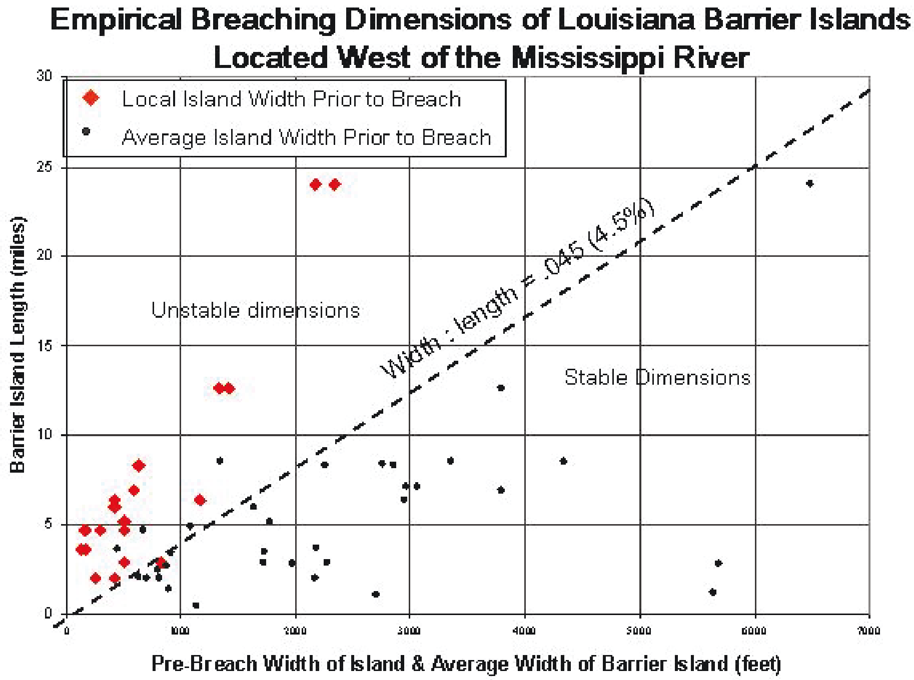


Figure 12. Graph of historical dimensions of barrier islands along the Louisiana coast west of the Mississippi River. Diamonds indicate the local island width prior to a breach. Circles indicate the average island width prior to a breach. The distinct data populations suggests barrier island widths greater than 4.5% of the length are less likely to breach. This relationship was considered in the design template for the Shell Island Restoration.

Recommended Plan

<u>Caminada Headland</u>

The selected plan at Caminada Headland would consist of dredging and placing 9 to 10 million cubic yards of sand along 13 miles of shoreline to create a dune approximately 6 feet high and a shoreward berm that is about 1,000 feet wide **(figure 13).** Thirteen existing breakwaters would be removed or covered. Approximately 2 million cubic yards of sand would be placed about every 10 years to periodically restore the dune and berm. About 6 million cubic yards of material would be placed to create a marsh area about 5 miles long and up to 1,200 feet wide. The existing eroding marsh would be nourished with a thin layer of dredged material. The BP Canal would be plugged in three places. The dune would be planted with native varieties of bitter panicum and sea oats for stabilization. After it consolidates, the marsh would be planted with smooth cordgrass, also a native variety.

Shell Island

The selected plan for Shell Island would include two components, Shell Island (west) and Shell Island (east). Shell Island (west) would involve placing 3.4 million cubic yards to create 139 acres of dune and berm and 74 acres of marsh **(figure 14)**. The dune would be planted with native varieties of bitter panicum and sea oats for stabilization. The marsh would be planted after it consolidated with smooth cordgrass, also a native variety. Shell Island (east) would involve placing 6.6 million cubic yards to create 223 acres of dune and berm and 191 acres of marsh **(figure 15)**. Material would be contained in geotubes on the gulf side and by earthen dike on the bay side. The dune would be planted with native varieties of bitter panicum and sea oats for stabilization. The marsh would be planted after it consolidated with smooth cordgrass, also a native variety.

Project Design

Project Design Considerations– Caminada Headland

Material for the dune and berm would be taken from Ship Shoal by hopper dredge. Ship Shoal is a sand body in the gulf located approximately 50 miles southwest of Belle Pass. It is about 31 miles long and 7 miles wide, lying at a depth of 9 to 30 feet. It is the remaining seaward shoal from one of the older abandoned deltas. The Maringouin delta was active 6,000 to 7,000 years ago. It is composed of well-graded quartz sand and is ideal for use in restoring the Caminada Headland since its grain size is slightly larger than the sand found on the headland.

If the pumpout is to be done in the Gulf of Mexico, the sand would be removed by hopper dredges and it would either be pumped into scows in the gulf or the hopper dredges would move to Port Fourchon for pumpout or unloading of the scows. Use of Ship Shoal sand as a borrow source would require a permit from the Department of Interior, Minerals Management Service. Permit coordination is in preliminary stages.

It is proposed to place 9 to 10 million cubic yards of good quality Ship Shoal sand along 13 miles of shore face of the beach in this reach. Ten million cubic yards is at the upper limit of the size of an achievable hopper dredge contract and any increased placement would have to be in water depths greater than 10 feet. This means less width would be attained per unit volume. In terms of headland longevity, width is an important consideration.

The rate of ecosystem restoration should be equal to the loss rate. The longshore transport is estimated to be on the order of 100,000 cubic yards per year. The loss rate due to profile adjustment to relative sea level rise is 90,000 cubic yards per year. Thus the total required restoration is 190,000 cubic yards per year. This number compares well to the dune-rebuilding requirement of 100,000 cubic yards per year computed for Grand Isle. The length of Grand Isle is roughly half that of the Caminada Headland and the required amount of sand is roughly half.

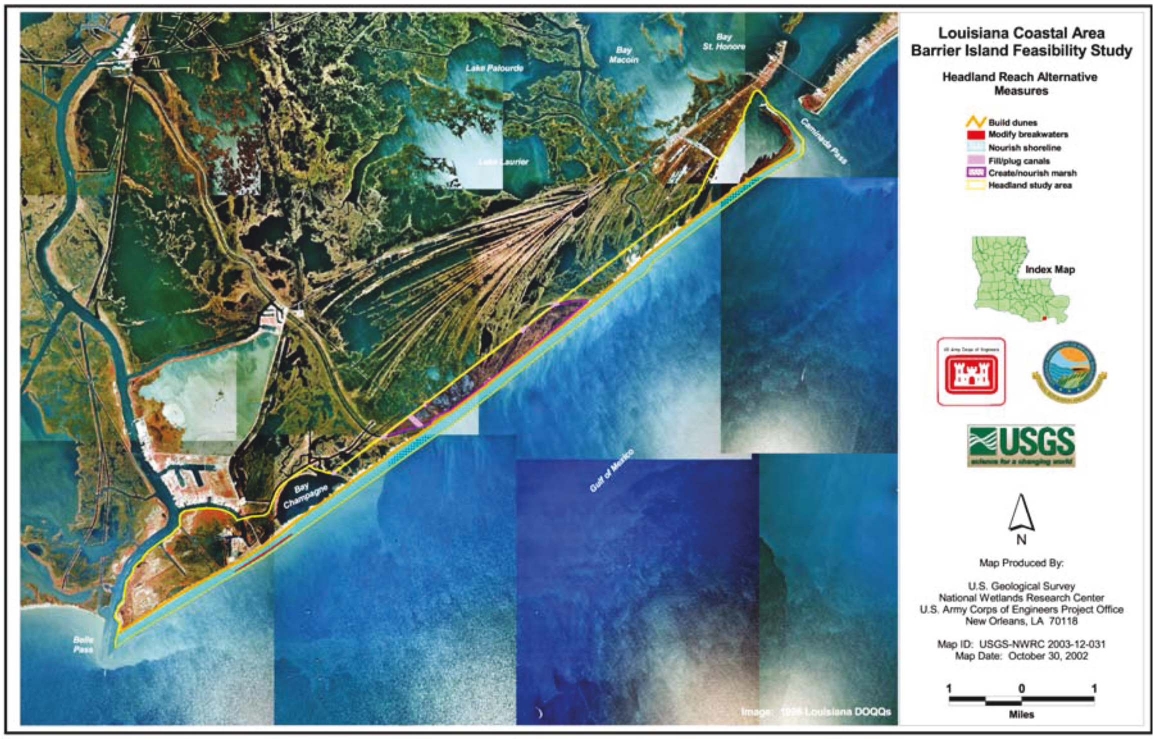


Figure 13. Caminada Headland map illustrating design template for shoreline, dune, and marsh creation.

In 2000, there were approximately 430 acres of dune and berm on the headland. The initial placement of material in a design template would raise the existing area and create another 529 acres of dune/berm habitat. But within a year the new dune would adjust to an equilibrium profile and there would be a total of 910 acres of dune/berm. If there were no ecosystem restoration, only a fraction of this would remain at the end of 50 years. This is because in the first 30 years the overwash processes would not play a significant role, but as time goes on and the barrier shoreline diminishes in both height (relative to the water level) and width, overwash would become more and more significant and thus accelerate the land loss. If the headland is nourished with periodic lifts of 2 million cubic yards every 10 years, it would erode to about 750 acres at the end of 10 years and then be re-nourished back to 910 acres.

When restoring barrier islands, a wide marsh is generally created behind the dune/berm to add stability to the island. This headland needs stabilization, but there is generally some marsh or scrub shrub immediately behind the beach/dune over much of the headland. Thus, most new marsh would be created in small back barrier lagoons that are enlarging south of the BP Canal and east of Bay Champagne. A total of five miles of marsh would be created and it would be up to 1,200 feet wide, where possible. In the areas where marsh would be created, there is now about 1,200 acres of marsh. These acres would be nourished and an additional 400 acres would be created. The BP Canal would be plugged at the three places it crosses Bayou Moreau. A short canal east of Bay Champagne would be filled to marsh level. When the marsh creation is completed, there would be a nearly continuous marsh platform between the dune and the BP Canal.

The required feasibility-level decision document for this project would consider the possibility of filling a portion of Bay Champagne. It would prevent this bay from suffering the same fate as Bay Marchand and becoming part of the gulf. Filling a portion of Elmers Lagoon would also be considered, as would a 7 to 10 foot high dune.

Small grain sized material appropriate for marsh creation would be removed from interior open water sites by cutterhead dredge and pumped to the headland. These inland borrow sites should not accelerate loss of adjacent marsh or decrease habitat value of the borrow site. Generally the fauna of a borrow site recovers within a year. During the feasibility-level document preparation, the possibility of a gulf borrow site would be considered.

In creating marsh habitat, one of the most critical factors is elevation. Created marshes change elevation over time due to three processes:

1) initial consolidation as the fill dewaters and consolidates (one to 12 months);
2) subgrade compression and settlement under the overburden of the placed material (one to five years); and
3) relative sea level rise.

Prior to starting construction, the elevation range of existing marshes would be measured. This would be the design grade, the desired range at the midpoint of design life. Prior to construction, the amount of initial consolidation would be determined by a geotechnical analysis of soil borings from the borrow sites and the fill sites. Once this is determined, grade stakes would be placed in the marsh fill area so the construction grade fill elevation can be easily determined as the job progresses. Where it is deemed necessary, low containment dikes would be built around portions of marsh creation areas. These dikes would be degraded or breached upon consolidation of the fill. Dune elevations are determined in a similar fashion, although the initial consolidation is less.

The created dune and marsh would eventually colonize naturally with native vegetation. However, to facilitate natural colonization and community diversity and to improve shoreline stability during storm events, the created areas would be planted as soon as possible. The dune would be stabilized with sand fencing prior to planting. Dune planting would occur as soon as sufficient rain has occurred to wash an appropriate amount of the salt from the fill out of the dune. Native cultivars of bitter panicum (Fourchon) and sea oats (Caminada) would be used to insure the greatest survival possible. Marshes would be allowed to consolidate for six months to one year before planting with smooth cordgrass. Work done on Grand Terre Island has indicated that this delay is essential for success.

The design described above incorporates most of the recommendations of the SRT from Appendix D of the LCA Main Report in that a wide beach berm is included and marsh is created in the existing lagoons. Recommendations for marsh elevation and for planting are also included.

Monitoring – Caminada Headland

The relative accessibility of the headland would facilitate annual surveys of the active profile. Monitoring of shoreline configuration and headland area would be done with remote-sensing techniques (aerial photography, LIDAR, satellite imagery). A regional sediment budget and a conceptual model of predominant processes on the headland should be developed utilizing the monitoring data. The success of the plantings would also be monitored. All data and knowledge gained from monitoring would be used to adaptively manage this project and to apply to subsequent barrier island projects.

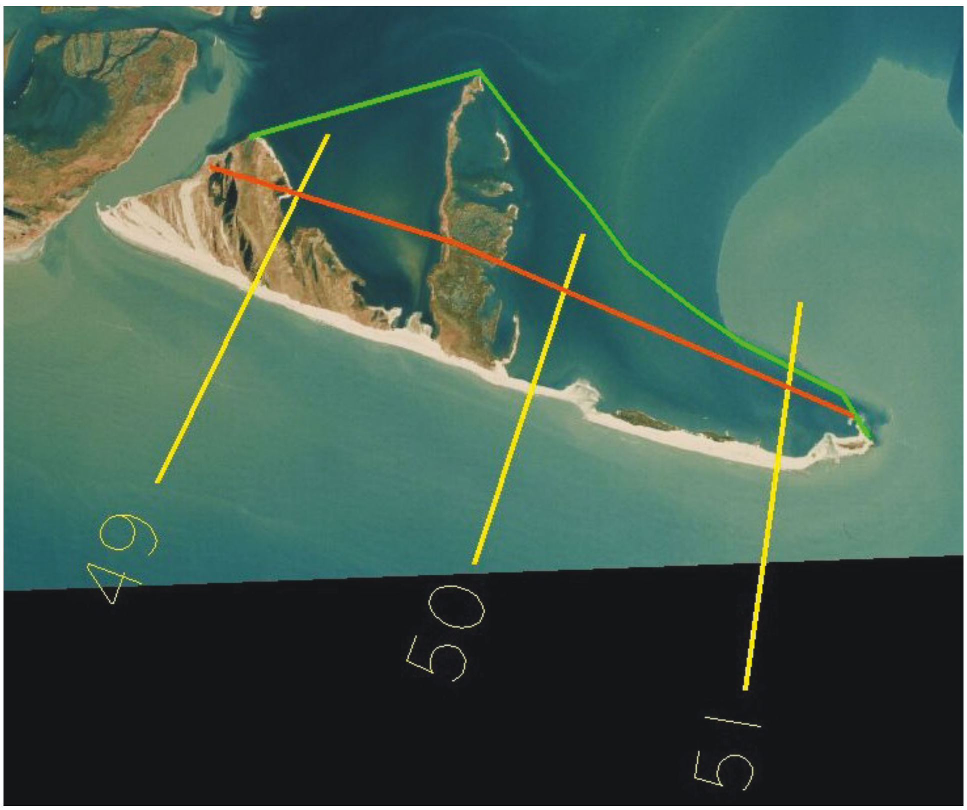


Figure 14. Map of Shell Island Reach (west) illustrating profile locations (yellow). Red line is northern limit of back of dune creation. Green line is proposed northern confinement for marsh creation.

Shell Island Reach

The extremely degraded condition of this reach requires a restoration project comprised of two sub reaches, Shell Island Reach (west) and Shell Island Reach (east) **(figures 14 and 15)**. The primary feature of both sub reaches is shoreline restoration. However, present water depth and exposure to marine conditions requires containment of placed material. Geotubes, terminal groins, and other shore protection features are required to allow the material to be placed and to protect the material after placement. Back marsh creation would be developed behind the restored beaches.

The Shell Island (west) restoration would include shoreline, dune and marsh creation **(figure 14).** The design builds upon the existing island. Sand would be pumped from a nearby offshore borrow site for the shoreline and dune restoration. The borrow site would be located sufficiently offshore to avoid wave refraction impact toe the shoreline.

The Shell Island (east) would be designed around existing remnants of marsh and marsh platform. Because the Shell Island Reach (east) affords protection to the Empire Waterway, an additional element is included to rebuild the platform west of the waterway. This would help maintain the integrity of this commercial waterway. Because of the rapid shoreline retreat in this area, the final alignment would likely change somewhat from what is shown in **figure 15**. Borings taken along the Shell Island Reach as part of the Barataria Feasibility Study indicate that the subsurface in this area is composed mainly of soft, interdistributary clays. In some areas, a thin layer of sand is found at the surface.

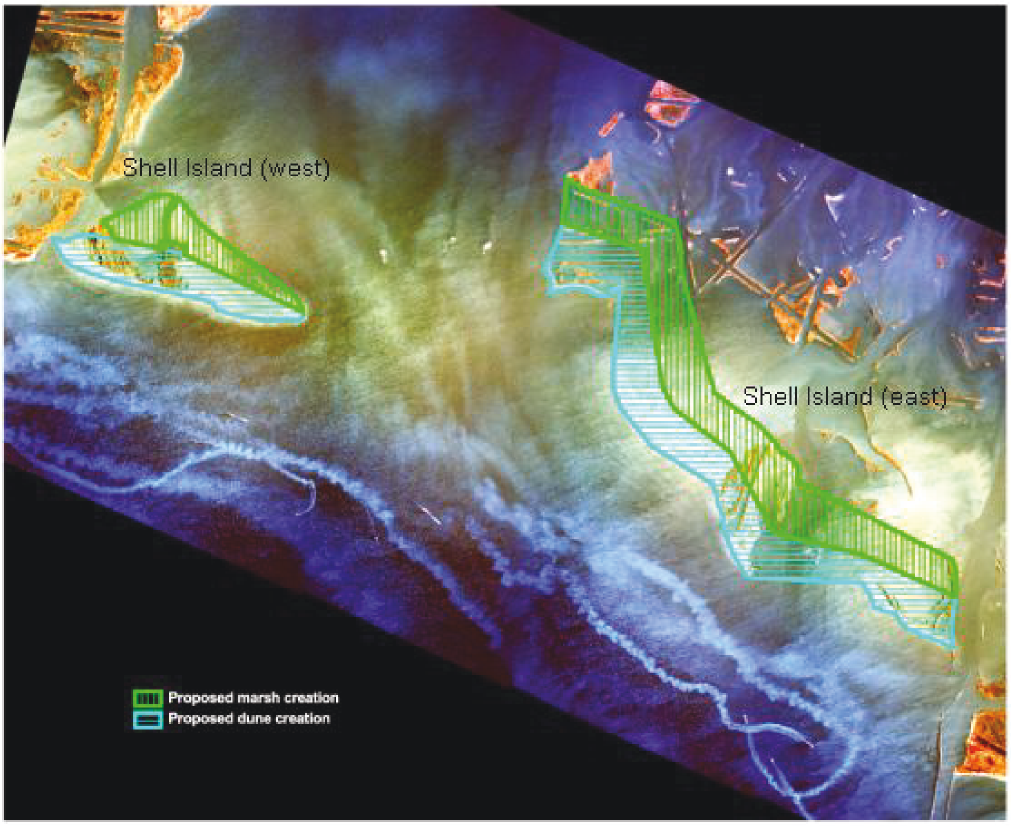


Figure 15. Map of the Shell Island Reach (east and west) illustrating the proposed location of sediment placement. The figure shows approximate locations of dune and marsh creation.

Monitoring – Shell Island

The entire active profile would be monitored for performance assessment and to determine maintenance volumetric needs. Monitoring of shoreline configuration and headland area would be done with remote-sensing techniques (aerial photography, LIDAR, satellite imagery). A regional sediment budget should be developed utilizing the monitoring data. The success of the plantings would also be monitored. All data and knowledge gained from monitoring would be used to adaptively manage this project and applied to subsequent barrier island projects.

Benefits

Caminada Headland

An interagency team with academic assistance performed both Wetland Value Assessments and Barrier Island Value Assessments during the partially completed 2000 Barrier Island Feasibility Study. The results showed that restoration of the dune/berm would produce 246 AAHUs. Marsh creation would achieve 486 AAHUs for a total of 732 AAHUs. In terms of acres, without the project there is estimated to be only about 110 acres of dune in 50 years. With the project, there is estimated to be 750 acres left, for a net gain of 640 acres of dune/berm at the end of project life. All the existing marsh on the headland is predicted to be lost in 50 years. The marsh creation effort is estimated to produce 1,780 additional acres of saline marsh at the end of 50 years. Thus, in 50 years there could be 2,440 additional acres on the headland.

The restoration done on the seaward portion of the headland would help preserve the valuable cheniere live oak forests, black mangrove thickets, and coastal dune shrub thickets that lie inland. Thus, vital habitat for small mammals, neotropical migratory birds, fish, and shellfish would be maintained. The marsh restoration/preservation would provide additional nursery habitat for fish and shellfish, feeding, nesting, and resting habitat for many songbirds, wading birds, terns, and gulls. Detritus from the marsh would help fuel the aquatic food web. Preservation of the headland would help slow the crash of Louisiana's fishery that would be caused by continued marsh loss. Numerous fish and shellfish would use the surf zone. The restored beach and berm would provide habitat for shorebirds.

Restoration of this headland would preserve the integrity of the western boundary of the Barataria Basin. It would also allow the headland to continue to nourish Grand Isle with sand transport. The headland would continue to protect the marshes to the north and keep salinity lower in the bays and lakes. The endangered brown pelican and Kemp's Ridley sea turtle and threatened Gulf sturgeon would have more fish and shellfish available. Critical intertidal habitat for the threatened piping plover would be preserved.

By adding dune/berm and marsh to the headland, all the human resources that it supports would be protected from the encroaching waters of the Gulf of Mexico. These areas include Port Fourchon, the LOOP facility, and Highways 1 and 3090 hurricane evacuation routes. This area would be able to continue to support oil and gas production in the Gulf that supplies about 20 percent of what the Nation uses.

This feature meets four of the five study objectives. Sand from Ship Shoal would be pumped onto the beach, berm and dune and would meet the hydrogeomorphic objective of increasing sediment input from sources outside the estuarine basin. Construction of the feature itself would maintain a natural landscape feature that is critical to sustainable ecosystem structure and function and thus meet another hydrogeomorphic objective. The first ecosystem objective is to sustain productive and diverse fish and wildlife habitats. The Caminada Headland is one of the most diverse habitats in the deltaic plain. The feature would also slightly help meet the second ecosystem objective of reducing nutrient delivery to the continental shelf by preserving a headland that would help trap nutrients behind it. This project is an excellent example of how ecological restoration of an exceedingly diverse and valuable ecological area can be combined with protection of Nationally important infrastructure.

In summary, this vitally important headland with its unique and diverse habitats and its commercial, recreational, and public infrastructure, that is so vital to the Nation, would be preserved. The Louisiana coast is a working wetland where people live on the natural ridges and work in the wetlands. In this area it makes sense and is wise use of public funds to preserve the wetlands, beaches, and dunes that protect vital infrastructure.

