CHAPTER 2 ALTERNATIVES

This is a programmatic effort for creating a coastal restoration program that addresses the critical ecological and human restoration needs of coastal Louisiana. Conceptual programmatic restoration opportunities (alternatives) were developed to address the critical ecological and human needs criteria identified through the scoping process and other forums. This chapter includes presentation of planning constraints, plan formulation rationale, alternative formulation phases, comparison of the potential impacts for each restoration opportunity, the recommended LCA Plan, and plan implementation. Detailed discussions of the plan formulation phases are contained in the Main Report. For the sake of clarity, the following sections reiterate some of the information contained in the Main Report about the plan formulation phases. A detailed listing of coast wide plans and corresponding measures is presented.

GENERAL

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 step in the plan formulation process is the initial problem identification. The second step 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 step, accounts for the level or amount of a particular resource that currently exists within the study, i.e. the "Existing Conditions." The step 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 step 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 step 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 step, 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 step, 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 step 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 this six-phase process, the LCA Plan that best meets NER objectives was developed.

2.1 PROGRAMMATIC 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.

An implementation constraint was funding availability for restoration efforts and the near-term time limit (10 years).

2.1.1 Scientific and Technological Uncertainties

Scientists have documented the importance of the LCA for fish and wildlife habitat (Coalition to Restore Coastal Louisiana, 1989; Keithly, 1991; Herke, 1993; Michot, 1993), 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 Zimmerman, 1991) 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., 1988; 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 LCA. 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 LCA 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 LCA, 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 LCA Project Delivery Team (PDT) reviewed annual Adaptive Management reports prepared to assess previously constructed CWPPRA projects. These efforts to identify "lessons learned" from the many CWPPRA projects, past and future, will also serve as a valuable assessment of "what worked" and "why it worked". Identification of the reasons why other projects did not meet initial project goals is also essential to reduce uncertainties.

The Main Report presents a more detailed discussion on scientific and technological uncertainties that is intended to illustrate the considerable information that has been developed from prior studies, but that data gaps still exist and considerable scientific and engineering uncertainties remain. There are numerous types of uncertainties that need 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. The Main Report also discusses the strategies to resolve the four uncertainty types:

- Type 1 - Uncertainties about physical, chemical, geological, and biological baseline conditions
- Type 2 - Uncertainties about engineering concepts and operational methods
- Type 3 - Uncertainties about ecological processes, analytical tools, and ecosystem response
- Type 4 - Uncertainties associated with socio-economic/political conditions and responses

2.2 PLAN FORMULATION RATIONALE

2.2.1 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. The broad geographic scope of the LCA and the complexity of aquatic ecosystem restoration efforts in general provided the rationale for convening a number of multi-disciplinary teams to provide technical expertise and expedite review and decision-making within the plan formulation process. 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.

2.2.1.1 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 (Region-6);
- 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 Committee - An Executive Committee was formed to provide executive-level guidance and support for the LCA Study. In addition, the Executive Committee worked with the District Engineer on various issues throughout the LCA Study and plan formulation.

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.

2.2.1.2 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), Southern 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

2.2.1.3 Special Teams

National Technical Review Team – 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 NTRC held its seventh meeting to review and provide comments on the LCA Study and plan development on April 28 to 29, 2004.

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.

Office of the Chief of Engineers Value Engineering Study Team – USACE-OVEST is a specialized agency 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.

2.2.2 Study Principles and Objectives 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 LCA. 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 in the LCA (as indicated by points, A, B, and C in **figure 2-1**).

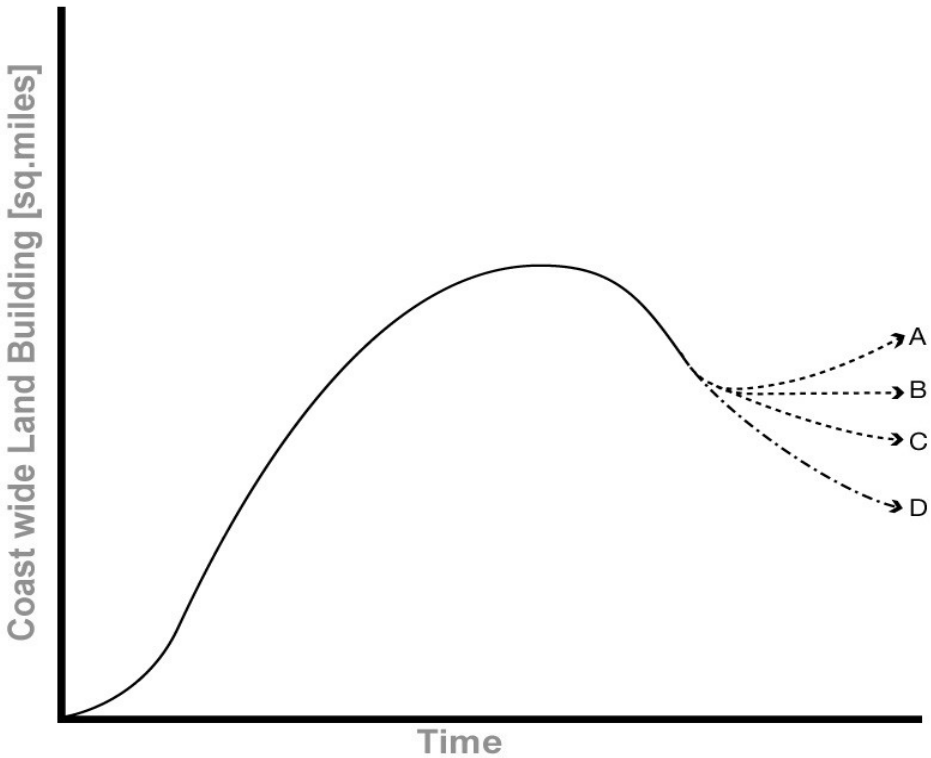


Figure 2-1. Ecosystem Degradation Trend Over Time. The arrows represent conceptual outcomes for restoration (A, B, C) and the predicted future without project (d). **(Not to scale.)**

2.2.3 Environmental Operating Principles

In 2002, the USACE reaffirmed its long-standing commitment to the environment by formalizing a set of EOPs applicable to all of its decision-making and 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.

2.2.4 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.

2.2.5 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.

2.3 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 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 needs. **Table 2-1** highlights the purpose, decision criteria, and results of the major iterations.

2.3.1 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 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.

The PDT determined that the highest, most ambitious scale would be an annual net increase in ecosystem function. This uppermost scale 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 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 2-1. 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	Plan that Best Meets the Objectives (PBMO)

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

The PDT, in conjunction with the VT 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 reports identified problems in both the current and future coastal landscape and laid out 93 broad-scale strategies for addressing ecosystem restoration.

Overall, the strategies would 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 resource 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 sediments 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.

2.3.3 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. Because 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, the potential restoration features represent surrogates for planning purposes. These features 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 determination of feature scale and location is intended to be addressed in decision documents subsequent to and contingent upon 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. 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.

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 in **table 2-2** 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, illustrated in **table 2-2**, 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 2-2. 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.

2.3.4 Phase IV - Develop and Evaluate Subprovince Frameworks

2.3.4.1 Development of Subprovince Frameworks

In Phase IV, the PDT first created multiple combinations of restoration features, or 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.

The combinations of restoration features in subprovince frameworks were guided by two requirements: the need to combine restoration features so that their collective output/benefit to restore ecosystem function would achieve one of the planning scales in the subprovince, and the need to develop significantly different combinations in each subprovince that would achieve a particular planning scale.

The PDT accomplished the second requirement with the use of restoration "approaches" that it created for each subprovince. The goal of each restoration approach provided the team with a basis to prepare combinations from the toolbox that would result in a significantly different mix of restoration features, and, in turn, a significantly 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 an 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
- Maximum Atchafalaya Flow
- Land Building by Delta Development
- Mississippi and Atchafalaya Flows

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

So as not to make the analysis of alternative frameworks overly complex, the number developed for each subprovince to address a planning scale was limited to three, unless such a limit excluded a reasonable framework or restoration feature that would not otherwise be reviewed. 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. The PDT developed a reasonable, "supplemental" framework for each subprovince in Phase V, 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, applied from the toolbox described in Phase III, to make up each subprovince framework are identified in **tables 2-3** through **2-6.** Full descriptions of subprovince frameworks are included in attachment 1 to appendix E PLAN FORMULATION.

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

Table 2-3. 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
Reauthorization 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 enhanced 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 2-4. 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
Reauthorization 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 2-5. 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 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 Bay 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 = Maximize Atchafalaya (NIC Third Delta); 2 = Land-building by delta development; 3 = Mississippi and Atchafalaya flows.

Table 2-6. 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 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.

2.3.4.2 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 in the Main Report.

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 plant productivity.

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

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

In order to develop “coast wide” frameworks, the subprovince frameworks were combined. 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. 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.

2.3.5.1 Cost Effectiveness/Incremental Cost Analysis

The LCA study evaluated alternative coast wide frameworks designed 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 measures were not readily translatable to dollar terms, traditional benefit-cost analysis was not possible. Consequently, the performance of the CE/ICA method allowed for the comparison of benefits and costs.

In the cost-effectiveness analysis, the coast wide frameworks were assessed according to their ability to produce output for a given cost level. The result was a listing of coast wide frameworks that would achieve each output level at the lowest cost, or an "efficient frontier" of restoration solutions. Restated, alternative frameworks screened in this manner met these two criteria: (1) no other solution produces the same output for less cost, and (2) no other solution provides more output for the same or less cost.

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 alternative. The combined weighted outputs and costs for each alternative were also displayed and ordered by cost. The primary factors of interest were ecological benefit versus cost, and an assessment of economic effects. Detailed discussion of this portion of the analysis can also be found in appendix E Plan Formulation of the Main Report.

The cost-effectiveness assessment 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). Potential economic impacts of the plans were roughly estimated and taken into consideration in project selection as follows: after cost effectiveness and incremental cost analysis (CE/ICA), both positive and negative economic impacts of plans in the final array were estimated on a gross basis to inform decision makers of the magnitude of these effects.

2.3.5.2 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. 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 significantly improve upon 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 significant features, such as barrier islands or a Third Delta feature, in subsequent implementation phases.

During this stage of the framework selection process, the PDT evaluated the frameworks that formed the cost-efficient frontier and eliminated several of the frameworks from further consideration. Some cost-effective frameworks were eliminated because they did not provide potential coast wide restoration or economic damage reduction. Other cost-effective alternative frameworks that met these criteria occurred at approximately the point in the cost-effective curve at which the cost per unit benefit begins to rise rapidly. Framework 7002 represented the terminal point of the cost-efficient frontier. Based on the criteria of cost-effectiveness, exceeding minimum program and output values, and providing maximum potential damage reduction, framework 5110 (made up of S1M2, S2R1, and S3R1) would be a rational framework selection. However, upon review of these frameworks, the PDT identified several environmentally significant features that were not included in or addressed by 5110 or any of the cost-effective frameworks on the curve shown in **figure 2-2** (7410, 7610).

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 significant features not in the cost-effective framework combinations. A number of additional frameworks were identified that addressed the identified significant 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, and 7610.

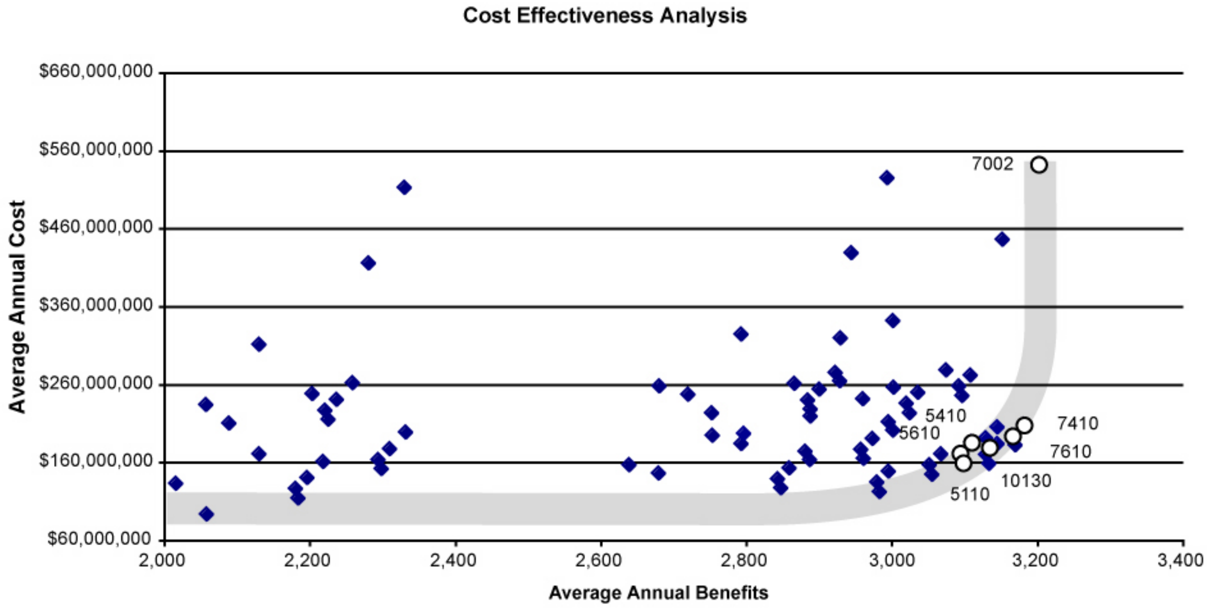


Figure 2-2. Preliminary Average Annual Costs and Average Annual Benefits for the Final Array of Alternative Frameworks for Subprovinces 1 to 3. *Note: the gray line denotes the cost efficient frontier.*

2.3.5.3 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 environmentally significant features. 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, which were predominantly based on framework 5610. These two supplemental frameworks were identical, except that one of the frameworks contained the 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. These 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.

This analysis revealed that the basic supplemental framework created more and similar benefits at less cost than those in the efficient frontier. The second supplemental framework was developed by combining the Third Delta feature with the basic supplemental framework. Neither framework plotted within the optimal range of the existing final array of frameworks. A review of the features included in the second supplemental framework revealed that several of the diversion features could be redundant and potentially not implementable with the inclusion of the Third Delta feature. Framework 7002 included several of the features identified for detailed investigation in the basic supplemental framework, as well as including the Third Delta feature. As a result, it was determined that the appropriate action would be to continue to develop the basic supplemental framework and include it as the supplemental framework along with framework 7002 in the final array.

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 other supplemental framework components in Subprovinces 1 and 3 could produce a modified supplemental framework that would enhance completeness and be 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.

Figure 2-2 illustrates the relationship of the final array of coast wide frameworks to all other frameworks considered. The results of the final iteration of cost-effectiveness illustrated that the frameworks identified in the tentative final array remained consistent in their position relative to the efficient frontier. The inclusion of the modified supplemental framework (10130) in this iteration of the analysis resulted in the addition of this framework to the efficient frontier. 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 alternative framework that was considered 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 2-2**. Any of the frameworks, with the exception of 7002, could suffice as a cost-effective framework for the Deltaic Plain.

2.3.5.4 <u>Development of the Final Array for the Chenier Plain</u>

Habitats in the Chenier Plain were created by processes that did not include periodic overflows of the river to build and maintain land. Accordingly, frameworks for Subprovince 4 that create and preserve habitat are not constrained by the amount of water and sediment available in the Mississippi River. 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 be 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 significantly 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.

2.3.5.5 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 2-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 significant 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 2-3**). As stated previously, the Chenier Plain was analyzed separately and thus frameworks that are not combinable were analyzed independently.

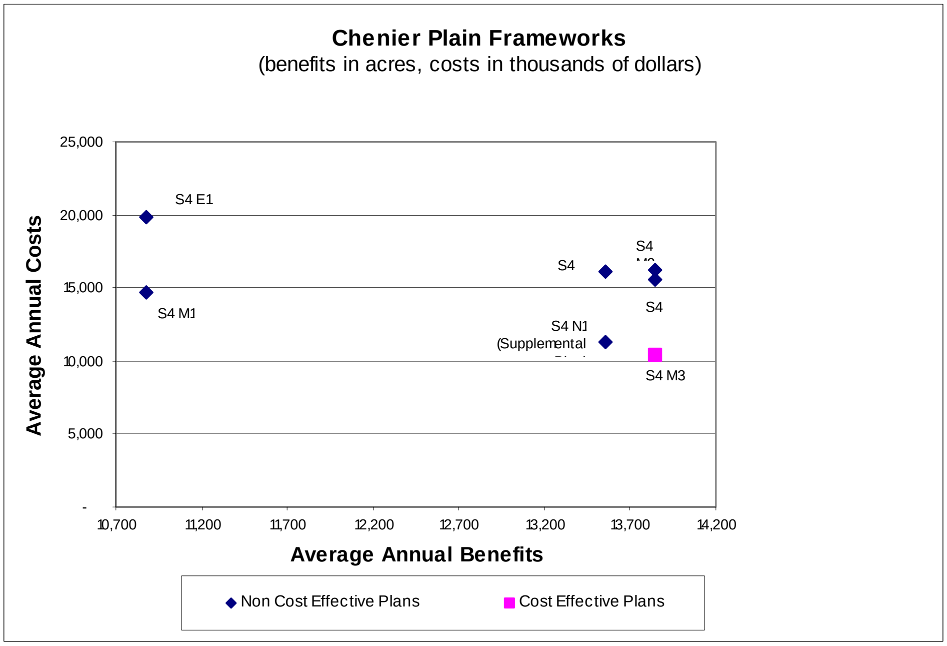


Figure 2-3. Costs and Benefits (acres) for all Chenier Plain Frameworks.

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 significantly 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.

2.3.5.6 Details of the Final Array of Coast Wide System Frameworks

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 2-7** 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 2-3** through **2-6** 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 2-7. 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 2-3** through **2-6**, 79 features are contained in the final array of coast wide frameworks identified in **table 2-7**. Descriptions of the 79 features are found in section 3.3.6.1.

2.3.6 Phase VI - Development of Alternative LCA Restoration Plans

Upon the completion of Phase V efforts, with attention to the science and technology (S&T) uncertainties and model uncertainties, the PDT redirected the plan formulation effort towards definition of a plan that focused on critical restoration efforts 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, the features within the final array of coast wide frameworks were used as the starting point for the identification of alternative LCA Plans. These 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.

2.3.6.1 Description of the Restoration Features Identified in the Final Array of Coast Wide Frameworks

The PDT 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. More detailed cost information regarding the features is available at the District upon request. The features are shown on **figures 2-4** through 2**-7**.

2.3.6.1.1 *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 Carre 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 sediments 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 sediments and nutrients to the system.

Small diversion at Hope Canal (CWPPRA Maurepas diversion): This restoration feature involves a small diversion from the Mississippi River through a new control structure at Hope Canal. The objective is to introduce sediments 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 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 sediments 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.

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) 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 enhance and create wetlands by placing dredged sediments in the shallow (1 to 2 feet) 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) open water areas in the vicinity of Fort St. Philip. Enhancement 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) open water in the area adjacent to these three water bodies. Enhancement 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) 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 sediments in the moderately shallow (3 to 5 feet) open waters of Quarantine Bay.

Opportunistic use of Bonnet Carre Spillway (CWPPRA project): 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 sediments from lake bottom sources. The objective of this feature is to create wetlands by placing dredged sediments 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 sediments, for wetland restoration. The objective of this concept is to greatly increase the deposition of Mississippi River sediments 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 under consideration by the MRGO Environmental Restoration 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 boat wake erosion have degraded large expanses of freshwater 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 and possible channel depth modification. Implementation of this feature would result in hydrologic restoration.

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. The structure has been operated as a salinity management feature, with freshwater introductions ranging between 1,000 cfs to 6,000 cfs, but in general averaging something 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 would seek an authorization change of the Caernarvon project purpose to include wetland creation and restoration, thereby altering the project's operational plan. This would allow an increase in the freshwater introduction rate, perhaps 5,000 cfs on average, to accommodate the wetland building function of the system. 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.

Rehabilitate Violet Siphon for enhanced 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 success of this feature would be enhanced with 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 enhanced 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 enhance the effect of the Violet Siphon structure rehabilitation restoration feature.

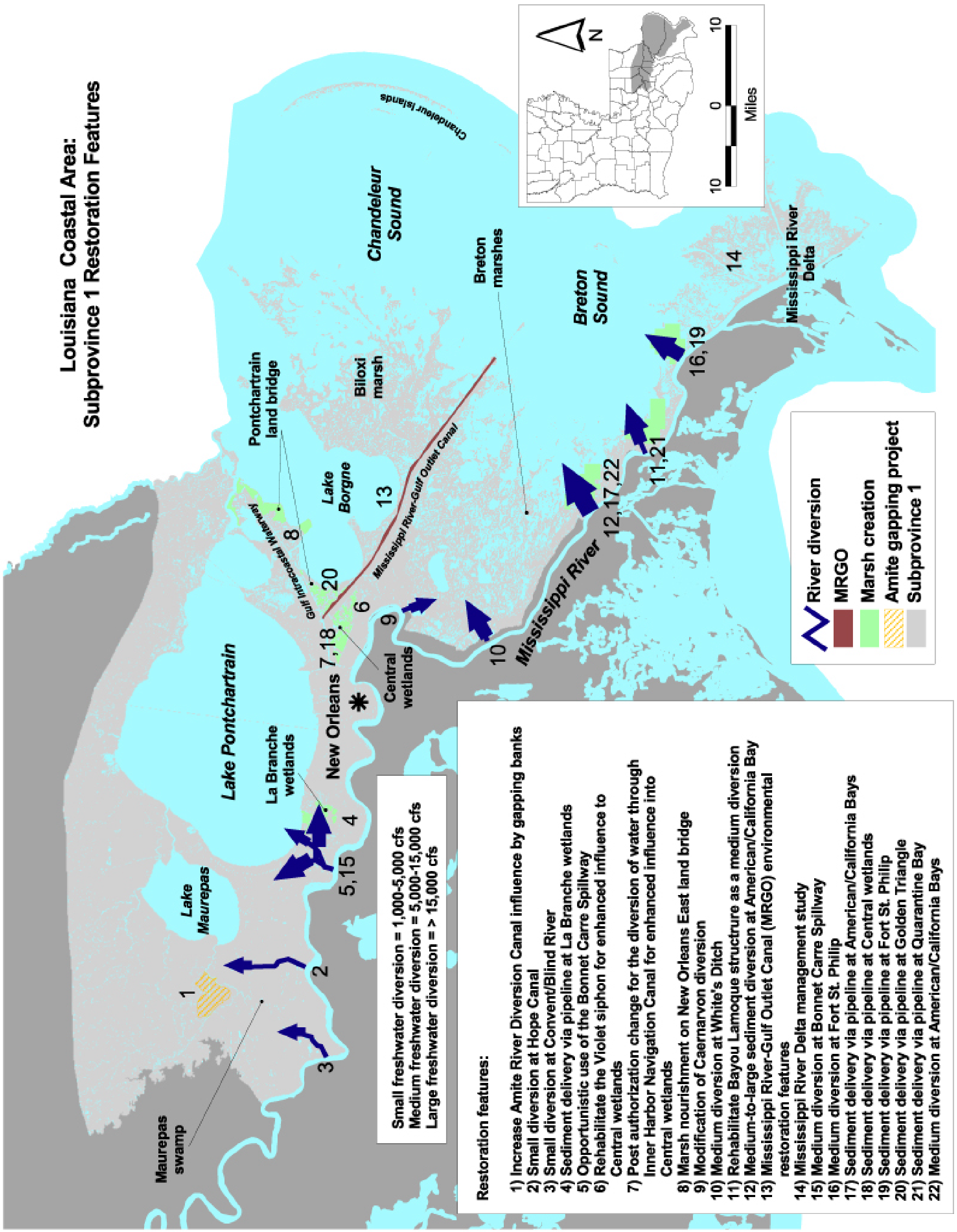


Figure 2-4. Subprovince 1 Restoration Features Identified in the Final Array of Coast Wide Frameworks.

