



Integrated Ecosystem Restoration and Hurricane Protection: Louisiana's Comprehensive Master Plan for a Sustainable Coast

Appendix A: Final Plan and Implementation

**Coastal Protection and Restoration Authority
of Louisiana**

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1.0 Introduction

This appendix describes the Master Plan in full together with the process for its implementation and future review. The first step in development of this Master Plan was the definition of the principles and objectives that provide the vision and direction for creation of the Plan. These are set out in full in Chapter 3, and provide the foundation for the entire decision making process (as reported in Appendices B and H).

The plan was defined through application of the decision making process and consultation upon the November 2006 Preliminary Draft and February 2007 Draft of the Master Plan. The complete set of measures, studies and programs that constitute the Master Plan are described in Chapter 4 of this Appendix.

Chapter 5 then sets out the process to be followed in implementation of this first iteration of the Master Plan. It should be noted that the priorities and sequence of implementation for this first iteration of the Master Plan is reported in the ‘Fiscal Year 2008 Annual Plan: Ecosystem Restoration and Hurricane Protection in Coastal Louisiana’ (Annual Plan) in order that it can be regularly reviewed and updated. Implementation recommendations include several critical components for the success of the Master Plan, beyond the sequencing of implementation of the individual measure and study recommendations. Included within this ‘Program Implementation Strategy’ are recommendations for the following actions.

- Establish a ‘Coastal Assessment Group’ to oversee and facilitate implementation of the Master Plan.
- Establish an Applied Coastal Engineering and Science Program to resolve areas of scientific uncertainty and promote technological advancements that will advance program implementation.
- Make necessary changes to policy and legislative issues such as land use planning, the need for dedicated funding sources and review of the Congressional authorization and appropriations process.
- Formulate and implement an adaptive plan management process, to include monitoring of measure and program performance, knowledge management, focused research, feedback mechanisms, reporting of progress and ongoing stakeholder engagement.

This Annual Plan will reflect the priorities and dependencies identified through the sequencing process.

The final chapter of this appendix then looks beyond the implementation of this version of the Master Plan to consider future iterations of the plan. The Master Plan is intended to be a ‘living document’ that will be reviewed periodically to reflect the new knowledge arising from plan implementation and changes to the physical, environmental, social or political setting. It is anticipated that the first review of the plan will occur within a relatively short timeframe (within 5 years) as the framework and understanding are anticipated to develop relatively rapidly following this initial plan. Thereafter, a regular cycle of plan review will be recommended together with unscheduled reviews as required when circumstances unexpectedly change. Chapter 6 also includes details of the process that should be adopted when undertaking a review of the Master Plan, from review of the objectives through to identification of the preferred plan.



2.0 Coastal Louisiana

2.1 Critical Need

Coastal Louisiana is a complex ecosystem composed of bottomland hardwood forests, swamps, marshes, cheniers (forested coastal ridges), prairies, bayous, bays, and barrier islands. Threaded through the eastern portion of the landscape are a series of ridges along former distributaries of the Mississippi River, upon which the majority of communities settled. In the west, the prairie and cheniers were the focus of settlement. The coastal Louisiana ecosystem contains 30 percent of the coastal marsh in the contiguous United States, yet it suffers 90 percent of the total coastal marsh loss. The alarming rate of land loss in coastal Louisiana has been well documented. Since the 1930s, coastal Louisiana has lost over 1.2 million acres (1,875 mi²), an area nearly the size of Delaware (Barras et al., 2003; and Dunbar et al., 1992). At present, the rate of loss is approximately 15,300 acres per year (23.9 mi²/yr), but estimates indicate that coastal Louisiana could experience a net loss of an additional 328,000 acres (513 mi²/yr) by the year 2050 (Figure 2.1; Barras et al., 2003).