Shell Island Reach

Initial benefits analysis indicates that the most effective restoration alternative produces approximately 322 additional AAHU over the no action condition, and roughly 147 more acres at project year 50. The beach restoration would provide habitat for shorebirds and critical wintering habitat for the threatened piping plover. Marsh creation would provide additional habitat for fish and shellfish. Wading birds, songbirds, and seabirds such as the endangered brown pelican use the saline marshes for foraging, resting, and nesting. One of the most important benefits of this feature is preservation of bay habitat. As Shell Island Bay, Bastion Bay, and Bay Adams coalesce and become subject to salinity and wave conditions characteristic of the open gulf, numerous estuarine-dependent fish and shellfish would cease to utilize this area as they do now. The existence of a sound from the gulf to the back levee at Empire would change the hydrology of the southeastern Barataria Basin. Restoration of these islands would help return the Plaquemines barrier shoreline to the continuous shoreface it once was. The restored islands would help protect the fragile interior marshes between Grand Bayou and the Empire Waterway. Filling the existing shoreline gap at Shell Island would enhance longshore transport to down drift shorelines. Other benefits include protection for the Empire Waterway, an important navigation canal to both the oil industry and commercial and recreational fishing industries. The presence of the islands would also help reduce storm surges that could reach the back levee near Empire. Hurricane Danny, a weak Category 1 hurricane in 1997, caused a tremendous amount of damage to Empire and the surrounding communities because of the absence of the Shell Island Reach and the trajectory of this storm. This project incidentally helps to protect the communities of Empire, Sunrise, Buras, and Triumph.

Costs

The estimate of total project costs is based upon a schedule of project expenditures that was provided for each year of the project. This schedule represents incremental, or "uninflated," costs. Expenditures include future planning, engineering, and design (PED) costs, construction costs, and monitoring costs. O&M costs are reported separately. As with any single USACE project, individual expenditures are either compounded or discounted to a given base year, defined as that year in which the project is generating all of the outputs intended by its design. The project cost estimate is derived through summing the compounded/discounted values to yield the present value of costs that is correlated to the corresponding base year. This figure is then annualized using the Federal discount rate (5-3/8 percent for fiscal year 2005) and a 50-year project life to yield an estimate of average annual project costs.

The estimate of total project costs and its average annual equivalent on a "fully-funded"
scribed above, except that the schedule of
project costs previously reported as incremental costs are adjusted to include inflation. The
factors

, Grand
eloped for
two island design widths: 3,000 feet and 1,500 feet The design for the barrier islands calls for
placem

restoration including both the Caminada Headland and the Shell Island reaches are detailed in **table 3**.

Table 3. Costs for the Barataria Basin Barrier Island restoration feature including both Caminada Headland and Shell Island Reaches.

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
01-	LANDS AND DAMAGES						
01--	Barataria Barrier Island Restoration						
	Headland Reach						
01B	Acquisitions						
01B20	By Local Sponsor (LS) (Oysters)				26,000	13,000	39,000
01B30	By Govt on Behalf of LS				75,980	37,990	113,970
01B40	Review of LS				9,750	4,880	14,630
01C	Condemnations						
01C30	By Govt on Behalf of LS				4,140	2,070	6,210
01E	Appraisal						
01E40	By Govt Contract on Behalf of LS				74,800	37,400	112,200
01E50	Review				3,200	1,600	4,800
01F	PL 91-646 Assistance						
01F30	By Govt on Behalf of LS				5,200	2,600	7,800
01G	Temporary Permits/Licenses/Rights-of-Entry						
01G30	By Govt on Behalf of LS				1,560	780	2,340
01R	Real Estate Payments						
01R1	Land Payments						
01R1B	By LS (Oysters)				66,550	33,280	99,830
01R1C	By Govt on Behalf of LS				7,895,450	3,947,790	11,843,240
01R2	PL 91-646 Assistance Payments						
01R2C	By Govt on Behalf of LS				175,000	87,500	262,500
01T	LERRD Crediting						
01T20	Administrative Costs (By Govt and LS)				8,650	4,330	12,980
51	Operations & Maintenance During Construction						
51B	Real Estate Management Services						
51B20	Outgrants (Over 5 Years)				15,000	7,500	22,500
51B30	Disposal/Quitclaim				6,000	3,000	9,000
	Subtotal: Headland Reach						8,367,280
	Contingencies						4,183,720
	Subtotal: Headland Reach						12,551,000
	Shell Island						

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
01B	Acquisitions						
01B20	By Local Sponsor (LS) (Oysters)				90,000	45,000	135,000
01B30	By Govt on Behalf of LS				183,488	91,738	275,226
01B40	Review of LS				33,750	16,880	50,630
01C	Condemnations						
01C30	By Govt on Behalf of LS				12,414	6,210	18,624
01E	Appraisal						
01E40	By Govt Contract on Behalf of LS				82,000	41,000	123,000
01E50	Review				8,000	4,000	12,000
01F	PL 91-646 Assistance						
01F30	By Govt on Behalf of LS				10,400	5,200	15,600
01G	Temporary Permits/Licenses/Rights-of-Entry						
01G30	By Govt on Behalf of LS				1,560	780	2,340
01R	Real Estate Payments						
01R1	Land Payments						
01R1B	By LS (Oysters)				788,700	394,450	1,183,150
01R1C	By Govt on Behalf of LS				220,300	110,650	330,950
01R2	PL 91-646 Assistance Payments						
01R2C	By Govt on Behalf of LS				540,000	270,000	810,000
01T	LERRD Crediting						
01T20	Administrative Costs (By Govt and LS)				8,650	4,330	12,980
51	Operations & Maintenance During Construction						
51B	Real Estate Management Services						
51B20	Outgrants (Over 5 Years)				15,000	7,500	22,500
51B30	Disposal/Quitclaim				10,000	5,000	15,000
	Subtotal: Shell Island						2,004,262
	Contingencies						1,002,738
	Subtotal: Shell Island						3,007,000
01--	TOTAL: LANDS AND DAMAGES						15,558,000
17--	BEACH REPLENISHMENT						
	<u>Subprovince 2</u>						
17--	Barataria Barrier Island Restoration						
17--	Caminada Beach Restoration						
	Mob and Demob	2	EA	500,000.00	1,000,000	300,000	1,300,000
	Beach Restoration	9,516,000	CY	10.00	95,160,000	28,540,000	123,700,000
17--	Subtotal: Caminada Beach Restoration						96,160,000

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
	Contingencies						28,840,000
17--	Subtotal: Caminada Beach Restoration						125,000,000
17--	Caminada Marsh Creation						
	Mob and Demob	LumpSum	LS	1,400,000.00	1,400,000	420,000	1,820,000
	Dredging	5,885,000	CY	1.20	7,062,000	2,118,000	9,180,000
17--	Subtotal: Caminada Marsh Creation						8,462,000
	Contingencies						2,538,000
17--	Subtotal: Caminada Marsh Creation						11,000,000
	Shell Island Beach Restoration						
	Mob and Demob	2	EA	1,900,000.00	3,800,000	1,140,000	4,940,000
	Nourish Beach	11,000,000	CY	2.80	30,800,000	9,260,000	40,060,000
17--	Subtotal: Shell Island Beach Restoration						34,600,000
	Contingencies						10,400,000
17--	Subtotal: Shell Island Beach Restoration						45,000,000
17--	TOTAL: BEACH REPLENISHMENT						181,000,000
30--	ENGINEERING AND DESIGN						
	Design Documentation (Feasibility)				8,500,000	1,700,000	10,200,000
	PED				5,667,000	1,133,000	6,800,000
	E&D				8,290,000	1,670,000	9,960,000
	Monitoring				1,966,000	396,000	2,362,000
30--	Subtotal: Engineering And Design						24,423,000
	Contingencies						4,899,000
30--	TOTAL: ENGINEERING AND DESIGN						29,322,000
31--	CONSTRUCTION MANAGEMENT						
	Supervision and Administration (S&A)				18,100,000	3,620,000	21,720,000
31--	Subtotal: Construction Management						18,100,000
	Contingencies						3,620,000

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
31--	TOTAL: CONSTRUCTION MANAGEMENT						21,720,000
	TOTAL PROJECT COST						247,204,000

Monitoring of the performance of the project features would be conducted as part of the construction portion of the plan. The purpose of including monitoring in the project is to document the performance of the structures in terms of meeting the goals of the selected plan. Monitoring would assess the engineering performance of the designs to aid in decisions regarding O&M needs and to feed information into an adaptive management program for the coast.

All of the structural components of this feature would require O&M to sustain engineering performance and achieve long-term project environmental goals. In general, the maintenance requirements are driven by the rate of shoreline retreat along the reconstructed segments. This rate would vary depending upon the return frequency of coastal storms and other factors that contribute to barrier shoreline erosion. Typical O&M actions would include engineering inspections of the sites and construction events to maintain the design elevations of the restored habitats. Maintenance of the headland would occur every 10 years when about 2 million cubic yards of sand are added to the dune and berm. No renourishment is scheduled for Shell Island. These OMRR&R actions would be the responsibility of the local sponsor. The estimated annual O&M cost is $500,000.

Table 4 provides a summary of the first costs for the Caminada Headland and Shell Island Reach features project.

Table 4. Summary of Costs for the LCA Plan (June 2004 Price Level)		
Lands and Damages	$	15,558,000
Elements:		
Beach Replenishment	$	181,000,000
Monitoring	$	1,966,000
First Cost	$	198,524,000
Feasibility-Level Decision Document	$	10,200,000
Preconstruction Engineering, and Design (PED)	$	6,800,000
Engineering, and Design (E&D)	$	9,960,000
Supervision and Administration (S&A)	$	21,720,000
Total Cost	$	247,204,000

A detailed breakdown of cost accounts between Federal funds and the share of the local sponsor is provided in **table 5**.

Table 5. Barataria Basin Barrier Shoreline Restoration
FEDERAL AND NON-FEDERAL COST BREAKDOWN
(June 2004 Price Level)

Item	Federal	Non-Federal	Total
Decision Document (50%Fed-50%NFS)	$ 5,100,000	$ 5,100,000	$ 10,200,000
PED (65%Fed-35%NFS)	$ 4,420,000	$ 2,380,000	$ 6,800,000
LERR&D (100% NFS)	$ -	$ 15,558,000	$ 15,558,000
Ecosystem Restoration (65%Fed-35%NFS)	$ 127,762,700	$ 53,237,300	$ 181,000,000
Engineering and Design (E&D) (65%Fed-35%NFS)	$ 6,474,000	$ 3,486,000	$ 9,960,000
Supervision and Administration (S&A) (65%Fed-35%NFS)	$ 14,118,000	$ 7,602,000	$ 21,720,000
Monitoring (65%Fed-35%NFS)	$ 1,277,900	$ 688,100	$ 1,966,000
Total Construction	**$ 154,052,600**	**$ 82,951,400**	**$ 237,004,000**
TOTAL COST	**$ 159,152,600**	**$ 88,051,400**	**$ 247,204,000**
Cash Contribution	*$ 159,152,600*	*$ 67,393,400*	

Implementation Plan

Initial PMP and scoping efforts to address the appropriate level of engineering detail required for the follow-up feasibility-level decision document for the Barataria Basin Barrier Shoreline Restoration features are currently underway. The PMP is expected to be negotiated by the end of December 2004 and would form the basis for assigning tasks between USACE and the sponsor, LDNR, as well as, detail the conduct of the feasibility-level analyses. Development of the decision document is anticipated to begin in April 2005, with completion estimated in two years (April 2007). PED efforts to finalize the detailed design and ready the project for construction would initiate once a design agreement is negotiated with LDNR to define the scope, schedule, and cost of the design. Preparations of plans and specifications for construction could commence in October 2007 and are forecasted for completion in September 2008. Construction of the features could begin following PED with approval and execution of a Project Cooperation Agreement (PCA). The current schedule would allow for construction to begin as early as October 2008, with construction completion estimated for spring in the year 2013.

These accelerated schedules are important for the implementation of the tentatively selected plan. Experience in designing and constructing similar features in coastal Louisiana indicates that these schedules are attainable. A high level of coordination and funding that will also be required to achieve the goals and objectives of the plan.

National Environmental Policy Act (NEPA)

The Programmatic Environmental Impact Statement (FPEIS) prepared for the LCA Study assessed impacts of two restoration opportunities and the Tentatively Selected Plan. These impacts are discussed for all affected natural and human resources in the study area. Cumulative impacts were analyzed as well. This PEIS provides a consistent basis for initiating a supplemental document to describe these two barrier shoreline restoration projects.

Scoping meetings would be held, a Supplemental PEIS would be prepared, as well as a Section 404(b)(1) Evaluation, Coastal Zone Consistency Determination, Endangered Species Assessment, Essential Fish Habitat Evaluation, Cultural Resources Assessment, HTRW Analysis, water and sediment quality assessment, and all other documents required by law. There would be public meetings on the EIS and all comments, verbal and written would receive responses.

Uncertainties and Risk

<u>Adaptive Management</u>

The Louisiana coast was naturally constructed of sediment delivered by the Mississippi River of which 70 percent is clay particles (mud). Of the remaining 30 percent, only a portion is sufficiently coarse to be stable within the environment of a gulf coast shoreline. The barrier islands of Louisiana are a thin sand cap over a thick mud system that is responding to a rapid relative sea level rise of about 1 cm per year (Penland and Ramsey 1991). The sand budget for shorelines is a relatively small fraction of available sediment and therefore the challenge for Louisiana barrier island or shoreline management is to maximize sand in the beach environment and minimize sand dispersal into the surrounding mud environments. This must be accomplished in a context of a highly dynamic system in which both fair weather (fair weather includes all weather conditions other than tropical systems such as hurricanes) and storm conditions may continuously or sporadically alter the movement of sand.

Fair Weather Conditions

Fair weather conditions are the dominant conditions and can be predicted from historical wind-rose data and from wave propagation models. The effect of waves on a simple continuous shoreline can be accurately modeled. However as complexity is added to the shape of the shoreline or with additional elements, such as tidal passes or artificial structures including groins or breakers, the accuracy of prediction becomes significantly less.

This requires a restoration approach, which considers multiple possible scenarios to ameliorate the risk of undesired results. This includes:

1) Maximizing the use of sand, which is sufficiently coarse to be stable in fair weather conditions;
2) Placement of sand in increments to allow future sand placement to adjust to the beach's response to restoration and other processes;
3) Placement of sand on the updrift to allow natural dispersal of sand;
4) Monitoring fair weather conditions processes, particularly sand movement;
5) Planning for loss or gains of sand from adjacent reaches;
6) Designing beach restoration with contiguous vegetated marsh platforms landward (either natural or constructed) which would protect the bayside of the islands;
7) Minimize breaches or passes through the reach to minimize tidal movement of sand away from the beach.

Storm Conditions

Storm conditions involve another set of physical conditions, which are much higher energy but are relatively brief i.e. a few days. Louisiana is impacted by a hurricane approximately every 1.2 years. The Caminada Headland and Shell Island Reaches can be expected to be impacted once every six to seven years, which suggests multiple impacts during the life of the project. Wind and sea conditions can be generally predicted from a storm but many variables related to these storms can alter the degree or type of impact. The angle of approach of a storm to the coast and the speed of the storm are just two variables that could easily increase or decrease the impact of an individual storm. The specific location and specific type of impact from a hurricane or tropical storm is impossible to predict in advance of project construction. In addition, cost to "hurricane proof" an entire barrier Island or gulf shoreline would probably require prohibitively expensive armoring and would defeat goals of environmental restoration. Armoring of the gulf shoreline should only be done strategically and minimally.

Generally it should be expected that passage of storm events would impact the natural and restored portions of the Caminada Headland and Shell Island Reaches. The types of impact include:

1) Significant, rapid shoreline retreat
2) Breaches through barrier islands
3) Dispersal of sand both gulfward and bayward
4) Loss of dunes
5) Loss of both emergent and submersed vegetation on or adjacent to the shoreline

All of these impacts can influence the subsequent response of the beach or barrier island. This response may be either positive or negative toward the restoration goals.

Strategies to ameliorate the immediate or subsequent impact of storm events include:

1) Design of barrier islands or beaches to sufficient height and width to minimize the risk of breaching

2) Planning for emergency repair of breaches for those reaches which are not likely to close by natural shoreline processes
3) Planning for emergency sand fencing and planting to quickly restore dunes
4) Compliment the barrier island and beach restoration with interior marsh restoration to reduce the increase in tidal prism

Subject to Feasibility

The major area of uncertainty in this restoration feature is the unpredictability of shoreline processes and the response to restoration. A detailed survey of existing conditions and processes would provide a foundation for modeling of shoreline processes necessary to design these features to result in the physical and biologic response necessary to produce the final decision document for this feature. The identification of secondary socioeconomic effects, if any, for existing private and commercial development in the immediate area also should be examined.

Contingent Authorization/Demos/S&T

Contingent authority allows for acceleration of the Baratria Basin Barrier Shoreline Restoration feature and flexibility necessary to address the dynamic and continuously evolving shoreline of this project. One certainty is that the shoreline conditions would continue to change and that Shell Island would continue to roll back and fragment and Caminada Headland would become detached from the mainland and breach into barrier islands.

Placement techniques and cost of material suitably coarse for effective beach nourishment would be significant precedents for future coastal restoration of the Louisiana coast. Due to inherent uncertainty of beach restoration, any large-scale barrier island or beach restoration would likely provide new understanding of the science and technology of beach restoration. Due to a scarcity of such projects in the Louisiana coast, this project is especially meaningful for the S&T of beach restoration and management.

Recommendations/Summary

The Barataria Basin Barrier Shoreline Restoration feature addresses critical ecological needs and would sustain essential geomorphic features for the protection of Louisiana's coastal wetlands and coastal infrastructure. The project is synergistic with future restoration by
aintaining or restoring the integrity of Louisiana's coastline, upon which all future coastal
t. The design and operation of the feature would maintain the opportunity
r, and support the development of, large-scale, long-range comprehensive coastal restoration.
The fea

ration

endangered and threatened species, continue to transport sand to Grand Isle, and protect Port Fourchon and the only hurricane evacuation route availab

The Shell Island

This page intentionally left blank.

Small Bayou Lafourche Reintroduction

A Near-Term Critical Feature for the Louisiana Coastal Area Plan

Small Bayou Lafourche Reintroduction
A Near-Term Critical Feature for the Louisiana Coastal Area Plan

Introduction

Bayou Lafourche occupies a central location in Louisiana's deltaic plain, between Terrebonne and Barataria Bays (**figure 1**). This valuable estuarine complex is also Louisiana's most endangered, due in large part to the disruption of natural deltaic processes. Once a major distributary of the Mississippi River, Bayou Lafourche was a critical conduit for freshwater, nutrients, and sediment, which helped build and nourish marshes in the Barataria-Terrebonne estuary complex. Although flows down Bayou Lafourche declined as the river switched its course 800 to 1,000 years ago, the bayou continued to provide important riverine inputs until it was dammed in 1904 to alleviate flooding problems. While a limited amount of river flow (currently around 200 cfs) was subsequently restored to the bayou, there is an opportunity to use this natural distributary to increase freshwater, nutrient, and sediment inputs to coastal areas with critical restoration needs.

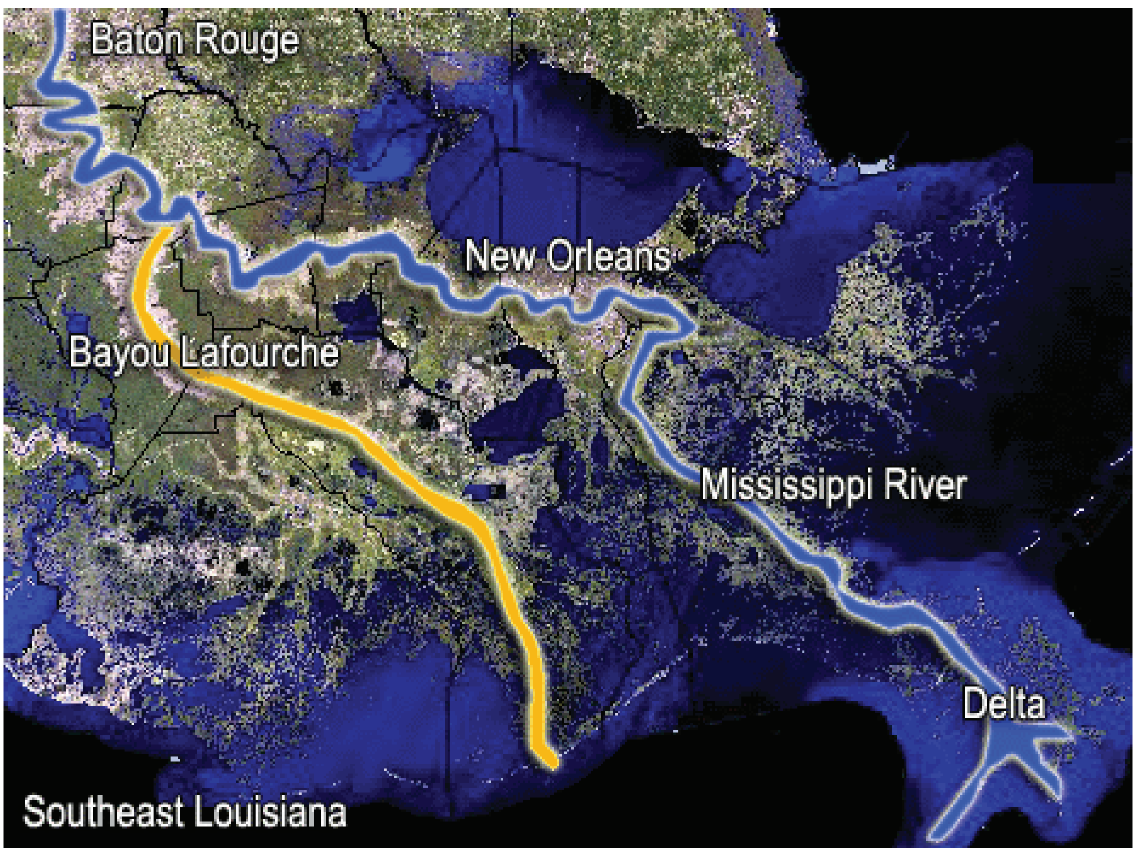


Figure 1. Project Area

The United States Environmental Protection Agency (EPA) has conducted an extensive study of Bayou Lafourche to determine if and how the channel might be enlarged to carry greater amounts of water from the Mississippi River to benefit deteriorating marshes in the lower Terrebonne and Barataria Basins. As currently proposed, the Bayou Lafourche project would increase Mississippi River flows down the bayou to approximately 1,000 cubic feet per second (cfs).

Having undergone years of interagency and public review, the Bayou Lafourche project is well suited for contingent authorization within the LCA Plan (**figure 2**). Since being selected by the CWPPRA Task Force in 1996, the Bayou Lafourche project has undergone considerable environmental and engineering review, including hydraulic modeling and environmental benefits assessment. Most recently, engineering, design, and the NEPA process have been initiated as part of the ongoing CWPPRA process. The existing information provides greater certainty with respect to costs and environmental outcomes, and will help expedite completion of both the feasibility study and EIS.