2.3.6.1.2 *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 sediments in the moderately deep (6 to 10 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, sediments would reach and supplement the barrier shoreline between Red Pass and the Empire to the gulf waterway. Sediment enrichment assumes use of 20-inch dredge at capacity for three months yielding 1,468,000 yd^3 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, sediments, 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, sediments, 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, sediments, 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 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 sediments in the moderately deep (6 to 10 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) 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 sediments in the moderately deep (6 to 10 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 dredge at capacity for three months yielding 1,468,000 yd^3 each year. Ultimately, sediments 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, sediments, 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, sediments, 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 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 yd^3 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, sediments 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 wide island footprint. The critical areas 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 zone. This reach of the Barataria shoreline also supports the only land-based access to the barrier shoreline in the Deltaic Plain.

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 for increased sediment input: The Davis Pond diversion structure, constructed in 2002 in upper Barataria Basin, has a maximum operating capacity of 10,600 cfs. 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 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 would seek an authorization change of the Davis Pond project purpose to include wetland creation and restoration, thereby altering the project's operational plan. This would allow an increase in the freshwater introduction rate, perhaps 5,000 cfs on average, to accommodate the wetland building function of the system. 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.

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) 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) 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. 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 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 diversion at maximum river stage into the Barataria Basin only. Enrichment of this diversion would also be considered and assumes use of 30-inch dredge at capacity for three months yielding 6,293,000 yd^3 each year. The study requires significant investigations of flood control, drainage, and navigation impacts in addition to environmental and design efforts.

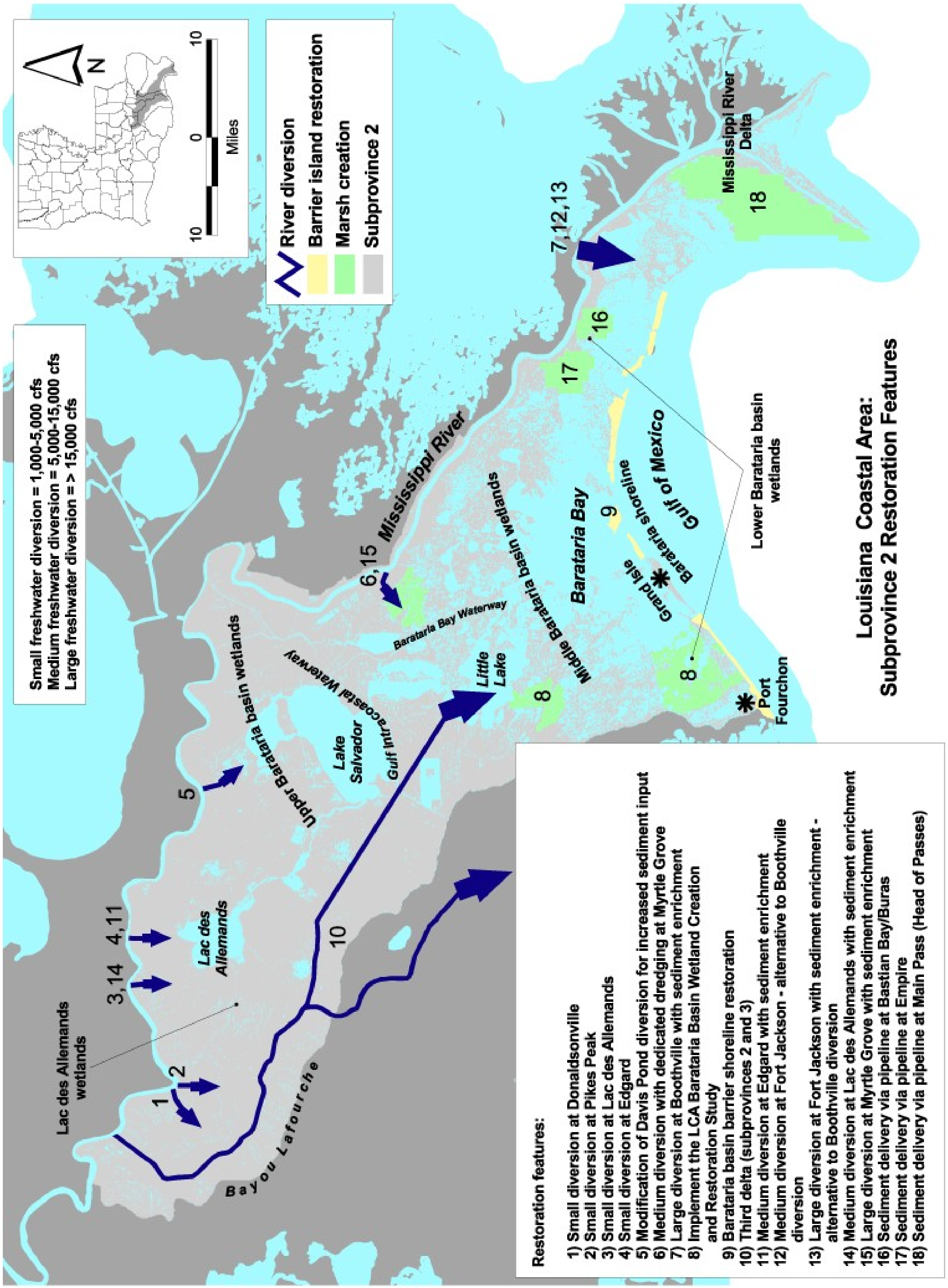


Figure 2-5. Subprovince 2 Restoration Features Identified in the Final Array of Coast Wide Frameworks.

2.3.6.1.3 *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 altering natural water circulation patterns. The 63,300 feet 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 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 enhance 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) 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 repairing banks along the GIWW and enlarging constrictions in the GIWW.

Freshwater introduction south of Lake De Cade: This restoration feature is intended to enhance 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 sediments 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 grid of numerous trenasses 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" extending from Bayou Terrebonne to Bayou Lafourche. This berm would allow the freshwater flowing down from the GIWW through Grand Bayou to have a greater influence on interior marshes through existing water exchange points along Grand Bayou north of the proposed land bridge.

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 sediments 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.

<u>Optimize flows and Atchafalaya River influence in Penchant Basin</u>: 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 zone.

<u>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</u>: This restoration feature would enhance Atchafalaya Delta growth and 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.

<u>Acadiana Bay estuarine restoration</u>: 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.

<u>Rehabilitate northern shorelines of Terrebonne/Timbalier Bays</u>: 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 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) and East Timbalier Island.

Stabilize banks of Southwest Pass: This restoration feature would maintain the integrity of Southwest Pass of the Atchafalaya River 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.

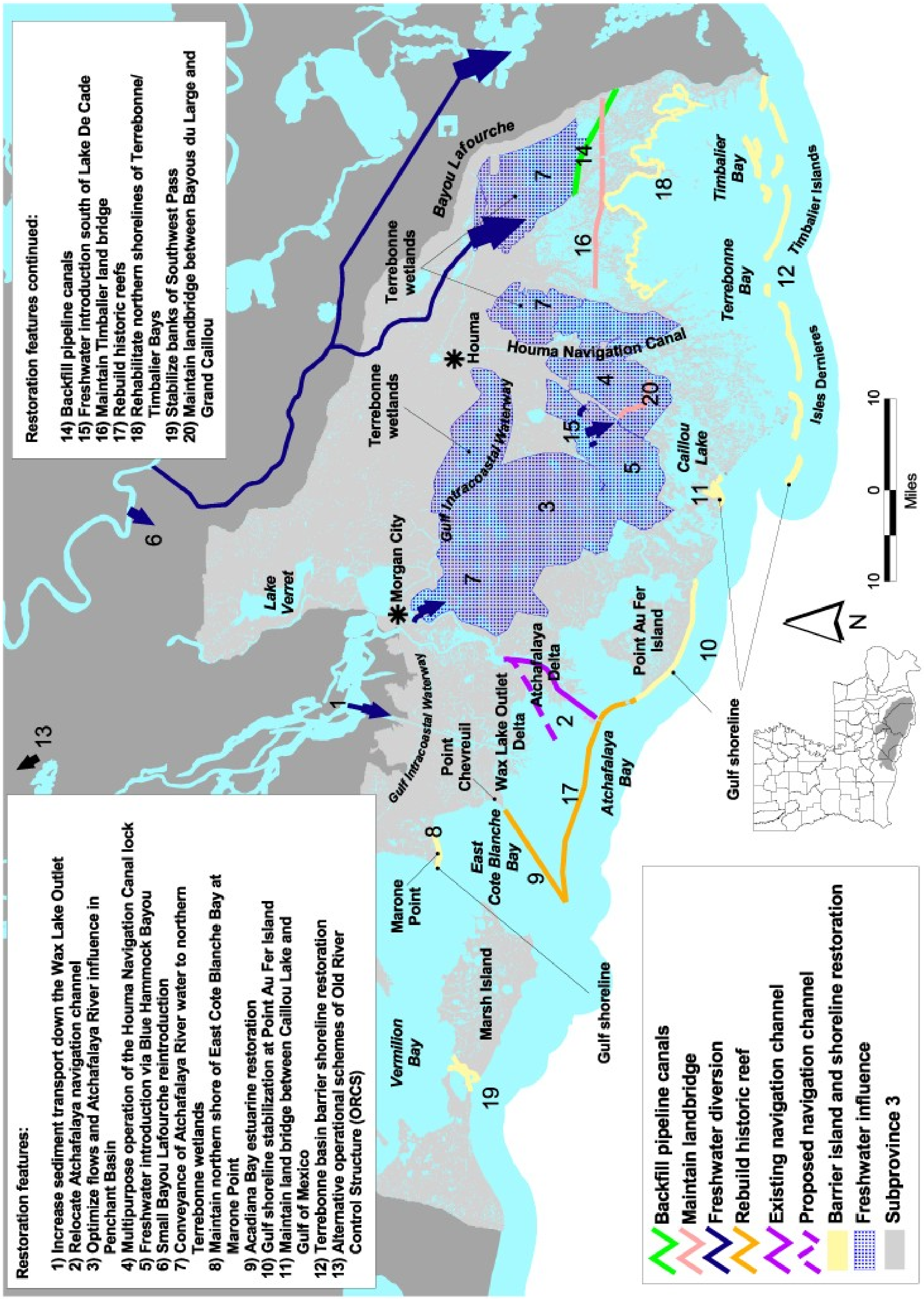


Figure 2-6. Subprovince 3 Restoration Features Identified in the Final Array of Coast Wide Frameworks.

2.3.6.1.4 *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 4,000,000 cubic yards. 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 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.

Stabilize Gulf shoreline near Rockefeller Refuge: 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.

Modify existing Cameron-Creole watershed structures: 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 would occur independent of salinity control at Calcasieu Pass.

New Lock at the GIWW: This feature consists of a new lock at the GIWW east of Alkali Ditch with dimensions of 75 to 110 feet wide by 15 feet 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.

Salinity control at Alkali Ditch: 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 wide by 8 to10 feet deep; the structure or weir with approximate dimensions 70 feet wide by 8 feet 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 wide by 10 feet 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 by 5 feet deep. The structure's approximate dimensions are 10 to 15 feet wide by 4 feet 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 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 wide by 4 feet 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 wide by 4 foot 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.

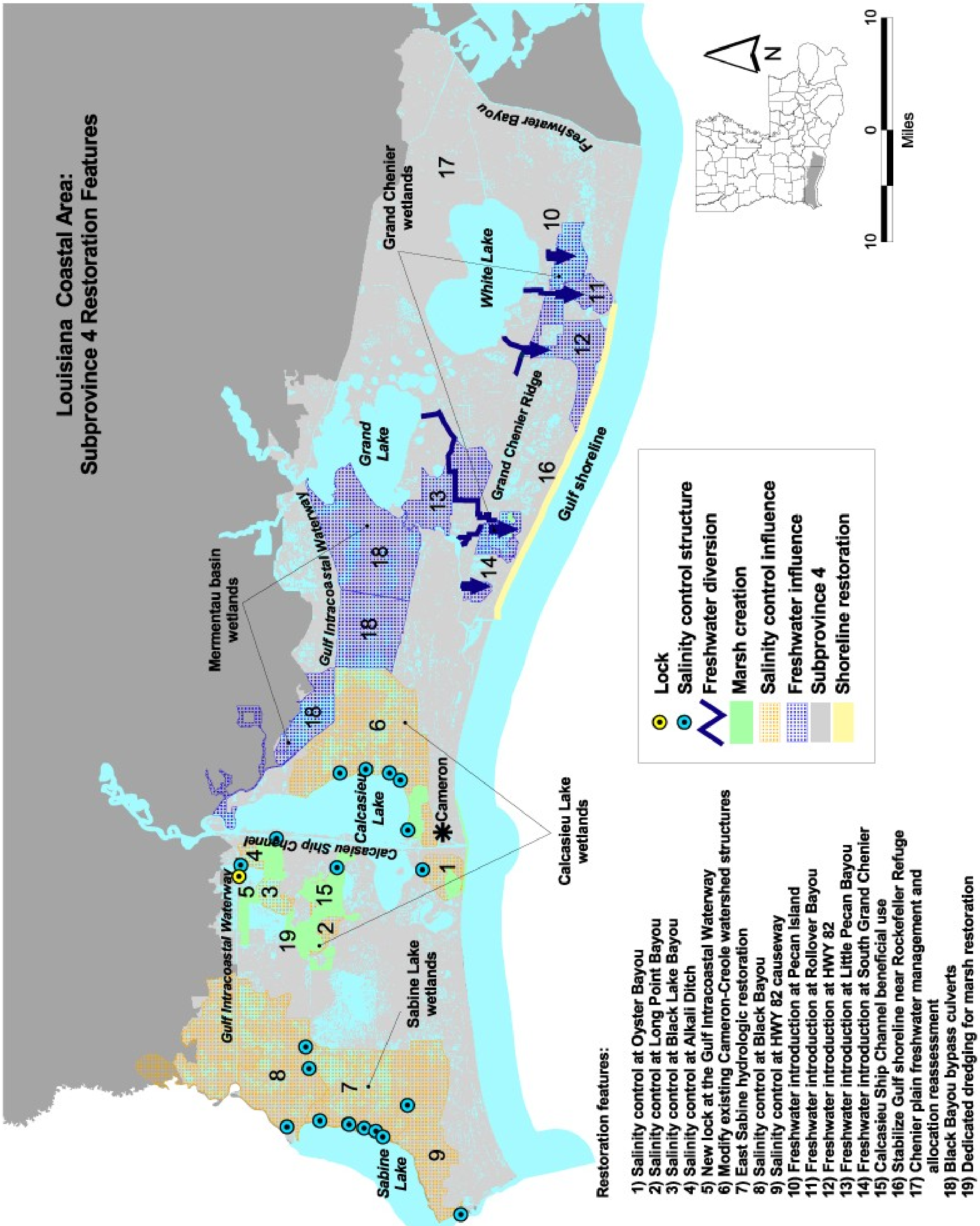


Figure 2-7. Subprovince 4 Restoration Features Identified in the Final Array of Coast Wide Frameworks.

2.3.7 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 previously. 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 need criteria.

2.3.7.1 Sorting Criteria

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 were completed;
- Necessary NEPA documentation were completed;
- Pre-construction engineering & design (PED) were completed; and
- Construction authorization was obtained and construction was 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.

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.

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 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 2-8**.

2.3.7.2 Critical Needs Criteria

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.

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 of the Main Report). This also applies to future predicted conversion of cypress swamp in areas with existing fragmenting marsh.

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 over-bank 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.

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.

Critical Needs Criterion #4 - Protects vital socio-economic 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.

2.3.7.3 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 2-8**).

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.

2.3.7.4 Development and Evaluation of Alternative Plans

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.

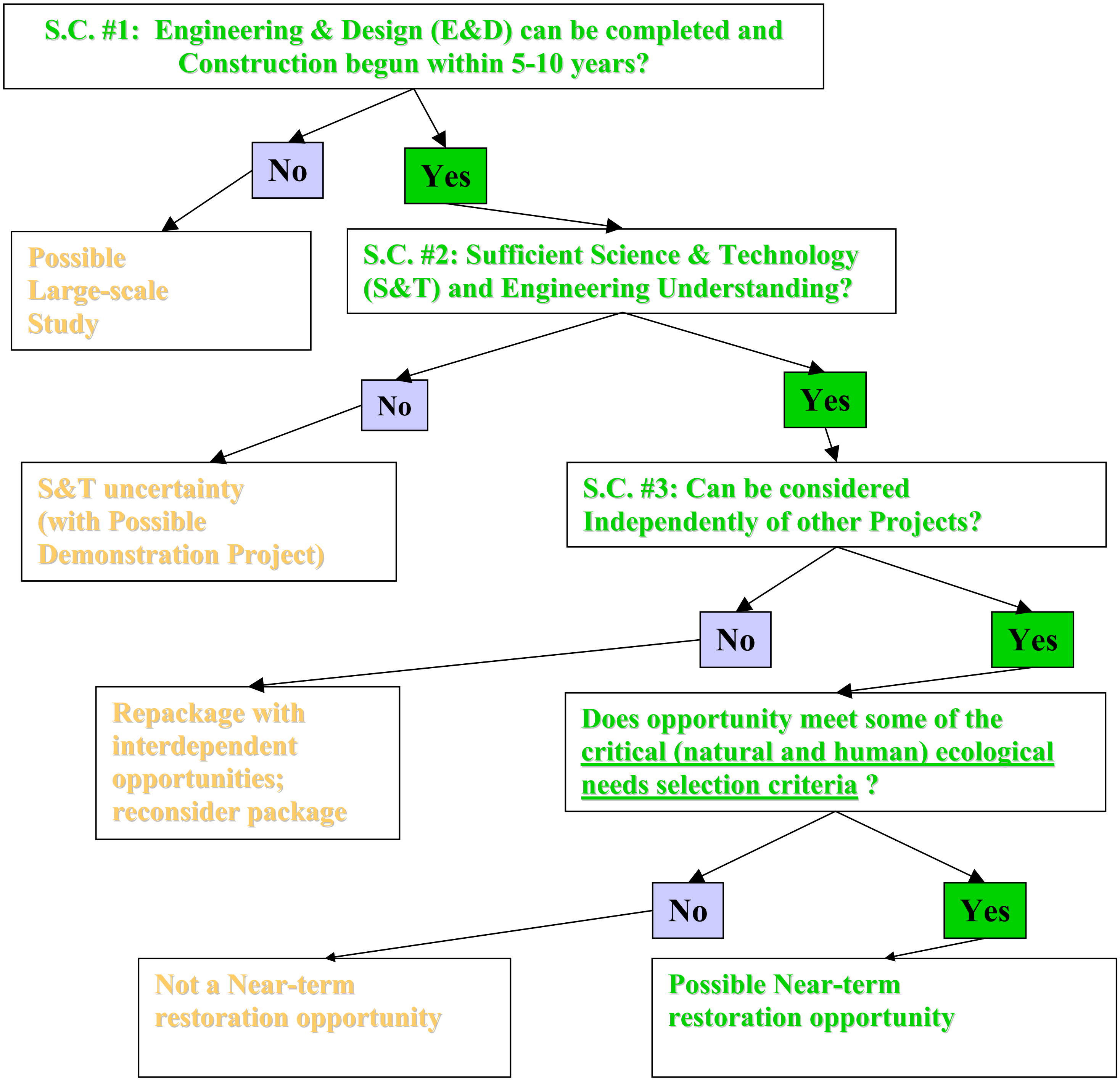


Figure 2-8. LCA Sorting Process Flow Diagram.

2.4 SORTING CRITERIA APPLICATION RESULTS

During Phase VI, each of the 79 restoration features was analyzed through the three Sorting Criteria (**figure 2-9**) 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.

2.4.1 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 2-8** 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 2-8.
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 enhanced 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 Bay 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*

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

Of the 61 features that met Sorting Criterion #1, 27 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 of the Main Report. 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 2-9** 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 2-9.
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 (CWPPRA project)

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

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

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

The remaining 34 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, 13 features were deemed to be independent (received a "Yes" for this criterion). These 13 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 2-10** identifies the 13 restoration features and 6 combined restoration opportunities (made up of 16 restoration features) that were further evaluated using the Critical Needs Criteria. **Figure 2-9** provides a graphic representation of the Sorting Criteria Evaluation Process.

Table 2-10.
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 (CWPPRA Maurepas Diversion)
  - 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 enhanced 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
- Freshwater introduction via Blue Hammock Bayou

Subprovince 4

- Calcasieu Ship Channel Beneficial Use

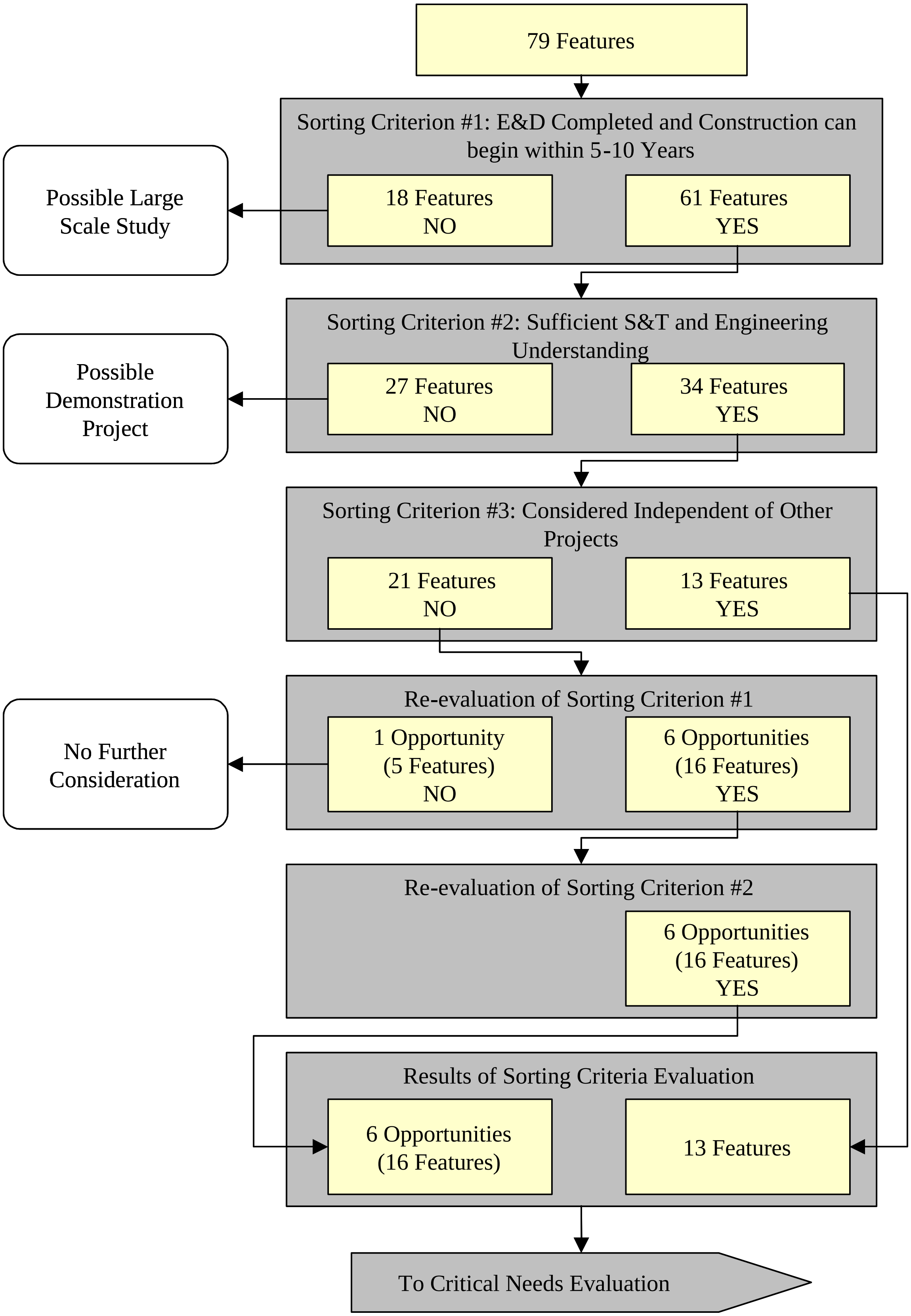


Figure 2-9. Application of Sorting Criteria to Restoration Features and Opportunities.