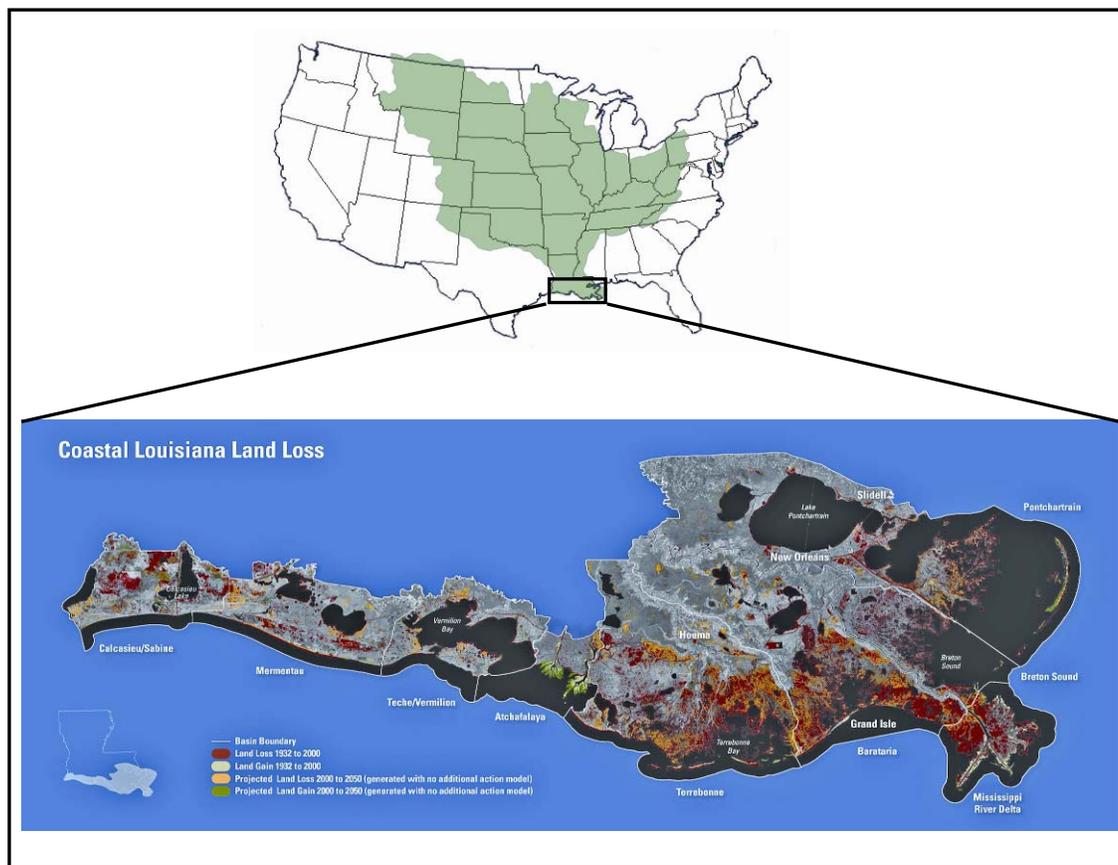


Figure 2.1: Mississippi River water shed and close-up of coastal Louisiana. Watershed map modified from Theodora Maps. Colors in Louisiana land loss map: red indicates land lost between 1932 and 2000; yellow indicates projected land loss from 2000 to 2050 if no additional action is taken to offset this trend (Barras et al. 2003).



In addition to this predicted trend, a study by the U.S. Geological Survey (USGS) has reported that the storms of 2005 converted approximately 138,880 acres (217 mi²) of marsh to water (Barras 2006). Of this total, 98 square miles of land were lost in southwestern Louisiana, and 119 square miles were lost in southeastern Louisiana. Analyses of future growing seasons will indicate how much of this damage is permanent, as marsh plants may rebound in some spots and not in others. Regardless of the final outcome, the storms have aggravated an already dire land loss emergency. The storms of 2005 called out another extreme vulnerability to the long-term viability of coastal Louisiana – that of the inadequacy of hurricane protection measures in this fragile region. Hurricanes Katrina and Rita caused severe damage to over 200,000 homes, and one year after the storm approximately 440,000 Louisiana citizens were still displaced from their homes. The Congressional Budget Office estimated that losses of physical capital totaled between \$70 and \$130 billion. Approximately 45% of these losses involved business structures or equipment, including resources owned by national concerns.