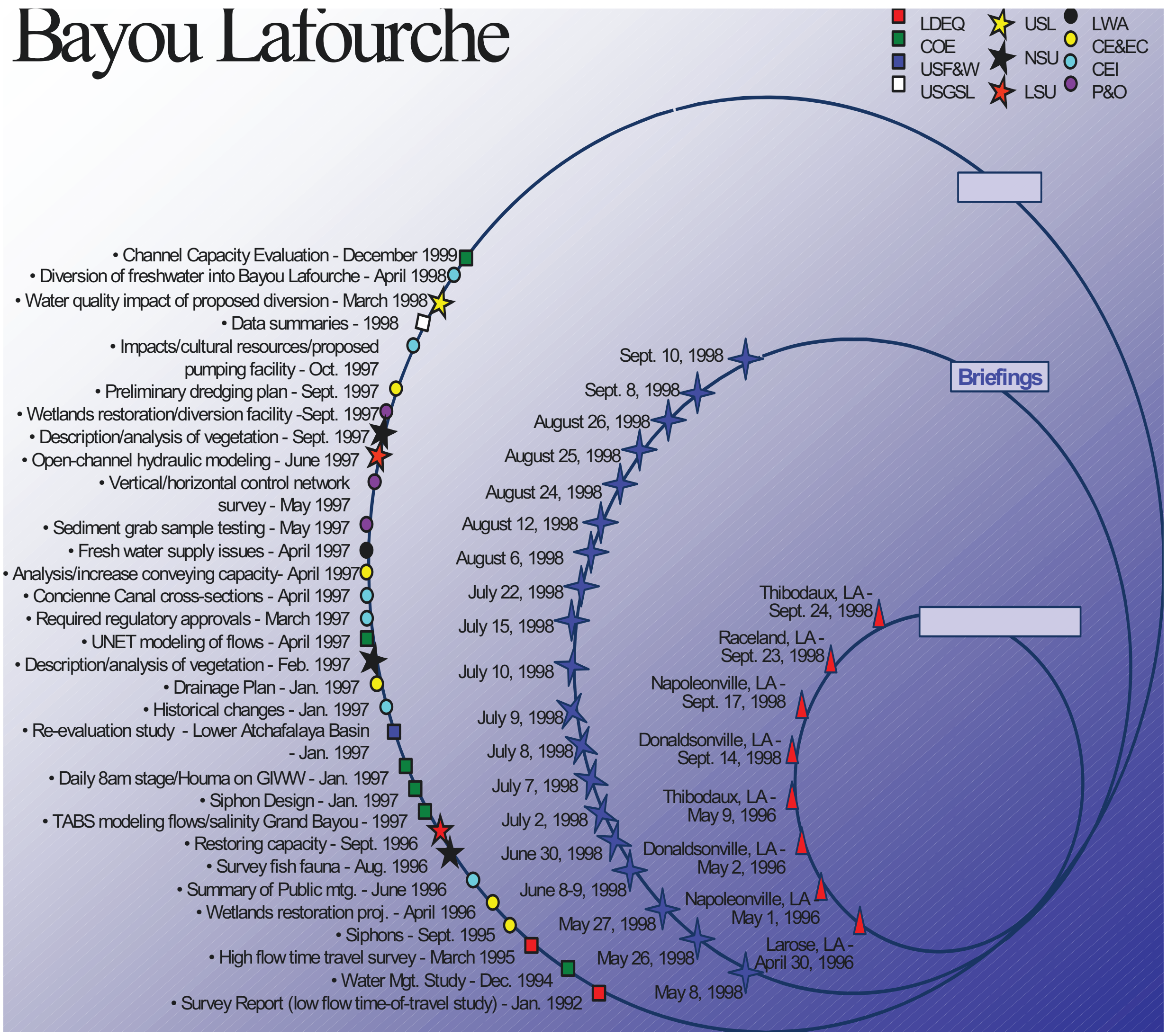


Figure 2. Project Public Involvement Description of Area

Extending 110 miles from Donaldsonville, Louisiana, to the Gulf of Mexico, Bayou Lafourche occupies a central location in Louisiana's deltaic plain, between Terrebonne and Barataria Bays, currently experiencing the highest rates of land loss in the Nation.

Following are estimates from the USGS regarding the magnitude of the past, ongoing, and future wetland losses:

- Between 1956 and 2000, the Barataria-Terrebonne estuary complex lost approximately 727.8 square miles of wetlands, or 456,800 acres, which amounts to 31 percent of the Barataria-Terrebonne land area and 61 percent of the total coastal loss in Louisiana during the same time frame.
- Between 1990 and 2000, this same area lost approximately 12.6 square miles each year, or 8,064 acres.
- USGS estimates that by 2050 this area could lose an additional 362 square miles, or 231,680 acres.

The bayou winds through the coastal parishes of Ascension, Assumption, and Lafourche. The waterway is the axis of a wide alluvial ridge created by the Mississippi River and, in its former, natural condition, the bayou fed a large number of distributary channels (**figure 3**.) The ridge slopes gently to the adjoining swamps and marshes of the Terrebonne and Barataria Basins. There is extensive commercial and residential development along the highways that parallel the bayou for most of its length. Between this development and the natural areas, the land use is primarily agriculture.

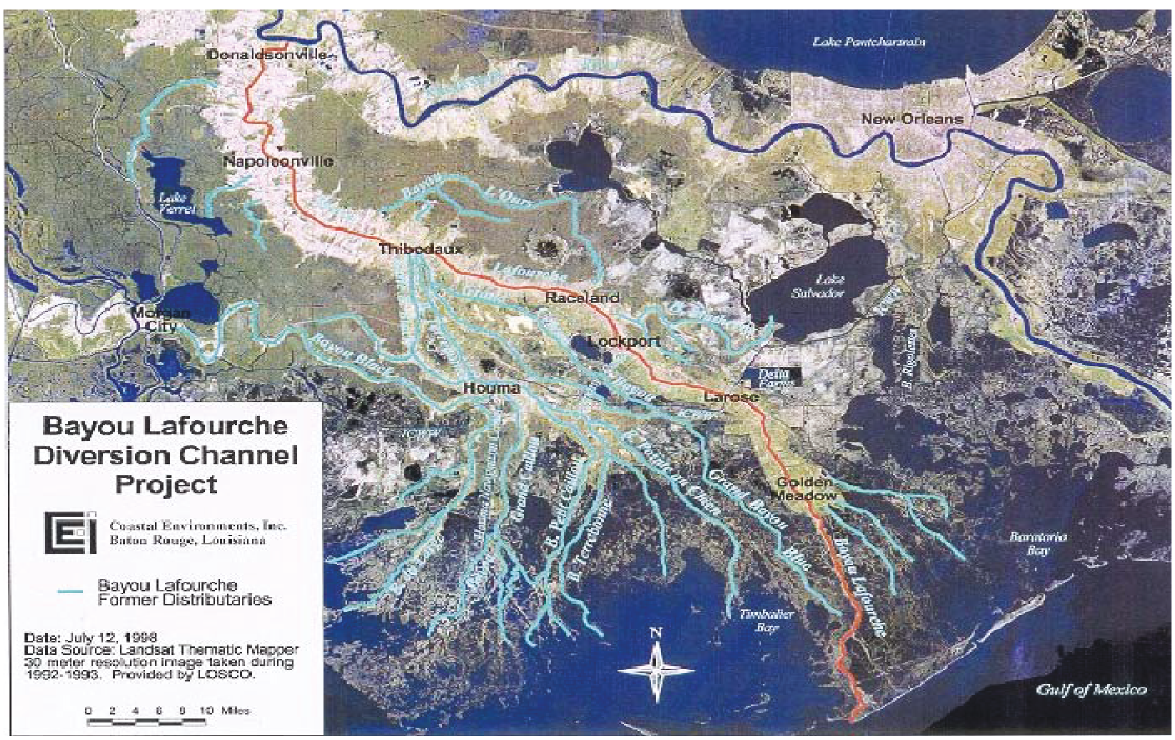


Figure 3. Proposed Diversion Channel

Historic Conditions

Approximately 2,000 years ago, the course of the Mississippi River began to occupy what is now Bayou Lafourche. This channel remained a primary distributary of the Mississippi River until about 800 to 1,000 years ago, when it was gradually replaced by the modern course of the river. While it was active, the Bayou Lafourche distributary built a large natural levee, with elevation ranging from over 20 feet NGVD near Donaldsonville, to approximately 1 foot near the mouth of the bayou.

In 1851 and 1858, discharge in Bayou Lafourche was measured at 6,000 to 11,000 cfs during high river stages. Thus, despite the shift in the river, Bayou Lafourche remained a major conduit by which freshwater, nutrients, and sediment were transported to coastal wetlands. During this time, the bayou was also extensively used for navigation.

Flows continued to decrease during the 19th century and by 1887 a bar had developed at the head of the bayou, which restricted flow and navigation. This led to annual dredging by the USACE. Additionally, the natural levee along the bayou was not sufficient to protect settled areas from flooding, and plantation owners gradually built up levees along most of the length of the bayou. Despite these levees, flood problems along Bayou Lafourche began to overshadow the usefulness of the channel for navigation. In 1902, Federal approval was given to construct a temporary dam across the head of the bayou. The dam was completed in 1904. The intent was to replace this dam with a lock, to allow for navigation. However, the dam was subsequently replaced by the Mississippi River flood control levee.

In 1906, a new problem arose: salt-water intrusion was recorded at Bush Grove Plantation just south of Lafourche Crossing. Agricultural, industrial, and domestic users recognized that fresh water would be necessary for their communities to continue to thrive. Also, damming the bayou contributed to dramatic salinity increases in the Barataria-Terrebonne estuary system. Anecdotal information gives evidence of the dramatic changes that resulted from the increased salinities. By 1910, for example, oysters were found growing in areas around Leeville, and where orange orchards and rice fields had once flourished, saltwater seeped into the land, killing the oak groves and making the soil unsuitable for farming.

Current Conditions

Responding to expanding industrial and residential demands, the Louisiana Legislature created the Bayou Lafourche Freshwater District in the 1950s. In 1955, a pump/siphon system with a capacity to reintroduce approximately 340 cfs was installed on the levee at Donaldsonville. No Federal funds were spent on that project. Because of channel constraints, this existing pump/siphon currently provides approximately 200 cfs of river water into the bayou. Approximately 80 percent of the current volume of water reintroduced to the bayou flows through the system, with approximately 20 percent being used for water supply (of which a relatively small amount is used for irrigation).

Today the bayou supplies fresh water to over 300,000 residents in four parishes: Ascension, Assumption, Lafourche and Terrebonne. In addition to residents and land-based businesses, Bayou Lafourche also provides potable water through Port Fourchon to offshore oil and gas facilities in the Gulf of Mexico. The bayou also provides aesthetic, recreation, drainage and navigation benefits to the numerous communities that have developed along its banks.

Project Background

Proposals to reconnect Bayou Lafourche as a restoration measure date back to at least 1992. At that time, coastal researchers from Louisiana State University's Center for Coastal Energy and Environmental Resources (CCEER; Currently LSU School of the Coast and the Environment) crafted a report that included reconnection of the former distributary as an innovative alternative to help address the land loss crisis in the Louisiana coastal zone. In the November 1993 Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) Main Report and Environmental Impact Statement (EIS) submitted to the U.S. Congress by the Task Force, reintroduction of Mississippi River water via Bayou Lafourche was listed as a major strategy for both the Terrebonne and Barataria basins.

Problems and Needs

The loss of riverine sediment, freshwater, and nutrients into the Barataria and Terrebonne basins is the most significant long-term problem facing the estuary. The damming of Bayou Lafourche, in conjunction with subsidence, sea-level rise, and other natural and anthropogenic factors has resulted in the highest rates of wetland loss in coastal Louisiana and the Nation. Other anthropogenic factors that have contributed to land loss in the area include dredging of canals, construction of navigation channels and other hydrologic modifications.

From 2000 to 2050, this estuary complex is predicted to lose approximately 231,000 acres of wetlands. This is 50 percent of the predicted loss in the entire state. In addition, approximately 465,000 acres have been lost in this complex over the past 50 years. The continued loss will further weaken an already stressed ecosystem that supports a wide range of resident and migratory animals. The highly diverse and numerous fish and shellfish populations in the complex would dramatically decline as land loss continues. In the future, there would be decreased habitat for neo-tropical migratory birds, furbearers, waterfowl, and threatened species such as the bald eagle.

Critical Need for the Project

The wetlands being lost in the Barataria-Terrebonne estuary complex are of vast ecological importance. It has been estimated that nearly one fifth of the Nation's estuarine-dependent fisheries rely on the diverse habitats of Barataria-Terrebonne estuary complex. nnual commercial fisheries landings have been estimated at more than $220 million, including , shrimp, crabs, and various finfish. The wetlands and other habitats of the Barataria-rrebonne estuary complex are also important for a wide range of resident and migratory birds. It is est

The ongoing loss and conversion of these wetlands will adversely affect a range of important fish and wildlife resources. Within the estuary complex, waterfowl populations are most seriously threatened by habitat loss. Over the last 10 to 20 years, dabbling ducks, wading birds, shorebirds, seabirds, furbearers, game mammals, and alligators have experienced decreasing populations in the study area, as a result of marsh loss and a conversion to saltier marsh types. Across this area, the greatest loss of coastal wetlands has occurred in the fresh and intermediate marshes of the Terrebonne and Barataria Basins. Given the ongoing and projected wetland loss, it can be assumed that delaying project implementation would result in continued adverse impacts to the habitat and living resources discussed above.

The North American Waterfowl Management Plan (NAWMP; Canadian Wildlife Service (CWS), and U.S. Fish and Wildlife Service (USFWS) 1986), a multi-nation agreement for the management of waterfowl, proposes to restore prairie nesting areas and protect migration and wintering habitat for waterfowl and other migratory bird populations in the lower Mississippi River and Gulf Coast regions, among others. The NAWMP identifies coastal Louisiana as part of one of the most important regions in North America for the maintenance of continental waterfowl populations. The Barataria-Terrebonne estuary complex is an essential component of this region, and as such is of critical importance to waterfowl and migratory bird species. The continued loss of the wetlands in the Barataria-Terrebonne estuary complex poses an immediate and ongoing threat to such species, and hampers efforts to implement the NAWMP.

The fisheries value of the estuary complex also cannot be overemphasized. The fish community in the Barataria Basin is the most diverse of any estuary in Louisiana, with 191 species. The adjacent Terrebonne Basin is only slightly less diverse, with 153 species. The vast majority of these species depend on coastal wetlands for their existence. Mobile estuarine species utilize inundated wetlands and the marsh/water edge as habitat. These marsh areas, along with the adjacent shallow water areas are critical nursery areas for many important species. The marsh is also a critical food source in terms of detrital export. Given the rapid wetland loss and conversion, the no action plan would continue to destroy the aquatic diversity and biological productivity in this estuary complex.

The Magnuson-Stevens Fishery Conservation and Management Act of 1996 promotes the protection, conservation, and enhancement of Essential Fish Habitat (EFH). The Barataria-Terrebonne estuary complex provides a range of EFH, particularly the emergent marsh, that would be protected by the Bayou Lafourche project. As with the NAWMP, the proposed project would help meet the goals of this important Federal legislation.

Opportunities

The Bayou Lafourche reintroduction project has the potential to provide an important piece of the response to rapid ongoing wetland losses in the Barataria-Terrebonne estuary complex, but it will in no way solve the problem. Additional measures (including CWPPRA projects, other LCA near-term projects, and future large-scale efforts) will all be needed to help address historic and ongoing wetland and barrier island losses in the estuary complex. However, the Bayou Lafourche project is a critical next step in providing a more complete response, one that will provide important wetland benefits while also facilitating future restoration measures. Without such a complete response, of which Bayou Lafourche is a central component, the Barataria-Terrebonne estuary complex will continue to suffer from unacceptable levels of wetland loss.

Contingent authorization of this project would help provide much needed ecological stability and resilience, while complementary restoration projects are evaluated and implemented. Increasing the health of wetlands in the benefit areas will enhance ecosystem resiliency, which can be defined as the ability to withstand and respond to various stressors. Most notably, by increasing freshwater flows to the benefit areas, the project would help reduce the potential for wetland losses associated with periodic high salinity events. The immediate need for the project was particularly evident during the drought conditions of 2000, which have been associated with a large-scale die back of marsh vegetation in the Barataria and Terrebonne basins (due to a condition referred to as "Brown Marsh"). Although such events are stochastic in nature (i.e., difficult to predict), contingent authorization of the project would minimize the exposure to such risks for wetlands in the potential benefit areas.

While it would be possible to implement the project through the standard authorization process, doing so would unnecessarily delay implementation of a much needed restoration project. Regardless of the stochastic risks discussed in the previous paragraph, it can also be assumed, given the background loss rate in the area, that delaying implementation of the project would result in greater wetland losses. These additional wetland losses would likely result in:

- Decreased vital habitat for a diverse and highly productive coastal fishery;
- Adverse impacts to EFH;
- Decreased habitat for a wide array of resident and migratory birds and other wildlife; and
- Increased risk of marsh loss due to stochastic events, particularly drought-related losses such as "Brown Marsh."

The cumulative effects of past losses, and the certainty that losses will continue if no restoration is conducted, establish a clear need for expediting project implementation through contingent authorization. Given the significant ecosystem services provided by the Barataria-Terrebonne wetlands and the fact that these areas are experiencing the highest loss rates in the Nation, every effort should be made to accelerate ecosystem restoration efforts through the contingent authorization process. It is clear that the ecosystem at issue is in immediate need of restoration, and that such restoration efforts should begin as soon as possible.

Alternative Investigation

The Bayou Lafourche reintroduction project has been approved by, or is consistent with, a number of major planning efforts for coastal Louisiana, including the Barataria-Terrebonne National Estuary Program Comprehensive Conservation and Management Plan, Coast 2050, the 1993 CWPPRA Comprehensive Restoration Plan, CWPPRA priority project list (PPL) 5, and all seven cost-effective, coast wide restoration frameworks developed as part of the LCA process.

Successful ecosystem restoration depends upon our ability to restore and/or mimic natural structures and processes essential to ecosystem health. In the deltaic plain of coastal Louisiana, the essential ecosystem processes that must be restored or mimicked are the natural connections between the river and the estuaries. These connections come in various forms, ranging in scale and duration from river switching, distributary flow (such as that which occurred down Bayou Lafourche), crevasses, and over-bank flow. Levees and other structures along the Mississippi River have interrupted these connections severing the essential link between the river and deltaic wetlands. Successful restoration of the deltaic plain therefore depends upon restoring the flow of Mississippi River water (with its nutrients, sediment, and freshwater) to coastal wetlands.

Consistent with the restoration rationale provided above, the analysis of alternatives for meeting river reintroduction needs is to some extent, "place-specific." In other words, there are distinct environmental and logistical advantages to using naturally existing distributaries or crevasse locations in lieu of creating artificial ones. In looking for ways to move Mississippi River water into eastern Terrebonne basin and western Barataria basin (both of which are areas of critical need), the most obvious path is via the existing distributary of Bayou Lafourche. Given the basic purpose of the Bayou Lafourche project (to restore approximately 1,000 cfs of Mississippi River flow to the study area), it would clearly not be cost effective to consider digging a new distributary channel. (Note: the cost effectiveness of creating a new distributary channel for a much larger river reintroduction project such as the so-called "Third Delta" would be reviewed as part of the proposed LCA large-scale studies.)

The Bayou Lafourche Project was initiated in 1996 and has undergone significant engineering and environmental study leading to the conceptual project, as described in the 1998 report. Leading up to the 1998 report, a number of alternatives were considered, including concepts of moving water into the area from both the east and west by "re-plumbing" the waterways in the basins. In general, it was found that the demand for freshwater in the study area far exceeded the potential supply from such alternatives. Other ways of increasing freshwater flows to Terrebonne and Barataria Bays should, therefore, be considered complements to the Bayou Lafourche project, as opposed to alternatives. Consistent with this finding, the draft LCA Study does contain another project that could deliver fresh water to the eastern Terrebonne basin (i.e., Convey Atchafalaya River Water to Northern Terrebonne Marshes). Again, rather than being alternatives to each other, these two projects are complementary components of a larger effort to address the critical needs of the Barataria-Terrebonne estuary complex.

Recommended Plan

Given the programmatic nature of the LCA Study, a definite reintroduction volume has not yet been identified. As currently conceived, the Bayou Lafourche project would increase flows in the distributary channel to approximately 1,000 cfs. Alternatives considered thus far, or currently under consideration for Bayou Lafourche, include maximizing the Mississippi River flow into Bayou Lafourche, different reintroduction structures (including siphons, pumps and gates of different capacities), and the possible use of a bypass channel around Donaldsonville. The current concept of the Bayou Lafourche project includes dredging the bayou and bank stabilization to maintain existing water levels and prevent bank failure, respectively. Following is a summary of proposed features of the Bayou Lafourche project (subject to review in the project-specific feasibility study):

- Upgrading the existing pump/siphon facility to operate at the full 340 cfs capacity and constructing a new 660 cfs pump/siphon facility.
- Improving channel capacity to 1,000 cfs by eliminating the existing fixed weir at Thibodeaux and dredging 6.7 million cubic yards of material over approximately 55 miles of the channel within its existing banks. If the dredged sediments are clean, they will be made available for local use and land application or sale. Any contaminated sediment will require special placement.
- Providing bank stability over three miles of the channel. The improved channel and bank stabilization would prevent flooding of bayou-side residents.
- Operating five monitoring stations to provide continuous information on water levels and other bayou conditions.
- Installing two adjustable weirs, one at Thibodeaux and another at Donaldsonville, to control water levels as necessary to eliminate current causes of bank instability and to facilitate passage of storm runoff.
- Constructing a sediment trap at Donaldsonville to control siltation of the main channel and insure that flows are not impeded. This trap would be cleaned on an as-needed basis.

The pumps or siphons would be operated to reintroduce Mississippi River water into Bayou Lafourche. All affected parishes would have involvement in the timing and amounts of flow. Flows would be reduced during storm events and at times of strong southerly winds. The two weirs will also control water levels. The diversion structures will be connected to the Early Warning System on the Mississippi River that lets members know of any oil or chemical spills.

UNET modeling performed by the USACE provided an estimate of the distribution and impacts of diverted water under different existing hydrologic conditions (i.e., high and low flow conditions in all major channels between Barataria estuary and Atchafalaya River, and average Gulf stage) for reintroduction inputs of 1 cfs, 500 cfs, 1,000 cfs, 1,500 cfs, and 2,000 cfs. The UNET model studies demonstrated that approximately one third of the water would go east into the Barataria Basin, one third south to the Grand Bayou marshes and lower Bayou Lafourche, and one third west toward Bayou Terrebonne and the Houma Navigation Canal.

Monitoring

The monitoring plan for this project will analyze water level and water quality data from the five monitoring stations in the bayou. Aerial imagery will be analyzed to determine if the projected marsh loss reduction is occurring. The knowledge gained from analysis of the monitoring data will be used to adaptively manage this project and to help formulate plans for other reintroductions.

Since the CWPPRA program has programmed nearly all its funds on smaller and less expensive projects, it is more appropriate to fund this ecosystem-wide project that costs more than $100 million under the LCA.

Benefits

By increasing the connection of the river to the bayou, the Bayou Lafourche project would nourish marshes, contribute to soil building through mineral sediment accretion and organic matter production, and combat saltwater intrusion during droughts or prolonged southerly winds. The associated increased vegetative health and vertical accumulation of the marsh surface would counterbalance subsidence and reduce future wetland loss in the area.

As part of the CWPPRA process, the wetland benefits of the Bayou Lafourche project, with regard to providing habitat for a variety of fish and wildlife species, were calculated using Wetland Value Assessment (WVA) methodology. The WVA was developed by the CWPPRA Environmental Work Group (EWG) to quantify changes in fish and wildlife habitat quality and quantity projected to be brought about as a result of a proposed wetland restoration project. Results are measured in Average Annual Habitat Units (AAHUs) that are representative of expected changes over time in wetland quality (habitat suitability) and quantity (acres) under future with and without project scenarios.