2.5 Critical Needs Criteria Application Results

Following the application of Sorting Criteria, the 13 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 13 features and 6 restoration opportunities using the Critical Needs Criteria, 7 features and 5 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, 6 features and 1 restoration opportunity (made up of 2 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.

2.5.1 Features Having Significant "Critical Needs Criteria" Value

2.5.1.1 Subprovince 1

MRGO Environmental Restoration Feature: This feature addresses Critical Needs Criteria 1, 3, and 4. Specifically, this feature has 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 socio-economic resources, such as developments located adjacent to the confluence of the MRGO with the GIWW.

Maurepas Swamp Reintroductions Opportunity: The Maurepas Swamp Reintroduction Opportunity includes the following features:

- Small diversion at Hope Canal (CWPPRA Maurepas Diversion)
- 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 socio-economic 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 socio-economic 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.

2.5.1.2 Subprovince 2

Barataria Basin Barrier Shoreline Restoration Feature: 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: preventing major future land loss where currently predicted to occur; restoring endangered, critical geomorphic structure at the gulfward boundary of the Barataria system; and protecting vital socio-economic resources, such as oil and gas infrastructure located on the leeward side of these islands. However, this feature entails 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 for increased sediment input
- 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 significant 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 socio-economic 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; and protect vital socio-economic resources such as the eco-tourism industry and residents in the upper Barataria Basin.

2.5.1.3 Subprovince 3

Small Bayou Lafourche Reintroduction Feature: 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 Feature: 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 socio-economic 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 Feature: 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 Feature: 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 socio-economic 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 socio-economic resources in the area, such as waterborne commerce and oil and gas infrastructure.

2.5.1.4 Subprovince 4

Calcasieu Ship Channel Beneficial Use Feature: 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 socio-economic resources of agricultural land use and oil and gas infrastructure. It also capitalizes on the existing navigation maintenance activity.

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

2.5.2.1 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 a significant influence on the critical need in the area. As a result, this opportunity was not included in any alternative plans.

Rehabilitate Violet Siphon for Enhanced Influence to Central Wetlands Feature: 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 Feature: 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.

2.5.2.2 Subprovince 3

Maintain Northern Shore of East Cote Blanche Bay at Point Marone Feature: 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 Feature: 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 socio-economic 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 Feature: While qualifying, with some effect relative to critical needs criteria, this feature does not appear to produce significant enough changes in the ecosystem to include it any alternative plans. The feature may be further investigated in conjunction with the large-scale Acadiana Bays Estuarine Restoration Study.

Freshwater Introduction via Blue Hammock Bayou Feature: While qualifying, with some effect relative to critical needs criteria, as near-term this feature it does not appear to produce significant enough changes in the ecosystem to include it any alternative plans.

2.6 ALTERNATIVE PLAN EVALUATION RESULTS

Table 2-11 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 2-11. Possible Alternative Plans and Associated Responsiveness to 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 & socio-economic 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 restoration features restoration opportunities included in each of the 15 alternative plans is detailed in **table 2-12**.

Table 2-12. Alternative Plan Make-Up.

Restoration Feature or Opportunity	Alternative Plans														
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**
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 significantly different alternative plans to meet the study objectives and Critical Needs Criteria. As **table 2-12** 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 significantly 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.

2.6.1 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 significantly 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 significantly 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 socio-economic 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.

2.6.2 Alternative Plans Designed to Meet Multiple Critical Need 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 significantly 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.

2.6.3 Comparison of Alternative Plans

Summarizing the analysis results detailed above, three significantly different alternatives (Alternative Plans B, D, and N) arose. A comparison of the restoration features and opportunities, and construction costs estimates for these three alternative plans is provided in **table 2-13**.

Table 2-13. 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	$30,025,000		$30,025,000
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	**$538,904,000**	**$518,850,000**	**$1,057,754,000**

Alternative Plan B (hereinafter Restoration Opportunity #1 [RO1]) 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 (**figure 2-10**). Alternative Plan B exhibits some shortcomings because it does not address critical geomorphic structures. Alternative Plan D (hereinafter Restoration Opportunity #2 [RO2]) 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 (**figure 2-11**). 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 significant environmental benefits, they each exhibit some weaknesses in addressing the complete range of study planning objectives and Critical Needs Criteria.

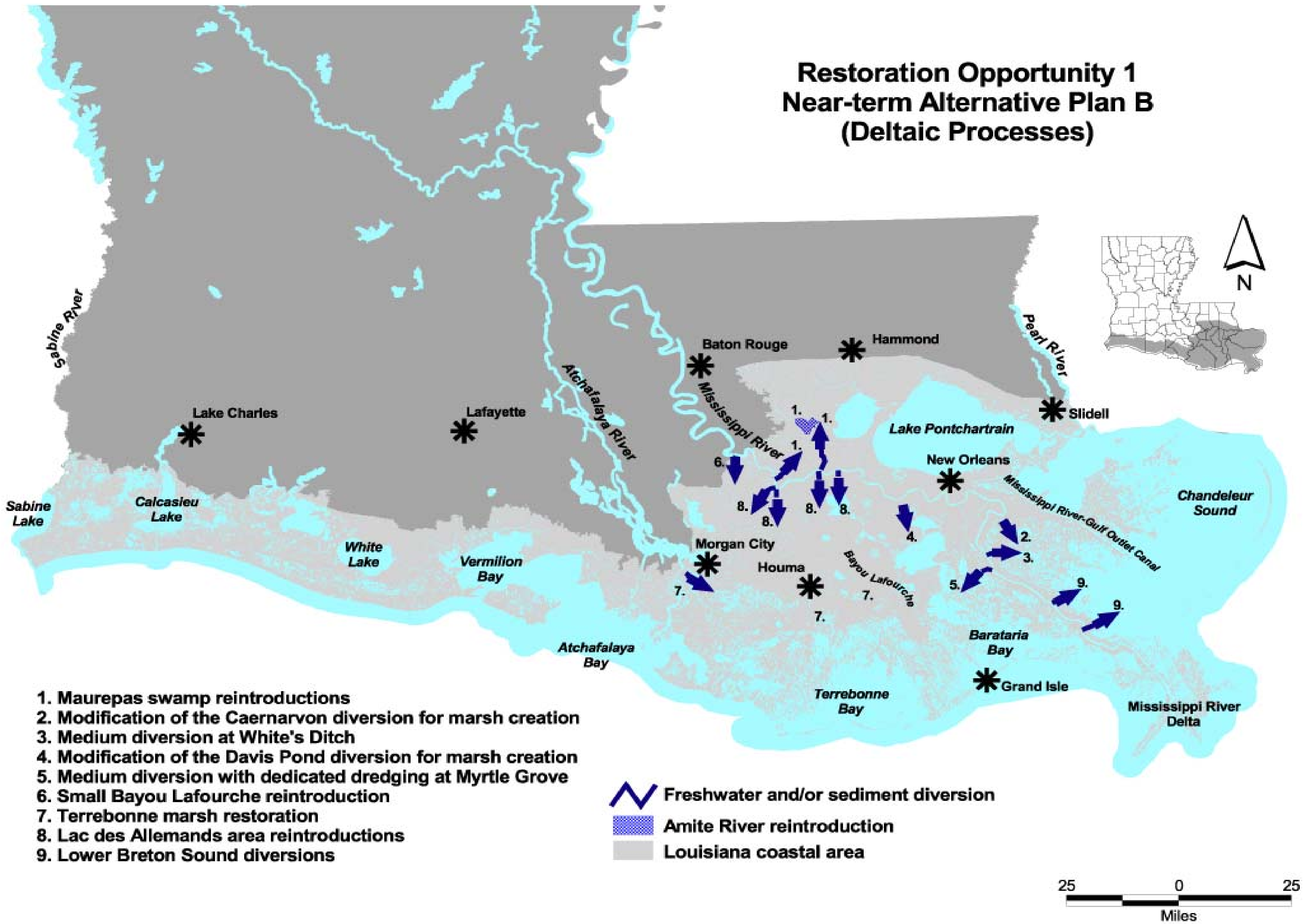


Figure 2-10. Alternative Plan B or Restoration Opportunity 1 (RO1).

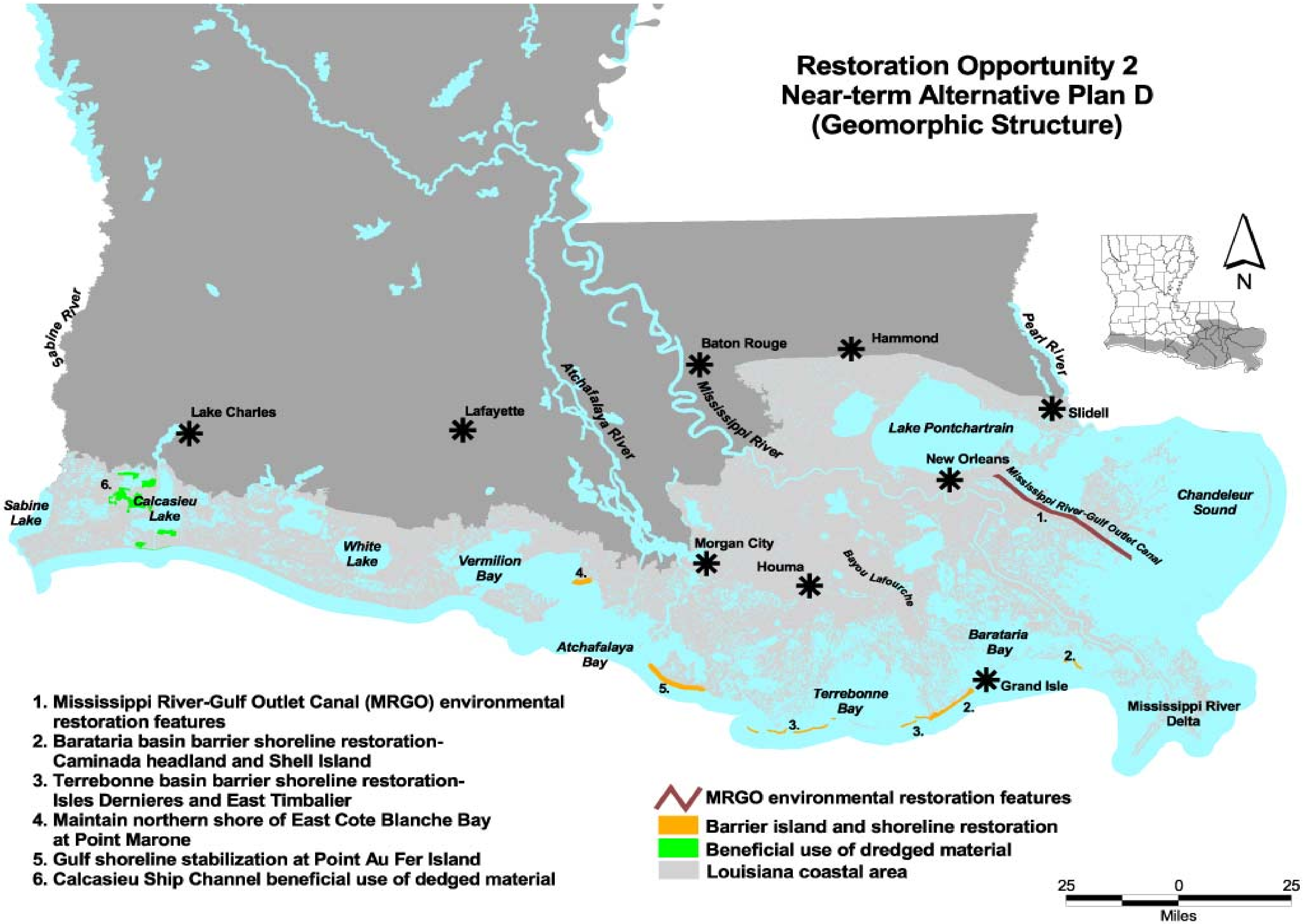


Figure 2-11. Alternative Plan D or Restoration Opportunity 2 (RO2).

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, river diversion features are more sustainable because they are continuously connected to the river resource and nourished by its sediment and nutrients. **Figure 2-12** provides a graphical representation of this discussion.

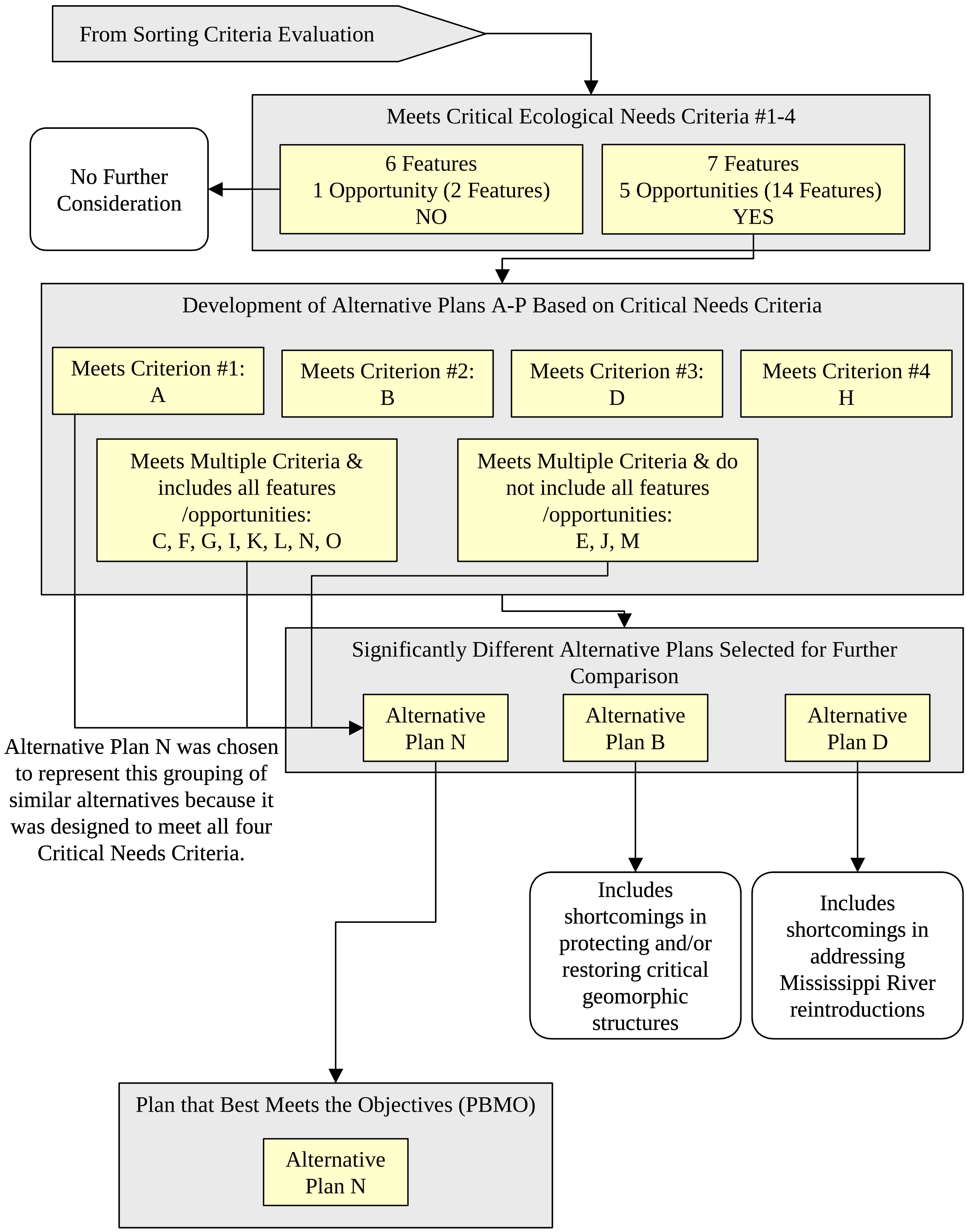


Figure 2-12: Alternative Plan Development and Selection Based on Critical Needs Criteria.

2.7 PLAN FORMULATION RESULTS

2.7.1 Description of the Plan that Best Meets the Objectives

As discussed in section 3.2 Plan Formulation Rationale and section 3.3 Plan Formulation in the Main Report, 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 LCA. 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.

2.7.2 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 sediments using natural processes and ensuring the structural integrity of the estuarine basins is key to this sustainable solution. A sustainable ecosystem would support Nationally significant 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 and sediments. 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 sediments. 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 and sediment, the improved management of Atchafalaya River water 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 significant 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. An Action Plan goal was developed by the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force and presented to Congress in January 2001. This goal calls for a 30 percent reduction in the mean annual load of total nitrogen delivered from the Mississippi River basin to the Gulf of Mexico. Based on an average annual loading of 1.6 million metric tons (CENR, 2000), a 30 percent reduction would be 480,000 metric tons annually. In addressing the critical near-term needs of the coastal ecosystem, the PBMO would have a limited effect in achieving this goal. Since diversion of river flows on a large-scale, as a means of meeting the most critical needs of the system, is not achievable in the near-term there is future opportunity to expand on achieving this particular objective.

2.7.2.1 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.

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

The PBMO consists of the components discussed below and displayed in **figure 2-12**. These combined components represent the best near-term approach for addressing coastal wetlands loss in Louisiana. Although the features and opportunities addressed below do not necessarily represent those features and opportunities included in final implementation, the identified restoration features and opportunities represent 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.

2.7.2.2.1 *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-Caminada Headland, Shell Island
- Small Bayou Lafourche reintroduction
- Medium diversion at Myrtle Grove with dedicated dredging
- Calcasieu River Beneficial Use of Dredge Material
- Modification of Caernarvon Diversion for marsh creation
- Modification of Davis Pond Diversion for marsh creation
- 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 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-Isles Dernieres, E. Timbalier Island
- Maintain land bridge between Caillou Lake and Gulf of Mexico
- Medium diversion at White's Ditch
- Gulf shoreline stabilization at Pt. 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

2.7.2.2.2 *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 significant 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) were deemed impractical in the near-term because of their being mutually exclusive with significant 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:

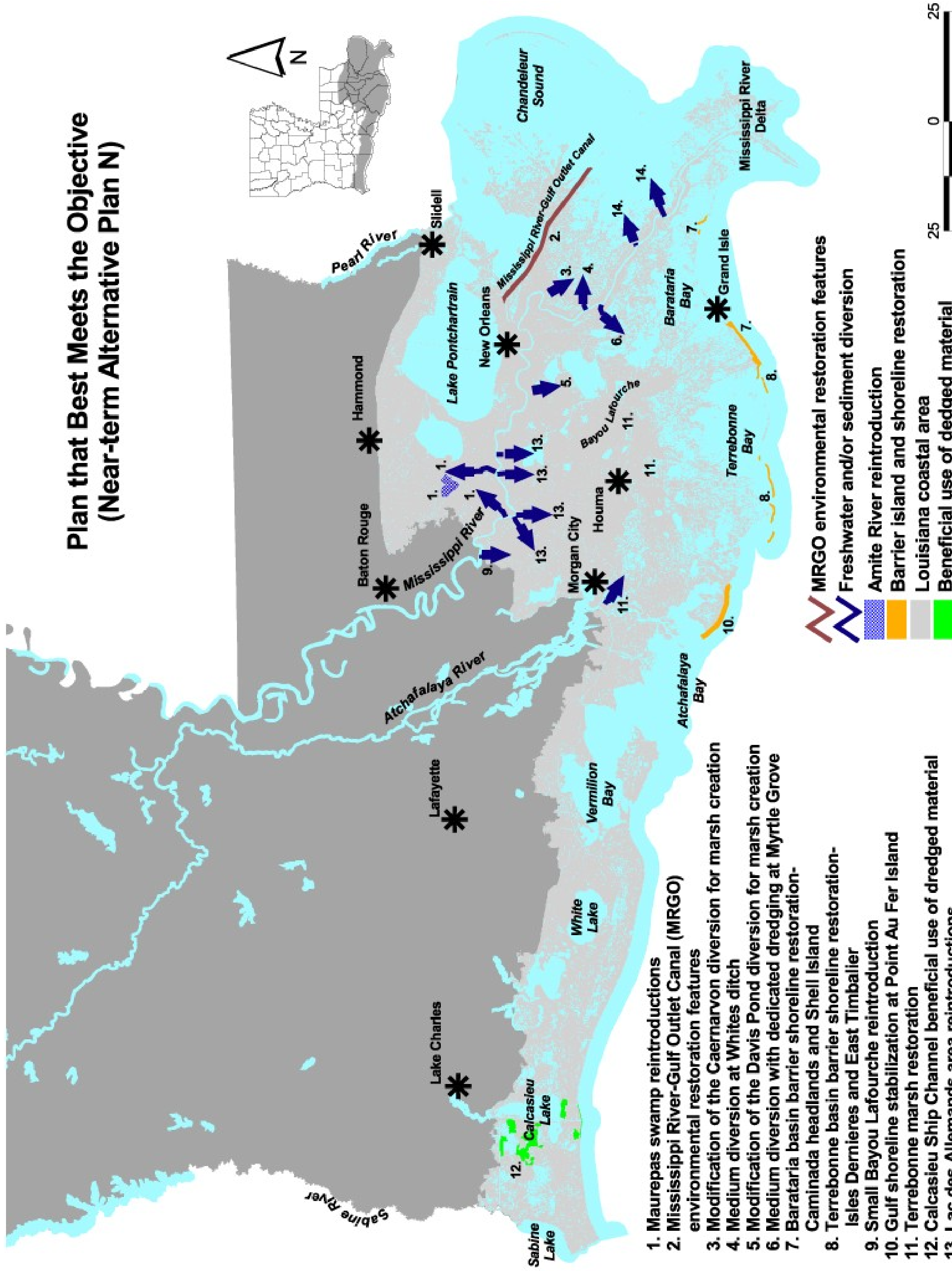
- Mississippi River Hydrodynamic Study
    - Mississippi River Delta Management Study
    - Third Delta Study

  - o Will incorporate relevant portions of Upper Atchafalaya Basin Study including evaluation of modified operational scheme of Old River Control Structure *funded under MR&T*
- Acadiana Bay Estuarine Restoration (includes Rebuilding Point Chevreuil Reef)
- Chenier Plain freshwater management and allocation reassessment

2.7.2.2.3 *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.