The past and continual degradation of Louisiana's coastal landscape will have significant ecological, societal, and economic impacts on the region and the Nation as tremendous resources supported by the coastal zone are put at risk. According to the 2000 census two million people, or over 65 percent of the population of Louisiana, live within 50 miles of the coast. Based on 2001 census estimates, the total population for the seventeen coastal parishes and the nine adjacent parishes that “connect economically to the coastal parishes” was almost three million (Richardson et al., 2004). Louisiana’s economy is concentrated in the southern region of the state. This includes 73.5 percent of total state employment, almost 60 percent of oil and gas employment, 77 percent of pre-Katrina/Rita construction employment, and 67 percent of all manufacturing employment in the state (Richardson et al., 2004). Nationally important industries directly tied to locations on the coast and major waterways include not only the production of oil and gas, but offshore oil and gas exploration, development and transport; shipbuilding and other manufacturing of transportation equipment; petroleum and chemical refining; and waterborne transportation, as well as seafood production and harvest.

Nearly 9,300 miles of oil and gas pipelines cross the wetlands of coastal Louisiana (USACE 2004). The network of associated energy facilities produces or transports nearly one-third of the nation’s oil and gas supply, and is tied to 50% of the nation’s refining capacity (DNR 2006). Additionally, 80% of the nation’s offshore domestic oil and gas supply is transported through coastal Louisiana. Coastal Louisiana also supports intermodal transportation that is critical to the viability of the nation. Five of the busiest cargo ports in the United States, ranked by total tons, are located here, handling approximately 19% of the annual U.S. waterborne commerce (USACE 2003). Louisiana is known as “Sportsman’s Paradise” for the diverse habitats found along its coast, which in turn support a vast diversity of fish and wildlife species. Louisiana is by far the nation’s largest shrimp, oyster, and blue crab producer and provides 26% (by weight) of the commercial fish landings in the lower 48 states. In fact, Louisiana is second only to Alaska in annual volume of seafood landings. According to National Oceanography and Atmospheric Administration reports (US Department of Commerce 2004; US Department of Commerce 2005), three of the nation’s top seafood ports by volume are in Louisiana. Coastal Louisiana’s wetlands also provide stopover habitat for millions of threatened and endangered neotropical migratory birds, and more than five million migratory waterfowl. These natural resources provide the state with vital jobs to support the commercial and recreational industries, and the nation with valued seafood. The richness of Louisiana’s culture, a richness in part driven by the history that is present throughout the state, is also a tremendous attraction to the Nation and the world. It is this indefinable richness that has made tourism such an important contributor to Louisiana’s economy, whether this richness comes from historic architecture, food, music, language or culture. According to the Louisiana Department of Culture, Recreation & Tourism over \$4.4 billion of visitor spending in Louisiana in 2004 was from New Orleans and Lake Charles. Where coastal Louisianans live, work, and play, is part of their identity. Sustaining Louisiana’s coastal culture is dependant on sustaining Louisiana’s coast.



Without barrier islands, wetlands and the protection of infrastructure and communities that supply the workforce for these industries, these nationally important resources would be at much greater risk to storm damage and supply disruptions. For these reasons and more, this region must be sustained for the well being of the state and the nation.

2.2 The CPRA – A New Approach

The Louisiana Legislature, through Act 8 of the First Extraordinary Session of the 2005 Louisiana Legislature, established the Coastal Protection and Restoration Authority (CPRA) to develop, implement, make reports on, and provide oversight for a comprehensive coastal protection master plan (Master Plan) and annual coastal protection plans, working in conjunction with state agencies, political subdivisions, including levee districts, and federal agencies. The Master Plan, as described herein, portrays the State's desires and needs relative to hurricane protection and coastal restoration, integrating these efforts in order to achieve long-term and comprehensive coastal sustainability.

The Master Plan builds on past efforts and existing programs to provide this comprehensive vision, and serves to unite the work of on-going programs including the Coastal Wetlands, Planning, Protection, and Restoration Act (CWPPRA); the Louisiana Coastal Area (LCA) Ecosystem Restoration plan; the Coastal Impact Assistance Program (CIAP); hurricane protection proposals; and the US Army Corps of Engineers (USACE) Louisiana Coastal Protection and Restoration (LACPR) Study. The CWPPRA, which is overseen by five Federal agencies and the State, has provided Louisiana and its Federal Partners with a dedicated funding source for coastal restoration projects. The CWPPRA Program has developed: an Annual Priority Project List Report since 1991; the Louisiana Coastal Wetlands Restoration Plan with its 10 appendices in 1993; a Quality Management Plan and Monitoring Program; the Coast 2050 Plan with its 6 appendices in 1998 (LCWCRTF and WCRA); and a Revised Coast 2050 Plan in 2001 (LCWCRTF and WCRA). Since 1991, the CWPPRA Program has constructed 67 projects, with another 72 projects either in engineering and design or currently under construction.