The Bayou Lafourche project was assessed using WVA methodology in 1998. This WVA assumed a flow of approximately 1,000 cfs delivered by siphon and/or pump. This meant that water could be diverted year-round.

Seven major wetland benefit areas were identified and subdivided according to marsh habitat type (see **figure 4**). The benefit areas encompass 85,094 acres (nearly 49,000 acres of wetlands and 36,000 acres of water). Wetland benefits were determined primarily in terms of the projected reduction in marsh loss expected to occur as a result of the project. The mechanisms through which the diversion was expected to impact marsh loss in the seven areas were: (1) the reduction of salinity stress due to increased freshwater flows, and (2) the stimulation of organic production in emergent marshes as a result of the introduction of clay sediment and nutrients. Based on the 1998 WVA, it is estimated that at the end of 50 years there would be approximately 2,500 more acres of marsh than if the project had not been built. The WVA also credited this project with increasing submerged aquatic vegetation (SAV) that improves habitat for fish and waterfowl.

Although the WVA measures many attributes of estuaries that fish and wildlife rely upon, there would be unquantifiable benefits over the 49,000 acres of wetlands and 36,000 acres of estuarine waters, especially with a project such as this that is synergistic with other projects. It is possible that the acres preserved are underestimated. There would be benefits to threatened species such as the bald eagle and higher quality EFH would be preserved. In addition, waterfowl habitat would be improved.

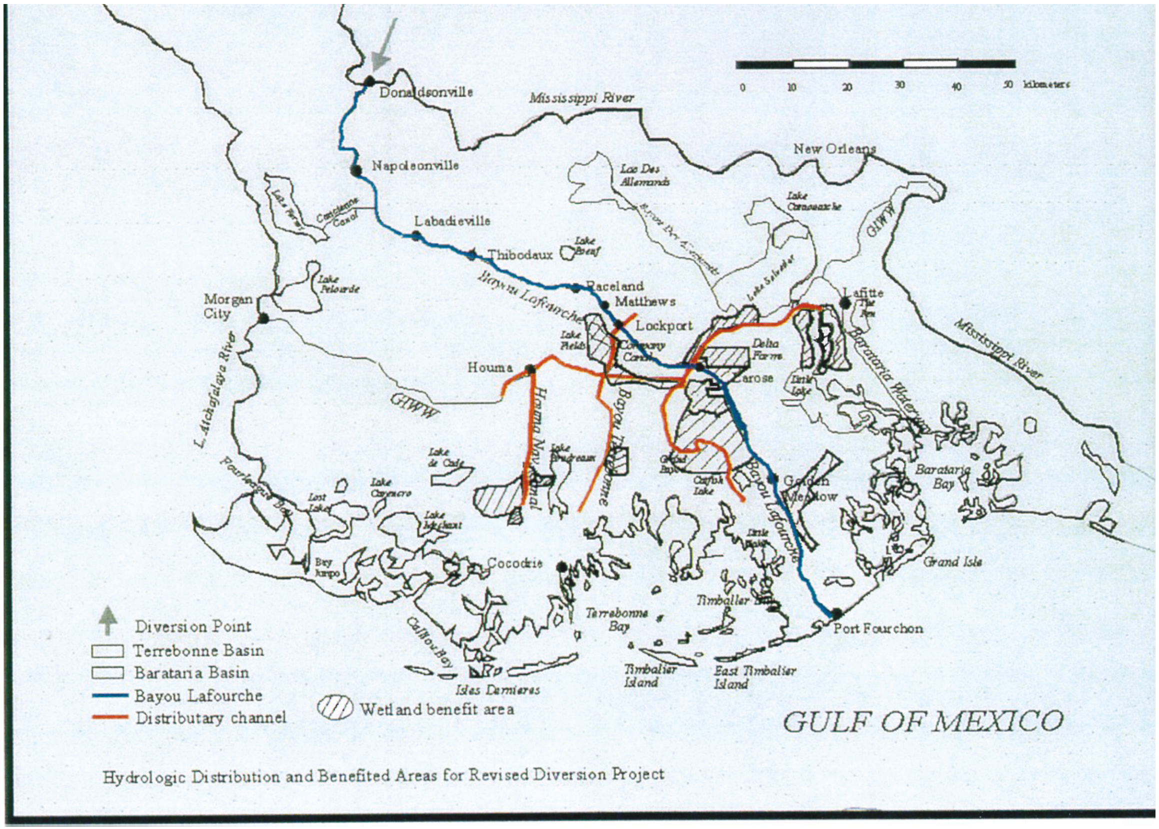


Figure 4. Project Benefit Areas

Additionally, the Bayou Lafourche project would provide important incidental benefits, which are intrinsically linked to the need to increase river flows into the distributary channel. These incidental benefits include:

- Maintaining potable water supply;
- Enhancing water quality;
- Maintaining or possibly increasing drainage capacity
- Enhancing recreational opportunities; and
- Reducing a small amount of nutrients currently being discharged into the Gulf of Mexico.

By combating saltwater intrusion, the Bayou Lafourche project would help protect valuable and threatened coastal wetlands, while also reducing the chances that municipal and industrial water supplies could be disrupted due to elevated salinity events. Because the project includes channel capacity improvements and added water control features, the project also has the potential to maintain and possibly improve drainage. Additionally, water quality would be improved by increased flushing of the bayou with river water. The state and EPA are currently in the process of revising the water quality standards for Bayou Lafourche. The project is projected to improve existing water quality, thereby possibly reducing the need for future infrastructure improvements related to National Pollutant Discharge Elimination System (NPDES) dischargers. Finally, by routing Mississippi River water through wetlands, there would be a relatively small reduction in nitrogen being discharged into the Gulf of Mexico. In this way, the project could contribute in a small way to the national goal of reducing hypoxia in the Gulf of Mexico.

Synergy with Other Restoration Projects

Consistent with the criteria for identifying critical near-term projects, a balanced approach to restoring coastal Louisiana should address both critical ecosystem processes and structures. In the case of the deltaic plain, the most important process is the connection between the Mississippi River and the estuaries, while barrier islands and shorelines serve as some of the most critical structural components of the ecosystem.

The Bayou Lafourche project would have a complementary and/or synergistic relationship with a number of past, ongoing, and future restoration projects, conducted pursuant to CWPPRA, other authorities, and, if authorized, the LCA Plan. In particular, the Bayou Lafourche reintroduction project would serve to restore to some extent deltaic processes in an estuarine complex that has benefited from a number of barrier island projects. The Bayou Lafourche project would also complement other LCA projects in the Barataria-Terrebonne estuary complex, particularly Barataria Basin Barrier Shoreline Restoration, Caminada Headland, Shell Island and, in a more general sense, the proposed Medium Diversion at Myrtle Grove, modification of the Davis Pond Freshwater Diversion, and Multipurpose Operation of the Houma Navigation Canal Lock, a component of the Morganza to the Gulf Hurricane Protection Levee.

As noted above, the Bayou Lafourche project could have a synergistic relationship with the LCA project entitled Convey Atchafalaya River Water to Northern Terrebonne Marshes. The combined effect of the two projects could greatly reduce saltwater intrusion in the eastern Terrebonne wetlands, and could create opportunities to address other areas of critical need. Moreover, potential measures to improve distribution of Bayou Lafourche reintroduction waters (e.g., enlargement of Bayou L'Eau Bleu and/or Grand Bayou Canal) could facilitate efforts to move Atchafalaya waters into areas of critical need. Given this positive interrelationship, opportunities to maximize synergy between these two projects should be fully evaluated in the feasibility study for the Bayou Lafourche reintroduction.

Costs

The estimate of total project costs is based upon a schedule of project expenditures that was provided for each year of the project. This schedule represents incremental, or "un-inflated," costs. Expenditures include future planning, engineering and design (PED) costs; construction costs; and monitoring costs. Operations and maintenance (O&M) costs are reported separately. As with any single USACE project, individual expenditures are either compounded or discounted to a given base year, defined as that year in which the project is generating all of the outputs intended by its design. The project cost estimate is derived by summing the compounded/discounted values to yield the present value of costs that is correlated to the corresponding base year. This figure is then annualized using the Federal discount rate (5-3/8 percent for fiscal year 2005) and a 50-year project life to yield an estimate of average annual project costs.

The estimate of total project costs and its average annual equivalent on a "fully-funded" basis is derived in exactly the same manner as described above, except that the schedule of project costs previously reported as incremental costs are adjusted to include inflation. The factors that are used to inflate project costs are those provided in the Fiscal Year 2006 Budget Engineering Circular.

As the project is developed, more and more information will become available to refine the project design, address uncertainties, and to allow for the selection of the most favored alternative. The following is a summary of cost information based on the conceptual project of 1,000 cfs. Additional cost information has been developed from ongoing preconstruction engineering and design work conducted in the CWPPRA for a freshwater introduction at Bayou Lafourche.

The estimated cost for designing and constructing the freshwater reintroduction is $144.116 million (including monitoring). Details of this cost estimate are provided in the following tables:

Table 1. MCACES Cost Estimate, Bayou Lafourche Reintroduction

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
01-	LANDS AND DAMAGES						
	Lands and Damages (Includes Influence Area)						
01B	Acquisitions						
01B20	By Local Sponsor (LS)				17,000	8,500	25,500
01B30	By Govt on Behalf of LS				1,519,138	759,570	2,278,708
01B40	Review of LS				21,640	10,820	32,460
01C	Condemnations						
01C30	By Govt on Behalf of LS				72,870	36,440	109,310
01E	Appraisal						
01E40	By Govt on Behalf of LS (Contract)				280,000	140,000	420,000
01E50	Review of LS				72,400	36,200	108,600
01F	PL 91-646 Assistance						
01F30	By Govt on Behalf of LS				115,000	57,500	172,500
01G	Temporary Permits/Liscenses/Rights-of-Entry						
01G10	By Government				99,925	49,960	149,885
01N00	Facility/Utility Relocations (Subordination Agreement)				55,800	27,900	83,700
01R	Real Estate Payments						
01R1	Land Payments						
01R1B	By LS (Oysters)				173,525	86,760	260,285

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
01R1C	By Govt on Behalf of LS				4,985,180	2,493,192	7,478,372
01R2	PL 91-646 Assistance Payments						
01R2C	By Govt on Behalf of LS				928,000	464,000	1,392,000
01T	LERRD Crediting						
01T20	Administrative Costs (By Govt and LS)				10,450	5,230	15,680
51	Operations & Maintenance During Construction						
51B	Real Estate Management Services				2,000	1,000	3,000
51B20	Outgrants (Over 5 Years)				15,000	7,500	22,500
51B30	Disposal/Quitclaim				25,000	12,500	37,500
01--	Subtotal: Lands And Damages (Includes Influence Area)						8,392,928
	Contingencies						4,197,072
01--	Subtotal: Lands And Damages (Includes Influence Area)						12,590,000
01--	TOTAL: LANDS AND DAMAGES						12,590,000
02--	RELOCATIONS						
02------	Pipeline Relocations (58)	Lump Sum	LS	9,200,000	9,200,000	5,520,000	14,720,000
	TOTAL: RELOCATIONS						14,720,000
09--	CHANNELS AND CANALS						
09--	Dredging						
	Channel Dredging (6,725,000 cy)	Lump Sum	LS	30,734,000	30,734,000	18,252,720	48,986,720
	Sand Trap (90,000 cy)	Lump Sum	LS	236,125	236,125	137,155	373,280
09--	Subtotal: Dredging						30,970,125
	Contingencies						18,389,875
09--	Subtotal: Dredging						49,360,000
09--	Remove Thibodaux Weir	Lump Sum	LS	115,000	115,000	66,000	181,000
09--	Deployable Weir at Thibodaux						

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
	Mob & Demob	Lump Sum	LS	32,400	32,400	18,792	51,192
	Rubber Dam	Lump Sum	LS	376,506	376,506	218,210	594,716
	Installation and Testing	Lump Sum	LS	1,500	1,500	870	2,370
	Foundation					0	
	Sheet Pile	9,350	SF	18	168,300	97,614	265,914
	Concrete	111	CY	400	44,400	25,752	70,152
	Excavation	75	CY	5	375	218	593
	Fill	65	CY	10	650	377	1,027
	Cofferdam (Temp sheet pile)	10,200	SF	11	112,200	65,076	177,276
	Rock Ramp	370	TN	35	12,950	7,511	20,461
	Misc.	Lump Sum	LS	9,050	9,050	5,249	14,299
09--	Subtotal: Deployable Weir at Thibodaux						758,331
	Contingencies						439,669
09--	Subtotal: Deployable Weir at Thibodaux						1,198,000
09--	Deployable Weir at Donaldsonville						
	Mob & Demob	Lump Sum	LS	37,540	37,540	21,773	59,313
	Rubber Dam	Lump Sum	LS	406,948	406,948	236,030	642,978
	Installation and Testing	Lump Sum	LS	1,500	1,500	870	2,370
	Foundation						
	Sheet Pile	11,700	SF	18	210,600	122,223	332,823
	Concrete	180	CY	400	72,000	41,760	113,760
	Excavation	450	CY	5	2,250	1,305	3,555
	Fill	130	CY	10	1,300	754	2,054
	Cofferdam (Temp sheet pile)	12,500	SF	11	137,500	79,750	217,250
	Rock Ramp	500	TN	35	17,500	10,150	27,650
	Misc.	Lump Sum	LS	9,650	9,650	5,597	15,247
09--	Subtotal: Deployable Weir at Donaldsonville						896,788
	Contingencies						520,212
09--	Subtotal: Deployable Weir at Donaldsonville						1,417,000
09--	TOTAL: CHANNELS AND CANALS						52,156,000

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
13--	PUMPING PLANTS						
13--	- New 660 cfs Pumping Station						
	Mob and Demob and Site Preparation	Lump Sum	LS	1,325,000	1,325,000	768,500	2,093,500
	Intake Structure	Lump Sum	LS	1,247,000	1,247,000	723,260	1,970,260
	Intake Lines	Lump Sum	LS	1,548,000	1,548,000	897,680	2,445,680
	Pump Pit Structure	Lump Sum	LS	1,333,000	1,333,000	773,140	2,106,140
	Mechanical and Electrical	Lump Sum	LS	2,265,000	2,265,000	1,313,700	3,578,700
	Discharge Pipes	Lump Sum	LS	1,466,000	1,466,000	850,280	2,316,280
	Discharge Structure	Lump Sum	LS	368,000	368,000	213,440	581,440
13--	Subtotal: New 660 cfs Pumping Station						9,552,000
	Contingencies						5,540,000
13--	Subtotal: New 660 cfs Pumping Station						15,092,000
13--	Replace Existing 340 cfs Pumps						
	45,000 gpm Variable Speed Pumps	2	EA	240,000	480,000	278,800	758,800
	Electric Motors	2	EA	100,000	200,000	116,000	316,000
	Install Pumps and Motors	2	EA	20,000	40,000	23,200	63,200
13--	Subtotal: Replace Existing 340 cfs Pumps						720,000
	Contingencies						418,000
13--	Subtotal: Replace Existing 340 cfs Pumps						1,138,000
13--	TOTAL: PUMPING PLANTS						16,230,000
16--	BANK STABILIZATION						
16--	Bulkheads (2 miles timber, 1 mile steel)	Lump Sum	LS	3,990,432	3,990,432	2,314,165	6,304,597
16--	Scour Protection at Bridges (9)	Lump Sum	LS	373,040	373,040	216,363	589,403

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
16--	Subtotal: Bank Stabilization						4,363,472
	Contingencies						2,530,528
16--	Subtotal: Bank Stabilization						6,894,000
16--	TOTAL: BANK STABILIZATION						6,894,000
30--	ENGINEERING AND DESIGN						
	Design Documentation (Feasibility)				11,250,000	2,250,000	13,500,000
	PED				7,497,000	1,503,000	9,000,000
	E&D				4,200,000	840,000	5,040,000
30--	Subtotal: Engineering And Design						22,947,000
	Contingencies						4,593,000
30--	TOTAL: ENGINEERING AND DESIGN						27,540,000
31--	CONSTRUCTION MANAGEMENT						
	Supervision and Administration (S&A)				10,800,000	2,160,000	12,960,000
31--	TOTAL: CONSTRUCTION MANAGEMENT						12,960,000
	TOTAL PROJECT COST						144,116,000

Monitoring the performance of the project features will be conducted as part of the construction portion of the recommended plan. The purpose of including monitoring in the project is to document the performance of the reintroduction in terms of meeting the environmental goals of the project. Monitoring will assess the engineering performance of the designs to aid in decisions regarding operations and maintenance needs and to feed information into an adaptive management program for the coast.

All of the structural components of this feature will require operations and maintenance to sustain engineering performance and achieve long-term project environmental goals. In general, the maintenance requirements are driven by the need to manage the freshwater introduction. Management will vary depending upon the specific flows in the Mississippi River that are variable from year to year. Typical operations and maintenance actions will include engineering inspections of the pipes and minor construction events to maintain the performance of outfall management measures. These OMRR&R actions will be the responsibility of the local sponsor. The estimated annual O&M cost is $1,400,000.

Table 2 provides a summary of the first costs for the LCA Plan to reintroduce Mississippi River water into Bayou Lafourche.

Table 2. Small Bayou Lafourche Reintroduction Summary of Costs for the LCA Plan (June 2004 Price Level)		
Lands and Damages	$	12,590,000
Elements:		
Relocations	$	14,720,000
Channels and Canals	$	52,156,000
Pumping Plants	$	16,230,000
Bank Stabilization	$	6,894,000
Monitoring	$	1,026,000
First Cost	$	103,616,000
Feasibility-Level Decision Document	$	13,500,000
Preconstruction Engineering, and Design (PED)	$	9,000,000
Engineering, and Design (E&D)	$	5,040,000
Supervision and Administration (S&A)	$	12,960,000
Total Cost	**$**	**144,116,000**

A detailed breakdown of cost accounts between Federal funds and the share responsibilities of the local sponsor is provided in **table 3.**

Table 3. Small Bayou Lafourche reintroduction FEDERAL AND NON-FEDERAL COST BREAKDOWN (June 2004 Price Level)			
Item	**Federal**	**Non-Federal**	**Total**
Decision Document (50%Fed-50%NFS)	$ 6,750,000	$ 6,750,000	$ 13,500,000
PED (65%Fed-35%NFS)	$ 5,850,000	$ 3,150,000	$ 9,000,000
LERR&D (100% NFS)	$ -	$ 27,310,000	$ 27,310,000
Ecosystem Restoration (65%Fed-35%NFS)	$ 66,683,500	$ 8,596,500	$ 75,280,000
Engineering and Design (E&D) (65%Fed-35%NFS)	$ 3,276,000	$ 1,764,000	$ 5,040,000
Supervision and Administration (S&A) (65%Fed-35%NFS)	$ 8,424,000	$ 4,536,000	$ 12,960,000
Monitoring (65%Fed-35%NFS)	$ 666,900	$ 359,100	$ 1,026,000
Total Construction	**$ 84,900,400**	**$ 45,715,600**	**$ 130,616,000**
TOTAL COST	**$ 91,650,400**	**$ 52,465,600**	**$ 144,116,000**
Cash Contribution	*$ 91,650,400*	*$ 18,405,600*	

Implementation Plan

Initial Project Management Plan (PMP) and scoping efforts to address the appropriate level of engineering detail required for the follow-up feasibility-level decision document for the Bayou Lafourche Reintroduction features are currently underway. The PMP is expected to be negotiated by the end of December 2004 and will form the basis for assigning tasks between the USACE and the sponsor (LDNR) as well as detail the conduct of the feasibility-level analyses. Development of the decision document is anticipated to begin in January 2005, with completion estimated in about one year (April 2006). Pre-construction engineering and design (PED) efforts to finalize the detailed design and prepare the project for construction would initiate once a design agreement is negotiated with LDNR to define the scope, schedule, and cost of the design. Preparations of plans and specifications for construction could commence in April 2006 and are forecast for completion in July 2007. Construction of the features could begin following PED with approval and execution of a Project Cooperation Agreement (PCA). The current schedule would allow for construction to begin as early as July 2007, with construction completion estimated in March 2012.

These accelerated schedules are important for the implementation of the tentatively selected plan. Experience in designing and constructing similar features in coastal Louisiana indicates that these schedules are attainable given the necessary level of coordination and funding that will be required to achieve the goals and objectives of the plan to address the critical needs facing coastal Louisiana.

National Environmental Policy Act (NEPA)

Procedures necessary to comply with the NEPA have been initiated as part of the ongoing CWPPRA process for the Bayou Lafourche project. A NOI to prepare an EIS for Mississippi River Reintroduction into Bayou Lafourche was published in the *Federal Register* on March 23, 2004. In April 2004, EPA hosted five NEPA scoping meetings in Gray, Donaldsonville, Larose, Napoleonville, and Thibodaux, Louisiana. A draft EIS is being prepared to accompany the design report. During the public scoping meetings, numerous private and public stakeholders expressed strong support for this project. Indeed, a number of stakeholders expressed frustration that the project has not yet been implemented.

The information gathered as part of this ongoing NEPA process would be directly applicable to the EIS that would be prepared as part of the LCA programmatic authorization process. As required by the NEPA process, the Bayou Lafourche Project EIS will consider the affected environment including the direct and cumulative affects of the project. The engineering and environmental information developed under CWPPRA for the Bayou Lafourche Project would expedite development of both the LCA EIS and the feasibility study.

The environmental impacts of the near-term features recommended in the LCA authorization are covered in the Programmatic Environmental Impact Statement (PEIS) for the study. In addition, each specific project recommended will proceed through feasibility study for approval requiring project specific review under NEPA through a Supplemental Environmental Impact Statement (SEIS) or Environmental Assessment (EA). These environmental compliance actions will be completed in decision documents to be reviewed and approved by the Secretary of the Army.

During the plan formulation process, the LCA PDT assessed the impacts of various specific restoration techniques, the specific subprovince restoration frameworks, the identified final array of coast wide frameworks, the alternative plans for best meeting the study objectives, and the LCA Plan. The PEIS identified and discussed these impacts by specific and cumulative natural and human environmental effects for the alternative plans carried over for detailed analysis. The PEIS provides a consistent basis for initiating NEPA documentation of individual restoration features in the context of larger systemic coastal needs and functions.

Uncertainties/Risks

All major environmental restoration projects come with uncertainties and risks. Thorough study and review prior to project implementation is critical for minimizing such risks and uncertainties. Effective monitoring and adaptive management (as is included as part of the LCA Study) is key for managing unforeseen consequences and maximizing project effectiveness.

As outlined above, the Bayou Lafourche project has already been the subject of interagency review, numerous planning processes, considerable public review, and a range of environmental and engineering analyses. This extensive review process has helped identify and address a number of potential questions/concerns, such as whether increased volumes of water in the bayou could cause flooding, what would occur if there is a hazardous substance spilled in the river near the reintroduction structure, and the extent to which there could be bank instability along the bayou. While the final Engineering and Design (E&D) is needed to substantively answer such questions, the information available to date indicates that such issues will either not occur or, if they could occur, are manageable and do not render the project infeasible or too risky. With respect to flooding in particular, as noted under the "Benefits" section of this report, the channel improvements envisioned as part of the project have the potential to increase drainage capacity.