Figure 2-13. Plan That Best Meets the Objectives


Plan that Best Meets the Objective
(Near-term Alternative Plan N)
N
Miles
25 0 25
Pearl River
Slidell
Hammond
Baton Rouge
Mississippi River
Atchafalaya River
Lafayette
Lake Charles
Sabine River
Sabine Lake
Calcasieu Lake
White Lake
Vermilion Bay
Atchafalaya Bay
Morgan City
Houma
Lake Pontchartrain
New Orleans
Mississippi River-Gulf Outlet Canal
Chandeleur Sound
Barataria Bay
Grand Isle
Bayou Lafourche
Terrebonne Bay
Mississippi River Delta
MRGO environmental restoration features
Freshwater and/or sediment diversion
Amite River reintroduction
Barrier island and shoreline restoration
Louisiana coastal area
Beneficial use of dedged material
1. Maurepas swamp reintroductions
2. Mississippi River-Gulf Outlet Canal (MRGO) environmental restoration features
3. Modification of the Caernarvon diversion for marsh creation
4. Medium diversion at Whites ditch
5. Modification of the Davis Pond diversion for marsh creation
6. Medium diversion with dedicated dredging at Myrtle Grove
7. Barataria basin barrier shoreline restoration- Caminada headlands and Shell Island
8. Terrebonne basin barrier shoreline restoration- Isles Dernieres and East Timbalier
9. Small Bayou Lafourche reintroduction
10. Gulf shoreline stabilization at Point Au Fer Island
11. Terrebonne marsh restoration
12. Calcasieu Ship Channel beneficial use of dredged material
13. Lac des Allemands area reintroductions
14. Lower Breton Sound diversions

2.8 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, Mississippi Valley New Orleans District: the District
- Coastal Louisiana Ecosystem Protection and Restoration Task Force: the Task Force
- State of Louisiana: the state

2.8.1 Evaluation of PBMO Implementation

The PBMO required sequencing and scheduling for implementation. This implementation evaluation is based on the near-term (5 to 10 years) and critical needs determinations. These criteria necessitated sequencing of the PBMO based on highest priority first and scheduled according to resource capabilities. The PDT 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.

2.8.1.2 Assumptions and Rules

There are 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 can begin in October 2004 based upon existing authority;
- Large-scale, long-term studies can begin in October 2004 based upon existing authority;
- Feasibility-level decision document preparation for demonstration projects can begin in January 2005 based upon successful completion of the Chief’s Report in December 2004;
- The annual execution capability of the District and non-Federal sponsor is approximately $200 million; and
- All components should be ready for construction with the next 10 years.

Sequencing Rules

- Near-term critical restoration features that if delayed, mean "Loss of Opportunity" to restore a critical needs area;
- Modifications to existing structures already identified as opportunities for significant contribution to LCA objectives;
- Critical restoration features that already have design initiated or completed; and
- Qualitative valuations that resulted in determining the features resident in the PBMO also allow for a prioritized ordering of the remaining features.

2.8.1.3 Sequencing of the PBMO

Utilizing these sequencing rules, the elements of the PBMO were prioritized as shown in **table 2-14**.

Table 2-14. Sequenced PBMO Components.

Near-term Critical Restoration Features
• (1) MRGO Environmental Restoration features
• (2) Small Diversion at Hope Canal
• (3) Barataria Basin Barrier shoreline restoration, Caminada Headland, Shell Island
• (4) Small Bayou Lafourche Reintroduction
• (5) Medium Diversion at Myrtle Grove with Dedicated Dredging
• (6) Multi-purpose Operation of the Houma Navigation Canal Lock
• (7) Terrebonne Basin Barrier-shoreline Restoration, E. Timbalier, Isle Dernieres
• (8) Maintain Land Bridge between Caillou Lake and Gulf of Mexico
• (9) Small Diversion at Convent / Blind River
• (10) Increase Amite River Diversion Canal Influence by gapping banks
• (11) Medium Diversion at White's Ditch
• (12) Stabilize Gulf Shoreline at Pointe Au Fer Island
• (13) Convey Atchafalaya River water to Northern Terrebonne Marshes
• (14) Re-authorization of Caernarvon Diversion – optimize for marsh creation
• (15) Re-authorization of Davis Pond – optimize for marsh creation
• (16) Penchant Basin Restoration
• (17) Lac Des Allemands Reintroductions

2.8.1.4 Implementation Scheduling Evaluation

Following sequencing, the PDT used its experience and technical implementation solutions for scheduling components using the guidelines, assumptions, and rules described previously. While the PDT attempted to include all PBMO components into the ten-year implementation schedule, the assumptions and rules precluded the simultaneous implementation of all the PBMO components. Discussions with the non-Federal sponsor led to the conclusion of the PDT that a limitation of approximately $200 million annual project expenditures was appropriate (attachment 3 Non-Federal Sponsor Financial Capability of the Main Report). The inclusion of all plan components would force the implementation schedule to either exceed the maximum funding limitation of approximately $200 million per year, or would force initial construction of some features in the PBMO beyond the first 10 years.

In all of the implementation sequences, the Penchant Basin Restoration and the Lac Des Allemands Reintroductions were found to be beyond the 10-year implementation window. Because of the study purpose to detail a plan that includes restoration features brought to construction within the first 10 years, these two restoration features were dropped from the PBMO and are not in the Tentatively Selected Plan (TSP).

2.8.2 Project Authorization Process Analysis

After applying the governing assumptions and implementation sequencing rules for all of the remaining restoration features within the subset of the PBMO, the PDT evaluated alternative implementation scenarios using two different authorization procedures: programmatic authorization for all critical features, and with standard authorization (no programmatic authority, i.e., WRDA authorization necessary for all critical features). 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. Beyond Year 5, both scenarios indicate execution at the annual capability of approximately $200 million. Another iteration was conducted to investigate the effects of programmatic authorization for only the top five highly critical opportunities. This scheduling iteration identified that partial programmatic authorization of the PBMO features (i.e., only the top five restoration features) provided the same increased execution capability in the first five years as the 100 percent programmatic authorization (all 15 restoration features). It became apparent that the annual funding limitations, not WRDA authorization of projects, limited the plan's annual execution in the second five-year period. The implementation scenario supported by partial programmatic authorization is optimal for expediting implementation of features that address the most urgent needs of the coastal area, allowing for the increased annual execution in fiscal years 07 (point A) and 08 (point B) (**figure 2-14**).

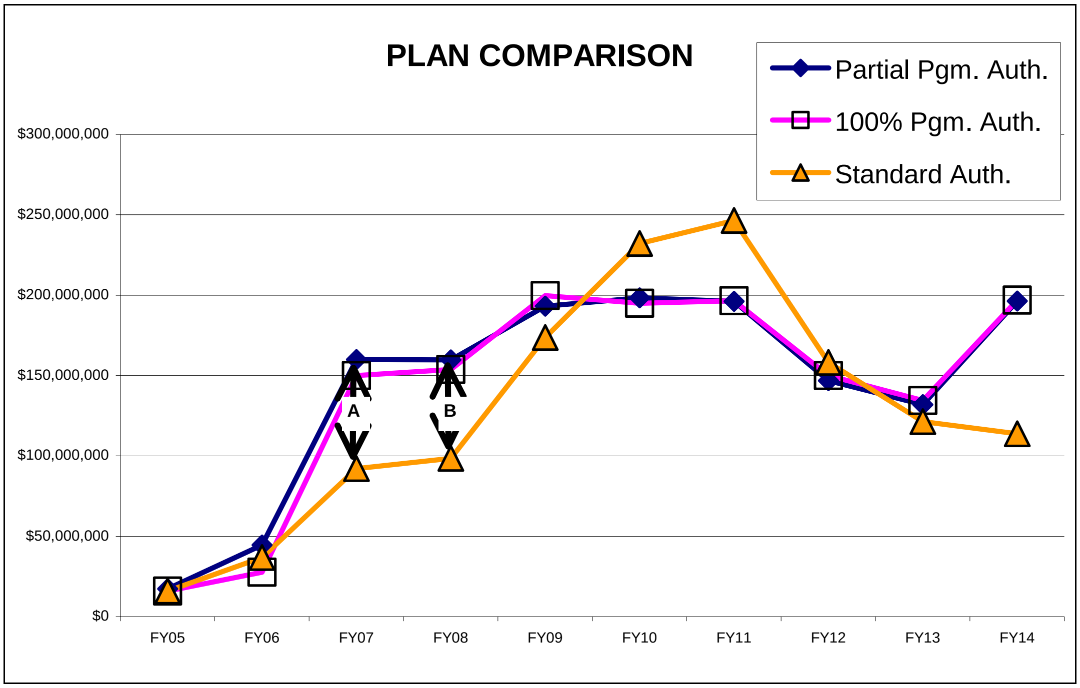


Figure 2-14. Alternative Implementation Sequences: *shows the varying annual execution capability under each scenario.*

Table 2-15 shows the PBMO components recommended for programmatic authorization and approval with future authorization.

Table 2-15. Scheduled PBMO Components.

Recommended for Programmatic Authorization *(Implemented with Programmatic Approval Authority)*
Near-term Critical Restoration Features • (1) MRGO Environmental Restoration features • (2) Small Diversion at Hope Canal • (3) Barataria Basin Barrier shoreline restoration, Caminada Headland, Shell Island • (4) Small Bayou Lafourche Reintroduction • (5) Medium Diversion at Myrtle Grove with Dedicated Dredging
Recommended for Approval With Future Authorization *(Implemented with Standard Approval Authority)*
Other Near-term Critical Restoration Features • (6) Multi-purpose Operation of the Houma Navigation Canal Lock • (7) Terrebonne Basin Barrier-shoreline Restoration, E. Timbalier, Isle Dernieres • (8) Maintain Land Bridge between Caillou Lake and Gulf of Mexico • (9) Small Diversion at Convent / Blind River • (10) Increase Amite River Diversion Canal Influence by gapping banks • (11) Medium Diversion at White's Ditch • (12) Stabilize Gulf Shoreline at Pointe Au Fer Island • (13) Convey Atchafalaya River water to Northern Terrebonne Marshes • (14) Re-authorization of Caernarvon Diversion – optimize for marsh creation • (15) Re-authorization of Davis Pond – optimize for marsh creation

2.9 SUMMARY OF THE TENTATIVELY SELECTED PLAN (TSP) COMPONENTS AND IMPLEMENTATION SCHEDULE

2.9.1 Description of the Tentatively Selected Plan (TSP)

As described in section 3.1 Planning Constraints of the Main Report, S&T uncertainties necessitate the need for strong and continued science and technology development supported by demonstration projects. In addition the existence of significant existing water resource projects offer the opportunity for modifications of these projects to advance restoration (modifications to existing structures and increased beneficial use). To better achieve completeness and effectiveness, the PDT incorporated these two additional programmatic plan components. This multi-component TSP represents the best near-term approach for addressing ecosystem degradation in Louisiana. The LCA program relies on Congressional approval of the TSP as a framework for programmatic and future authorization actions.

Components of the TSP are:

- Programmatic authorization of initial Near-term Critical Restoration Features;
- Programmatic authorization of S&T Program;
- Programmatic authorization of S&T Program Demonstration Projects;
- Programmatic authorization for the Beneficial Use of Dredged Material, and programmatic authorization to Initiate Studies of Modifications to Existing Water Control Structures;
- Future Congressional authorization required for the remaining components of the TSP in subsequent WRDAs; and
- Feasibility studies for the continued development of long-term and large-scale restoration concepts.

Figure 2-15 and **tables 2-16a** and **2-16b** list the components of the TSP.

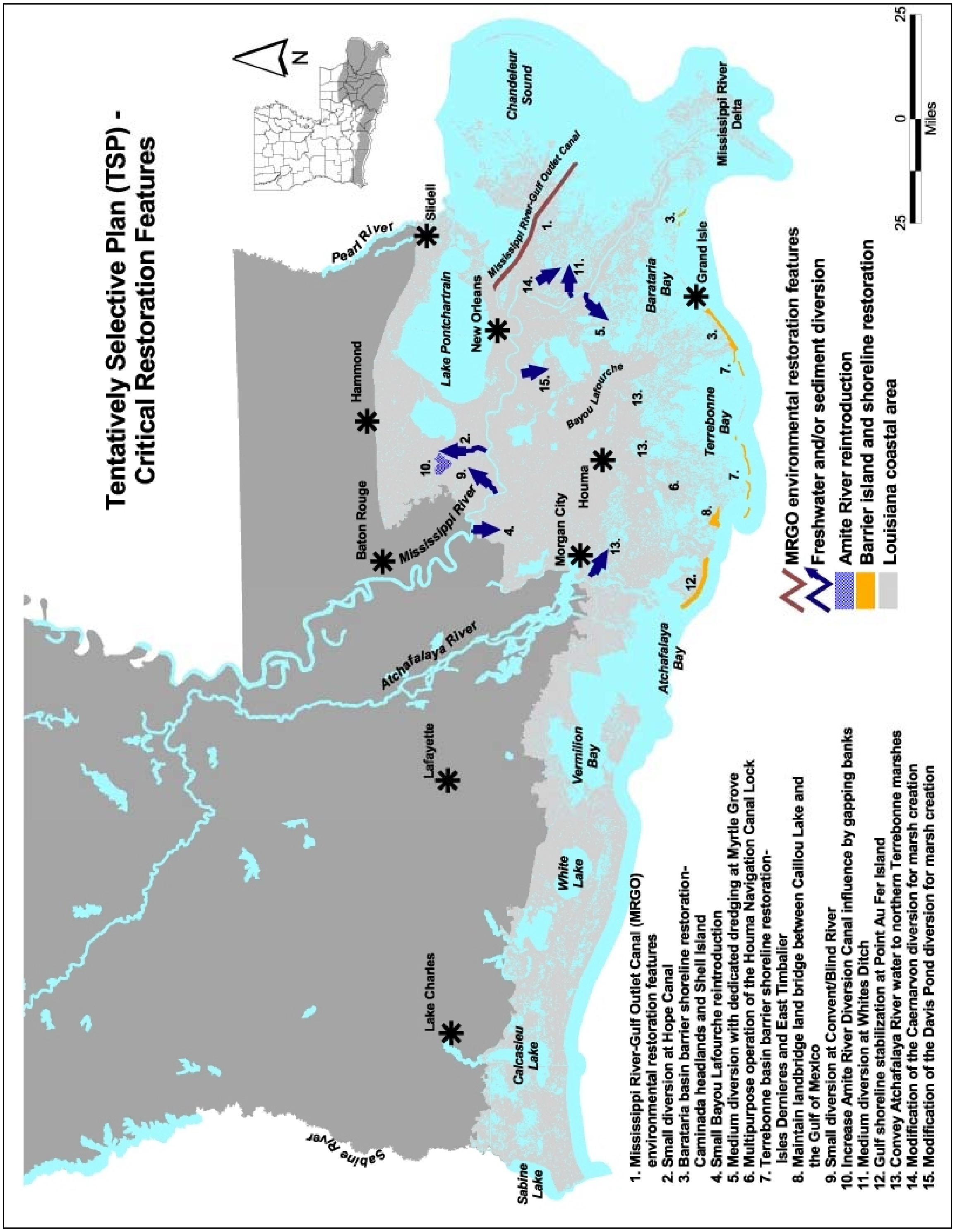


Figure 2-15. LCA Tentatively Selected Plan.

Table 2-16a. Components of the LCA Tentatively Selected Plan.

Recommended for Programmatic Authorization *(Implemented with Programmatic Approval Authority)*
1. Near-term Critical Restoration Features • (1) MRGO Environmental Restoration features • (2) Small Diversion at Hope Canal • (3) Barataria Basin Barrier shoreline restoration, Caminada Headland, Shell Island • (4) Small Bayou Lafourche Reintroduction • (5) Medium Diversion at Myrtle Grove with Dedicated Dredging 2. S&T Program 3. Initial S&T Program Demonstration Projects • Wetland Creation in Vicinity of Barataria Chenier Unit (freshwater chenier restoration) • Pipeline Conveyance of Sediment to Maintain Land Bridge • Pipeline Canal Restoration (various methods and locations • Shoreline Erosion Protection Test Sections in the Vicinity of Rockefeller Refuge • Barrier Island Sediment Sources Demo in Vicinity of Terrebonne Barrier Islands 4. Programmatic Authority for the Beneficial Use of Dredged Material 5. Programmatic Authority to Initiate Studies of Modifications to Existing Water Control Structures

Table 2-16b. Components of the LCA Tentatively Selected Plan.

Recommended for Approval With Future Authorization *(Implemented with Standard Approval Authority)*
6. Other Near-term Critical Restoration Features • (6) Multi-purpose Operation of the Houma Navigation Canal Lock • (7) Terrebonne Basin Barrier-shoreline Restoration, E. Timbalier, Isle Dernieres • (8) Maintain Land Bridge between Caillou Lake and Gulf of Mexico • (9) Small Diversion at Convent / Blind River • (10) Increase Amite River Diversion Canal Influence by gapping banks • (11) Medium Diversion at White's Ditch • (12) Stabilize Gulf Shoreline at Pointe Au Fer Island • (13) Convey Atachafalaya River water to Northern Terrebonne Marshes • (14) Re-authorization of Caernarvon Diversion – optimize for marsh creation • (15) Re-authorization of Davis Pond – optimize for marsh creation 7. Large-scale and Long-term Concepts Requiring Detailed Study • Mississippi River Hydrodynamic Model ▪ Mississippi River Delta Management Study ▪ Third Delta Study ▪ Upper Atchafalaya Basin Study including evaluation of alternative operational schemes of Old River Control Structure *funded under MR&T* • Chenier Plain Freshwater Management and Allocation Reassessment Study • Acadiana Bay Estuarine Restoration Study

2.9.2 Sequencing of the TSP

Tables 17a-c show the implementation schedule for the TSP, developed with programmatic authorization for critical features 1 through 5, and standard authorization process for features 6 through 15.

Table 2-17a.

TSP Implementation Alternative (W/ Partial Programmatic Authority)

1 of 3

Planned / Critical / Milestone / Progress

ID	Activity Desc.	Original Duration	Early Start	Early Finish
A01A	MRGO Environmental Restoration Features (SP1) DD	520d	10/01/04	09/28/06
A01B	MRGO Environmental Restoration Features (SP1) PED	520d	10/03/05	09/28/07
A01C	MRGO Enviro. Rest. Construction	1040d	10/02/06	09/24/10
A01C2	MRGO Enviro. Rest. E&D, S&A	1040d	10/02/06	09/24/10
A01C3	MRGO Enviro. Rest. RE	1040d	10/02/06	09/24/10
B02A	Small Diversion at Hope Canal (SP1) DD	460d	10/01/04	07/06/06
B02B	Small Diversion at Hope Canal -PED	460d	07/07/06	04/10/08
B02C	Div. at Hope Canal Construction	1210d	04/11/08	11/29/12
B02C2	Div. at Hope Canal E&D, S&A	1210d	04/11/08	11/29/12
B02C3	Div. at Hope Canal RE	1210d	04/11/08	11/29/12
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	520d	10/01/04	09/28/06
C03BA	Barat. Basin Barrier Shore Rest. Cam., Shell-PED	520d	10/03/05	09/28/07
C03C	Barat Basin Barrier Shore. Rest. Cam, Shell Is Const	1300d	10/02/06	09/23/11
C03C2	Barat Basin Barrier Shore. Rest. Cam, Shell Is E&D, S&A	1300d	10/02/06	09/23/11
C03C3	Barat Basin Barrier Shore. Rest. Cam, Shell Is RE	1300d	10/02/06	09/23/11
D06A	Small Bayou LaFourche Reintroduction (SP3)-DD	330d	10/03/05	01/05/07
D06B	Small Bayou LaFouche Reintroduction (SP3)-PED	330d	01/08/07	04/11/08
D06C	Small Bayou La Fourche Reintro Construction	1210d	04/14/08	11/30/12
D06C2	Small Bayou La Fourche Reintro E&D, S&A	1210d	04/14/08	11/30/12
D06C3	Small Bayou La Fourche Reintro RE	1210d	04/14/08	11/30/12
E07A	Medium Diversion w/ Dedicated Dredging at Myrtle Grove- DD	650d	10/03/05	03/28/08
E07B	Medium Diversion W/ Dedicated Dredging at Myrtle Grove-PED	650d	03/31/08	09/24/10
E07C	Med. Div. at Myrtle Grove Construction	1210d	09/27/10	05/15/15
E07C2	Med. Div. at Myrtle Grove E&D, S&A	1210d	09/27/10	05/15/15
E07C3	Med. Div. at Myrtle Grove RE	1210d	09/27/10	05/15/15
FST01	Science & Tech Program FY05-FY15	2608d	10/01/04	09/30/14
GDEMO1A	Small Marsh Creation to Eval. Saltwater Sediment-DD	521d	01/03/05	01/01/07
GDEMO1B	Small Marsh Creation to Eval. Saltwater Sediment Construct.	660d	01/02/07	07/13/09
GDEMO2A	Pipeline Conv. of Sed. to Maintain Land Bridge-DD	455d	01/03/05	09/29/06
GDEMO2B	Pipeline Convey of Sed. to Maintain Land Bridge Construction	1305d	10/02/06	09/30/11
GDEMO3A	Restor. Pipeline Canals (Test Diff. Methods) - REPORT	521d	10/02/06	09/29/08

Table 2-17b

TSP Implementation Alternative (W/ Partial Programmatic Authority)