The LCA report, with its 12 appendices, was completed by the USACE and the State of Louisiana in 2005. The LCA Plan was developed with input from all resource agencies, stakeholders, and the public at large. Although not a comprehensive solution to the challenges facing coastal Louisiana, it lays the groundwork for a system-scale coastal restoration effort. Numerous studies, interagency and agency engineer manuals and handbooks, and technical reports by the USACE, Natural Resources Conservation Service, U. S. Geological Survey, and U. S. Fish and Wildlife Service have also been compiled over the past 30 years that include data on the Mississippi River and other rivers pertinent to Louisiana's sediment sources, and Coastal Louisiana data as they relate to problems on the Louisiana coast (listed in Appendix K, Bibliography).

The Master Plan has also been developed in close coordination with the Coastal Impact Assistance Program (CIAP) plan that was released in February 2007. These two plans are complementary, and in fact the CIAP plan serves as an early opportunity for substantial progress toward implementation of the Master Plan.

At the same time, other nations have been faced with similar problems with their shorelines, wetlands, and river deltas, such as the Netherlands, the United Kingdom (UK), Germany, France and Italy. All efforts provide important insights into the technologies that may be used to provide coastal protection in Louisiana. In particular, the technologies and lessons learned by the Dutch are of relevance to issues we face in coastal Louisiana today. However, for the purposes of developing a strategic planning approach, the approach used in the United Kingdom was identified as the most suitable. This approach has been developed over the past 15 years by the UK Department of Environment, Food, and Rural Affairs (formerly the Ministry of Agriculture, Fisheries, and Food).



3.0 Master Plan Principles and Objectives

Central to the definition of a long-term and comprehensive coastal protection and restoration plan is the concept of sustainability. Put simply, sustainability seeks to ensure that actions taken today, to address present day issues, avoid to the extent possible tying future generations into inflexible and unacceptably expensive approaches. There are many aspects to sustainability to consider in a comprehensive plan that is seeking to address the long-term management of both coastal protection and restoration. The Master Plan sets a path toward the achievement of sustainable long-term management of coastal Louisiana.

The process of defining the Comprehensive Coastal Protection Master Plan began with identification of principles to provide fundamental guidance for that plan. Concepts related to sustainable management of the coast (described in detail in Appendix D), were translated into a series of principles and objectives to direct definition of the Master Plan. In addition to these concepts, the State directive, in identifying broader plan requirements, provided a further basis for the principles.

These principles identify the range of value-based considerations applied in developing the comprehensive plan, and in doing so, they build on legislative directives. Many of the principles defining environmental-related considerations are derived directly from those developed for the Louisiana Coastal Area (LCA) Ecosystem Restoration Study. Additional principles are included that define the considerations associated with risk reduction of coastal economic and environmental assets and the ability to balance and sustain current uses with improved risk reduction.

These principles define a broader set of subcomponents of those common fundamental objectives found in the State and Federal directives. They also aid in the identification of assets and risks in the landscape and support the definition of planning objectives that indicate levels of success.

3.1 Master Plan Purpose

For the benefit and protection of the state as a whole, its citizens and its localities, hurricane protection and ecosystem restoration are vital to survival. It is without question that the viability of residential communities; agricultural, energy, fish and wildlife production; and commercial and industrial development in coastal Louisiana is dependent on a sustainable coastal ecosystem. The State and Nation must therefore act to provide protection to coastal Louisiana through the use of a holistic, comprehensive plan integrating ecosystem restoration with structural and non-structural measures for storm damage reduction.

3.2 Program Principles

Program principles identify the critical manners in which implemented plans and measures may ultimately interrelate with and alter the activities and assets within the coastal landscape. They describe the range of critical considerations required to develop appropriate and effective plans and plan components. These principles, set out below, represent the *rules* by which the program implementation, including the plan formulation process, is conducted.

- In order to achieve a sustainable long-term solution for comprehensive hurricane protection and coastal restoration, projects and plans will be integrated and evaluated on a 100 year planning horizon to understand future implications of current actions.