Recommendations/Summary

The Bayou Lafourche project has been recommended for contingent authorization based on its capability to address critical ecological needs such as slowing the dramatic land loss, preserving habitat for numerous fish and wildlife species and reducing salinity intrusion. At least five years of these critical losses could be avoided by contingent authorization. The Bayou Lafourche Project will restore, to some extent, the natural distributary process in which the bayou serves as a conduit to provide Mississippi River water to coastal areas with the highest wetland loss rates in the U.S. Moreover, because this project has the potential to provide important incidental benefits to water supply and water quality, it would also serve as a model for how restoration efforts can provide immediate, near-term benefits to humans.

The Small Bayou Lafourche Reintroduction project also offers an excellent opportunity to capitalize on existing environmental and engineering information to provide near-term environmental benefits to an area of critical need. Because the project is currently in the process of engineering and design, it is in a unique position to move forward relatively quickly. Likewise, the logistical and environmental information gained from both the planning and implementation of the project would be invaluable to future LCA efforts. For all of these reasons, the Bayou Lafourche reintroduction project should be included in the contingent authorization category for the LCA Study.

Sources

Cost estimate provided by USACE-MVN.

U.S. Environmental Protection Agency, Region 6. September 1998. Preliminary Draft Evaluation of Bayou Lafourche Wetlands Restoration Project: Summary Report. Volume I. Unpublished.

U.S. Environmental Protection Agency and U.S. Department of Army, Corps of Engineers. April 2001. Draft Bayou Lafourche Update. www.bayoulafourche.org/client_files/editor_files/BLFrecon4_12_01_TFMtg.pdf

Medium Diversion with Dedicated Dredging at Myrtle Grove

A Near-Term Critical Feature for the Louisiana Coastal Area Plan

Medium Diversion at Myrtle Grove with Dedicated Dredging
A Near-Term Critical Feature for the Louisiana Coastal Area Plan

Introduction

The Medium Diversion with Dedicated Dredging at Myrtle Grove critical near-term feature addresses both the need to preserve long-term restoration opportunities and to bring significant reversal of the wetland loss trend. In preserving long-range restoration opportunities, implementation of this feature also supports several possible outcomes of proposed large-scale studies. The immediate restoration impact of the implementation of the Myrtle Grove feature is significant in addressing predicted future wetland loss in an ecologically critical zone of habitat transition in one of the most productive estuaries in the Nation. In addition, commercial and private development at the perimeter of this basin, located to take advantage of its productivity and to support local, regional, and National economic interests, would receive incidental benefits from the restoration of these wetlands. These benefits would include continued sustainable biologic productivity in the estuary as well as the indirect benefit of reduction of storm-driven tidal stages.

Currently authorized Federal environmental projects (in this specific case, the Davis Pond Freshwater Diversion project) have been designed to sustain and stabilize the present basin wide salinity regime. This outcome falls short of the broader restoration objectives but existing projects can and will be incorporated or modified in the implementation of this feature and other future restoration efforts. In this manner, the proposed restoration feature will also support adaptive management and learning goals and provide a platform for additional learning through add-on demonstration projects.

The proposed restoration feature considers a diversion ranging from 2,500 to 15,000 cfs coupled with dedicated dredging for the creation of up to 19,700 acres of new wetlands. This combination will allow for rapid creation of wetland acreage and long-term sustainability. The diversion will allow the reintroduction of freshwater, sediment, and nutrients into the critically effected area of the basin in a manner similar to the rise and fall of the river's hydrologic cycle. The rate of reintroduction will be optimized according to the overall planning objectives of the LCA restoration effort to maintain hydro-geomorphic diversity and connectivity, as well as habitat diversity. The dedicated dredging component of the Myrtle Grove feature will allow immediate recovery of former wetland areas already converted to open water. The combination is also expected to maximize the amount of acreage created per yard of sediment placed by capitalizing on incremental accretion of diverted sediment.

Stand-alone marsh creation typically requires over-building the marsh substrate to a designated pre-settlement elevation from which the newly created marsh will settle to an optimal, tidally-influenced elevation. However, wetland soils (particularly fresher marsh types) have a high organic content as a result of their normally high vegetative productivity. The combination of marsh creation with dredged material coupled with subsequent sediment and nutrient reintroduction should reduce or eliminate the need to over-build and allow vertical accretion through accumulation of organic biomass.

The key components of the proposed feature, which will be discussed in greater detail, include:

- A gated diversion structure with a capacity of approximately 5,000 cfs
- Inflow and outflow channels totaling approximately 16,000 feet
- Associated channel guide levees and infrastructure relocation
- Identified marsh creation sites adequate for the creation of at least 6,500 acres

Description of Area/Background

Located in Subprovince 2, the project area is on the west bank of the Mississippi River in Plaquemines Parish, in the vicinity of Myrtle Grove, Louisiana (see **figure 1**). The project area is focused around the highly deteriorated marshes adjacent to the river, extending southward to central portions of Barataria Basin. The Barataria Basin is located in the following Louisiana parishes: Ascension, Assumption, Jefferson, Lafourche, Orleans, Plaquemines, St. Charles, St. James, and St. John the Baptist.

Soil borings and vibracores taken in the Myrtle Grove area indicate that this area has received deltaic sedimentation from two deltaic systems. Approximately 3,000 years ago, a major distributary of the St. Bernard Delta was actively depositing sediment into an open water setting in the Myrtle Grove area. This open water was filled with prodelta, interdistributary, and marsh deposits. After several hundred years, the St. Bernard Delta shifted away from this area and the processes of subsidence and erosion became dominant. Much of this area was converted to shallow open water, which remained until the next episode of delta progradation entered the area.

Approximately 1,000 years ago, the Plaquemines Delta began to deposit sediment in the Myrtle Grove study area. Shallow water areas were filled with interdistributary and marsh deposits. The Mississippi River has been in its present location for the past 1,000 years, and the study area continued to receive fresh water and sediment from the Mississippi River and its distributaries.

With the development of the Mississippi River levee system over the last century, once frequent introductions of sediment and nutrients were disrupted. These introductions helped the area accrete sediment and detritus, and the marshes kept pace with subsidence. Another major factor was the dredging of oil and gas and navigation canals that allowed salt water to encroach far inland, resulting in a shift from intermediate marshes to slower-growing brackish marshes. The high subsidence rate combined with these factors resulted in a rapid degradation of the marshes in the area.

In 1949, the marshes in the Myrtle Grove project area were primarily intermediate marsh (60 percent) and brackish marsh (40 percent). By 1978, the habitat had shifted almost entirely to brackish marsh. Concurrent with the shift in habitat was a period of high land loss. This was mainly due to altered hydrology, wind erosion, subsidence, and direct losses from dredging.

Loss rates continue to be high, and reflect the effects of saltwater and tidal intrusion as well as a high subsidence rate (2.1 to 3.5 ft/century).

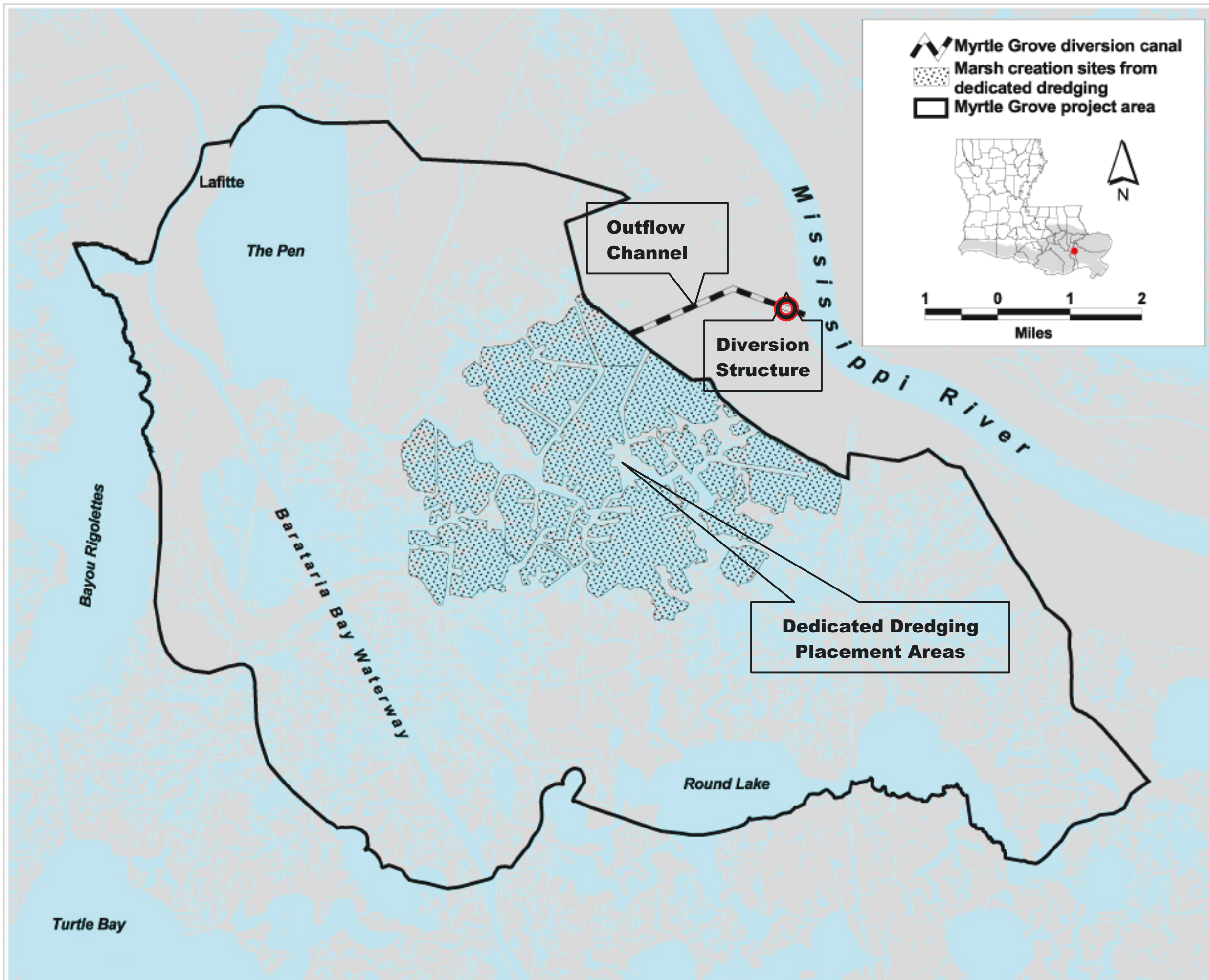


Figure 1. Medium Diversion at Myrtle Grove with Dedicated Dredging Feature Elements and Primary Influence Area

Two projects in the vicinity have helped reduce these impacts. The siphons at West Pointe a la Hache and Naomi have reduced loss rates in their project areas. A diversion in the Myrtle Grove, Louisiana area into the marshes to the west is expected to benefit the marshes as well. The scaling of the diversion would account for salinity patterns in the area, especially in conjunction with the Davis Pond Diversion, which introduces fresh water at the northern end of the Barataria Basin. This would be accomplished with a hydrologic model that would account for the interaction of these two major diversions with the isohalines in the project area.

The salinity regime is important because of the productivity of seafood in the area. The Barataria Basin is a primary fishing ground for brown and white shrimp, blue crab, spotted seatrout, menhaden, red drum, and oyster. Most of these species are estuarine dependent, and utilize the marshes for nursery habitat. Decreases in the acreage of marsh could affect recruitment of these species, as well as the abundance of their prey.

The marsh is comprised primarily of marsh-hay cordgrass and smooth cordgrass. These marshes support a great diversity of fish and wildlife, including red and black drum, spotted seatrout, menhaden, flounder, oyster, shrimp, blue crab, wading birds, shorebirds, seabirds, and alligator. The numerous bayous provide access to fish nursery habitat, and these young fish provide a base for the food chain of larger predators.

Problems and Needs

The project area is currently a sediment-starved system with little freshwater input. These factors have magnified the high subsidence in the area, resulting in massive land loss. To counteract this loss, the project area needs inputs of both sediment and water. The Davis Pond diversion provides fresh-water input to the basin to the north, but local marshes are too far removed from the diversion structure to benefit directly from the introduction of nutrients, and the salinity regime would be more controllable with a fresh-water input closer to the area of need.

A diversion from the Mississippi River would provide both resources, and would provide a relatively cost-effective way to recreate land in the project area. Nevertheless, the land accretion process is slow, and an introduction of material through dedicated dredging would provide for a marsh platform immediately. To balance the need for wetland acreage in the near-term with the ability to sustain the marshes over the long-term, various combinations of marsh creation through dedicated dredging and fresh-water introductions through a river diversion will be examined.

Without Project Conditions

<u>Critical Need</u>

The proposed restoration feature has the potential to prevent significant future land loss where currently predicted to occur in the central portion of the Barataria Basin. U.S. Geological Survey (USGS) data indicates that within just the immediate influence area of the feature approximately 12,900 acres have been lost since 1956. An approximate 7,900 additional acres are predicted to be lost by 2050. This represents a loss of 26.75 percent of the currently existing wetlands in the Myrtle Grove area.

This area is a transitional zone in the estuary where brackish-saline type and intermediate-fresh type marshes merge, transitioning from saline marsh to the south and into fresh marsh at the northern extent near the Gulf Intracoastal Waterway (GIWW). These transitional habitats are some of the most productive within the estuarine system supporting a wide array of both juvenile and adult fisheries species. Current habitat data for the immediate Myrtle Grove influence area indicates that 66 percent of the remaining marsh is brackish and an additional 24 percent is intermediate in nature. This is significant in contrast to the 1956 habitat classification data that identifies, in addition to there being a greater quantity of wetland acreage in the Myrtle Grove area, that of the existing acreage at that time 89 percent was fresh/intermediate and 4 percent saline/brackish in nature.

The Future Without Action conditions forecast by ecologic modeling indicates that, in the next fifty years, all saline and brackish marsh and approximately 40 percent of the intermediate marsh in the Barataria Basin will be lost. This can be attributed to lack of sediment input, and continued soil subsidence. In addition to directly resulting in wetland loss, these factors are compounded by the low success of saline vegetation reestablishing on the highly organic soils established in fresh marshes. These combined factors along with the projected hydraulic and ecologic trends in, and current make up of, the area in the vicinity of Myrtle Grove indicates that it is at particularly high risk.

The proposed feature also takes advantage of the resources available from the Mississippi River to meet study objectives (establishing dynamic salinity gradients, increasing sediment inputs, establishing and maintaining hydrologic processes, sustaining biologic diversity, and reducing nitrogen delivery to the Gulf of Mexico). Reconnecting the river to the estuary and placing river borne sediments into the system promotes long-term ecosystem sustainability. The feature also addresses the improvement of overall water quality within the basin.

The restoration of wetlands in this area will also protect and support socio-economic interests located in the central and upper portions of the Barataria basin to capitalize on the fisheries productivity of the estuary. The communities of Lafitte and Barataria represent the southernmost development in the interior of the Barataria Basin and are located outside of any existing hurricane protection works. Loss of the existing wetland structure will have an immediate impact on the sustainability of these communities. In addition, industries located along the Mississippi River in the vicinity of Myrtle Grove would also become threatened with the loss of interior wetlands in this area. Currently, there is no Federal hurricane protection levee parallel to the river in this area. The absence of this protection is due, in part, to the historic presence of the wetlands.

Projected Near-Term Loss -- *Criticalness*

There is a need to factor both discreet land loss events (such as hurricanes and drought induced dieback) as well as linear functions of erosion (subsidence, shoreline erosion, etc.) in to any projection of wetland loss. As a result of this “smoothing” of historic data into a trend, the resulting projections do not identify dramatic short-term loss potential. However, ecologic modeling projections, for no-action conditions, do estimate a loss of 119,000 acres within the entire Subprovince 2 area over the next 50 years. This simulation also estimates that approximately 24 percent of this loss would occur in the first 10 years, a rate of about 2,800 acres per year. Since the majority of the wetland loss without action is projected to occur in the areas of intermediate to saline marsh, the central area of the Barataria Basin is likely to experience significant losses in the near-term. In addition, these marsh types typically represent the most biologically diverse and productive portion of the estuary. The discreet hydrologic events mentioned previously have a significant impact on overall system loss and the rate of loss. In addition to the direct losses that result from periodic storm events, there are even greater losses associated with secondary effects of these storms and longer-term hydrologic events such as droughts. These events typically have the effect of creating drastically elevated salinity across the landscape, which results in relatively rapid plant mortality. As the coastal ecosystem becomes increasingly more deteriorated and stressed, the level of risk for rapid or accelerated loss due to such events increases at a compounded rate.

This would also indicate that the development in the vicinity of the central area of the basin would be place at more immediate risk. The presence of this development is directly related to the presence and magnitude of the natural and biologic resources found in the estuary. As the system deteriorates the resource output of the system may remain high, however, the direct risk for structure and infrastructure damage and loss also increases. Ultimately the loss of critical productive habitat and diversity will result in lost livelihoods as the resource outputs of the system diminish. Restoration of function in critically affected areas, and eventually the entire system, provides for the sustainability of diverse ecosystem resources even though the physical and spatial distribution of the resources may be altered.

Synergy with Other Restoration Projects

The recommended diversion and marsh creation feature at Myrtle Grove has links to two of the large-scale, long-range studies identified in the LCA Plan. One, the Mississippi River Delta Management study, would investigate the multiple-use management of the lower Mississippi River. This might include the relocation of current navigation routes for the purpose of making available additional river flow and sediment for restoration. Previous analysis of alternative navigation routes has identified the need to use a system of locks to manage river flow and deep draft navigation traffic effectively.

If such a concept were ultimately found feasible and recommended, the currently proposed Myrtle Grove diversion feature would support such future action. If the navigation channel were proposed for relocation into Barataria Basin, then features such as the Myrtle Grove diversion would offset increases in salinity that occur in the presence of such a deep draft channel. The conditions in the vicinity of the Mississippi River – Gulf Outlet are an example of such an adverse effect. Conversely, if future long-range studies indicate that status quo with regard to navigation and flood control is appropriate, then the near-term implementation of the Myrtle Grove diversion feature will provide critical wetland restoration and stability in the Barataria Basin.

The second large-scale, long-range study that the Myrtle Grove diversion is linked to is the Third Delta Study. This study would investigate the possible creation of a third delta-building distributary of the Mississippi River. Should such a concept be found to be appropriate in the Barataria Basin, the necessary feature development, land acquisitions and multiple feature construction could take 20 years or more to complete. Even with the completion of such a large-scale feature, current assessments indicate its effects in the northeastern portion of the Barataria Basin would be secondary in nature. Any land building in the vicinity of Myrtle Grove as a result of this major feature may take additional decades. The near-term implementation of the Myrtle Grove diversion feature is compatible with this large-scale concept and would affect direct land building in this area, restoring and maintaining the ecologically critical central basin wetlands. In addition, the near-term establishment of wetlands in the middle and eastern extent of the basin would influence future delta building in the direction of the coast, and maximize the beneficial effect of a future large-scale diversion feature by limiting the hydrologic backwater effect.

In addition to those long-range concepts to be considered, the Myrtle Grove diversion feature is compatible with other proposed critical near-term features in the area. The Davis Pond Freshwater Diversion has the capacity to influence salinities in the central portion of the Barataria Basin. However, it is not capable of building new wetlands or supplying the critically needed nutrients to the badly deteriorated area of Myrtle Grove. Coordinated operation of these two features will allow the restoration of the appropriate beneficial system function in each specific area of the Barataria estuary.

The Small Bayou Lafourche Reintroduction feature is a logical first step in attempting to direct riverine resources specifically into the wetlands of the Eastern Terrebonne Basin. However, the magnitude of the wetland loss problem dictates that means of introducing additional amounts of freshwater, sediment, and nutrients into this area will be required in the future. The LCA Plan addresses this by identifying additional critical near-term features and the investigation of the Third Delta large-scale, long-range concept. In addition, the coordinated operation of the Davis Pond and Myrtle Grove diversion features has the potential to provide additional flow to this area of the Terrebonne Basin through the GIWW. This would be input supplemental to the Bayou Lafourche reintroduction.

Alternative Investigations

The development of alternative configurations for this restoration feature stretches over a number of years. The CWPPRA planning process has identified and approved investigation of a number of possible projects at various sites in the vicinity of Myrtle Grove including: management of the existing Naomi siphon located immediately to the north of the area to optimize existing resources, restoration of the banks of the Barataria Bay Waterway to reduce tidal exchange in the area, construction of an additional siphon diversion directly into the area, creation of wetlands in the area through dedicated dredging, and finally a comprehensive evaluation study to coordinate all of these efforts as well as possible larger-scale diversion opportunities. The CWPPRA task force also funded the Mississippi River Sediment, Nutrient, and Freshwater Redistribution study (MRSNFR) to investigate and optimize the reintroduction of river resources into coastal wetlands. This study identified and developed two scales of diversion, 5,000 and 15,000 cfs, in the vicinity of Myrtle Grove. The findings of this overarching assessment of riverine potential lead to the initiation of the comprehensive evaluation study in the Myrtle Grove area. Every one of these projects or study efforts has involved initial public involvement in the decision of whether to proceed and subsequent public involvement in determining potential alternative actions. Ultimately, these efforts resulted in the inclusion of these alternative features in the LCA analysis.

Initial assessments of the proposed feature were preformed in the 2000 MRSNFR study. Some differences between the current analyses and the information provided by that study effort are the specific location of the diversion and the boundary of the primary impact area. Over the course of the various investigative efforts, several locations for a diversion in the vicinity of

Myrtle Grove have been assessed and the configuration of the primary impact area has varied slightly; however, the overall size of this area has been relatively consistent between efforts. The MRSNFR study was developed to a draft report stage and adopted by the CWPPRA Task Force as the basis for a number of diversion projects that were approved for detailed design. Many of those same projects were considered in the LCA Ecosystem Restoration study and the MRSNFR report provided the initial basis for design and cost of those features as well as a basis for scaling designs and costs for additional project alternatives.

Following the completion of the MRSNFR study and identification of real estate issues related to the potential siphon project near Myrtle Grove, the CWPPRA Task Force determined that a more comprehensive analysis of restoration options at this location be undertaken. In 2001, the task force approved the Delta Building Diversion at Myrtle Grove detailed design study, based on the potential for a small to moderate diversion project with some form of land building at this location. The initial federal sponsor of the study was the National Marine Fisheries Service (NMFS). At the request of the NMFS the Federal sponsorship of the study effort was later transferred to the USACE.

After coordination between the LCA cost-share partners, the USACE and the Louisiana Department of Natural Resources (LDNR), it was decided to proceed with the Myrtle Grove study effort. The study effort has been conducted according to USACE planning guidance for feasibility-level studies and includes the development of NEPA compliance and an Environmental Impact Statement (EIS).