2 of 3

Planned | Critical | Milestone | Progress

ID	Activity Desc.	Original Duration	Early Start	Early Finish
GDEMO3B	Restor. Pipeline Canals (Test Diff Methods) - CONST	521d	09/30/08	09/28/10
GDEMO4A	Shoreline Erosion Test Sec. , Vic Rockefeller Ref - REPORT	521d	10/01/08	09/29/10
GDEMO4B	Shoreline Erosion Test Sec., Vic Rockefeller Ref - CONST	521d	09/30/10	09/27/12
GDEMO5A	Barrier Is. Rest. Demo., Source Material Vic Terrebonne - DD	520d	01/03/05	12/29/06
GDEMO5B	Barrier Is. Rest Demo. Source Material Vic Terrebonne- Const	352d	01/01/07	05/06/08
GDEMO6A	ADDITIONAL PROJECT DD	1300d	10/01/09	09/24/14
GDEMO6B	ADDITIONAL PROJECTS CONSTRUCTION	2300d	10/01/10	07/25/19
HPGMA	Prog. Auth. for Beneficial Use of Dredged Mtrl.-DD	2600d	10/01/04	09/18/14
HPGMB	Prog. Auth. for Beneficial Use Construction	2340d	10/02/06	09/18/15
HPGMB2	Prog. Auth. for Beneficial Use RE	2340d	10/02/06	09/18/15
IMODA	Mod to Existing Structures-Other Opportunities DD & PED	2347d	10/02/06	09/29/15
IMODB	Mod to Existing Structures-Other Opportunities Const.	2347d	10/02/07	09/28/16
J08A	Multi-Purpose Ops of Houma Nav. Canal (HNC) Lock	396d	10/01/04	04/07/06
J08B	Multi-Purpose Ops of Houma Nav. Canal (HNC) Lock PED	264d	04/10/14	04/14/15
J08B2	Multi-Purpose Ops of Houma Nav. Canal (HNC) Lock RE	264d	04/10/14	04/14/15
K09A	Terr. Basin Barrier Shore. Rest. Isles Derniere,E.Timbalier	594d	10/01/10	01/09/13
K09B	Terr. Basin Barrier Shore. Restoration PED	494d	01/10/13	12/02/14
K09C	Terr. Basin Barrier Shore. Restoration Construction	726d	12/03/14	09/13/17
K09C2	Terr. Basin Barrier Shore. Restoration E&D, S&A	726d	12/03/14	09/13/17
K09C3	Terr. Basin Barrier Shore. Restoration RE	726d	12/03/14	09/13/17
L10A	Maintain Land Bridge b/t Caillou Lk. and Gulf of Mexico-SP3	520d	10/01/08	09/28/10
L10B	Maintain Land Bridge b/t Caillou Lake and Gulf of Mexico-PED	560d	09/29/10	11/20/12
L10C	Maintain Land Bridge b/t Caillou Lake & Gulf Construction	528d	11/21/12	11/28/14
L10C2	Maintain Land Bridge b/t Caillou Lake & Gulf E&D, S&A	528d	11/21/12	11/28/14
L10C3	Maintain Land Bridge b/t Caillou Lake & Gulf RE	528d	11/21/12	11/28/14
M11A	Small Diversion at Convent / Blind River (SP1)	726d	10/01/08	07/13/11
M11B	Small Div. at Convent/Blind River PED	625d	07/14/11	12/04/13
M11C	Small Div. at Convent/Blind River Construction	1210d	12/05/13	07/25/18
M11C2	Small Div. at Convent/Blind River E&D, S&A	1210d	12/05/13	07/25/18
M11C3	Small Div. at Convent/Blind River RE	1210d	12/05/13	07/25/18
N12A	Increase Amite River Influence by Gapping Bank (SP1)	528d	10/01/08	10/08/10
N12B	Increase Amite River Influence PED	520d	10/11/10	10/05/12

Table 2-17c

TSP Implementation Alternative (W/ Partial Programmatic Authority)

3 of 3

Planned — Critical — Milestone △ — Progress

ID	Activity Desc.	Original Duration	Early Start	Early Finish
N12C	Increase Amite River Influence Construction	352d	10/08/12	02/11/14
N12C2	Increase Amite River Influence E&D, S&A	352d	10/08/12	02/11/14
N12C3	Increase Amite River Influence RE	352d	10/08/12	02/11/14
O13A	Medium Diversion at Whites Ditch (SP1)	726d	10/01/08	07/13/11
O13B	Med. Div. at Whites Ditch PED	630d	07/14/11	12/11/13
O13C	Med. Div. at Whites Ditch Construction	1210d	12/12/13	08/01/18
O13C2	Med. Div. at Whites Ditch E&D, S&A	1210d	12/12/13	08/01/18
O13C3	Med. Div. at Whites Ditch RE	1210d	12/12/13	08/01/18
P14A	Gulf Shore. Stabilization at Pt. Au Fer Island (SP3)	484d	10/01/08	08/09/10
P14B	Gulf Shore. Stabilization at Pt. Au Fer Island-PED	780d	08/10/10	08/05/13
P14C	Gulf Shore. Stabilization at Pt. Au Fer Is. Construction	352d	08/06/13	12/10/14
P14C2	Gulf Shore. Stabilization at Pt. Au Fer Is. E&D, S&A	352d	08/06/13	12/10/14
P14C3	Gulf Shore. Stabilization at Pt. Au Fer Is. RE	352d	08/06/13	12/10/14
Q15A	Convey Atch. River to Terrebonne Marsh via Small Div.	594d	10/01/09	01/10/12
Q15B	Convey Atch. River to Terrebonne Marsh-PED	504d	01/11/12	12/16/13
Q15C	Convey Atch. River to Terrebonne Marsh-Construction	1672d	12/17/13	05/13/20
Q15C2	Convey Atch. River to Terrebonne Marsh-E&D S&A	1672d	12/17/13	05/13/20
Q15C3	Convey Atch. River to Terrebonne Marsh-RE	1672d	12/17/13	05/13/20
R04A	Modification to Caernarvon Div (SP1) DD	780d	10/01/04	09/27/07
R04C	Modification to Caernarvon Div Construction	780d	09/28/07	09/23/10
R04C2	Modification to Caernarvon Div E&D, S&A	780d	09/28/07	09/23/10
R04C3	Modification to Caernarvon Div RE	780d	09/28/07	09/23/10
S05A	Modification to Davis Pond Div. for Increased Sed.SP2 DD	520d	10/01/04	09/28/06
S05C	Modification to Davis Pond Diversion Construction	1040d	09/29/06	09/23/10
S05C2	Modification to Davis Pond Diversion E&D, S&A	1040d	09/29/06	09/23/10
S05C3	Modification to Davis Pond Diversion RE	1040d	09/29/06	09/23/10
TLS1	Mississippi River Hydrodynamic Study	780d	10/01/04	09/27/07
TLS2	Third Delta (SP2 and 3)	1560d	10/01/04	09/23/10
TLS3	Upper Atchafalaya Basin Study w/Mod Old Riv Cont Struct Scm	660d	10/01/04	04/12/07
TLS4	Chenier Plain Freshwater Mgt. and Allocation Reassess (SP4)	780d	10/01/04	09/27/07
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

2.9.2.1 Programmatic Authority for Implementation of Critical Restoration Features

Feasibility-level decision documents will be developed for each of the initial near-term critical restoration features. These feasibility-level decision documents will 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 programmatic authorization for the initial near-term critical restoration features. All of these features have a basis in cost effectiveness and in their value to significantly 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 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. This information shows that average annual environmental output for this programmatically authorized feature package would be on the order of 22,000 habitat units at an average annualized cost of $2,600 per unit provided.

2.9.2.1.1 *Mississippi River Gulf Outlet (MRGO) Environmental Restoration Features*

Construction and maintenance of the MRGO began in 1958 and was completed in 1968. Construction of the MRGO has 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. During construction of the MRGO, dredging and filling destroyed more than 17,000 acres of wetlands, and an important hydrologic boundary was breached when the channel cut through the ridge at Bayou LaLoutre. After the MRGO was completed, significant habitat shifts occurred because the impacted area converted to a higher salinity system as a result of saltwater intrusion. 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 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. 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. Such a breach would accelerate marsh loss in the area.

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. Without action, critical landscape components that make up the estuary would be lost and future efforts to restore other parts of the ecosystem would be much more difficult and expensive.

This feature has been identified as a near-term critical effort based first on its inclusion in seven of the seven cost-effective, coast wide restoration frameworks, and on its ability to meet specified critical need criteria. It has been recommended for programmatic 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 ecological solutions in the ecosystem does not necessarily equate to identification of cost effective solutions. While this feature was 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 and/or opportunity for restoration.

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 at Anotonio’s Lagoon 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 rock breakwaters along the entire north bank of the MRGO and along important segments of the southern shoreline of Lake Borgne that may breach in the near future. Strategic placement of these similar protective breakwaters has been effectively used along the MRGO to prevent shoreline retreat and would preserve large amounts of estuarine marshes from further erosion. The placement of rock dikes can also enhance marsh creation efforts, such as those that employ dedicated dredging and/or beneficial use of dredged material, because they serve to contain and protect the restored wetlands.

The benefits of the proposed shoreline protection features include preserving large amounts of wetlands, protecting critical habitat in Lake Borgne for the Federally-threatened Gulf sturgeon, avoiding significantly higher long-term restoration costs, protecting critical infrastructure, and providing opportunities for value added wetland restoration in conjunction with other ongoing programs. 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 Average 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. This feature addresses identified, imminent, and critical needs by preventing wetland loss where it is predicted to occur, preserving critical, endangered geomorphic structure, and protecting vital socio-economic resources. Programmatic authorization would expedite attainment of these environmental benefits.

The estimated cost for constructing critical rock breakwaters along the MRGO and Lake Borgne is:

Component	Cost (see details below)
DD	$5,400,000
PED	$3,600,000
Construction	$80,000,000
E&D/S&A	$14,240,000
Real Estate	$4,188,000
Total	*$107,428,000*

Feature costs are based upon completed construction of similar projects funded under the New Orleans District's channel operations and 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 design work conducted in the Coastal Wetlands Planning, Protection and Restoration Act. 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.

2.9.2.1.2 *Small Diversion at Hope Canal*

The Maurepas Swamp is an area of considerable ecological, socioeconomic, 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, sediment, or nutrient input. Lacking this riverine input, soil building in the swamp has been minimal and insufficient to keep pace with subsidence. As a result, 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 that make up a large portion of this hardwood-swamp ecosystem. These factors, combined with increasing occurrences of high salinities have resulted in a highly degraded swamp system, which is at risk of eventual conversion to open water.

The combination of little to no regeneration of swamp hardwoods and more frequent incidence of higher then tolerable salinity place this system at high risk. In 1988, drought conditions, coupled with sustained easterly winds, produced conditions of intermediate to brackish salinity in this normally fresh system. Recent tropical storm events occurring at a rate of one to two a year have also produced measurable spikes in salinity in the area. With subsidence, the lack of substrate accretion, and reduced organic productivity, this area has very little chance to avoid the die-off that is already occurring in similar lake rim areas in western Lake Pontchartrain. With the increasing water depth in these areas, it is highly likely that habitat will be converted to broken open water rather than intermediate or brackish marsh. The degradation and potential loss of cypress/tupelo swamp is significant because tree regeneration to replace those portions of the swamp that experience ~~a~~ die-off can take several decades, at a minimum.

Delaying action would expose the project area to potential risks of additional high salinity events (associated with droughts and tropical storms), which in the past have resulted in high mortality of cypress and tupelo trees and fresh marsh understory. Without action, the area would remain highly stressed, productivity of existing trees would continue to decline, the existing trees would remain vulnerable to predation and disease, and an opportunity would be missed to remove nutrients from the Mississippi River that would otherwise contribute to hypoxia in the Gulf of Mexico. Failure to protect the existing forest could result in the long-term disappearance of this important ecosystem. The loss of this freshwater retaining portion of the system would eventually result in a shallow, seasonally brackish open water system extending to the heavily developed Interstate 10 corridor.

This feature has been identified as a near-term critical effort based first on its inclusion in 5 of the seven cost-effective, coast wide restoration frameworks, and on its ability to meet specified critical need criteria. It has been recommended for programmatic implementation based primarily on its capability to address critical ecological needs, as well as the fact that significant design efforts are already underway. The identification of ecological solutions in the ecosystem does not necessarily equate to identification of cost effective solutions. While this feature was not specifically evaluated for cost effectiveness, it was found to be a critical feature of 5 feasible and cost-effective, coast wide restoration frameworks. In addition, the feature addresses an identified, imminent, and critical need and/or opportunity for restoration.

The purpose of the small diversion at Hope Canal is to restore and maintain the health and productivity of the swamps south of Lake Maurepas. This restoration feature proposes to restore the cypress/tupelo swamps in the southern portion of the Maurepas Swamp by reintroducing 1,000 to 2,000 cubic feet per second of nutrient-rich water from the Mississippi River. The specific objectives of this restoration feature are to: restore natural swamp hydrology; increase sediment and nutrient loading to the project area; increase substrate accretion; retain and increase existing areas of swamp vegetation, including overstory cover; and reduce salinity levels.

The proposed Hope Canal feature includes: two gated box culverts; a receiving pond reinforced with riprap; and an outflow channel roughly 27,500 feet long that would run from the receiving pond to U.S. Interstate 10. Outflow channel banks would be built up to retain 90 percent of the diverted flow within the channel until passing under Interstate 10.

The Hope Canal project would enhance approximately 36,000 acres of swamp. The Wetland Value Assessment (WVA) performed for the CWPPRA PPL-11 project submission estimated a project output of 8,486 AAHU over the project influence area. The maintenance of the swamp would in turn aid in maintaining the ecological health and diversity of the entire upper Pontchartrain Basin estuary. This feature addresses identified, imminent, and critical needs by preventing degradation of cypress tupelo swamp where it is predicted to occur, reintroducing riverine water and sediments, and protecting vital socio-economic resources. Programmatic authorization would expedite attainment of these environmental benefits.

The estimated cost of the Hope Canal feature is as follows:

Component	**Cost (see details below*)***
DD	$4,504,000
PED	$3,002,000
Construction	$30,025,000
E&D/S&A	$6,005,000
Real Estate	$26,383,000
Total	*$69,919,000*

There is an ongoing CWPPRA feasibility study of the proposed actions in the vicinity of Hope Canal that has completed scoping and initial hydrologic modeling. Several previous study efforts have identified the Hope Canal vicinity as an appropriate and critical location, relative to the overall Pontchartrain Basin, for the introduction of riverine sediments, nutrients, and freshwater. The CE/ICA analysis of The Mississippi River, Sediment, Nutrient, and Freshwater Redistribution Study identified a diversion in the vicinity of Hope Canal as cost-effective means of utilizing Mississippi River resources for restoration.

2.9.2.1.3 *Barataria Basin Barrier Shoreline Restoration*

Restoration of Caminada Headlands Reach

The Caminada Headlands Reach stretches 12 miles from Belle Pass to Caminada Pass and forms the western boundary of the Barataria Basin. The reach contains several important coastal habitats, including the largest Black Mangrove forest in coastal LA, one of the only maritime forests of Live Oaks, and highly productive marsh communities. The Black Mangrove forest forms a critical Caminada Landbridge that protects vast salt marshes, oyster resources, and other Essential Fish Habitat (EFH) elements. Separated by long linear salt marsh ponds filled with submerged aquatic vegetation, the Chenier Caminada maritime forest is important neotropical bird habitat. The marshes are highly significant nurseries to many important recreation and commercial species of fish, oysters, and shrimp.

The reach has had high rates of recession and, in the future, will begin to breach and fragment, which will significantly reduce the protection to both economic and ecologic elements afforded by this natural beach. The erosion along this reach of the coast is some of the highest and most chronic in the State of Louisiana. Between 1884 and 2002, the long-term average erosion rate averaged 41 ft/yr with a range of 51.9 ft/yr to 8.6 ft/yr (see appendix D Shoreline Restoration Study Team Report of the Main Report). **Figure 2-16** displays the long-term erosional history of the Caminada Headland area. In 2003, the passage of Tropical Storm Bill eroded the beaches back as far as 50 to 80 ft. This pattern of shoreline erosion will continue because tropical storms impact coastal Louisiana every 1.2 years, on average. Historic estuarine bays, such as Bay Marchand, and bayous, such as Pass Fourchon, no longer exist due to this rapid, persistent erosion.

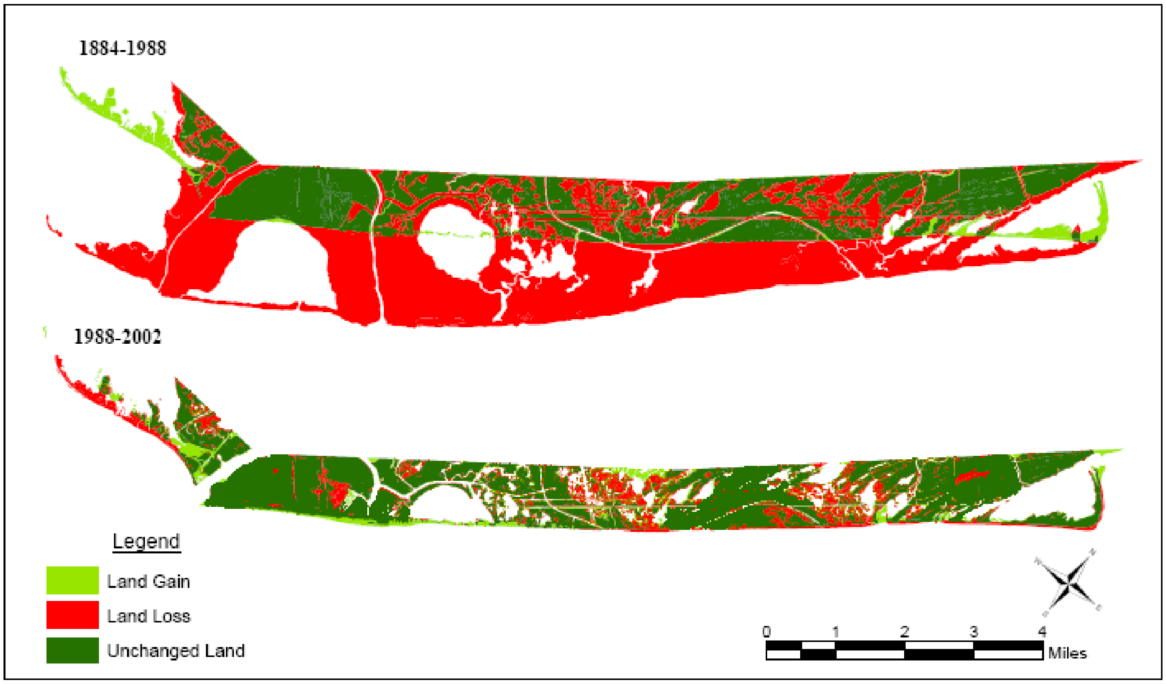


Figure 2-16. Caminada Headland Erosional History 1884 to 2002.

Breakwaters have exacerbated the erosion problem by creating an erosional shadow, resulting in multiple storm breaches during the 2002-2003 hurricane seasons. Inland, these breaches are allowing increasingly higher wave energy conditions to attack the Caminada Land bridge, which threatens critical natural and human resources landward. Located on the lee side of this shoreline, Highway 1 is an evacuation route for Louisiana's only town located on a barrier island at Grand Isle. Continued erosion also threatens the largest onshore oil and gas base in coastal Louisiana at Port Fourchon, the largest fishing port located on the coast, major oil and gas infrastructure, the largest coastal community, the LOOP, Inc. Super Port, LA, and Highways 1 and 3090.

Restoration of Caminada Headland Reach is advantageous since it is in a condition more amenable to restoration than many other reaches. A beach is still present over much of the reach and fragments of marsh and ridges are present behind the beach. These residual elements provide critical foundation for restoration of the Caminada Headland Reach. Delaying the project would allow further deterioration of this foundation, which would result in higher cost and would likely preclude some restoration elements. Without restorative action in the next 1-3 years, the Bay Champagne barrier beach would erode away, resulting in the failure of the Caminada Landbridge and the direct exposure of Port Fourchon, recreational and commercial fishing ports, highways 1 and 3090, and residential and commercial promontories to daily wave and tidal erosion action and the ever present summer hurricanes and winter storms. This scenario is also likely to result in a costly and less ecologically sound need to develop hard shoreline protection measures to protect navigation canals and highways.

This feature has been identified as a near-term critical effort based first on its inclusion in all seven of the cost-effective, coast wide restoration frameworks, and on its ability to meet specified critical need criteria. It has been recommended for programmatic implementation based primarily on its capability to address critical ecological needs. This feature addresses historic erosion and the potential for increased erosion, which threaten existing natural and human resources, if near-term action is not taken. The identification of ecological solutions in the ecosystem does not necessarily equate to identification of cost effective solutions. While this feature was not specifically evaluated for cost effectiveness, it was found to be a critical feature of 7 feasible and cost-effective, coast wide restoration frameworks. In addition, the feature addresses an identified, imminent, and critical need and/or opportunity for restoration.

Restoration of the Caminada Headlands Reach of the Barataria Barrier Shoreline provides critical needs restoration by preventing land loss where it is predicted to occur, restoring endangered critical geomorphic structure, and by providing some storm surge protection to populated areas, critical oil and gas infrastructure, and marsh habitat residents in southwest Barataria Bay. Initial analysis (see attachment 4 for additional information) indicates that the most effective restoration alternative for this reach produces approximately 732 AAHUs, and about 1,500 more acres at project year 50. This benefit would include restoration of beach (dune and shoreface) habitats as well as emergent saline marsh. The beach restoration would provide fisheries and aviary habitats. The emergent saline marsh would provide additional nursery area for commercial and recreational species. Indirect benefits would be to maintain the gulf shoreline integrity of a highly critical reach of ecologic and economic significance. The restoration of this barrier shoreline reach would provide ecologic benefit and protection and sustainability to the western boundary of the Barataria Basin, including all of the natural and human resources it supports.

The proposed Caminada Headland Reach restoration project includes both beach restoration and marsh creation features. Material for beach restoration would be pumped from an offshore site and deposited on the gulfward side of the existing headland. Material for marsh creation would be pumped from interior open-water sites and deposited in various cells defined by existing marsh and canals. The combined width of the marsh creation and beach restoration would be at least 3,000 feet. This width should reduce the chance of breaching and fragmentation of the headland beach. Marsh creation would reduce bayside marsh fragmentation and bayside erosion of the beach. The beach restoration would provide gulfward protection to the existing fragile emergent marshes and those newly developed by marsh creation efforts.

Restoration of Shell Islands Reach

The Shell Islands Reach stretches 2.5 miles to the west from Fontanelle Pass to Grand Bayou Pass. Bayou Fontanelle and its pass is the largest headland in the eastern border of the Barataria Basin. The Shell Islands Reach is currently highly fragmented into small shoals and islands, which altogether represent a fraction of the once continuous shoreline developed along a spit extending northwest from the Empire Jetty. The residual shoals and islands have migrated northward into Shell Island Bay.

The Shell Islands Reach is important in terms of its location in the Plaquemine's Shoreline. The Bayou Fontanelle Headland/Shell Island system establishes the geologic framework for the orientation of the downdraft barrier islands of Bay Joe Wise, Chaland Island, and Cheneiere. For the management of the Plaquemine's barrier shoreline it is important to understand that the alongshore sediment transport is towards the northwest along this shoreline. Shell Island Bay and Bastion Bay are some of the most productive oyster habitat and the have traditionally supported important recreational and commercial fisheries.

The long-term erosion rate for the Shell Islands Reach is 38.5 ft/yr with a range of 8.0 to 101.5 ft/yr. **Figure 2-17** shows the long-term erosional history of the Shell Island area. Historically, Lanuax or Shell Island has migrated onshore and merged with the small barrier island at Grand Bayou Pass. By 1956, Bayou Fontanelle had been jettied and Lanaux Island or Shell Island migrated onshore and attached to the new Empire jetties. An erosional shadow extended from the western Empire Pass jetty. This erosional shadow began affecting Shell Island because western alongshore sediment transport along the Plaquemines shoreline was disrupted. The erosion rates along Shell Island accelerated from 8ft/yr to 79.5 ft/yr. Shell Island narrowed rapidly and Hurricane Bob, in 1979, breached Shell Island, forming Coupe Bob. The shoreline erosion rates accelerated further to 101.5 ft/yr and Shell Island Bay was exposed to the erosive forces of the gulf. This pattern of barrier island degradation continued with the enlargement of Coupe Bob, and by 2003 Bastion Bay was also exposed to gulf forces, including full saltwater inflow from the Gulf of Mexico. These changes resulted in significant degradation to the oyster reefs, on which many local residents depend.