- The comprehensive hurricane protection and coastal restoration plan will provide a basis for follow-on decisions regarding redevelopment of south Louisiana and effective evacuation planning.
- The plan will identify the frequency and severity of future flooding and erosion risks so informed decisions can be made regarding future development and land use in coastal Louisiana, to reduce inundation of coastal communities, and to ensure sustainable and productive coastal habitation.
- The Master Plan will be developed and implemented with the participation and input of the numerous and diverse interests that live, work, and play in coastal Louisiana, along with national interests who depend upon coastal Louisiana's continued health and existence.
- An integrated, standardized procedure and scoring system will be developed and followed that will allow reasonable and informed decisions between and within planning units.
- The protection and restoration of coastal Louisiana will be an ongoing and evolving process. The selected plan will include an effective monitoring and evaluation process that reduces scientific and engineering uncertainty, assesses the success of the plan, and supports adaptive management of plan implementation.
- The level of detail provided for a measure may only be as great as the level of understanding of the problems, needs, and opportunities for a region or the proposed solutions. Promising concepts must be evaluated expeditiously and implemented if shown to be appropriate.
- The plan will be reviewed on a regularly scheduled basis and after exceptional events, and will be reformulated as necessary to respond to changing economic, social, and environmental conditions.
- 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 wetland ecosystems, such as from rivers or from the Gulf of Mexico.
- Constraints on coastal protection and restoration will be identified in plan formulation. Such constraints may include resource limitations (e.g., sediment availability, freshwater sources, funding), scientific or technical uncertainties (e.g., subsidence and sea level rise rates, effectiveness of certain restoration techniques, modeling uncertainty), and socio-economic considerations (public acceptability of proposed actions; preferred land uses such as agricultural, residential, industrial, fisheries).
- Projects will be designed and implemented in the most cost efficient manner using adaptive management and appropriate engineering, economic, and scientific criteria.
- Synergies between traditional flood and storm protection measures and coastal restoration opportunities will be encouraged, and cost-effective solutions will be sought.
- Protection and restoration alternatives that minimize long-term operation and maintenance costs will be preferred. For example, restoration measures should always be considered in conjunction with levees in order to minimize exposure of hard structures to open Gulf conditions. Further, restoration alternatives that rely on natural cycles and processes for ecosystem sustainability, rather than external energy subsidies, will be preferred.
- Allowing development of low-lying areas within protection systems not only increases exposure to damages in the event of a system failure, but also diminishes effectiveness of the protection works themselves by removing water storage areas from the system. This program will support and promote close coordination among all jurisdictional authorities to encourage strict enforcement of laws and regulations. Appropriate easements will be obtained in wetlands landward of hurricane protection systems to maintain these important natural buffer zones.



- Recognizing that disturbed and degraded ecosystems can be vulnerable to invasive species, implementation of the plan needs to be coordinated with other State and Federal programs addressing such invasions. Project designs will promote conditions conducive to native species by incorporating appropriate features to protect against invasion to the extent possible without diminishing project effectiveness.
- Program implementation, including development of the plan, will comply with all applicable state and federal laws and regulations. It is understood that a component of program implementation is to seek revisions to laws and regulations, if appropriate, to ensure timely implementation of the master plan.

3.3 Coastwide Planning Objectives and Plan Formulation Principles

The ‘Coastwide Planning Objectives’ provide a broad set of overall aspirations, which the Master Plan seeks to deliver. These objectives provide the basis for determining the relative success of all potential plans or individual plan components.

By establishing a full and diverse range of values, these objectives ensure that the Master Plan is gauged and selected to meet both State and Federal directives, while delivering a sustainable long-term Master Plan. The coastwide planning objectives, which represent the desired attributes of any plan, are listed below.

Plan formulation principles identify the necessary considerations for identifying potential measures and the comprehensive coastal protection plan. They address the definition of potential measures, potential constraints for development of plans, possible limitations in application of types of measures, and provide guidance on how these factors should be addressed. These principles, as set out below for each of the objectives, serve as the guidelines that cannot be violated during plan formulation.

Objective 1. Reduce economic losses from storm based flooding to residential, public, industrial, and commercial infrastructure, assuring that assets are protected, at a minimum, from a storm surge that has a 1% chance of occurring in any given year.