Screening Process (How alternatives were screened out)

The current CWPPRA study of Myrtle Grove was initiated in March 2002 with the issuance of a Notice of Intent (NOI) to complete an EIS and a series of four public scoping meetings focusing on the specific problems, needs, and opportunities of the Barataria Basin (Subprovince 2) in the vicinity of Myrtle Grove. An interagency Plan Development Team (PDT) reviewed and screened the public input from the scoping meetings, identifying and formulating alternative restoration plans. These plans incorporated the previously identified CWPPRA and MRSNFR projects, as well as new feature ideas, combinations, and scales developed from the scoping input. A key commonality between all of the previously identified alternatives was their basic fit within a local ecosystem. The nature of the marsh in the vicinity of Myrtle Grove is broken and continuing to deteriorate rather than being completely open or nearly lost. As such, the alternatives developed in the previous CWPPRA and MRSNFR efforts capitalize on synergistically working with the remaining wetlands. The result of the 2002 scoping effort was a range of diversion options between 2,500 and 15,000 cfs in potential combinations with the direct creation of marsh using dredged sediments.

From this scoping effort, hydraulic and salinity modeling of the immediate Myrtle Grove outfall area was completed along with the development of potential marsh creation sites.

The scoping and formulation effort for the LCA Ecosystem Restoration study was undertaken two to three months subsequent to scoping for the Myrtle Grove CWPPRA study effort. The LCA effort also considered possible features near Myrtle Grove but did so in a larger context of restoration for an entire subprovince. As a result, the LCA formulation, while identifying alternatives similar to the current CWPPRA study, also identified large to extremely large diversions as possible alternatives at this site. Although providing a broader range of potential alternatives, this was a departure from the more location-specific problems and needs-based formulation of the CWPPRA effort. It was decided at that point that further design efforts under the CWPPRA effort should be limited to site identification, hydraulic assessments of the small- to moderate-scale diversions, and development of receiving area and marsh creation site-based data.

How we got to where we are

It was decided that the plan formulation effort under LCA would be utilized to determine the appropriate range and scale of alternatives in the Myrtle Grove area. The alternative frameworks developed for Subprovince 2 included potential diversions in the Myrtle Grove vicinity ranging from 5,000 to 150,000 cfs with various combinations of marsh creation, and sediment introduction to the diversions. Hydraulic and ecological modeling of the subprovince frameworks and a cost effectiveness analysis to develop the complete range of possible coast wide frameworks were performed. From the final cost effectiveness analysis, seven coast wide frameworks were identified as potentially complete, effective, and efficient solution sets. Six of the seven alternative coast wide frameworks included a 5,000 cfs diversion feature near Myrtle Grove. One of these six frameworks also identified the possibility of periodic pulses of higher diversion flow with the 5,000 cfs scale feature as a base. The seventh framework represented the maximum achievable output and focused on extremely large-scale diversions.

In addition, the analysis performed in the MRSNFR study was geared toward identifying the most effective and efficient means of applying the resources available in the Mississippi River to the coastal restoration effort. The study screened over seventy diversion types and scales based on potential level of direct output, the appropriateness of the expected outputs for the area being affected, and relative cost effectiveness in achieving outputs. Eleven alternative features that represented optimal combinations of type and location for diversion or reallocation of river resources were identified in an intermediate alternative array. This array included the two diversion scales identified at Myrtle Grove. A cost effectiveness and incremental cost analysis was performed on these eleven features during the MRSNFR study.

The cost effectiveness incremental cost analysis developed 1,300 combinations of the intermediate alternatives. The combinations representing cost effective solutions for achieving successive levels of environmental outputs numbered 68. Of these 68 combinations of alternatives, 12 specific combinations defined the most incrementally efficient steps of achieving the maximum outputs. In these efficient plans, the 5,000 cfs scale at Myrtle Grove appeared as the most cost effective of the diversion features analyzed. This result indicates that the most efficient mode of restoration through diversion is a small- to moderate-scale project directed into areas of deteriorated marsh. Review of the rest of the results of this analysis appears to indicate that small-scale diversion into intact but impaired wetlands would be the next most effective application of the resource. This would be followed by moderate- to large-scale diversion into highly or totally degraded areas. Moderate to large-scale diversions, such as the 15,000 cfs diversion scale at Myrtle Grove, appear more effective than extremely large-scale diversions, unless a very high level of output is required, based on the MRSNFR analysis.

As noted, the CWPPRA has identified a diversion at Myrtle Grove as a priority list project. Initial efforts to develop the project under the CWPPRA program have been initiated. However, limited program funds and identification of numerous other projects across the coast have diminished the likelihood that such a large-scale ecosystem restoration project will be completed under the program. This is evidenced as the Task Force has limited the Phase I funds provided for the project design effort and the accounting procedures no longer carry the estimated construction cost for the project. Under these circumstances, the time is appropriate to move this effort into the near-term plan for the large-scale restoration of the Louisiana coast under this study.

Recommended Plan

The results of the MRSNFR and LCA cost effectiveness analyses seem to indicate that an appropriate diversion scale, both locally and on a subprovince basis, is approximately 5,000 cfs but less than 15,000 cfs. If combined with direct marsh creation through dedicated dredging, a potentially smaller scale may be appropriate. Based on this information, it appears that the formulation in LCA, and the feature identified in the LCA Plan, is consistent with the scoping efforts of the PDT under the CWPPRA study. The formulation is therefore appropriate to support the completion of the required decision document.

The components of the proposed feature included a gated box culvert diversion structure incorporated into the Mississippi River and Tributaries (MR&T) flood protection levee. This inflow configuration would include a 2,600-foot channel with an invert elevation of –15 feet NGVD and appropriate guide levees. The outflow channel would be approximately 13,000 feet in length and also include guide levees as necessary to contain project flows. The outflow channel would transition from the –15-foot NGVD invert elevation at the diversion structure to a elevation of –5 feet NGVD at the point of discharge into the marsh. The channel width will transition proportionally from the structure to the discharge point to ensure transport of sediments. The locations of the various elements of this feature are shown on **figure 1**. Levee and highway relocations will also be required for channel construction along with accommodation of local utilities and drainage.

The creation of marsh through dedicated dredging will involve placement of material in 19 to 23 identified sites (**figure 1**) ranging in size from 10 to 1,200 acres to create a total of approximately 6,500 acres. The marsh creation will require the removal of approximately 2 million cubic yards of sediment per year from the Mississippi River. It is anticipated that this borrow area will be replenished by the river on an annual basis. Based on an estimated yield for this area of 400 acres per 2 million cubic yards, the marsh creation component of this feature will take 16 years to complete. There is no Federal navigation maintenance performed in the Mississippi River within approximately 50 miles of this feature location. Additionally, the annual amount of material projected to be removed is not expected to have a measurable effect on current maintenance efforts downstream.

Benefits

The components of this feature are intended to function synergistically to produce a rapid and sustainable response in the critical central portion of the Barataria Basin. A diversion in the range of 2,500 to 15,000 cfs should provide not only a significantly beneficial input of sediment and nutrients to the remaining wetlands in this area of the Barataria basin, but also stabilize the composition of those existing marsh classes. The currently available estimates of ecologic outputs specific to this restoration feature have been generated using the qualitative and consensus-based assessments procedures produced by the CWPPRA PDT. Higher resolution modeling efforts executed under the LCA study focused on the subprovince-wide effects of features combined to achieve outputs within specifically defined restoration frameworks. While the results of the LCA analyses provide insight into the optimal feature scales and combinations, they do not identify feature-specific outputs or benefits. However, based on the cumulative result of previous investigations and those insights derived from the LCA study effort, an advanced level of confidence in the range and magnitude of probable outputs the Myrtle Grove feature will provide can be assumed.

Based on the initial efforts from the MRSNFR study, and carried over into the LCA formulation, the estimated land building potential of the medium-scale 5,000 cfs diversion is 2,500 acres of new marsh with the potential prevention of future loss of an additional 2,500 acres. The largest scale of diversion has the potential to produce up to 6,900 acres of new emergent marsh with the potential prevention of future loss of an additional 6,300 acres. Dedicated dredging could produce up to approximately 6,500 acres of new marsh or marsh platform across the diversion influence area, further stabilizing this transitional area of the basin. The diversion will be designed and operated to support the growth and expansion of marsh created through dedicated dredged material placement to allow more efficient use of dredged material and other restoration resources. As stated in the previous section, the cost effectiveness analysis performed in the LCA study as well as various other planning efforts has pointed toward the 5,000 cfs scale as the probable optimum diversion. Based on this information, the expected benefits of this feature would be in the range of 11,500 acres at the lower end.

This estimate likely does not completely account for broader beneficial effects of salinity reduction and nutrient introduction. Comparison of the initial consensus-based PDT estimates of outputs for various subprovince frameworks versus the benefit output, based on the model analysis, has indicated that the potential for prevention of future loss is generally higher than the initial assumptions. For the Subprovince 2 frameworks, that were found in the final array of cost effective coast wide frameworks, and that included the Myrtle Grove feature, model projections of output were found to exceed initial PDT estimates by an average of 70 percent.

Additionally, operation and monitoring of the existing Caernarvon freshwater diversion has provided insight into the beneficial effects of freshwater reintroduction. Two studies investigating marsh biomass were conducted at Caernarvon by LSU and ULL researchers (Delaune 2002; Twilley 2002). The LSU study conducted a gradient analysis of the impact of the diversion on mineral and organic matter accumulation and plant biomass. The measured accretion was sufficient to offset water level rises due to subsidence. Mineral sediment input was greatest near the diversion and decreased further from the diversion. But the lower salinity at the distant sites reduced the mineral need for maintaining brackish marsh. Plant biomass increased due to nutrient addition and lower salinity and consequently enhanced marsh stability. Plant biomass also supplied matter for accretion to keep pace with subsidence. A marsh soil accretion model indicated that the marsh should remain stable for the next 100 years. The study concluded that Caernarvon diversion is stabilizing marshes and can slow or reduce marsh loss.

The ULL study investigated the significance of reduced salinity stress and increased nutrient availability at promoting soil organic matter production and promoting marsh soil formation at upstream and downstream sites. Pore water nutrients, salinity, bulk density and phosphate decreased further from the diversion. The lowered salinity and increased nutrients should slowly increase biodiversity. Controlled experiments indicated that salinity reduction alone did not increase biomass. Sediment additions increased total biomass production under conditions of low salinity. The operation of the diversion needs to deliver resources like sediment and nutrients and reduce stressors like salinity to produce optimal conditions for plant growth. The essence of these effects were integrated into the ecologic modeling tools used for LCA.

In the Breton Sound basin, as in the Myrtle Grove area, there was very little fresh and intermediate marsh habitat prior to the Caernarvon diversion. Caernarvon operations have succeeded in returning fresh and intermediate marsh to the upper Breton Sound estuary. Experience from operating the diversion indicates that water needs to sheet flow over the marsh to be beneficial. This requires 2,500 to 3,000 cfs at minimum. Higher flows could reach a greater area for a larger footprint of benefits. Also, aerial photo analysis indicates that even at high flows, water does not affect all areas equally. Some areas more conducive to flow may be receiving greater benefits than others and account for some of the variation seen in fisheries and land loss data. Pulsing of high discharge may be a strategy to maximize benefits.

The lesson learned from the Caernarvon operation and these investigations have helped to define, and support, the Myrtle Grove diversion feature being proposed.

Wetland Value Assessment Information

In addition to the analysis performed in the LCA study, benefits were previously estimated in the MRSNFR study using a community-based Habitat Evaluation Procedure (HEP) model and a new model that was developed for CWPPRA entitled the Wetland Value Assessment (WVA). Similar diversions of 5,000 and 15,000 cfs were investigated in the MRSNFR study. The results of the WVA assessments for the 5,000 cfs scale diversion provide some insight to the specific habitat related effects of the proposed diversion feature.

The WVA model is driven by the consensus professional judgment of multiple-users supported by available habitat data and user observation. This model expands upon professional judgment by formalizing user consensus, and standardization of methodology. The model does not mathematically interpolate expressions of biologic response beyond the user defined spatial extent of the project area, or sub areas, in the manner of a numeric model. In this regard, there are general understatements of the projections of beneficial output.

MRSNFR WVA for 5,000 cfs Freshwater Diversion in the Vicinity of Myrtle Grove

The project area is the brackish marshes just west and south of Highway 23 at Ironton, Louisiana (**figure 1**). This project area of this diversion was divided into Areas 1 and 2. Area 1 consists of the marshes adjacent to the river and the area most significantly affected by the freshwater diversion project. Area 2 encompasses a larger area of brackish marsh to the west and south of Area 1 and would be affected by the freshwater diversion project to a lesser degree than Area 1. The overall benefit according to the WVA in Areas 1 and 2 combined is 3,606 AAHUs for an overall benefit of 180,300 habitat units over a 50-year period.

<u>Area 1</u>

The overall net benefit is 708 AAHUs and this area encompasses 3,262 acres. Current land loss rates are approximately 1.8 percent per year. Approximately 16 percent (522 acres) is brackish marsh and 84 percent (2,740 acres) is open water. Based on a land loss rate projection of 1.8% per year, marsh acres would decrease from 522 acres at target year 0 to 202 acres (6 percent) at target year 50 without project.

The assessment team estimated wetland loss rate would be reduced for Area 1 by 85 percent from 1.8 percent to .28 percent per year for the 50-year period of analysis. This alternative had been evaluated earlier through the CWPPRA program and a WVA completed for an equivalent sized project. It was estimated in the original WVA that the wetland loss rate would be reduced by 85%. To remain consistent, the assessment team used that same value. In addition, a basic model assessment estimated that 2,454 acres of wetlands would be built over the 50-year period of analysis. An assumption was made that the additional wetlands would be built at a linear rate of 49.08 acres per year for the life of the project. Based on these assumptions and estimates, marsh acreage in the area would increase from 16 percent (522 acres) at target year 0 to 84 percent (2,745 acres) at target year 50 with project. Average salinity was estimated to increase slightly from 6 ppt at target year 0 to 8 ppt at target year 50 without project. With-project estimates indicate a freshening from an average of 6 ppt at target year 0 to 3 ppt at target year 50.

A HEP analysis preformed for specific species suggests that wildlife in general would benefit from this freshwater diversion, while fisheries species that would be impacted the most would be brown shrimp, white shrimp, and spotted seatrout. This assessment is consistent with the ecologic model outputs for species-specific habitat suitability developed in the LCA study for various subprovince frameworks. These model outputs indicated that net gains in habitat suitability could be achieved, although there would be a tradeoff in habitat between specific species. More importantly, restoration results in a net gain in total habitat due to the introduction of a wetland building function. Habitat reductions are seen in more saline fisheries species while increases are seen for fresher fish and wildlife species. A summary of the HEP analysis for the Myrtle Grove Freshwater Diversion Option performed under MRSNFR is provided in **table 1.** This MRSNFR analysis did not investigate the addition of freshwater fisheries habitat in the project area or provide a comparison of existing conditions.

Table 1. Habitat Evaluation Procedure Output
For the Myrtle Grove Freshwater Diversion Option

Species	Area 1			Area 2			Both Areas
	FWP	FWOP	Net	FWP	FWOP	Net	
Brown shrimp	15	1,755	-1,740	18,670	37,175	-18,505	-20,245
White shrimp	28	2,547	-2,518	40,797	38,953	1,844	-674
Spotted Seatrout	-	-	-	0	5,772	-5,772	-5,772
Red Drum	-	-	-	-	-	-	-
Nutria	116	24	92	1,479	1,333	146	238
Muskrat	579	120	459	7,394	6,664	731	1,190
Puddle ducks	198	41	157	2,535	2,285	251	408
Alligator	463	48	415	5,915	2,665	3,250	3,665

Area 2

Area 2 encompasses 43,582 acres and WVA analysis indicates that this project would create 2,898 AAHUs. Once again, the effect of the feature in this broader area would be to shift the balance of suitable habitats from saline toward fresh types and increase the amount of existing marsh in the future. The land loss rate at the time of analysis was measured as approximately .5 percent per year. Area 2 is approximately 49 percent (21,530 acres) brackish marsh and 51 percent (22,052 acres) open water. Based on a land loss rate projection of .5 percent per year, marsh acreage would decrease from 21,530 acres at target year 0 to 16,707 acres (38 percent) at target year 50 without project.

An initial WVA was completed previously for a similar sized project. The initial WVA estimated a reduction in wetland loss by 85 percent with project. Again, the assessment team sought to remain consistent. With-project estimates reduced the loss rate to .1 percent for the 50-year period of analysis. However, while marsh acreage was projected to show a significant increase over no-action conditions, acreage was still estimated to decline slightly from 49 percent (21,530 acres) at target year 0 to 48 percent (20,727 acres) at target year 50. No new marsh acreage is estimated to be created at this distance from the diversion site. With-project estimates for Area 2 indicate a freshening from an average of 8 ppt at target year 0 to 4 ppt at target year 50.

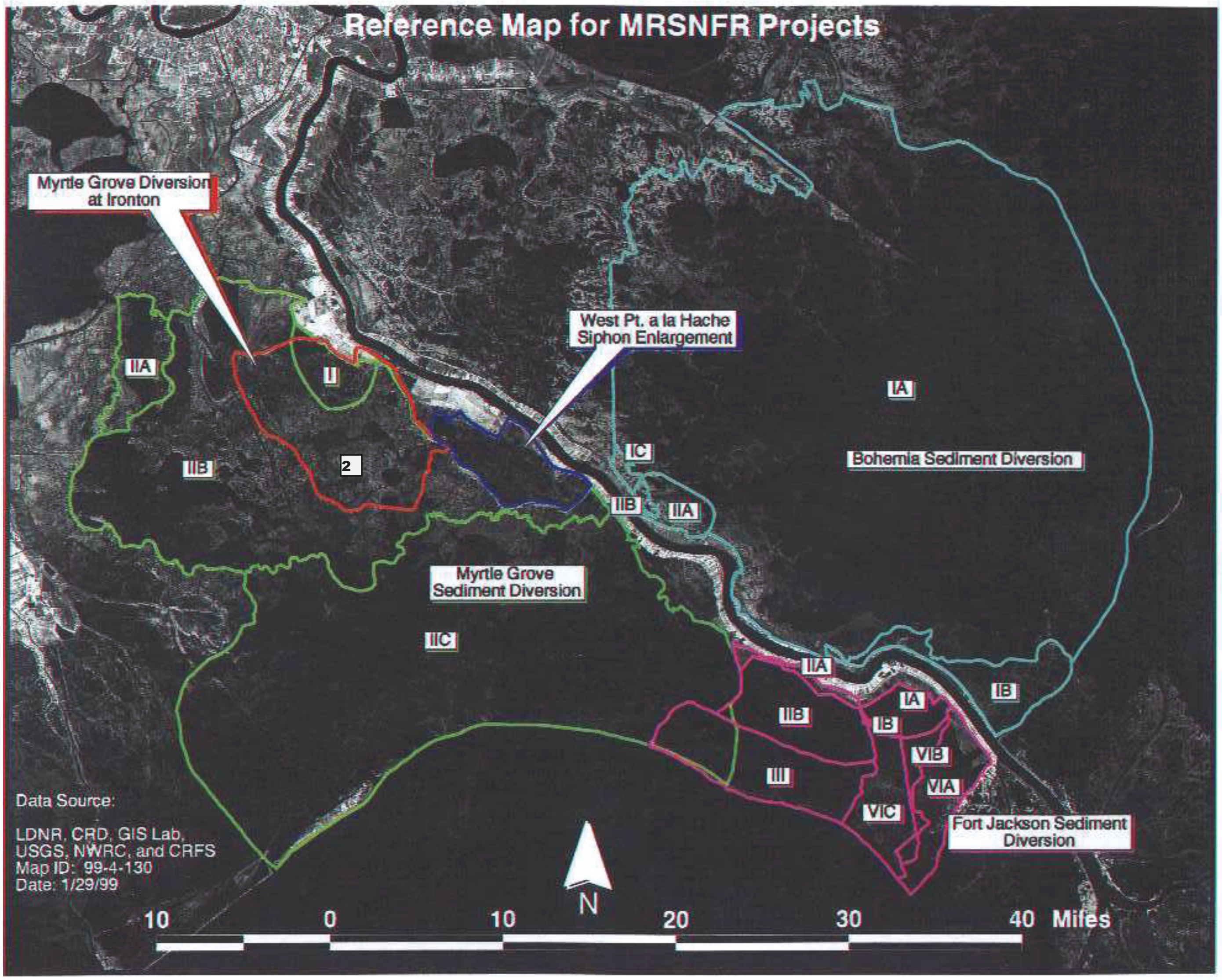


Figure 2. Wetland Value Assessment Analysis Areas from Mississippi River Sediment, Nutrient, and Freshwater Redistribution Study

Reduction of submerged aquatic vegetation (SAV) coverage was estimated to be greater for Area 1 when compared to Area 2 without action. This is due to the assumption that much of Area 1 at target year 50 without project would be open water compared to Area 2 with an estimated 38 percent marsh. Much of Area 2 would consist of small shallow ponds that would support submerged aquatic vegetation. Some fine sediment will likely pass through Area 1 and settle in Area 2. This would result in increases in the potential SAV coverage with the feature of over 100 percent in Area 1 and 200 percent in Area 2.

The HEP analysis for Area 2, shown in **table 1**, was similar to that for Area 1, except for white shrimp and alligator habitats. The project appeared to have a greater positive effect on alligator habitat in this area. White shrimp habitat appears to only be slightly affected by the project in Area 2, but is a significant reduction relative to the degree of effect indicated in

Area 1. This may be due to the fact that white shrimp can utilize fresh water more readily than brown shrimp.

Anticipated Systemic Effects on Biologic Productivity

These effects are those anticipated to occur throughout the broader Barataria Basin ecosystem as a result of this feature in the context of a cohesive restoration plan. The LCA effort has focused on identifying the optimally synergistic feature combinations and has therefore not yet produced estimates of feature specific outputs. Ecologic modeling performed in the LCA study for the supplemental framework in Subprovince 2, which included the 5,000 cfs Myrtle Grove diversion with dedicated dredging, has indicated that a relative balance between the conversion of existing habitat and the creation of new habitat is achievable. The modeling for the complete framework indicates that slight habitat reductions (less than 5 percent) would be experienced by most saline species (menhaden, white and brown shrimp) over 50 years. The inclusion of additional marsh creation through dedicated dredging would also increase marsh habitat in areas that would be conducive to white shrimp. Oyster habitat is an exception since it is heavily influenced by salinity level. Habitat for the remaining species that were assessed (bass, croaker, trout, mink, otter, muskrat, alligator, and duck) was projected to increase from 5 to 40 percent. Subsequent ecologic modeling specifically for this feature is expected to indicate that this same relative balance should be achieved in the trade-off of habitat conversion versus creation.

The effects of the Caernarvon diversion on fisheries have reflected the motility of fish species, the variation in flow patterns of the diversion, and biotic and abiotic patterns from the diversion such as food availability and salinity. Coastal fisheries production is heavily dependent on energy and primary production in estuaries. Martin’s (2002) emergy analysis estimated a greater primary production and consequent fishery production at the Caernarvon and Davis Pond diversions with diversion compared to no diversion. At Caernarvon, overall finfish biomass increased 62 percent post-operation, substantiating the emergy speculations.

In addition to the expected beneficial effects on bio-productivity, the feature also meets four of the five LCA planning objectives: maintaining dynamic salinity gradients within the estuary, reestablishing the introduction of sediment from outside sources, maintaining diverse habitat and wildlife composition, and reducing nitrogen delivery to the Gulf of Mexico.

As identified previously, the 5,000 cfs scale diversion identified as the optimal scale in the LCA study should produce or prevent the loss of at least 11,500 acres in addition to beneficially affecting approximately 22,052 wetland acres per year. Based on the MRSNFR estimated average annual habitat output and the additional marsh created through dedicated dredging, the Myrtle Grove feature would produce approximately 3,606 AAHUs. The annualized Myrtle Grove feature cost, based on the cost estimate presented at the end of the next section, is $20,682,000 per year.