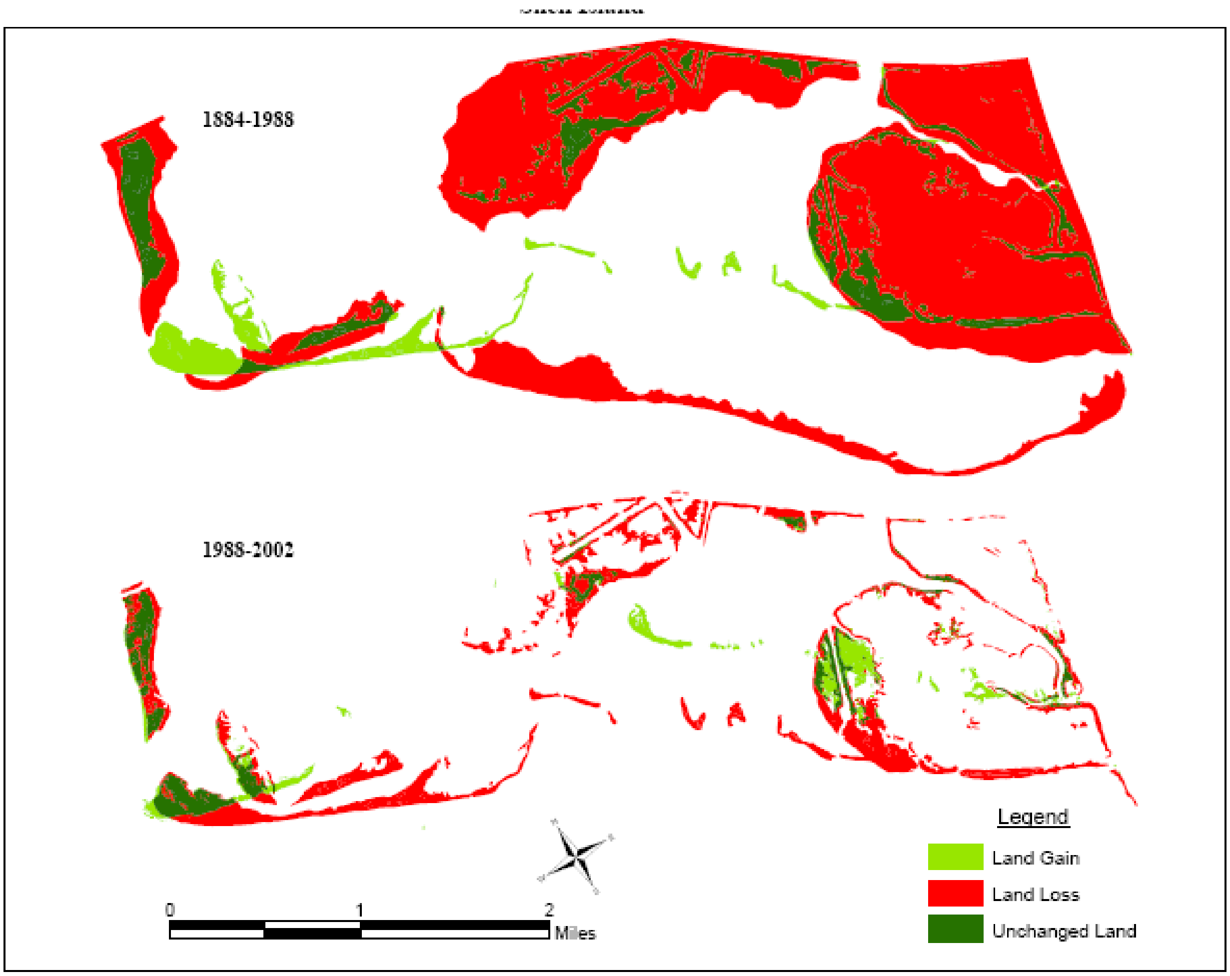


Figure 2-17. Shell Island Erosional History 1884 to 2002.

The re-establishment and maintenance of Shell Island is critically important now. Shell Island restoration would bring back the oyster fishery lost when Shell Island was washed away by a combination of the disruptive updrift Empire Pass jetties, Hurricane Bob in 1979 and the subsequent storms in the following years. The traditional recreational and commercial shrimp and finfish fishery would also return. Shell Island was a historic rookery for Threatened and Endangered shore birds, which would return with the restoration of Shell Island. Shell Island is a critical storm and hurricane protection buffer for the Empire, Sunrise, Buras, and Triumph communities. The tropical storm turned into a weak category 1 hurricane, Danny in 1997, and caused tremendous damage to Empire and the surrounding communities in part due to the absence of Shell Island. The tropical storms and hurricanes in 2002 and 2003 demonstrated the importance of restoring Shell Island. Monitoring the impacts of these storms validated the supposition that historic storms of the same strength were having a greater and greater impact as the barrier islands and back barrier marshes erode away.

Delay in the Shell Islands Reach jeopardizes the remaining framework of interior bays north of the Shell Islands Reach. Shell Island Bay north of Shell Islands Reach is nearly open into the adjacent Bastian Bay. Complete opening would nearly double open water and fetch within these bays, decreasing their use by some fishermen. North of Bastian Bay, only a few marsh islands and small ridges separate it from the much larger Bay Adams. Coalescence of the three bays would continue and accelerate without this project. Without the project, a large sound would develop open to the Gulf of Mexico. This sound would have a profound impact on the entire region. Ecologic changes would occur and be less productive. Storm surges would increase and require greater levels of flood and wave erosion protection. The further this scenario progresses toward a development of a sound, the more expensive restoration would be to address.

This feature has been identified as a near-term critical effort based first on its inclusion in all seven of the cost-effective, coast wide restoration frameworks, and on its ability to meet specified critical need criteria. It has been recommended for programmatic implementation based primarily on its capability to address critical ecological needs. The identification of ecological solutions in the ecosystem does not necessarily equate to identification of cost effective solutions. While this feature was not specifically evaluated for cost effectiveness, it was found to be a critical feature of 7 feasible and cost-effective, coast wide restoration frameworks. In addition, the feature addresses an identified, imminent, and critical need and/or opportunity for restoration.

The extremely degraded condition of this reach requires a restoration project comprised of several features. The primary feature is shoreline restoration. However, current water depth and exposure to gulf sea conditions require containment of placed material. Geotubes, terminal groins and other shore protection features are required to first allow the material to be placed and to then reduce erosion. Back marsh creation would be developed behind the restored beach. Since the Shell Islands Reach 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.

Initial benefits analysis (see attachment 4 for more detailed information) indicates that the most effective restoration alternative produces approximately 230 additional Average Annual Habitat Units over the no action condition, and roughly 280 more acres at project year 50. The beach restoration and marsh creation features would provide dune aviary habitat and shoreface fisheries habitat. Other significant benefits are the protection of the interior bays. Without this restoration project, Shell Island Bay, Bastian Bay and Bay Adams would likely coalesce and become a sound. A sound would be open to the Gulf of Mexico and extend northward to the back levee along the Mississippi River at Empire, LA. This sound would represent a dramatically changed ecology and hydrology in the southeastern portion of Barataria Bay. Oyster beds and fisheries productivity would decrease and storm surges would rise. Within these sounds and adjacent marsh are oil and gas pipelines and fields. The restored Shell Island would also serve as protection for the Empire waterway, an important navigation canal to both the oil industry, commercial and recreation fishing industries.

The estimated combined cost of Caminada Headlands Reach and Shell Islands Reach features is as follows:

Component	**Cost (see details below)**
DD	$10,200,000
PED	$6,800,000
Construction	
Beach Restoration (Caminada)	$125,000,000
Marsh Creation (Caminada)	$11,000,000
Beach Restoration (Shell Island)	$45,000,000
E&D/S&A	$31,680,000
Real Estate	$15,558,000
Total	*$245,238,000*

The estimated Average Annual Cost for this feature based on the implementation sequencing effort undertaken for the study is $17,221,000. The two restored barrier island reaches are estimated to produce a combined benefit of 962 AAHUs over the period of analysis. This equates to an annualized cost of $17,901 per habitat unit.

2.9.2.1.4 *Small Bayou Lafourche Reintroduction*

Bayou Lafourche is a historic distributary of the Mississippi River. After the river switched its course, the bayou continued to serve as a connection between the river and coastal wetlands until 1904, when water control structures were installed to protect area communities from flooding. Pumps and a siphon with a 340 cfs capacity were built in 1955 to provide fresh water, mainly for residential and industrial use.

Bayou Lafourche is located in the Barataria/ Terrebonne National Estuary, which currently experiences the highest wetland loss rates in the Nation. The isolation of these coastal wetlands from a freshwater and sediment source has accelerated land loss in the Barataria/Terrebonne area. In the next three years alone, an additional 1500 acres could be lost there. By the year 2050, this National Estuary is predicted to have lost 265,000 acres in the next 50 years. 81 per cent of Louisiana's wetland loss is estimated to occur there. By reconnecting the river to the bayou, this feature 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.

This is an ongoing CWPPRA project and has had extensive study and initial engineering efforts completed. This critical needs feature has wide public support and is consistent with the Barataria/Terrebonne National Estuary Program Comprehensive Coastal Management Plan. This feature has been identified as a near-term critical effort based first on its inclusion in all seven of the cost-effective, coast wide restoration frameworks, and on its ability to meet specified critical need criteria. It has been recommended for programmatic implementation based primarily on its capability to address critical ecological needs, as well as the fact that significant design efforts are already underway. The identification of ecological solutions in the ecosystem does not necessarily equate to identification of cost effective solutions. While this feature was not specifically evaluated for cost effectiveness, it was found to be a critical feature of all seven feasible and cost-effective, coast wide restoration frameworks. In addition, the feature addresses an identified, imminent, and critical need and provides an opportunity to expedite restoration.

The purpose of the Small Bayou Lafourche Reintroduction is to increase riverine influence in surrounding wetlands. E&D has been initiated on this project. Several alternatives are being considered which would provide year-round flow into the bayou, including gated culverts and a pump/siphon station at Donaldsonville. Additional features that would be required, regardless of the type of diversion structure built, include modification of existing infrastructure, bank stabilization, dredging, and channel improvements.

At the end of 50 years, there would be approximately 2,500 more acres of marsh than if the project had not been built (1998 WVA). A WVA performed for the Bayou Lafourche Freshwater Reintroduction Detailed Design Study authorized under CWPPRA estimated a project output of 705 AAHU over the project influence area. A project area of 85,000 acres (nearly 49,000 acres of wetlands and 36,000 acres of water) could benefit from this diversion. Salinities would be slightly reduced over this wide area, submerged aquatic vegetation would be increased as would fish and wildlife populations. Other project benefits would include continuation of recreational opportunities and maintenance of storm protection for surrounding communities as well as for vital petroleum and navigation infrastructure. Salinities would be reduced in upper Bayou Lafourche throughout the year. Thus, water intakes on Bayou Lafourche may not need to be closed during future salinity spikes up the bayou. In the recent drought of 1999-2001, a paper mill was forced to temporarily close because of excess salinity in the bayou. EPA has estimated that the area would receive enough clay sediments to sustain the needs of about 5,250 acres of brackish marsh per year if the efficiency of transferring this sediment to the marsh surface was 100%. The flow also would deliver enough nitrogen, which if applied to salt marsh with 100% efficiency could double the standing crop biomass on about 4,100 acres per year. The predicted removal of nitrogen by the wetlands would slightly reduce hypoxia in the Gulf of Mexico.

Another advantage would be that monitoring of this small diversion would provide data that could be used to estimate the benefits of the much larger Third Delta feature being proposed for a long-term study. Since the cost of restoring lost land is far greater than that of sustaining existing land, a major impact of delaying action could be result in a substantial increase in the costs of future restoration projects in the same area. Beyond increased project costs, delayed action would also likely result in additional costs to repair or replace infrastructure that may be compromised by lost land. The small Bayou Lafourche diversion addresses identified, imminent, and critical needs by preventing wetland loss where it is predicted to occur, reintroducing riverine water and sediments, and protecting vital socio-economic resources. Programmatic authorization would expedite attainment of these environmental benefits.

The Office of the Chief of Engineers conducted a Value Engineering study of the Bayou Lafourche Siphon Restoration project in July 2001. The cost estimate for this restoration feature is as follows:

Component	Cost (see details below)
DD	$13,500,000
PED	$9,000,000
Construction	$90,000,000
E&D/S&A	$18,000,000
Real Estate	$12,590,000
Total	*$143,090,000*

The estimate Average Annual Cost for this feature based on the implementation sequencing effort undertaken for the study is $11,727,000. The two restored barrier island reaches are estimated to produce a combined benefit of 705 AAHUs over the period of analysis. This equates to an annualized cost of $16,634 per habitat unit.

2.9.2.1.5 *Medium Diversion with Dedicated Dredging at Myrtle Grove*

This area is a transitional zone in the estuary where brackish and intermediate marshes merge, transitioning from saline marsh in the south and to fresh marsh at the northern extent near the GIWW. The future without-project condition forecasts that in the next fifty years, all saline and brackish marsh and approximately 40 percent of the intermediate marsh in this area would be lost.

Land loss data do not provide sufficient detail to project near-term impacts for anything less than a 10-year period; however, under the future without- project condition, the model estimates a loss of 152,000 acres over the next fifty years. This simulation also estimates that approximately 24 percent of this loss would occur in the first ten years. Because 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. This would also indicate that the residential development in the vicinity of the central area of the basin would be placed at more immediate risk.

The proposed Myrtle Grove feature would include two major components: a diversion of freshwater, sediments, and nutrients from the Mississippi River and the creation of new wetlands or geomorphic marsh building platforms using sediments from the Mississippi River. The diversion would consist of a gated box culvert diversion structure, outfall channel, and guide levees connecting the MR&T flood protection levee with the privately constructed hurricane protection levee. The dedicated dredging would create marsh or marsh building platforms in shallow open water areas throughout the receiving area of the diversion.

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 of 2,500 to 15,000 cfs would provide not only a significantly beneficial input of sediments and nutrients to the remaining wetlands in this area of the Barataria Basin, but also stabilize the composition of those existing marsh classes. The largest scale of potential diversion would produce up to 13,000 acres of new emergent marsh. The associated dedicated dredging would produce approximately 5,600 acres of new marsh or marsh platform across the diversion influence area, thus further stabilizing this transitional area of the basin. The diversion would be designed and operated to support the growth and expansion of marsh created through dredge material placement to allow more efficient use of dredge material and other restoration resources.

This feature has been identified as a near-term critical effort based first on its inclusion in all seven of the cost-effective, coast wide restoration frameworks, and on its ability to meet specified critical need criteria. It has been recommended for programmatic implementation based on sequencing rules that identify the feature as either a potential risk for loss of opportunity, as being in an advanced state of design, or as an existing opportunity that could be capitalized on to expedite restoration. The identification of ecological solutions in the ecosystem does not necessarily equate to identification of cost effective solutions. While this feature was not specifically evaluated for cost effectiveness, it was found to be a critical feature of 7 feasible and cost-effective, coast wide restoration frameworks. In addition, the feature addresses an identified, imminent, and critical need and/or opportunity for restoration.

The proposed feature takes advantage of the resource available from the Mississippi River to meet other study objectives by reconnecting the river to the estuary and placing river borne sediments into the system, thus promoting long-term ecosystem sustainability. The feature also addresses the improvement of overall water quality both within the basin and by reducing nitrogen delivery to the Gulf of Mexico. The restoration of wetlands in this area would help protect vital socio-economic resources located in the central and upper portions of the Barataria basin. The communities of Lafitte and Barataria represent the southern most development in the interior of the Barataria Basin and lay outside of any existing hurricane protection works. Loss of the existing wetland structure would have an immediate impact on the sustainability of these communities. 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.

There is an ongoing CWPPRA feasibility study of the proposed actions in the vicinity of Myrtle Grove that has completed scoping and initial salinity modeling. The modeling of alternative plans and assessments of ecologic benefits are pending. Barataria basin-wide modeling is being undertaken to better coordinate the proposed actions with the operation of the Davis Pond diversion structure. Several previous study efforts have identified the Myrtle Grove vicinity as a historic crevasse site and as an appropriate and critical location, relative to the overall Barataria Basin, for the introduction of riverine sediments, nutrients, and freshwater. The CE/ICA analysis of the Mississippi River, Sediment, Nutrient, and Freshwater Redistribution (MRSNFR) Study identified two scales of diversions in the vicinity of Myrtle Grove as cost-effective means of utilizing Mississippi River resources for restoration.

The following information is provided from the 2000 MRSNFR Study. That 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 basis for design and cost of those features as well as a basis for scaling designs and costs for additional project alternatives.

Benefits were estimated in MRSNFR using a community based HEP that was titled the WVA. This model is driven by multiple user professional judgment supported by available habitat data and user observation. This model expands upon professional judgment by formalizing consensus, and standardization, of methodology. The model does not mathematically interpolate expressions of biologic response over the defined spatial extent of the project area in the manner of a numeric model. In this regard there is an understood limitation to these projections of beneficial output. This restoration feature doe address identified, imminent, and critical needs by preventing wetland loss where it is predicted to occur, reintroducing riverine water and sediments, and protecting vital socio-economic resources. Programmatic authorization would expedite attainment of these environmental benefits.

The diversions of freshwater and sediment would flow into the rapidly subsiding marsh area near Round Lake and Lake Laurier to the west of Bayou Grand Chenier and east of Louisiana Highway 23. This area consists of remnant brackish marsh and shallow bays. The project area is divided into five separate geographical subareas for analysis **(figure 2-18)**.

The net WVA-projected benefits 9,281 AAHUs (1,897 - Area 1; 4,783 - Area 2; 1,238 - Area 3; 1,118 - Area 4; and 245 - Area 5). This alternative would create 6,000 acres of wetlands, with a net gain of 27,970 acres over the 50-year project life.

The WVA Team assumed a current, future without-project, and future with project land loss rates and % shallow water as shown in **table 2-18**.

Table 2-18. Land Loss Rates and Shallow Water Conditions.

	Land Loss Rate (%)		% Shallow Water (<1.5 ft)		
	Current and future w/o project	Future with project	Current	Future w/o project	Future with project
Area 1	1.88	0.28	50	25	90
Area 2	0.63	0.06	50	30	65
Area 3	1.10	0.55	20	10	18
Area 4	0.91	0.46	10	5	8
Area 5	0.94	0.38	10	5	8

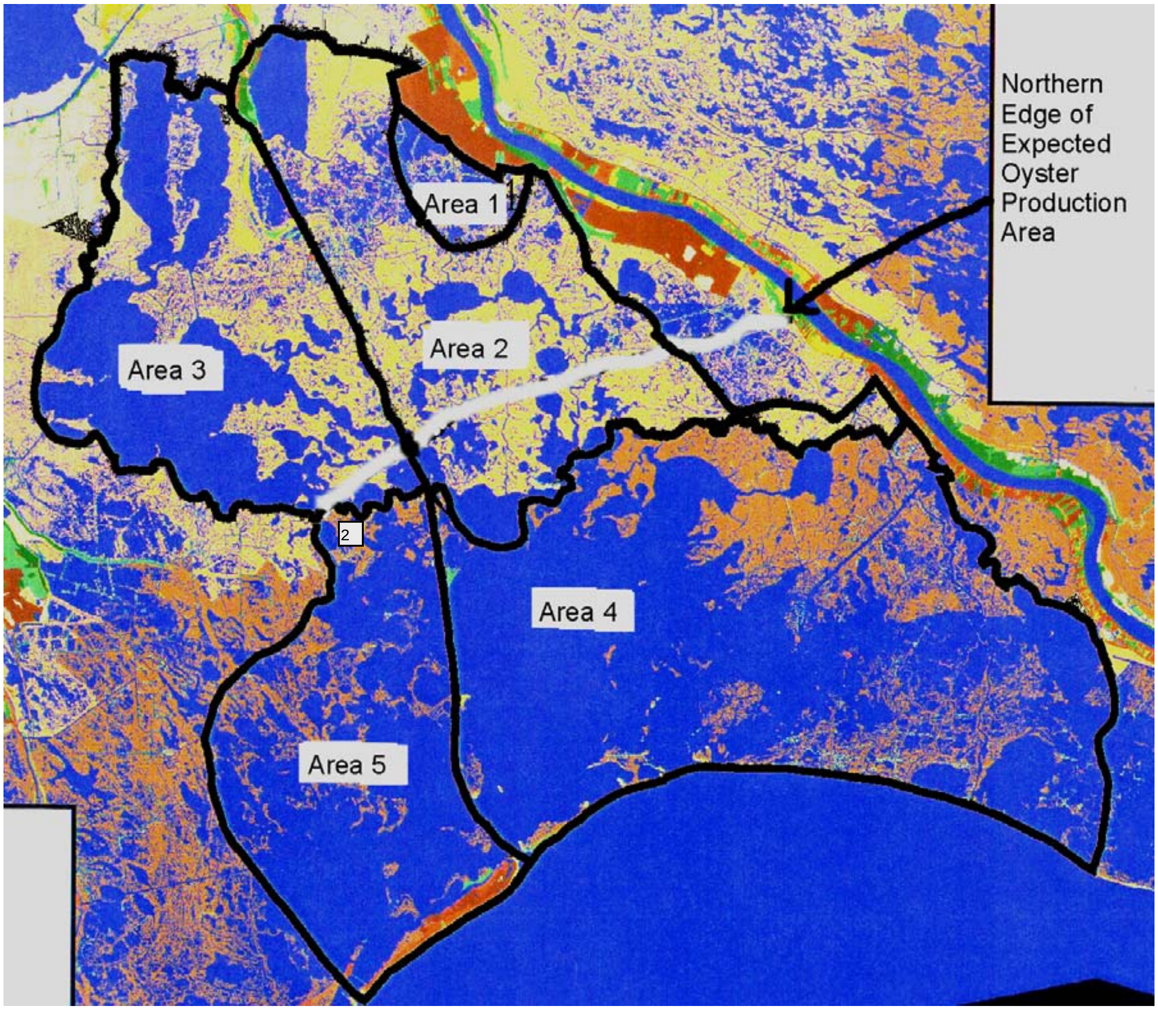


Figure 2-18. Map of Myrtle Grove Benefit Area (from USGS/LDNR).

The estimated cost of the Myrtle Grove feature is as follows:

Component	Cost (see details below)
DD	$22,005,000
PED	$14,670,000
Construction	
Diversion Structure (estimated for 15,000 cfs)	$49,200,000
Pipeline Relocation	$530,000
Dedicated Dredging	$96,970,000
E&D/S&A	$29,340,000
Real Estate	$7,720,000
Total	*$220,435,000*

The estimated Average Annual Cost for this feature based on the implementation sequencing effort undertaken for the study is $15,885,000. The 15,000 cfs diversion component of this feature was estimated to produce a benefit of 9,281 AAHUs over the period of analysis. This equates to an annualized cost of $1,712 per habitat unit. WVA analysis has not been completed for all variations of dedicated dredge material placement but a currently approved CWPPRA project to create 538 acres of new marsh resulting in 189 AAHUs. Extrapolating this estimate a larger 5,600 acre dedicated dredging project might produce roughly 1,950 AAHUs. The combination of dedicate dredging and freshwater diversion would increase habitat quality and sustainability further increasing habitat unit productivity.