- This may be achieved by implementing plans, projects, policies, and programs intended to provide for hurricane protection and coastal conservation and restoration, including constructing levee and floodgate systems, enhancing natural landscape elements, and elevating, flood-proofing or relocating structures.
- Protection of resources of national and statewide significance will be a priority; including major oil and gas facilities and refineries, deep draft ports and waterways, military and military-support facilities, the Gulf Intracoastal Waterway, interstate and other major highways, and historic sites.
- This objective explicitly deals with protection of assets. Effective evacuation procedures must be implemented.

Objective 2. Promote a sustainable coastal ecosystem by harnessing the processes of the natural system.

- A sustainable system is one characterized by high levels of productivity and resilience (the ability of a system to withstand naturally variable conditions and/or recover from disturbances).
- This may be achieved by providing for daily, seasonal and episodic fluctuations in water levels and salinities, and/or reestablishing natural pathways of sediment movement and nutrient uptake.
- Appreciation of the dynamic nature of the coastal system must be integral to the planning and selection of preferred alternatives.



- Design, construction, and operation of new flood and storm protection measures should avoid or minimize effects that would reduce ecosystem resilience. Where practicable, disrupted hydrologic systems should be rehabilitated to re-establish sustainable processes.
- Project design should promote conditions that route riverine waters through estuarine basins and promote sheet flow over wetlands in order to maximize nutrient assimilation.

Objective 3. Provide habitats suitable to support an array of commercial and recreational activities coastwide.

- As Louisiana's coastal ecosystem degrades, critical habitat that supports fish and wildlife species continues to be lost. Therefore, the plan will seek to increase the magnitude of suitable fish and wildlife habitats coastwide.
- The plan will seek to ensure a continued diversity of fish and wildlife habitats coastwide.

Objective 4. Sustain, to the extent practicable, the unique heritage of coastal Louisiana by protecting historic properties and traditional living cultures and their ties and relationships to the natural environment.

- Louisiana coastal communities are valuable. They are living stewards of the culture, history, land and environmental resources of the coast for themselves, for the state, and for the nation.
- Sensitivity and fairness must be shown to those in the coastal communities whose homes, lands, livelihoods, and ways of life may be adversely affected by the implementation of any selected alternatives.
- Displacement and dislocation of resources, infrastructure, and possibly communities may be unavoidable under some scenarios. Because of the negative near-term effects some restoration projects may have on the sustainability of existing cultures, careful consideration of mitigation efforts on human disruption must be undertaken.



4.0 The Full Plan

4.1 Background

The long-term Master Plan is a detailed vision that provides guidance for the future of Coastal Louisiana. This plan represents the State's first approximation of the comprehensive, integrated solution for ecosystem restoration and hurricane protection. It builds upon previous planning, research, and lessons learned. The Master Plan is also an integrated approach meant to balance objectives in a comprehensive manner while allowing implementation in a feasible, cost-effective way to provide for all the resources and citizens of Louisiana. This plan represents a point of departure from how planning of activities along coastal Louisiana has been done in the past. As such, it does not represent an end product, but instead a new direction and a new philosophy for how we live in, and manage the resources of, coastal Louisiana.

Many adjustments will need to be made in the first few years of implementation, including revisions to existing management practices, policies, and legislation. Additionally, although the Master Plan builds upon decades of experience, implementation of this program and some of the measures which comprise the plan will require much further analysis including modeling, engineering & design, and environmental study. Therefore, mechanisms for change – not only early in plan implementation, but throughout the life of its implementation – will be required to meet the needs of the Master Plan. Such activities are discussed further in Chapter 5 of this appendix. This chapter, describing the plan, lays out the “constructable” components of the Master Plan, including those large-scale planning, and coastwide programmatic, measures that will support construction of measures. Order of presentation does not indicate order of priority; for further discussion of the process for identification of urgent early actions, refer to Chapter 5.2.