Engineering Design Data and Costs

Diversion design data and assumptions

Hydraulic Design

The PDT established goals and objectives for the various diversion structures designed in this study. Twenty-four locations were investigated along the Mississippi River between River Mile 177.0 just below Donaldsonville and River Mile 3.0 near Pilottown. There were 11 locations on the East bank of the river and 13 on the west bank. In general, three different-sized structures were designed for each location depending upon the planning objectives. **Table 2** contains a complete list of the alternative structures sized for the features included in the LCA Plan. The table contains pertinent design details for the various structures and is organized by the various subprovinces that would receive the diverted flows.

Types of Diversion Structures

Freshwater Diversions are designed to meet specific freshwater needs to the surrounding marshes specified by the PDT over a 50-year period of analysis. Freshwater Sediment Diversions were designed to meet specific land building requirements specified by the PDT over a 50-year period of analysis. In general, the size or design capacity of this type structure is much larger than the freshwater diversion structure because the land building objectives require very large volumes of water on a yearly basis to meet land building targets.

Design Procedure

Mississippi River gage data are available at 11 locations on the river, and reach from River Mile 302.4, Red River Landing Gage, to River Mile 10.0, Venice Gage. For this effort, all gages from the Donaldsonville gage to the Venice gage were used to develop statistics for river stages. Plate D-2 in the MRSNFR report shows the location of the Mississippi River gages in the USACE Mississippi Valley New Orleans District (MVN). The USACE-MVN district boundary contains approximately the lower 320 miles of the Mississippi River.

Period of Record

Generally, daily river gage data are available from 1935 to present. Data files are stored electronically in Hydrologic Engineering Center Data Storage System (HEC-DSS) format in the USACE's water control computers; however, the period of record used for this analysis is from 1977 to 2002. The period from 1977 to 2002 was used because 1977 marks the beginning of when the Old River Control Structure project (ORCS) began controlling the latitude flow at 70 percent/30 percent on a daily basis. In 1977, the Low Sill Control Structure, a feature of the MR&T Flood Control Project, was retrofitted with adjustable gates so that orifice flow control could be achieved. Prior to 1977, the Low Sill Control Structure's gates either operated in a fully open or fully closed position. The lack of orifice control led to conditions where a wide variance in flow occurred about the authorized 70 percent/30 percent -flow distribution. A change in the operation of the ORCS would affect the river stage statistics used in this study. The river statistics developed for this study make the assumption that the ORCS project will be operated in the future as it has been operated since 1977. It has been determined that a change in the operation requirements at Old River would necessitate Congressional approval as its operation was established in Law.

Another point concerning the MR&T Flood Control Project is that stages and discharge in the river are controlled by a system of spillways and diversion structures in the USACE-MVN. During floods, the ORCS and the Morganza Spillway are designed to limit the flow in the river to 1.5 million cfs below the Morganza Spillway. The Bonnet Carre Spillway just north of the City of New Orleans funnels an additional 250,000 cfs off the river into Lake Pontchartrain so that the discharge past New Orleans is no more than 1.25 million cfs. The implication of the flood control operation for the lower Mississippi River is that the river will never see a discharge flood event greater than about a 10-year recurrence flood event. Events greater than the 10-year event are managed with the spillway system up to the Project Design Flood, which has a recurrence interval of about once in 900 years.

Stage Exceedence Analysis

A stage exceedence analysis was done using the USACE Hydrologic Engineering Center's statistical analysis computer program for each stage recording gage in the lower 177 miles of the Mississippi River. The program uses time series data to perform several types of user specified statistical analyses. The USACE-MVN maintains a daily digital record of 8:00 AM stages for each of the Mississippi River gages used in the exceedence analysis. The stage information is contained in the HEC-DSS data format and readily usable in the STAT program. HEC-DSS data files for the period of analysis were read directly into the STAT program. The program examines the number of values or observations in the record, looks at the minimum and maximum stages for the daily values, and establishes the total range for the period of record. Since this analysis is designed to determine the percentage of observations that are equal to or greater than a particular value in the record, the program simply tracks the number of those observations and computes the percentage of the total observations that the number represents. Therefore, 100 percent of the values in the record will equal or exceed the minimum value or stage in the data set. The user specifies an interval, delta Y in feet, to increase the minimum stage, and the program recomputes and records the percentages for the stages that are greater than or equal to the new stage (minimum stage plus delta Y). The program continues to increment and record the percentage exceedence associated with each successive "new" stage until the maximum value or stage in the record is reached and at that point, zero percent of the stages in the record will equal or exceed the new value. The term 50 percent "duration" stage is used to signify the stage that is exceeded 50 percent of the time. A 0.2-foot delta Y was used in this analysis. The program can look at the entire record, yearly basis, or group the record by month and compute exceedence on a monthly basis.

Diversion	Nominal Capacity (cfs)	River Mile	Bottom Width (ft.)	Invert Elevation (ft-NGVD)	Channel Length (ft)	Type	Structure
Blind River	10,000	162.0	25	-20	25,000	Controlled	Culverts
Blind River	1,000	162.0	15	-10	25,000	Controlled	Culverts
Romeville	5,000	162.0	45	-10	15,000	Controlled	Culverts
Hope Canal/Garyville	2,100	139.6	50	-10	14,900	Controlled	Culverts
Reserve Relief Canal	5,000	137.0	45	-17	9,100	Controlled	Culverts
Reserve Relief Canal	1,000	137.0	20	-10	9,100	Controlled	Culverts
Caenarvon	150,000	76.5	500	-35	6,800	Controlled	ORC Type
White's Ditch	10,000	64.5	90	-18	8,000	Controlled	Culverts
White's Ditch	8,000	64.5	90	-15	8,000	Controlled	Culverts
Myrtle Grove	150,000	62.5	300	-45	2,600	Controlled	ORC Type
Myrtle Grove	15,000	62.5	150	-20	2,600	Controlled	Culverts
Myrtle Grove	5,000	62.5	70	-15	2,600	Controlled	Culverts

Nominal Discharge Capacity

The stage that is equaled or exceeded 50 percent of the time on a yearly basis was used in sizing the diversion structure at the various locations along the river. In general, three "nominal" discharge values were selected at each location on the river and three different-capacity structures designed for the location. For example, 2,500, 5,000 and 15,000 cfs structures were designed for the Myrtle Grove location. Therefore, when one sees the description for a 5,000 cfs structure at Myrtle Grove, the 5,000 cfs value refers to the "nominal" capacity of the structure. The structure is capable of delivering substantially more flow than its nominal capacity might infer, since the river stages for a particular location will be greater than its yearly 50 percent duration stage at least one half of the time. The converse of this statement is also true. Half of the time the structure will pass less than 5,000 cfs and for some structures, when river stages are very low, the structure will not pass any flow from the river into the receiving area.

Hydraulic Design of Freshwater Diversion Structures

To design a diversion structure, it is first necessary to know the headwater or river stages that are available at the proposed diversion site. Since most of the proposed diversion sites in the study did not fall exactly at a gage site, linear interpolation between gages was done to establish the stage statistics at the location in question. As previously mentioned, , the yearly 50 percent exceedence stage was used to design the freshwater diversion structures. Topographic USGS quadrangle maps at a scale of 1:24,000 were used to estimate ground surface elevations and approximate length of culverts necessary to pass water through the levee system and any adjacent roads or railroads. Culvert design was done using standard procedures for a culvert flowing at capacity. Since the headwater elevation and energy grade are controlled by the Mississippi River stage, head requirements dictated tailwater elevations needed convey the specified flow. In general, trial and error backwater calculations are necessary to arrive at an optimum design between channel size and structure size. This procedure was facilitated by the use of the HEC-RAS computer program. Procedurally, the topographic maps were used to layout a proposed channel alignment. Natural ground surface elevations were estimated from the maps and cross sections were cut perpendicular to the proposed channel alignment. HEC-RAS channel improvement routine was used to size the channel needed to convey the design flow to the receiving area and satisfy tailwater requirements at the proposed structure. Channel invert elevation and bottom width were varied to arrive at the necessary channel size for tailwater constraint. Channel side slopes were assumed to be 1 vertical unit on 3 horizontal units and invert slope was assumed to be flat. Manning's "n" value for the channel was assumed to be 0.03. HEC-RAS channel improvement routine also has the capability to compute estimates of the channel cuts necessary to construct the proposed channel. In general, the process for designing an optimal combination of structure size and channel size to minimize costs is a laborious process. In this study, considerable professional judgment was employed to produce the numerous designs needed in the relative short design schedule. Designs presented in this report are considered to be of a reconnaissance scope but are believed to be appropriately-sized to meet delivery requirements, albeit not completely optimized for total project cost.

Hydraulic Design of Controlled Sediment Diversion Structures

Procedurally, the design for the sediment diversion structures was done as previously described. No specific consideration was given to whether the diversion was for freshwater or sediment. Culvert design was done using standard procedures for a culvert flowing at capacity.

For the large controlled diversions, in excess of 110,000 cfs, a structure similar to the Old River Auxiliary Control Structure was considered appropriate. The Hydraulic Design Charts, sheets 320-8 and 32-8/1 were used to compute the discharge per gate for the available head. These charts can be found at the following web site: http://chl.wes.army.mil/library/publications/hydraulic_design_criteria/. The gate sill elevation was set at –35 feet NGVD. This sill elevation would allow for the necessary freeboard for the MR&T flood control as well as encourage some of the courser sediment bed material load to pass through the control structure. The maximum number of gates was based on the total sediment required for the 50-year period of analysis.

Hydraulic Design of Uncontrolled Sediment Diversion Structures

Procedurally, the design for the sediment diversion structures was done as previously described in the section titled Hydraulic Design of Freshwater Diversion Structures. No specific consideration was given to whether the diversion was for freshwater or sediment.

Geotechnical Investigations

Based on available subsurface information and the geologic, slope stability and pile capacity information was provided for numerous locations where diversion structures were to be estimated. Where shoreline erosion control structures were to be considered, structure side slopes and construction losses due to foundation conditions were estimated based on available foundation data, general geology information, and experience in the coastal area.

Under the MRSNFR study, two geologic profiles were constructed, one paralleling the river and another perpendicular to the river. Natural levee deposits overlie the entire area parallel to the river. The profile perpendicular to the levee was constructed mainly with data extrapolated from geologic maps and nearby borings. Perpendicular to the river, natural levee deposits are located at the river's edge to approximately 1,900 feet from the river, where marsh deposits overlie the area. Natural levee deposits consist of inter-bedded, very soft to stiff, fat and lean clay with occasional layers and lenses of silt. Natural levee deposits average 15 feet thick and range in elevation from 6 to -14 feet NGVD. Marsh deposits consist of interbedded very soft, organic fat clay and peat. Marsh deposits average 14 feet thick and range in elevation from 3 to -14 feet NGVD. Swamp deposits underlie natural levee deposits except in places where swamp deposits underlie natural levee and marsh deposits. Swamp deposits consist of interbedded soft to stiff, organic fat clay with wood and occasional layers and lenses of peat and lenses of silt. These deposits average 12 feet thick and range in elevation from -5 to -28 feet NGVD. Interdistributary deposits underlie swamp and marsh deposits and consist of interbedded very soft to medium fat clay with occasional layers and lenses of silt and soft, lean clay and lenses of silty sand. These deposits average 36 feet thick and range in elevation from -14 to -61 feet NGVD. Prodelta deposits underlie the interdistributary deposits and consist of homogeneous medium to stiff fat clay with occasional lenses of medium lean clay. Prodelta deposits average 50 feet thick and range in elevation from -54 to -110 feet NGVD. Near-shore gulf deposits underlie prodelta deposits and consist of interbedded sand, silty sand, and silt with shell fragments and occasional layers and lenses of medium to stiff fat and lean clay. Near-shore gulf deposits average 11 feet thick and range in elevation from -104 to -120 feet NGVD. Pleistocene deposits underlie near-shore gulf deposits and consist of interbedded, oxidized, stiff to very stiff fat and lean clay, sand, silty sand, and silt. The surface of the Pleistocene deposits averages -120 feet NGVD in elevation and these deposits extend to an unknown depth.

Structural Design

The proce ates fo
province is pre raphs.

Subprovinces ydraulic
h as project locat
th of culvert),

e taken from the feas th
m

- Natural ground elevation taken from USGS topographic maps
- Mississippi River flood protection elevation based on nearest river mileage
- All excavations have side slopes of 1 vertical unit on 6 horizontal units

Rudimentary designs were performed to establish the nominal dimensions of structural components and high cost items. These rudimentary designs w
concepts and historical data. Items deemed as not critical to the
engineerin
range of d

The structure used for this project feature was modeled after the Davis Pond Diversion Structure. The diversion structure is compromised of inflow, gate, box culvert, downstream bulkhead, and outflow monoliths. A brief description of each portion is presented in the following paragraphs. The invert for the structure is at elevation –20 ft NGVD. Natural ground was assumed to be at elevation +5.0 ft NGVD.

A cofferdam will be required to maintain the Mississippi River flood protection

Phase 2 input on the river for the proposed location and an area of d to develop the desired flow-rate of freshwater into the target sy g approximate elevations from USGS topog aps, presented in **table 3**, a quick determination of channel excavation, parallel flood protection, and scour protection was determined.

Table 3. Existing Elevations for Projects Taken from USGS Topographic Maps For LCA Plan Features and Alternatives

Proposed Alternat	annel Length to Target Area (feet)	Exi Elev (f	Water Elevation (feet)	hannel y t/second)

Table 4. Levee Information According to LCA Plan Feature Alternative

Proposed Alternative	Levee Height (feet)	Offset Bench (feet)	Fert/Seed (acre)	Levee Quantity (cy)	Armor Length (feet)	Armor Quantity (ton)
Blind River	10	300	51.7	1,203,704	1000	30,166.7
Hope Canal	6	300	21.2	312,347	500	12,666.7
Reserve Relief	6	300	12.1	178,764	500	14,750.0
N. Myrtle Grove 150k	10	300	27.3	635,556	1000	107,000.0
N. Myrtle Grove 15k	10	300	27.3	635,556	1000	57,000.0
N. Myrtle Grove 5k	10	300	27.3	635,556	1000	38,666.7
S. Myrtle Grove 150k	10	300	5.8	134,815	1000	107,000.0
S. Myrtle Grove 15k	10	300	5.8	134,815	1000	57,000.0
S. Myrtle Grove 5k	10	300	5.8	134,815	1000	38,666.7
Caernarvon	10	300	14.0	327,407	1000	179,000.0
Romeville	8	300	25.5	485,333	1500	35,250.0
White's Ditch						
Convent	8	300	25.5	485,333	1000	23,500.0

Four levee configurations were analyzed under the MRSNFR study effort - an all-earth levee, an uncapped sheetpile I-wall, a fabric-reinforced levee, and a combination fabric reinforced levee with I-wall. The guide levees will be constructed parallel to the channel to tie-in the Mississippi River mainline levee to the diversion structure. The alternative levee configurations were assessed to determine cost effectiveness and the most timely method to achieve design height and allow the start of operation.

Diversion Channels

Proposed diversion channel design dimensions are provided in **table 5**.

Table 5. Proposed Channel Dimensions for LCA Plan Alternatives

Proposed Alternative	Channel Bottom Width (feet)	Channel Invert Elevation (feet)	Channel Slope Run	Channel Length (feet)	Dredging Quantity (cy)
Blind River	25	-20	3	25,000	1,275,926
Hope Canal	50	-10	3	15,900	698,776
Reserve Relief	45	-15	3	9,100	644,280
N. Myrtle Grove 150k	300	-45	3	13,200	12,489,644
N. Myrtle Grove 15k	150	-20	3	13,200	3,212,978
N. Myrtle Grove 5k	70	-15	3	13,200	1,357,644
S. Myrtle Grove 150k	300	-45	3	2,800	2,649,319
S. Myrtle Grove 15k	150	-20	3	2,800	681,541
S. Myrtle Grove 5k	70	-15	3	2,800	287,985
Caernarvon	500	-35	7	6,800	7,799,096
Romeville	45	-8	3	15,000	341,333
White's Ditch	90	-15	3	8,000	654,222
Convent	45	-10	3	15,000	341,333

Local drainage

Because the proposed diversion channel would bisect an impounded area, local drainage must be accommodated. Under a CWPPRA priority project investigation of a small siphon, diversion work was preformed under contract to assess the effectiveness and design of inverted siphons under the proposed diversion channel. The inverted siphons could deliver local storm runoff to an existing privately operated pump station.

A pump station to accommodate local drainage was also analyzed under the MRSNFR study. The pump design should be capable of pumping 750 cfs from a drainage canal, over a levee, and into the marsh area. The maximum head against which the station would have to pump was estimated to be approximately eight feet. The station design assumed a pile-founded structure built in the dry in a dewatered open cut excavation. The pumps and motors would be housed in a weather-tight building above a concrete sump area. Dewatering bulkheads were to be included along with trash racks to prevent floating debris from damaging the pump intakes.

Relocations

Pipeline relocations were identified and relocation costs were developed for as many measures as possible. Information on pipeline locations was taken from existing maps. Estimates were developed by identifying the number and size of affected pipelines and determining the affected length. It was assumed that all pipelines would be relocated through directional drilling.

Additional detailed analysis of relocations was performed under the MRSNFR study. Relocation data was developed using the "1990 Louisiana Parish Pipeline and Industrial Atlas," various oil and gas maps, USGS topographic quadrangle maps, and aerial photographs. Several field trips were made to verify this data. Contact was made with owners to obtain detailed information for use in generation of preliminary in-house relocation plans. Estimates for relocation of highways, utilities, and power and communication lines for the proposed projects include 8 percent for owner's engineering, 6 percent for owner's contract administration, and 25 percent for contingencies. The typical relocations required in the Myrtle Grove area were identified and are discussed in the following paragraphs.

Railroad Easements (1).

A railroad easement currently exists approximately 460 feet west of the Mississippi River. There is no railroad track present, but Plaquemines Parish may install a track and activate the line to service a coal terminal south of Myrtle Grove. No time frame has been established for installation and subsequent activation of this track; however, the existing railroad easement passes through the alignment of the proposed diversion project, and therefore will be accommodated in future design. Future government participation in installation and activation of the railroad line cannot be determined at this time.

Highways (1).

Louisiana Highway 23 is a 4-lane, concrete, primary highway. Lane and shoulder widths are 12 and 10 feet, respectively. Louisiana Highway 23 traverses the proposed diversion project and will require relocation.

Pipelines (1).

A 20-inch water main belonging to Plaquemines Parish, and operated and maintained for the parish by Professional Services Group, Inc., runs parallel to and east of Louisiana Highway 23, crossing the proposed alignment of the diversion project outfall channel. The water main will require relocation.

Power and Communication Lines (4).

Electrical service is provided by Entergy Louisiana, Inc.; telephone service is provided by BellSouth Telecommunication Inc.; and cable service is provided by Plaquemines Cable Co. Aerial electrical, telephone and cable television service lines run parallel to and east of Louisiana Highway 23. Service on the west side consists solely of aerial electrical lines. On both sides of Louisiana Highway 23, support for power and communication lines is provided by power poles located approximately 250 feet apart. In all instances, the power poles, power lines, and communication lines travel across the proposed diversion project. This, coupled with the relocation of Louisiana Highway 23, will eliminate maintenance access to and require the relocation of the lines.

Cost Estimates

The estimate of total project costs is based upon a schedule of project expenditures that was provided for each year of the project. This schedule represents incremental, or "un-inflated," costs. Expenditures include future planning, engineering and design (PED) costs; construction costs; and monitoring costs. Operations and maintenance (O&M) costs are reported separately. As with any single USACE project, individual expenditures are either compounded or discounted to a given base year, defined as that year in which the project is generating all of the outputs intended by its design. The project cost estimate is derived by summing the compounded/discounted values to yield the present value of costs that is correlated to the corresponding base year. This figure is then annualized using the Federal discount rate (5-3/8 percent for fiscal year 2005) and a 50-year project life to yield an estimate of average annual project costs.

The estimate of total project costs and its average annual equivalent on a "fully-funded" basis is derived in exactly the same manner as described in the preceding paragraph, except that the schedule of project costs previously reported as incremental costs are adjusted to include inflation. The factors that are used to inflate project costs are those provided in the Fiscal Year 2006 Budget Engineering Circular.

The cost estimates for the LCA study features were based on existing design cost estimates for similar type features completed at feasibility- to reconnaissance-level. These available estimates were used to scale additional estimates of features for which no previous design efforts had been completed prior to the LCA study. The majority of the project features in the LCA Comprehensive Study fall into several major categories: diversions, control structures, barrier island work, shore/bank protection, and marsh creation. Costs from existing studies or projects were used whenever possible (CWPPRA, MRSNFR, Mississippi River Phase 3, Land

Loss and Marsh Creation Feasibility, etc.) and updated where necessary. The cost estimates are at a pre-reconnaissance level because of the expedited time schedule and limited or non-existent design information.

The underlying construction features of the various potential projects fall into five major types of construction common to the USACE-MVN:

- Channels
- Levees
- Structures – diversions (large, box culverts, siphons), locks, control structures
- Dredging – channels, beach nourishment, and marsh creation by pipeline and/or hopper
- Rock – dikes, jetties, paving, weirs

For those measures for which quantities were developed, USACE-MVN cost engineers developed unit costs based on available data, current labor and equipment, in-house knowledge and experience, or USACE-MVN historical data for similar type work. All of the construction work (e.g., excavation, embankment, concrete placement, rock, dredging, etc.) is common to USACE-MVN. The primary line items of work (not unit costs) of the cost estimates were developed from the feasibility reports or designs for each of the following projects.

- Large diversion (Old River Auxiliary Structure)
- Box culvert diversion (Davis Pond)
- Siphon diversion (Hero Canal)
- Locks (Bayou Sorrell Lock Replacement)
- Navigable Gated Structure (Morganza to the Gulf - Bayou Grand Caillou Sector Gate)
- Rock structures (existing breakwaters, terminal groins (jetties), and foreshore dikes)

<u>Contingencies</u>

The contingency was developed based on the degree of uncertainties in both quantities and unit prices due to the expedited time schedule and limited or unavailable design information. Contingencies were based upon similar cost estimates that had a risk analysis performed using a range estimating computer program, experience, historical data, or regulation. Contingencies of 30 percent were used for all new estimates.

Sediment Delivery via Pipeline Design Data and Assumptions

The USACE-MVN has completed many of these projects by hydraulic transport via a cutter-head suction dredge with pipeline transport of sediment in a fluid mix to the target area. A breakdown of the analysis by study phases is summarized in the following paragraphs.

The analysis assumed limited pipeline lengths of 25,000 ft per pumping plant. Borrow areas in the Mississippi River extended from one mile upstream and one mile downstream of the pipeline crossing point into the adjacent wetlands. Pipelines could be moved within the marsh area with marsh equipment. An additional booster would require enormous flotation requirements that might be deemed economically or environmentally undesirable. Borrow area assessments did not include a calculation of available material above the stability line for the levee, revetments and docks near the borrow area, and concerns for operating a hydraulic dredge in the vicinity of high traffic areas.