2.9.2.2 Standard Process for Implementation of Critical Restoration Features

The near term critical restoration features within the TSP that are not programmatically authorized would be submitted to Congress for standard authorization in future WRDAs. Based on an analysis of the current TSP 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. TSP implementation would begin with basin-by-basin studies evaluating hydrodynamic and ecological responses of the non-programmatically authorized critical restoration features. The outputs would be evaluated by CE/ICA to determine the cost-effective alternatives for implementation. This CE/ICA analysis would support the restoration features feasibility-level decision documents submitted for Congressional authorization.

2.9.2.3 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 TSP. 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, recommendations for action would be documented in the manner specified for other features not qualifying for programmatic authority and would be subject to the standard review and authorization process for USACE water resources projects.

2.9.2.4 Science and Technology Program

Section 3.1 Planning Constraints of the Main Report detailed the key scientific uncertainties and engineering technology challenges in LCA implementation. Appendix A Science and Technology Program of the Main Report details the proposed plan and program to resolve these challenges and facilitate effective implementation. It is proposed that a 10-year 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 science and technology plan) at a total amount not to exceed $100,000,000. A major component of the S&T Program would be programmatically authorized demonstration projects, as explained below.

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 TSP features, as well as other coastal restoration projects and programs, such as CWPPRA. There are five primary components in the LCA S&T Program, and each component has a different emphasis and requirement. These components include: (1) Science Information Needs, (2) Data Acquisition and Monitoring, (3) Data and Information Management, (4) Modeling and Adaptive Management, and (5) Research. Determining Science Information Needs requires a continuous process in place that solicits and organizes science needs from Program Managers, the Program Execution Team, and scientists. Data Acquisition and Monitoring requires an organized plan with standard operating procedures and rigorous adherence to those standards. Data and Information Management requires standards and procedures to assure that data can be shared or compiled from a variety of sources. Modeling and Adaptive Management requires broad interactions among scientists, Program Management, and the Program Execution Team. Research requires clear hypothesis identification and clarification, testing, and documentation with a substantial degree of scientific independence but close coordination with the Program Execution Team.

The LCA S&T Program would perform the following:

- Work with LCA Program Management and the LCA Program Execution Teams to review and assess goals, objectives, and key documents of the LCA Program;
- Identify science needs to assist in the attainment of program goals and objectives;
- Establish and maintain independent science and technology advisory and peer review committees;
- Through scientific evaluations, assessments, and peer reviews, assure that the best available science is implemented, conducted or produced by the S&T Program and that this science 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 Adaptive Environmental Assessment and Management (AEAM) and infuse this improved information into ongoing or future restoration planning, projects and processes conducted by the Program Execution Team;
- 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 a comprehensive data management structure and process;
- Establish, in concert with the CRMS, key monitoring stations to collect critical baseline data for planned projects;
- 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 TSP 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 PLAN.

2.9.2.5 Programmatic Authority 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. 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 Planning Constraints of the Main Report. 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 serving to resolve the list of "Type 2" uncertainties detailed in this report, 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. Demonstration projects can be nominated by either the Program Execution Team or the LCA S&T Program Director to the Program Manager. The Program Manager would forward candidate demonstration projects to the Secretary of the Army for approval. Once approved, construction funding can be budgeted. In addition to standard decision document information, the demonstration project feasibility-level decision 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 that contribute to overall LCA program effectiveness.

2.9.2.5.1 *Demo 1 – Marsh Restoration and/or Creation Using Saline Sediments*

This demonstration project would address the uncertainty involved in selecting sources of material 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.

This demonstration project would 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. This project would be constructed in four 200-acre cells, each one constructed using different methods for thin placement including spray dredge and unconfined/semi-confined traditional hydraulic techniques at varying depths.

The demonstration project would be monitored to determine plant mortality, landform stability occurring within the different cells. Monitoring would also evaluate impacts related to the acquisition of borrow material and its effect on the local ecosystem. Approximate design and construction costs for DEMO1 would total $12 million.

2.9.2.5.2 *Demo 2 – Land bridge Restoration Using Long-Distance Conveyance of Sediments*

This demonstration project would address the uncertainty involved in land bridge restoration through long distance conveyance of sediments via pipeline. Concerns about the cost effectiveness of using conventional dredging techniques to transport large quantities of sediments long distances from sediment sources must be addressed. Conventional dredging equipment typically requires large pipelines for transport of sediments. However, there are uncertainties about how the material can be effectively transported efficiently over long distances and distributed. Variability in the sections of the land bridge would facilitate monitoring to determine optimal 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 but smaller dredges could be used to then disperse the material into final locations.

This demonstration project would be located along the degrading land bridge between Bayous Dularge and Grand Caillou in the lower Terrebonne Basin. Approximate design and construction costs for DEMO2 would be $10.3 million.

2.9.2.5.3 *Demo 3 – Pipeline canal Restoration Using Different Methods*

This demonstration project would address uncertainties involved in restoration of pipeline canals. Pipeline canals have been cut throughout the coastal marshes and have resulted in fragmentation and accelerated erosion of many of the marshes. There has been considerable uncertainty and debate about the most effective approach to restoring existing and future pipeline canals. There are also uncertainties about the viability of restoration efforts and the timing of restoration. Different approaches to restoration should 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 spoil bank 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 must be addressed.

This demonstration project would be constructed in locations in both Barataria and Terrebonne basins, with planned closure of twenty different canal sections via the five different methods described above. Approximate design and construction costs for DEMO3 would be $20 million, within each test section at approximately $1 million.

2.9.2.5.4 *Demo 4 – Shoreline Erosion Prevention Using Different Methods*

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 and sustainability. Project monitoring would include comparative evaluations of settlement occurring within the various erosion protection/foreshore protection features.

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 fifteen different one-mile stretches of the rapidly eroding Rockefeller Refuge shoreline in the Chenier Plain.

Approximate design and construction costs for DEMO4 would be $20 million. Depending on the protective measure used, reconnaissance level estimates indicate that costs for one-mile test sections will vary between $1.5 to .75 million.

2.9.2.5.5 *Demo 5 – Barrier Island Restoration Using Offshore Sources of Sediments*

This demonstration project would address uncertainties involved in restoration of barrier islands with offshore 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. 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. The 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.

This demonstration project would be constructed along sections of the Terrebonne barrier islands. Approximate design and construction cost for DEMO5 would be $20 million.

It is proposed that demonstration projects developed by the S&T program be funded as a construction item at an amount not to exceed $175 million over 10 years, including a maximum cost of $25 million per project. The five initial candidate demonstration projects developed by the PDT have an estimated total project cost of $82,300,000. For responsiveness to the need for an additional 5 to 20 demonstrations projects to be defined during implementation, the LCA Programmatic Authority for demonstration projects would include an additional $92,700,000.

2.9.2.6 Programmatic Authority 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 of material dredged. Currently, approximately 14.5 mcy 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 $15,000,000 in annual funding spread throughout USACE) do not provide the resources for the District to take full advantage of the available sediment resources.

The TSP would be enhanced by a programmatic authority 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 of material beneficially if funding were made available. (A portion of the average annual material total of 70 mcy 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. Areas with significant opportunity for additional beneficial use of material include:

- The bar channel of 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 bar channel of the Atchafalaya River and Bayous Chene, Boeuf, and Black, LA, project; and
- The inland reach of the Calcasieu River and Pass, LA, project.

The TSP recommends $100,000,000 in programmatic authority to allow for the extra cost needed for beneficial use of dredged material. Approximately 15 percent would be used for feasibility studies, and the remaining $85,000,000 would be used for placement of dredged material within the acquired disposal sites. Past 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 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 of newly created wetlands. This beneficial use program represents a significant 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 would 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 $100,000,000 over the initial 10 years of the LCA program and would support a significant increase in achieving restoration objectives with the existing sediment resources from LCA navigation channels.

2.9.2.6.1 *Programmatic Authority to Initiate Studies for Modifications to Existing Water Control Structures and/or Operation Management Plans*

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.

Initiation of studies of restoration opportunities relative to such modifications requires advanced budgeting. Standard budget sequencing may limit responsiveness to recommendations made within the TSP. As a result, the TSP seeks programmatic authorities to initiate studies of existing structures utilizing funds within the LCA appropriations, not to exceed $10,000,000.

2.9.2.7 Cost Estimates for Components of the TSP

Estimated costs for each of component of the TSP are shown in **table 2-19**. Cost estimates are based on June 2004 price levels.

Table 2-19
TSP Recommended Component Cost Estimates
(June 2004 Price Levels)

Item		Cost ($)
MRGO environmental restoration features	$	80,000,000
Small diversion at Hope Canal	$	30,025,000
Barataria Basin Barrier shoreline restoration, Caminada Headland, Shell Isl.	$	181,000,000
Small Bayou Lafourche reintroduction	$	90,000,000
Medium diversion at Myrtle Grove w/ possible dedicated dredging	$	146,700,000
SUBTOTAL	$	527,725,000
Real Estate	$	66,439,000
First cost SUBTOTAL	$	594,164,000
Feasibility Level Decision Investigations and NEPA Documentation	$	55,609,000
PED	$	37,072,000
Near-term Approval and Implementation Documentation Cost SUBTOTAL	$	92,681,000
Engineering & Design (E&D) / Supervision & Administration (S&A)	$	99,265,000
Programmatically Authorized TSP Cost	**$**	**786,110,000**
Science & Technology Program Cost (10 year Program)	**$**	**100,000,000**
Demonstration Program Cost (10 year Program)*	**$**	**175,000,000**
Beneficial Use Dredge Material Program*	**$**	**100,000,000**
Modification of Existing Structures	**$**	**10,000,000**
Total Programmatically Authorized TSP Cost	**$**	**1,171,110,000**
Multi-purpose operation of the Houma Navigation Canal Lock #	$	-
Terrebonne Basin Barrier shoreline restoration E. Timbalier, Isle Dernieres	$	84,850,000
Maintain Land Bridge between Caillou Lake & Gulf of Mexico	$	41,000,000
Small diversion at Convent / Blind River.	$	28,564,000
Amite River diversion (spoil banks gapping)	$	2,855,000
Medium diversion at White’s Ditch	$	35,200,000
Stabilize Gulf Shoreline at Pointe Au Fer Island	$	32,000,000
Convey Atchafalaya River Water to Northern Terrebonne marshes	$	132,200,000
Caernarvon - optimize for marsh creation (project modification)	$	1,800,000
Davis Pond - optimize for marsh creation (project modification)	$	1,800,000
SUBTOTAL	$	360,269,000
Real Estate	$	208,100,000
First cost SUBTOTAL	$	568,369,000
Feasibility Level Decision Investigations and NEPA Documentation	$	54,100,000
PED	$	36,067,000
Near-term Approval and Implementation Documentation Cost SUBTOTAL	$	90,167,000
Engineering & Design (E&D) / Supervision & Administration (S&A)	$	71,734,000
Conventionally Authorized TSP Cost	**$**	**730,270,000**
Mississippi River Hydrodynamic Study	$	10,250,000
Third Delta	$	15,290,000
Upper Atchafalaya Basin Study w/ Mod Operations of Old Riv Control ^	$	-
Chenier Plain Freshwater Management and Allocation Reassessment	$	12,000,000
Mississippi River Delta Management Study	$	15,350,000
Acadiana Bay Estuarine Restoration	$	7,110,000
Large-scale Studies Cost	**$**	**60,000,000**
Total Conventionally Authorized TSP Cost	**$**	**790,270,000**
Total LCA Restoration TSP Cost	**$**	**1,961,380,000**

*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 recommended in the reports of the Chief of Engineers dated 23 August 2002 and 22 July 2003.

^ Study to be funded under the Mississippi River and Tributaries authority

2.10 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 TSP 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. The Main 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 2-19**), the purpose, structure, and roles and responsibilities are described in the Main Report. 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 2-19** depicts their overall relationship and the interaction that would be needed to achieve coastal restoration and consistency.

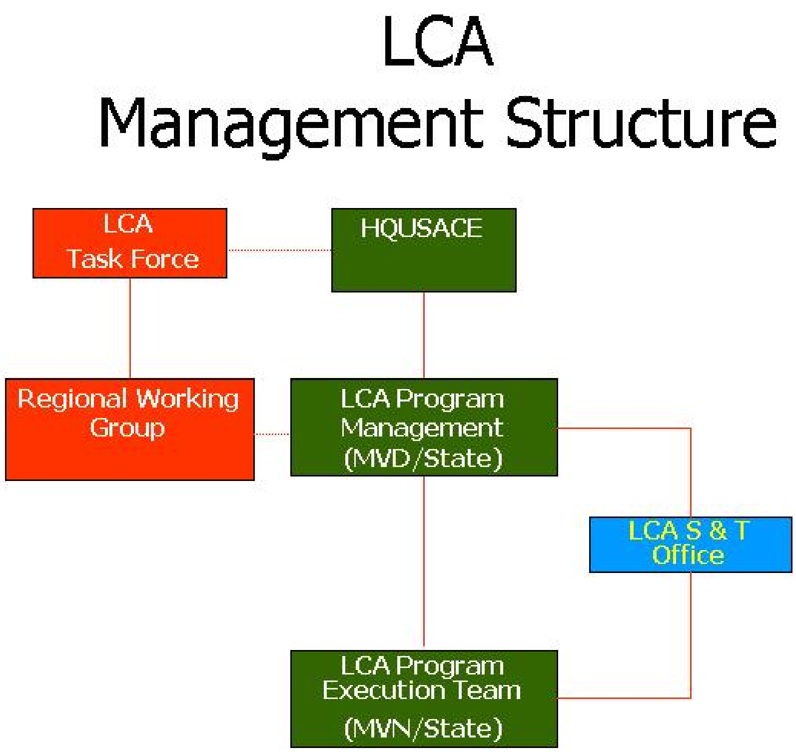


Figure 2-19. Coastal Restoration Management Structure.

2.11 ADAPTIVE ENVIRONMENTAL ASSESSMENT AND MANAGEMENT (AEAM)

Large coastal ecosystems like the LCA 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 2.2 Programmatic Constraints of the Main Report, as well as watershed influences that affect delivery of water, sediments, and nutrients, and uncertainty in the timing and magnitude of infrequent, but high-energy events such as floods and storms, make these large ecosystems inherently difficult to manage. Integration of an adaptive environmental assessment and management (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 based on assessment of monitoring data and the development of new tools or technologies. Specifically, the Program Execution Team would be responsible for reviewing the overall program and preparing annual reports and recommendations to the Program Manager so that necessary adjustments to better meet program objectives could be made. The Program Manager would issue updated programmatic guidance to both the Program Execution Team and the S&T Office. **Figure 2-20** depicts this iterative process and the roles of the different groups. It is important to note that the scale of decisions dealt with in the “decision process” highlighted in **figure 2-20** would differ in scale. One way of expressing this is to distinguish between strategic decision 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 implementation of AEAM within LCA Program management would build upon lessons learned over the past several years in CWPPRA. Along with informing LCA management methods, CWPPRA-initiated tool development, such as the Coast-wide Reference Monitoring System (Steyer et al., 2003), would be useful within the LCA AEAM effort.

The structures and general process outlined for the LCA S&T Program provide the basic elements of an AEAM program. However, making AEAM work means that all participants involved in the TSP acknowledge that implementation is a learning process, and adaptation is a necessity. The key to this is timely and effective communication of information to assist all participants in furthering attainment of program objectives. Examples of communication tools are project-specific report cards, annual programmatic AEAM report, and science symposia convened on an annual or biennial basis. Appendix A Science and Technology Program of the Main Report expands on this general discussion of AEAM.

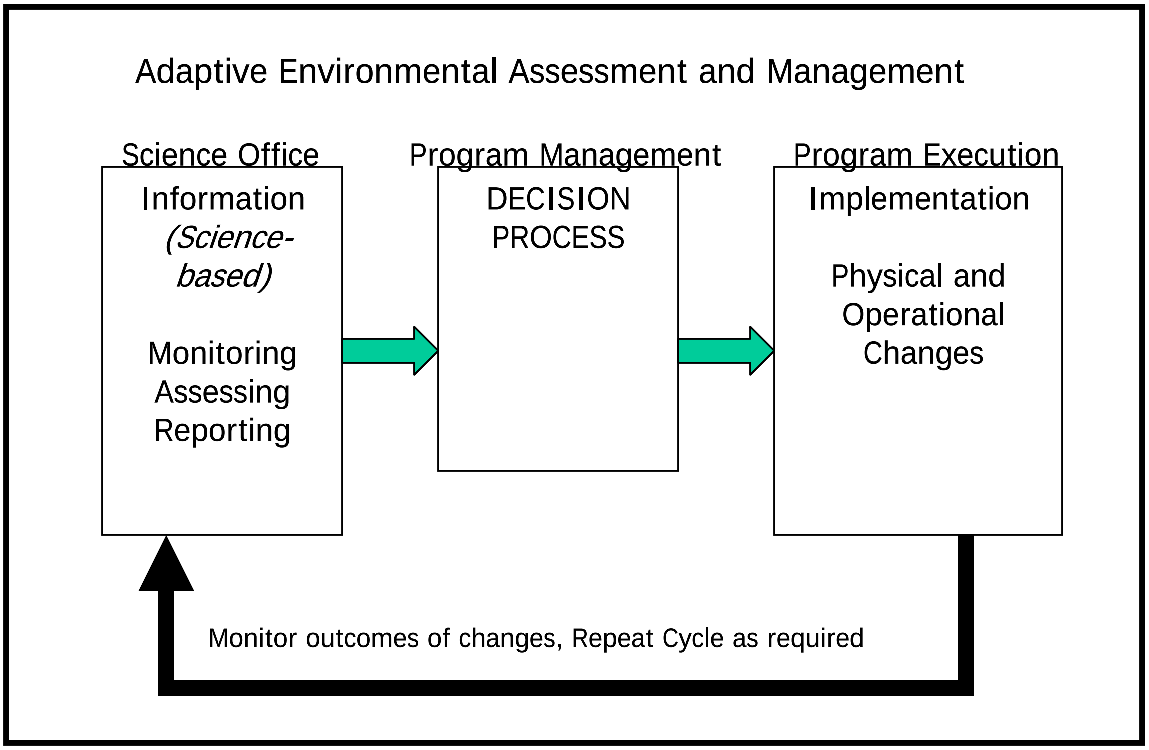


Figure 2-20. Adaptive Environmental Assessment and Management Process.

2.12 COMPARISON OF RESTORATION OPPORTUNITES

2.12.1 No Action Alternative ─ Future Without-Project

The No Action Alternative or future without-project assumes no further ecosystem restoration 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 1.7 "Opportunities" of this DPEIS and Section 1 "Introduction" of the Main Report.

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 significant land loss.

Louisiana coastal wetlands have been subjected to high rates of relative sea level change (rise) for centuries at least due to high subsidence rates associated with the compaction and dewatering of deltaic sediments. 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). 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. Quantification of future land loss is described in Section 1.5.2.8 Projected Land Change Summary.

The preliminary modeling output predicted habitat changes in acres resulting from future without-project conditions. These changes were due to land lost or gained and habitat change due to future conversion between habitat types. Overall there would be a net loss of 13 percent of today's wetland acres. In **table 2-20**, 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 2-21** to **2-24**). These figures 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 for more information on plant productivity modeling and calculations).

Table 2-20. Percent Habitat Composition.
With the Future Without-Project Conditions (No Action Alternative) 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.
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 ECOLOGIAL MODELING.

Subprovince 1

Over 5 percent of the total emergent wetland acres are predicted to be lost by 2050. Land acreage would continue to decrease through year 2050, while plant productivity would initially increase through year 10, and then decrease slightly through year 2050 (**figure 2-21**). The majority of the direct wetland loss is expected to be caused by shoreline erosion in the brackish and saline Biloxi Marshes. Cypress swamp could be lost to the west of Lake Maurepas.

Fresh marsh is expected to nearly triple in acreage, especially in the upper Breton Sound marshes where influence of the Caernarvon Diversion would be felt. The predicted approximately 40 percent loss in intermediate marsh is mainly because it is expected to convert to fresh marsh in the Caernarvon influence area. Much of the predicted loss of 20 percent of the existing brackish marsh would be due to conversion to intermediate marsh. By 2050, fresh marsh and swamp/wetland forest are predicted to make up 65 % of the wetlands and saline marsh only 7 percent.

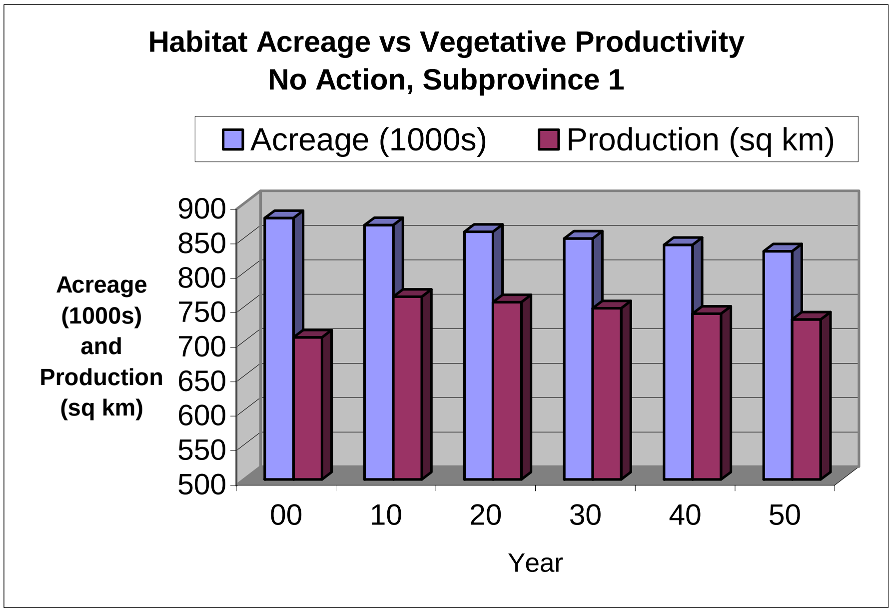


Figure 2-21. Habitat Acreage and Vegetative Productivity for Subprovince 1 Under Future Without-Project Conditions.

Subprovince 2

Approximately 22 percent of the existing emergent wetlands are predicted to by lost by 2050. Land acreage would continue to decrease through year 2050, while plant productivity would initially increase through year 10, and then decrease significantly through year 2050 (**figure 2-13**). The majority of the wetland loss is expected to occur in the lower portions of the subprovince, as existing brackish and saline marshes convert to open water. Losses are also predicted in the upper area in cypress swamp.

Anticipated inputs from the Davis Pond Diversion are predicted to greatly expand the area of fresh marsh by causing the conversion of existing intermediate and brackish marshes as they convert to fresh. The total loss of saline marshes is predicted to be mainly due to conversion to open water. However, some saline marsh is expected to convert to intermediate and brackish marsh. By 2050, over 90 percent of the subprovince is anticipated to by fresh marsh and swamp/wetland forest with the remaining 9 percent either intermediate or brackish marsh.

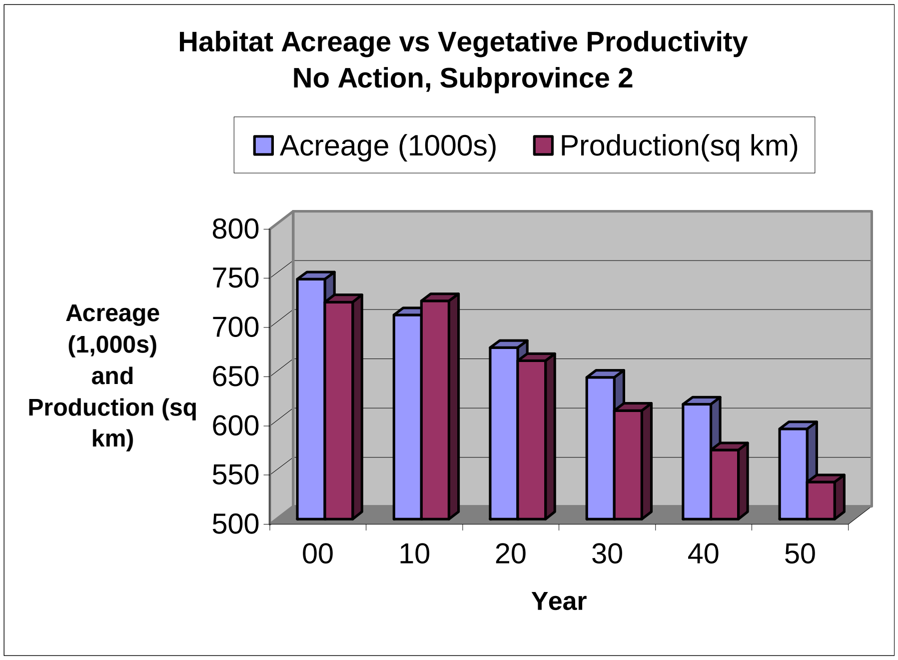


Figure 2- 22. Habitat Acreage and Vegetative Productivity for Subprovince 2 Under Future Without-Project Conditions.

Subprovince 3

Approximately 16 percent of the existing emergent wetlands are predicted to by lost by 2050. Land acreage would continue to decrease through year 2050, while plant productivity would initially increase through year 10, and then decrease moderately through year 2050 (**figure 2-23**). The majority of the loss would occur in the eastern portion of the subprovince with loss increasing from north to south. Additional loss is also predicted north of the GIWW. Significant land gain is anticipated in the two deltas in Atchafalaya Bay.

Approximately 13 percent of the swamps are predicted to be lost, mainly due to elevated water levels in the Verret Basin. A large increase (220 percent) in intermediate marsh is predicted by the model. This increase is probably due to threshold constraints of the model and the necessity of averaging salinities from western Terrebonne with Atchafalaya Bay. Most of the predicted decrease in fresh marsh is due to conversion to intermediate marsh. The 80 percent decrease in brackish marsh is expected to be caused by conversion to other marsh types and loss to open water. Most of the predicted 95 percent loss of salt marsh would occur as it becomes open water. By 2050, almost 60 percent of the emergent wetlands are predicted to be intermediate marsh, and 33 percent will be swamp and wetland forest.

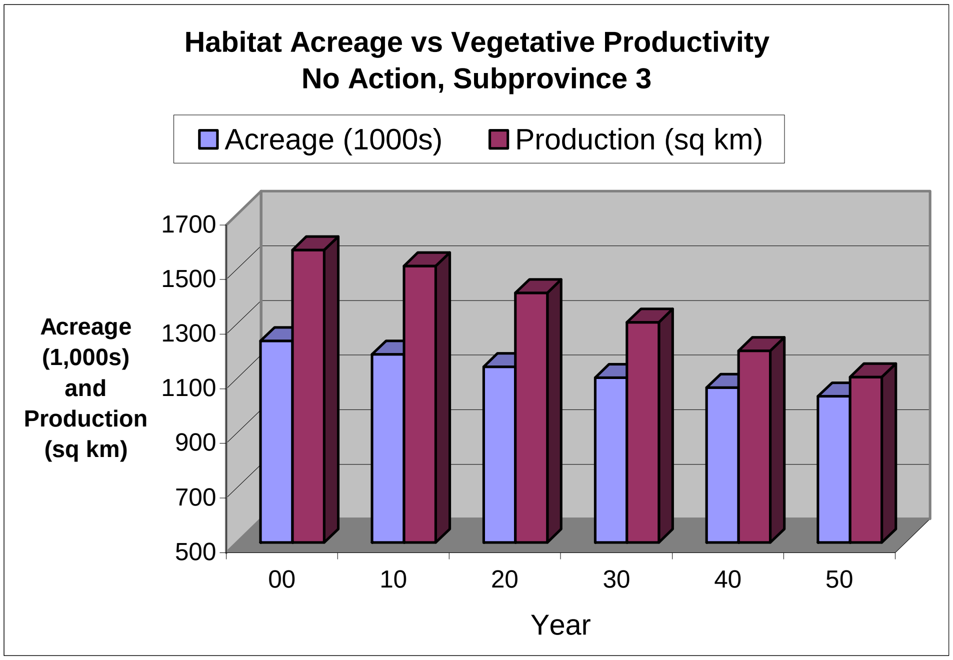


Figure 2- 23. Habitat Acreage and Vegetative Productivity for Subprovince 3 Under Future Without-Project Conditions.

Subprovince 4

Approximately 6 percent of the existing emergent wetlands are predicted to by lost by 2050. Land acreage would continue to decrease through year 2050, while plant productivity would initially increase through year 10, and then decrease slightly through year 2050 (**figure 2-24**). Much of the loss in anticipated to occur south of Highway 82 and in the Big Burn area.

Brackish marsh is predicted to expand by almost 150 percent of the current acreage. This increase will be almost entirely because increasing salinity causes conversion of fresh, intermediate marshes to brackish. By 2050, 41 percent of the wetlands will be fresh marsh, 32 percent intermediate marsh and 27 percent brackish marsh.

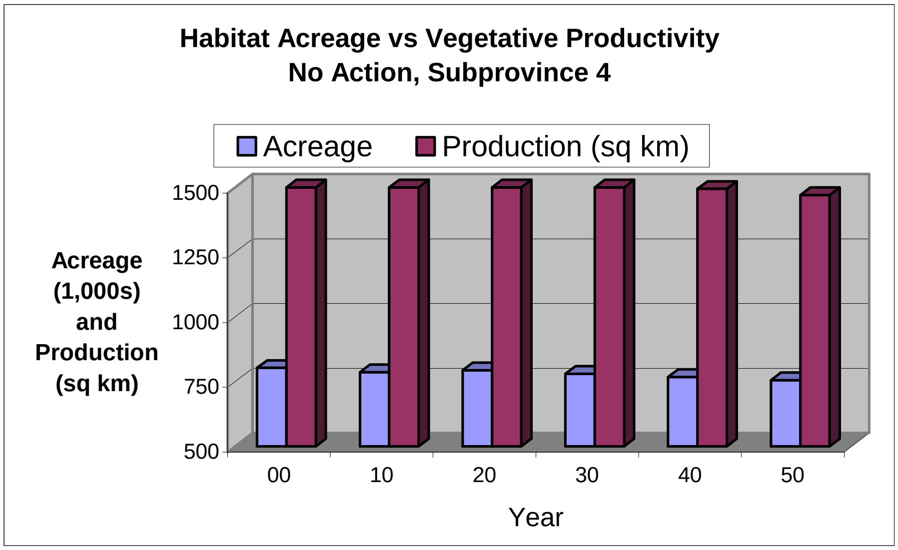


Figure 2-24. Habitat Acreage and Vegetative Productivity for Subprovince 4 Under Future Without-Project Conditions.

Table 2-21 is a comparison of the potential impacts of each restoration opportunity to significant resources.

TABLE 2-21
Comparison of Restoration Opportunities to No Action Among Significant Resources

Significant Resource	No Action	Restoration Opportunity 1 (deltaic processes)	Restoration Opportunity 2 (geomorphic structure)	TSP
Soils	Continued coastal land loss with predicted 328,000 acres lost over next 50 years; organic soils will not be able to maintain their elevation.	River diversions would build and/or nourish land; dedicated dredging would build new land; hydrologic restoration improves conditions for plant growth resulting in reduction of soil erosion.	Marsh creation would build new land; hydrologic restoration improves conditions for plant growth resulting in reduction of soil erosion.	Impacts would be combination of both RO1 and RO2.
Offshore Sand Resources	Natural processes continue to build offshore sand deposits; continued multiple uses of offshore sands and sand bodies.	RO1 does not present any likely restoration opportunities for use of offshore sand resources.	Almost all of RO2 restoration features could potentially impact offshore sand resources; there would be short-term minor to long-term significant adverse impacts due to removal of over 61 million cy of sands required for restoration purposes.	Impacts similar to RO2.
Salinity Regimes	Preliminary modeling shows freshening in influence areas of existing diversions (Subprovince 1&2). However, some increased salinity intrusion into some interior portions of all subprovinces due to human-induced and natural coastal land loss.	Long-term minor direct to long-term minor-to-moderate indirect impacts associated with slight freshening from diversions in localized areas of subprovince 1, 2 and 3; otherwise, salinity regimes would be similar to the future without conditions.	Impacts would be similar to RO1 but to a much lesser degree.	Impacts would be a combination of RO1 and RO2.
Barrier Systems	Continued natural and human-induced land-loss processes at rates similar to present.	No direct or indirect impacts to barrier systems.	Long-term significant positive impacts of restoring over 32 miles of barrier systems; short-term minor adverse impacts due to construction of restoration features.	Impacts would be a synergistic combination of RO1 and RO2.
Barrier Reefs	Natural and human-induced processes continue form/erode barrier reefs.	No restoration features for barrier reefs.	No restoration features for barrier reefs.	No restoration features for barrier reefs.
Coastal Vegetation	Long-term significant coast wide net decrease due to continued coastal land losses.	Long-term significant net decrease of all coastal wetland vegetation habitat types, but with a minor reduction in the rate of loss, particularly with small increase in productivity of fresh and intermediate marsh and swamp/wetland forest; brackish and saline marsh and barrier shoreline vegetation would remain similar to the future without conditions.	Long-term significant net decrease of all coastal wetland vegetative habitat types (depending upon the locations of beneficial use), but with a minor reduction in the rate of loss, particularly with brackish, saline and barrier shoreline vegetation.	Impacts would be somewhat greater than the combination of both RO1 and RO2. Long-term significant net decrease of all coastal wetland vegetation habitat types would occur, but with a small reduction in the rate of loss, and small increases in productivity in all habitat types.
Wildlife	Continued decline in most coastal Louisiana wildlife species.	Most coastal Louisiana wildlife species would benefit.	Most coastal Louisiana wildlife species would benefit.	Impacts would be a combination of RO1 and RO2.

TABLE 2-21
Comparison of Restoration Opportunities to No Action Among Significant Resources

Significant Resource	No Action	Restoration Opportunity 1 (deltaic processes)	Restoration Opportunity 2 (geomorphic structure)	TSP
Plankton	Increased potential for algal blooms due to increases in nutrients.	In the Delta Plain, freshwater diversions result in species switching from saltwater-dominant to freshwater dominant.	Restoration of geomorphic structure only would result in negligible impacts.	Impacts similar to RO1.
Benthic	Increases in benthic species and community diversity.	In the Delta Plain, freshwater diversions result in species switching from saltwater-dominant to freshwater dominant; creation of significant acres of new habitat with greater heterogeneity and interspersion.	Unavoidable direct loss of benthos due to construction activities; however, creation of significant acres of new habitat with greater heterogeneity and interspersion.	Impacts would be a combination of both RO1 and RO2.
Marine Fisheries	Would have a net loss in fisheries population size and diversity.	Long-term benefits may overcome adverse impacts of increased freshwater input.	Some adverse impacts, with long-term benefits.	Marine fisheries would benefit from this plan
Estuarine-Dependent Fisheries	Would have a net loss in fisheries population size and diversity.	Estuarine-dependent fisheries would benefit due to preservation of habitat.	Estuarine-dependent fisheries would benefit due to preservation of habitat.	Estuarine-dependent fisheries would benefit due to preservation of habitat.
Freshwater Fisheries	Would have a net loss in fisheries population size and diversity.	This plan would benefit freshwater fisheries.	Minimal, if any adverse impacts; some long-term benefits of marsh creation.	Combination of RO1 and RO2.
Essentiel Fish Habitat	Continued loss and degradation of EFH.	This plan would preserve some highly productive categories of EFH expected to be lost with no action	This plan would preserve some highly productive categories of EFH expected to be lost with no action in isolated areas of the LCA. This preservation is not expected to be sustainable.	Of the near term plans, this plan best preserves some highly productive categories of EFH expected to be lost with no action.
Threatened & Endangered Species	Continued population decline and loss of critical habitat principally for the piping plover and sea turtles.	Would generally increase and enhance all coastal wetland habitats.	Would increase and enhance piping plover critical habitat (barrier islands) and would generally enhance all habitats.	Would increase and enhance piping plover critical habitat (barrier islands) and would generally enhance all habitats.
Hydrology Flow Patterns	Flow rates would continue to increase.	Increase freshwater flow to the wetlands, Subprovinces 1-3, decrease Mississippi River flow. Effects on water levels not known.	Reduce Gulf flow and alter flow patterns.	Increase freshwater flow to the wetlands, Subprovinces 1-3, decrease Mississippi River flow. Effects on water levels not known. Reduce Gulf flow and alter flow patterns.
Sediment	Sediment supply does not offset land loss.	Increased sediment deposition in wetlands, Mississippi River, existing channels and canals, and estuarine areas, Subprovinces 1-3. Changed deposition patterns in all Subprovinces.	Decreased sediment output in wetlands and estuarine areas Subprovinces 1-3. Changed depocenter patterns in all Subprovinces.	Decreased sediment output in wetlands and estuarine areas all subprovinces. Changed depocenter patterns in Subprovinces 1-3, Increased sediment deposition in wetlands, Mississippi River, existing channels and canals, and estuarine areas Subprovinces 1-3.

TABLE 2-21
Comparison of Restoration Opportunities to No Action Among Significant Resources

Significant Resource	No Action	Restoration Opportunity 1 (deltaic processes)	Restoration Opportunity 2 (geomorphic structure)	TSP
Water Use & Supply	Some coastal areas, saltwater intrusion events continue & increase in frequency and magnitude. Result is reduced surface supplies & increased reliance on ground water, which is limited in many coastal areas.	All LCA components will generally increase freshwater availability in the receiving areas of the subprovinces and decrease freshwater availability in the Mississippi River.	Negligible effects on water use and supply (freshwater availability).	All LCA components will generally increase freshwater availability in the receiving areas of the Subprovinces and decrease freshwater availability in the Mississippi River.
Groundwater	Continued withdrawals.	Unlikely impacts on groundwater.	Unlikely impacts on groundwater.	Unlikely impacts on groundwater.
Water Quality	Continued institutional recognition to restore and protect waterbodies, especially with respect to point sources. Nonpoint sources still unregulated and increasing potential for accidental discharges due to exposed infrastructure because of coastal land loss.	Long-term minor-to-moderate positive/adverse effects (depending upon perceptions of water uses) of introducing river water from diversions into receiving basins; similar to what occurred naturally prior to construction of levees. Sediments introduced into the receiving basins from diversions or from direct placement (dredge material disposal) would add some constituents, but would likely not exceed alert levels or harm the environment.	Sediments introduced into the receiving basins from diversions or from direct placement (dredge material disposal) would add some constituents, but would likely not exceed alert levels or harm the environment.	Impacts of the TSP would be a synergistic result over and above the additive combination impacts and benefits of RO1 and RO2.
Historic & Cultural Resources	Potential loss of resources due to natural and human causes.	Requires project specific cultural resources investigation	Requires project specific cultural resources investigation	Requires project specific cultural resources investigation
Recreation	Potential loss of recreational resource base due to coastal land loss.	RO1 would support and sustain a greater number of freshwater-based recreational opportunities, provide for a more stable freshwater-based recreation economy, and possibly increase the Louisiana recreation industry compared to the future without-project conditions.	RO2 would support and sustain a greater number of saltwater-based recreational opportunities, provide for a more stable saltwater-based recreation economy, and possibly increase the Louisiana recreation industry compared to the future without-project conditions.	Impacts similar to RO1 and RO2 in that the TSP includes restoration features common to both of these restoration opportunities.
Aesthetic	Continued human population growth and development and other human activities have the potential to destroy, enhance, or preserve visual resources.	Impacts of maintaining visually appealing resources systems would further support tourism as one travels Louisiana's Scenic byways and remote areas of visual interest.	Impacts similar to RO1.	Impacts would be a combination of RO1 and RO2.

TABLE 2-21
Comparison of Restoration Opportunities to No Action Among Significant Resources

Significant Resource	No Action	Restoration Opportunity 1 (deltaic processes)	Restoration Opportunity 2 (geomorphic structure)	TSP
Air Quality	Continued decline in air quality as human population growth and development increases and despite legislative attempts to address problems.	Some abatement of air quality since restoration would result in reduction of the rate of loss of vegetated habitats and small increase in productivity of fresh and intermediate marsh and swamp/wetland forest thereby positively impacting air quality via absorption of carbon dioxide and other air pollutants. Short-term minor adverse impacts due to construction activities.	Generally same as RO1 except fewer restoration features would result in less long-term abatement and less short-term negative construction impacts.	Impacts would be similar to RO1 and RO2 since the TSP includes restoration features from both plans.
Noise	Continued noise pollution as human population growth & development, industry, and other human activities continue to increase	Noise typically associated with actual construction activities. All legal requirements for noise abatement would be followed. No significant cumulative impacts anticipated.	Similar, but less than RO1, since RO2 has fewer restoration features.	Impacts would be a combination of RO1 and RO2.
HTRW	Continued growth of human population, development, industry, and other activities would further increase HTRW areas of concern within the LCA.	An HTRW Phase I ISA would be performed on a project-by-project basis. Any HTRW identified will be avoided or removed prior to initiation of construction activities.	An HTRW Phase I ISA would be performed on a project-by-project basis. Any HTRW identified will be avoided or removed prior to initiation of construction activities.	An HTRW Phase I ISA would be performed on a project-by-project basis. Any HTRW identified will be avoided or removed prior to initiation of construction activities.
Gulf Hypoxia	Continued nutrient loading into Gulf of Mexico; possible upstream abatement.	Small reduction in nutrient loading from Mississippi River to Gulf of Mexico.	No effect.	Small reduction in nutrient loading from Mississippi River to Gulf of Mexico.
Population	Due to coastal erosion population would shift further inland and to urban and suburban areas.	Population shift would be slower. With implementation subsistence fishermen would potentially relocate to follow fishery species that are affected by the change in salinity levels.	Impacts would be similar to RO1, but less due to fewer restoration features. There would be no relocation of subsistence fishermen.	Impacts would be similar to RO1 and RO2.
Infrastructure	Infrastructure nearest to the coast would be exposed to more frequent erosion and damage. Infrastructure would have to be relocated, replaced, and repaired.	RO1 would reduce some erosion and damage.	Similar to RO1, but less due to fewer restoration features.	Impacts would be similar to RO1 and RO2.
Socio-Economic and Human Resources	Some industrial employers, petroleum, and seafood would be threatened by coastal land loss and storms, thus causing a loss of associated employment and income. Population would shift further inland and to urban and suburban areas.	RO1 would reduce coastal erosion and protect these assets. Loss of jobs and income due to coastal erosion and storms would be reduced.	Impacts would be similar to RO1, but less due to fewer restoration features.	Impacts would be similar to RO1 and RO2.

TABLE 2-21
Comparison of Restoration Opportunities to No Action Among Significant Resources

Significant Resource	No Action	Restoration Opportunity 1 (deltaic processes)	Restoration Opportunity 2 (geomorphic structure)	TSP
Commercial Fisheries	The fishing industry and its supporting business and activities would experience a decline.	Overall with RO1 the industry would be more stable. RO1 could cause a shift from some saltwater species to brackish species. The diversions could increase costs to get to marine waters, though sustainability of the resource is enhanced. The diversion could have a positive impact on the crawfish industry.	RO2 would not impact the industry as much as RO1.	Impacts would be similar to RO1 and RO2.
Oyster Leases	Gradual loss of production from leases. Increased production in bands of intermediate distance from freshwater introduction.	SP1-2 reduced production from leases; SP3 slight impacts both negative and positive; no oyster leases in SP4	SP1-3 minimal localized impacts in construction areas; no oyster leases in SP4.	Impacts similar to RO1 and RO2.
Oil, Gas & Minerals	Increased damages to refineries, wells, and other oil and gas producing facilities and equipment. Some relocations would occur due to erosion.	RO1 would reduce damages and provide protection to these assets.	Similar to RO1, but would provide some increased protection to the LOOP facility due to restoration of the Caminada-Moreau Headland.	Impacts similar to RO1 and RO2.
Navigation	Probable damages to and relocation of port facilities, inland waterways, and traffic.	Possible negative impacts due to increased O&M dredging requirements. Could have positive impacts for GIWW traffic.	Possible negative impacts for O&M funding competing with beneficial use funds. Possible significant negative impacts depending on MRGO restoration measures selected.	Similar impacts to both RO1 and RO2.
Flood Control	Continuing erosion of the coast would cause increased flood damages due to storm surge. Some people would choose to relocate.	RO1 would reduce flood damages and prevent some relocations.	Impacts would be similar to RO1, but less due to fewer restoration features.	Impacts similar to RO1 and RO2.
Pipelines	Increased damages to pipelines and related equipment. Some relocations would occur due to erosion. Potential for environmental damage and disruptions in our energy supply.	RO1 would increase protection these assets and decrease damages.	Impacts would be similar to RO1. Barrier islands and shoreline protection can be expected to increase protection for pipelines.	Impacts similar to RO1 and RO2.
Hurricane Protection Levees	Continuing erosion of the coast would cause increased flood damages to levees due to storm surge and increased maintenance.	RO1 would reduce some of the damage and increased maintenance to levees. Short-term minor impacts to some levees due to construction activities.	RO2 would have minimal impact on the levee system; some storm surge reduction.	Impacts similar to RO1 and RO2.
Agriculture	Continuing erosion of the coast would cause increased agricultural flood damages due to storm surge and increased salinity levels.	RO1 would benefit agriculture by limiting saltwater intrusion and would prevent he loss of some agricultural land. Some minor loss of land due to the footprint of construction activities.	RO2 would prevent some of the damage to agricultural lands.	Impacts similar to RO1 and RO2.

TABLE 2-21
Comparison of Restoration Opportunities to No Action Among Significant Resources

Significant Resource	No Action	Restoration Opportunity 1 (deltaic processes)	Restoration Opportunity 2 (geomorphic structure)	TSP
Forestry	Continued coastal land loss reduces forestry opportunities.	A net decrease in forestry resources although the rate of loss compared to future without-project would be reduced and small increase in productivity of swamp and wetland forest habitat. Project-induced increases in swamp and wetland forests habitat would provide some opportunities for forestry activities.	No impacts on forestry resources by RO2.	Impacts similar to RO1 and RO2.
Water Resources	Increased levels of salinity in some of the coastal areas. Potentially businesses could relocate, adversely impacting jobs, income, population, and employment.	RO1 would reduce salinity levels.	RO2 would have negligible effects. Possibly some decrease in salinity in the MRGO area.	Impacts similar to RO1 and RO2.