Field investigations of individual target areas were not performed. Variables at each site that would affect the magnitude of fill required to construct the desired wetland include surveys, existing vegetation, soil type, and moisture content of existing substrate. Design calculations assumed an optimum target of 70 percent land and 30 percent open water.

Standardized estimating criteria

Assumptions included: 3 feet of fill is required to construct to the elevation of adjacent wetlands; 100 percent of material placed in bottom 2 feet will remain; 90 percent of third foot of lift will remain while 10 percent of material bleeds into adjacent marsh. Based on these assumptions, an acre of broken marsh will require 5,000 cy/acre marsh of fill.

The USACE Cost Engineering Branch developed a matrix for dredging costs based on typical pumping distances, which are presented in **table 6**. The costs are based on the following assumptions:

1. Minimum quantity per contract is 2 million cubic yards.
2. Eight foot face available over a 500 foot swing.
3. Pipeline and boosters are available to perform work within a reasonable radius to the project site with average pipeline length shown in **table 6** as “pumping distance.”
4. Borrow material is silty sand, maintenance material.

Table 6. Dredging Costs Based on Pipeline Lengths

Pumping distance (feet)	**Unit Cost** ($/cubic yard)	**Mobilization/demobilization** ($)	**Boosters** (each)
5,000	0.80	550,000	0
10,000	0.90	750,000	0
15,000	1.20	800,000	0
20,000	1.40	950,000	0
25,000	1.55	1,250.000	1
30,000	1.70	1,450,000	1
35,000	1.95	1,550,000	1
40,000	2.25	1,750,000	1
45,000	2.30	2.100,000	2
50,000	2.55	2,350,000	2
60,000	2.85	2,950,000	3
65,000	3.30	3,050,000	3

Table 7 shows the minimum and maximum pipeline lengths for dredge placement sites considered under LCA. Some effort was made to utilize best access routes. Access routes for pipeline should be field verified.

Table 7. Minimum Pipeline Lengths for Each Site

Target Area	**Minimum Pump Distance** (miles/feet equivalent)	**Maximum Pump Distance** (miles/feet equivalent)
SW Big Mar	15,840	26,400
Golden Triangle	42,240	63,360
Myrtle Grove	13,200	60,720
Empire	5,280	58,080
Bastian Bay	2,640	34,320
Fort Jackson	10,560	36,960
American Bay	5,280	52,800
Quarantine Bay	7,920	58,080
Fort St. Philip	5,280	26,400
Labranche	15,840	36,960
Central Wetlands	10,560	52,800
Sediment Trap East	0	21,120
Sediment Trap West	0	21,120

For the diversion structure and related features at Myrtle Grove, additional detailed design and cost information was available from the CWPPRA / MRSNFR study efforts. This feature was used as a design guide for other features being considered. The detailed cost estimate information is presented in MCACES format in the following paragraphs.

Dedicated dredging for marsh creation design assumptions

General

Problems include target areas void of existing barriers, target areas outside the reach of traditional hydraulic dredge created wetlands, and limitations on available borrow sites. An example of target areas void of existing barriers includes sediment flow that crosses the Barataria Bay Waterway on the Myrtle Grove influence area.

Pipeline lengths were limited to 25,000 ft per pumping plant. Borrow areas in the Mississippi River extended from one mile upstream and one mile downstream of the crossing into the adjacent wetlands. Pipelines can be moved within the marsh area with marsh equipment. An additional booster would require enormous flotation requirements that might be deemed economically or environmentally undesirable. The borrow area did not include a calculation of available material above the stability line for the levee, revetments, and docks near the borrow area, and concerns for operating a hydraulic dredge in the vicinity of high traffic areas.

Assumptions included: 3 feet of fill is required to construct to the elevation of adjacent wetlands; 100 percent of material placed in bottom 2 feet will remain; 90 percent of third foot of lift will remain while 10 percent of material bleeds into adjacent marsh. Based on these assumptions, an acre of broken marsh will require 5,000 cy/acre marsh of fill.

The USACE Cost Engineering Branch developed a matrix for dredging costs based on typical pumping distances, which are presented in **table 8**. The costs are based on the following assumptions:

1. Minimum quantity per contract is 2 million cubic yards.
2. Eight foot face available over a 500 foot swing.
3. Pipeline and boosters are available to perform work within a reasonable radius to the project site with average pipeline length shown in **table 8** as "pumping distance."
4. Borrow material is silty sand, maintenance material.

Table 8. Dredging Costs Based on Pipeline Lengths

Pumping distance (feet)	**Unit Cost** ($/cubic yard)	**Mobilization/ demobilization** ($)	**Boosters** (each)
5,000	0.80	550,000	0
10,000	0.90	750,000	0
15,000	1.20	800,000	0
20,000	1.40	950,000	0
25,000	1.55	1,250.000	1
30,000	1.70	1,450,000	1
35,000	1.95	1,550,000	1
40,000	2.25	1,750,000	1
45,000	2.30	2.100,000	2
50,000	2.55	2,350,000	2
60,000	2.85	2,950,000	3
65,000	3.30	3,050,000	3

This project is predicted to create/preserve 6,563 acres over the next 50 years. The estimated cost for designing and constructing the Myrtle Grove Diversion and Dedicated Dredging feature is $293.962 million (including monitoring). **Table 9** provides a detailed MCACES format cost estimate for the proposed restoration features.

Table 9. MCACES Format Cost Estimates,
Medium Diversion with Dedicated Dredging at Myrtle Grove

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
01-	LANDS AND DAMAGES						
	Channel and Structure						
01B	Acquisitions						
01B20	By Local Sponsor (LS)				5,000	2,500	7,500
01B30	By Govt on Behalf of LS				88,680	44,340	133,020
01B40	Review of LS				1,560	780	2,340
01C	Condemnations						
01C30	By Govt on Behalf of LS				4,138	2,070	6,208
01E	Appraisal						
01E40	By Govt on Behalf of LS (Contract)				9,600	4,800	14,400
01E50	Review of Contract				3,200	1,600	4,800
01G	Temporary Permits/Liscenses/Rights-of-Entry						
01G30	By Govt on Behalf of LS				4,568	2,304	6,872
01N00	Facility/Utility Relocations (Subordination Agreement)				250	130	380
01R	Real Estate Payments						
01R1	Land Payments						

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
01R1C	By Govt on Behalf of LS				4,998,000	2,499,000	7,497,000
01T	LERRD Crediting						
01T20	Administrative Costs (By Govt and LS)				8,650	4,330	12,980
51	Operations & Maintenance During Construction						
51B	Real Estate Management Services				2,000	1,000	3,000
51B20	Outgrants (Over 5 Years)				15,000	7,500	22,500
51B30	Disposal/Quitclaim				6,000	3,000	9,000
01--	Subtotal: Channel and Structure						5,146,646
	Contingencies						2,573,354
01--	Subtotal: Channel and Structure						7,720,000
01-	LANDS AND DAMAGES						
	Influence Area						
01B	Acquisitions						
01B20	By Local Sponsor (LS)				125,000	62,500	187,500
01B30	By Govt on Behalf of LS				18,891,713	9,445,860	28,337,573
01B40	Review of LS				12,400	6,200	18,600
01C	Condemnations						
01C30	By Govt on Behalf of LS				951,000	475,500	1,426,500
01E	Appraisal						
01E40	By Govt on Behalf of LS (Contract)				2,830,000	1,415,000	4,245,000
01E50	Review of LS				944,000	472,000	1,416,000
01F	PL 91-646 Assistance						
01F30	By Govt on Behalf of LS				6,000	3,000	9,000
01G	Temporary Permits/Liscenses/Rights-of-Entry						
01G30	By Government				352,000	176,000	528,000
01N00	Facility/Utility Relocations (Subordination Agreement)				112,000	56,000	168,000
01R	Real Estate Payments						
01R1	Land Payments						
01R1B	By LS (Oysters)				866,800	433,400	1,300,200
01R1C	By Govt on Behalf of LS				22,260,735	11,135,292	33,396,027
01R2	PL 91-646 Assistance Payments						
01R2C	By Govt on Behalf of LS				60,000	30,000	90,000
01T	LERRD Crediting						
01T20	Administrative Costs (By Govt and LS)				11,400	5,700	17,100
51	Operations & Maintenance During Construction						
51B	Real Estate Management Services				2,000	1,000	3,000
51B20	Outgrants (Over 5 Years)				15,000	7,500	22,500
51B30	Disposal/Quitclaim				70,000	35,000	105,000
01--	Subtotal: Influence Area						47,510,048

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
	Contingencies						23,759,952
01--	Subtotal: Influence Area						71,270,000
01--	TOTAL: LANDS AND DAMAGES						78,990,000
02--	RELOCATIONS						
02031815	Pipeline Relocations	Lump Sum	LS	410,000.00	410,000	120,000	530,000
0201----	Roads and Bridges						
	New Temp Detour 2 Lane Hwy	4,260	LF	175.00	745,500	225,400	970,900
	Demolish Existing 4 Lane Hwy	3,500	LF	50.00	175,000	52,910	227,910
	New Permenant 4 Lane Hwy	3,500	LF	450.00	1,575,000	476,190	2,051,190
0201----	Subtotal: Roads and Bridges						2,495,500
	Contingencies						754,500
0201----	Subtotal: Roads and Bridges						3,250,000
02--	TOTAL: RELOCATIONS						3,780,000
06---	ECOSYSTEM RESTORATION						
	Sediment Delivery via Pipeline						
	Mob & Demob	7	EA	1,600,000.00	11,200,000	3,360,000	14,560,000
	Dredging	28,000,000	CY	2.25	63,000,000	19,410,000	82,410,000
	Subtotal: Sediment Delivery via Pipeline						74,200,000
	Contingencies						22,770,000
	Subtotal: Sediment Delivery via Pipeline						96,970,000
06--	TOTAL: ECOSYSTEM RESTORATION						96,970,000
09--	CHANNELS AND CANALS						
09--	15,000 cfs Diversion						
	Mobilization/Demobilization of Levee Contract	Lump Sum	LS	100,000.00	100,000	30,000	130,000
	Clearing and Grubbing	340	AC	2,500.00	850,000	255,000	1,105,000
	Levee	565,000	CY	6.00	3,390,000	1,013,000	4,403,000
	Fert/Seeding	30	AC	500.00	15,000	4,500	19,500
	Mobilization/Demobilization for Stone Contract	Lump Sum	LS	50,000.00	50,000	15,000	65,000

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
	Armor	57,000	TN	25.00	1,425,000	427,500	1,852,500
	Mobilization/Demobilization of Dredge Contract	Lump Sum	LS	750,000.00	750,000	225,000	975,000
	Dredging	4,000,000	CY	3.00	12,000,000	3,600,000	15,600,000
09--	Subtotal: 15,000 cfs Diversion						18,580,000
	Contingencies						5,570,000
09--	Subtotal: 15,000 cfs Diversion						24,150,000
09--	TOTAL: CHANNELS AND CANALS						24,150,000
15--	DIVERSION STRUCTURES						
15--	5,000 cfs Diversion						
	Mob & Demob	2	EA	250,000.00	500,000	150,000	650,000
	Care and Diversion of Water						
	PSA 23 Sheet Pile for Cells	60,600	SF	16.00	969,600	295,400	1,265,000
	Sand for Cells	8,300	CY	8.00	66,400	19,920	86,320
	SPZ 26 Sheet Pile	5,700	SF	18.00	102,600	30,780	133,380
	Dewatering System	Lump Sum	LS	840,000.00	840,000	255,000	1,095,000
	Earthwork for Structure						
	Clearing & Grubbing	5	AC	2,500.00	12,500	3,750	16,250
	Degrading Existing Levee	17,500	CY	3.25	56,875	17,065	73,940
	Rebuild Existing Levee	17,500	CY	6.00	105,000	31,500	136,500
	Seeding & Fertilizing	5	AC	500.00	2,500	750	3,250
	Structural Excavation	73,500	CY	4.00	294,000	89,000	383,000
	Compacted Backfill	23,000	CY	8.00	184,000	55,200	239,200
	Bedding Material	4,800	CY	30.00	144,000	43,200	187,200
	Riprap (dry)	27,000	TONS	50.00	1,350,000	410,000	1,760,000
	Foundation						
	SPZ-22 Steel Sheet Piling	12,200	SF	13.00	158,600	47,580	206,180
	14" x 14" PPC Piling	110,000	LF	30.00	3,300,000	1,005,000	4,305,000
	Reinforced Concrete						
	Base Slab	5,600	CY	250.00	1,400,000	420,000	1,820,000
	Walls & Roof	7,500	CY	425.00	3,187,500	972,500	4,160,000
	Wing Walls	800	CY	400.00	320,000	98,000	418,000
	Unreinforced Concrete						
	Stabilization Slab	1,500	CY	100.00	150,000	46,000	196,000
	Apron	300	CY	100.00	30,000	9,000	39,000
	Special Construction						
	Instrumentation	Lump Sum	LS	40,000.00	40,000	12,000	52,000
	Miscellaneous Metals						
	Embedded Metals	69,300	LBS	2.00	138,600	41,580	180,180

Account Code	Item	Quantity	Unit	Unit Cost	Amount	Contingency	Project Cost
	Gates and Associated Items						
	16'x16' Cast Iron Sluice Gates	5	EA	530,000.00	2,650,000	810,000	3,460,000
	Structural Steel Bulkheads	103,700	LBS	3.00	311,100	93,500	404,600
	Electrical						
	Power & Lighting	Lump Sum	LS	120,000.00	120,000	36,000	156,000
	Emergency Generator	Lump Sum	LS	37,000.00	37,000	11,100	48,100
	Mechanical						
	Operating Machinery	Lump Sum	LS	250,000.00	250,000	75,900	325,900
15--	Subtotal: 15,000 Diversion						16,720,275
	Contingencies						5,079,725
15--	Subtotal: 15,000 Diversion						21,800,000
15--	TOTAL: DIVERSION STRUCTURES						21,800,000
30--	ENGINEERING AND DESIGN						
	Design Documentation (Feasibility)				18,338,000	3,667,000	22,005,000
	PED				12,235,000	2,435,000	14,670,000
	E&D				6,895,000	1,320,000	8,215,000
	Monitoring				2,257,000	451,000	2,708,000
30--	Subtotal: Engineering And Design						39,725,000
	Contingencies						7,873,000
30--	TOTAL: ENGINEERING AND DESIGN						47,598,000
31--	CONSTRUCTION MANAGEMENT						
	Supervision and Administration (S&A):						
	Diversion				5,968,000	1,194,000	7,162,000
	Sediment Delivery via Pipeline				11,636,000	2,327,000	13,963,000
31--	Subtotal: Construction Management						17,604,000
	Contingencies						3,521,000
31--	TOTAL: CONSTRUCTION MANAGEMENT						21,125,000
	TOTAL PROJECT COST						293,962,000

Monitoring the performance of the project features will be conducted as part of the construction portion of the recommended plan. The purpose of including monitoring in the project is to document the performance of the reintroduction in terms of meeting the environmental goals of the project. Monitoring will assess the engineering performance of the designs to aid in decisions regarding operations and maintenance needs and to feed information into an adaptive management program for the coast.

All of the structural components of this feature will require operations and maintenance to sustain engineering performance and achieve long-term project environmental goals. In general, the maintenance requirements are driven by the need to manage the freshwater diversion volume. Management will vary depending upon the specific flows in the Mississippi River that are variable from year to year. Typical operations and maintenance actions will include engineering inspections of the culverts and minor construction events to maintain the performance of any outfall management measures. Additional actions may be required to maintain the marsh areas created through dedicated dredging. These OMRR&R actions will be the responsibility of the local sponsor. The estimated annual O&M cost is $120,000.

Table 10 provides a summary of the first costs for this feature.

Table 10. Medium Diversion with Dedicated Dredging at Myrtle Grove Summary of Costs for the LCA Plan (June 2004 Price Level)

Lands and Damages	$	78,990,000
Elements:		
Relocations	$	3,780,000
Ecosystem Restoration	$	96,970,000
Channels and Canals	$	24,150,000
Diversion Structures	$	21,800,000
First Cost	$	225,690,000
Feasibility-Level Decision Document	$	22,005,000
Preconstruction Engineering and Design (PED)	$	14,670,000
Engineering and Design (E&D)	$	8,215,000
Supervision and Administration (S&A)	$	21,125,000
Monitoring	$	2,257,000
Total Cost	**$**	**293,962,000**

A detailed breakdown of cost accounts between Federal funds and the share of the local sponsor is provided in **table 11**.

Table 11. Medium Diversion with Dedicated Dredging at Myrtle Grove FEDERAL AND NON-FEDERAL COST BREAKDOWN (June 2004 Price Level)			
Item	**Federal**	**Non-Federal**	**Total**
Decision Document (50%Fed-50%NFS)	$ 11,002,500	$ 11,002,500	$ 22,005,000
PED (65%Fed-35%NFS)	$ 9,535,500	$ 5,134,500	$ 14,670,000
LERR&D (100% NFS)	$ -	$ 82,770,000	$ 82,770,000
Ecosystem Restoration (65%Fed-35%NFS)	$ 142,920,000	$ -	$ 142,920,000
Engineering and Design (E&D) (65%Fed-35%NFS)	$ 6,339,750	$ 1,875,250	$ 8,215,000
Supervision and Administration (S&A) (65%Fed-35%NFS)	$ 16,509,750	$ 4,615,250	$ 21,125,000
Monitoring (65%Fed-35%NFS)	$ 1,467,050	$ 789,950	$ 2,257,000
Total Construction	**$ 176,772,050**	**$ 95,184,950**	**$ 271,957,000**
TOTAL COST	**$ 187,774,550**	**$ 106,187,450**	**$ 293,962,000**
Cash Contribution	*$ 187,774,550*	*$ 12,414,950*	

Implementation Plan

Initial Project Management Plan (PMP) and scoping efforts to address the appropriate level of engineering detail required for the follow-up feasibility-level decision document for the Myrtle Grove diversion and dredging features are currently underway. The PMP is expected to be negotiated by the end of December 2004 and will form the basis for assigning tasks between the USACE and the sponsor (LDNR) as well as detail the conduct of the feasibility-level analyses. Development of the decision document is anticipated to begin in April 2005, with completion estimated in two and a half years (April 2007). Pre-construction engineering and design (PED) efforts to finalize the detailed design and prepare the project for construction would initiate once a design agreement is negotiated with LDNR to define the scope, schedule and cost of the design. Preparations of plans and specifications for construction could commence in October 2007 and are forecast for completion in two and a half years (March 2010). Construction of the features could begin following PED with approval and execution of a Project Cooperation Agreement (PCA). The current schedule would allow for construction to begin as early as April 2010, with construction completion estimated for the end of calendar year 2014.

These accelerated schedules are important for the implementation of the LCA Plan. Experience in designing and constructing similar features in coastal Louisiana indicates that these schedules are attainable given the necessary level of coordination and funding that will be required to achieve the goals and objectives of the plan to address the critical needs facing coastal Louisiana.

National Environmental Policy Act (NEPA)

The Programmatic Environmental Impact Statement (PEIS) undertaken in the LCA study has assessed the impacts of various restoration techniques, the specific subprovince restoration frameworks, the identified final array of coast wide frameworks, the alternative plans for best meeting the study objectives, and the LCA Plan. These impacts are identified and discussed by specific and cumulative natural and human environmental effects. The PEIS provides a consistent basis for initiating NEPA documentation of individual restoration features in the context of larger systemic coastal needs and functions.

The specific NEPA effort for the proposed Myrtle Grove restoration feature has already been initiated. The public scoping has been completed and documented along with the development of a range of potential alternative plans developed in coordination with the concurrent LCA study effort. As previously discussed, the combined screenings in several previous investigations have consistently identified the proposed feature or a similar range of restoration features.

A NOI to prepare an EIS for the Myrtle Grove Ecosystem Restoration Analysis, Louisiana, was published in the Federal Register on Wednesday, January 30, 2002. Three scoping meetings were originally scheduled (March 13, 2002 - Belle Chasse, Louisiana; March 20, 2002 - Buras, Louisiana; and March 27, 2002 - Jefferson Parish School Board Administration Building, Louisiana). A fourth meeting was held on April 15, 2002 in Belle Chasse at the request of the interested public.

Existing conditions of significant resources likely to be encountered and the occurrence of HTRW within the proposed project area are being investigated by the USACE-MVN. Analysis of future conditions with project (action alternative(s)) will not be initiated until current resource modeling efforts and the selection of action alternatives are concluded. However, coordination with interested local, state, and Federal agencies continues on an as-needed basis until a more detailed plan, other than the no-action (or Future Without Project) alternative is made available.

Uncertainties/Risks

<u>Adaptive Management</u>

The basic components of this restoration feature represent relatively high certainty and low risk. There is a great deal of working experience with marsh creation using dredged sediments (e.g., current beneficial use activities, Labranche wetland restoration, etc.) as well as for influencing wetland restoration using river diversions (e.g., Naomi Siphon, Caernarvon, Davis Pond, etc.). However, the combination of these two components is particularly suited for application of adaptive management. The response of the marsh platform and operation of the diversion can then be monitored and adjusted to optimize wetland building. Variations can be measured against constructed and natural marsh platform parameters, level and frequency of diversion operation, timing of diversion, and distance from the diversion. These are applications exportable to any location where river diversions might be applied with or without mechanical wetland creation, or where marsh creation might be utilized in the presence of some amount of riverine influence.

Subject to Feasibility

The major area of uncertainty in this restoration feature is the combining of the proposed diversion and its operation with other existing diversions and their combined effect on the Barataria Basin as a whole. The detailed study of these hydrologic effects, the combined operational consideration, and the resulting ecological response is a necessary product of the final decision document for this feature. The identification of secondary socio-economic effects, if any, for private and commercial development in the immediate area is also a significant question with implications to the rest of the LCA restoration effort.

Contingent Authorization/Demos/S&T

The combination of direct creation of wetlands and river diversion also allows variations in the specifications of the dredge material placement as a demonstration. Just as the combination of these two restoration techniques is conducive to adaptive management, initial variations in the placement of dredged material could produce additional insight for future wetland construction. The vegetative response of various created wetland platforms could aid in identifying the minimum and optimum material placement requirements when additional inputs of sediment are available. This would allow for maximum use of available sediment resources and also be applicable in certain beneficial use applications.

Recommendations/Summary

The Medium Diversion with Dedicated Dredging at Myrtle Grove restoration feature addresses critical ecological needs in a sensitive area of the most highly productive estuarine systems in the Nation. The components of the feature create a synergy that will result in highly productive and sustainable outputs. The design and operation of the feature will maintain the opportunity for and support the development of large-scale, long-range comprehensive coastal restoration. The feature will also support opportunity for resolution of scientific and technical uncertainties through incorporation of demonstration measures and/or adaptive management.

The level of investigation in this area undertaken to date provides a high level of certainty in the appropriateness of the restoration feature and the range of alternative configurations that should be addressed in a final decision document. These previous investigations have also provided enough technical insight to provide confidence in the relative costs and potential benefits of the feature. These parameters will be refined along with the specific feature design for final consideration for implementation. The current status of analyses and NEPA documentation also provide a high degree of confidence that the design and documentation for this restoration feature can be completed for approval and implementation on an expedited schedule.

For these reasons, the Medium Diversion with Dedicated Dredging at Myrtle Grove feature has been recommended for contingent authorization. The execution of this restoration feature constitutes an element of the most appropriate near-term action for achieving the restoration of coastal Louisiana.