4.1.1 Plan Formulation

A decision making process (described in Appendix B) was developed in order to provide a consistent framework to consider the relative merits of any potential management options to achieve the principles and objectives (Chapter 2). The process was supported by technical analyses (see appendices E, F, and G) and applied to evaluate the outputs from appraisal of two alternative plans which had been developed as an aid to the process of defining the Master Plan (see Appendix H). The outputs from evaluation of these alternative plans, together with the assessments of the certainty of these evaluations, were used to generate the Preliminary Draft Master Plan, also presented in Appendix B. The IPT sought public comments on the Preliminary Draft Master Plan, which was released for public review on November 29, 2006, through a series of nine public meetings, meetings with the LCA Science Board and the CPRA Science and Engineering Review Team, and a public comment period that ended on January 5, 2007. Based upon comments (see Appendix C-2) and further analyses of the Preliminary Draft Master Plan, the Draft Master Plan was prepared and released for public review on February 6, 2007. The IPT sought public comments on the Draft Master Plan through a series of three public hearings, two public meetings, a joint meeting with the LCA Science Board and the CPRA Science and Engineering Review Team, and a public comment period that ended on April 2, 2007. Based upon comments (see Appendix C-1) Final Master Plan was revised and is presented below. This plan was approved by the CPRA on April 12, 2007.

4.1.2 Measure Definition

Measure descriptions contained in this chapter were used to generate cost estimates for planning purposes. In many cases, there is extensive planning and design that will be necessary, including more detailed analyses of alternatives, before finalizing alignments, features, costs, and operational schemes. For example, we have identified areas of Louisiana's coast that require hurricane protection through construction of hurricane protection



structures. It is recommended that certain areas of the coast are protected from storm surges that have a 1% chance of occurring in any given year. Other areas are recommended for protection from larger storm surges, but given the status of ongoing data collection and storm surge, engineering, and economic analyses, it is difficult to say with certainty how high the level of protection may be. For the purposes of this report, these areas have been analyzed as being provided protection from storm surges with a 0.2% chance of occurring in any given year because planning data indicate risks that require substantially greater protection measures than the baseline level (1%). Completion of additional analyses, such as those progressing within the Corps of Engineers' *Louisiana Coastal Protection and Restoration Project*, will inform and ultimately define the technically feasible level of protection. In any case, the goal is to provide protection to these areas proportional to the total economic consequences that may be incurred when larger storm surges impact the coast.

4.2 Coastwide Benefits of the Plan

The appraisals undertaken to support development of this plan clearly demonstrated that without significant action the coastal landscape of Louisiana will continue to degrade, reducing the sustainability and productivity of the coast, while also increasing the flooding risk to built assets. With no further action, it has been previously estimated that 513 square miles of land may be lost by 2050 (Barras, 2003). Analyses undertaken for this study (see Appendix G) indicate that as much as 762 square miles of land could be lost by 2050.

The economic consequences from storm surge flooding include direct damages to property and infrastructure, emergency costs, evacuation and subsistence costs, and reoccupation and clean up costs. The storm surge and economic appraisals have demonstrated that, under existing conditions, the areas vulnerable to flooding with a 1 percent annual probability includes over 430,000 residencies, with potential economic consequences of over \$34 billion coastwide. The 0.2% probability risk area includes over 871,000 residencies, with potential economic consequences of over \$157 billion coastwide.

Although the above represent total coastwide risk, any individual storm of these magnitudes would also result in tremendous losses to the economy of the entire Nation by increasing the costs of goods because of disruptions to navigation and by increasing the costs of natural gas and oil products. Additionally, tremendous burdens are placed on other areas in the region by the large number of evacuees that must be provided for in the wake of hurricanes. In summary, hurricane protection for south Louisiana can be considered of critical importance to the local citizens, the Region, and the Nation. The Master Plan sets out an integrated combination of measures representing a significant reduction in these potential negative future impacts.

The proposed protection measures provide for the avoidance of the large majority of potential damages to built assets under the two storm surge levels analyzed. If aggressively implemented the plan is capable of reducing total potential damages to areas vulnerable to flooding with a 1 percent annual probability by 90 percent to less than \$4 billion, and reduces the number of residences at risk by 96 percent. The 0.2% annual probability risk damages may be reduced by 84 percent to less than \$25 billion and the number of residences at risk is reduced by 80 percent. Additional to these benefits is the avoidance of many of the National economic impacts identified above. These figures represent strong economic case for the storm surge protection measures set out in this preliminary draft plan.

Analyses performed to forecast the nature of changes to the coastal wetland system under the Master Plan indicate that if all of the Master Plan's restoration projects were aggressively implemented, Louisiana will be able to increase sustainability in significant portions of the coastal zone. It should be noted, however, that this analysis did not account for effects of some of the larger restoration measures, such as the Mississippi River Delta



Management plan because of their conceptual nature (see description of large-scale planning efforts, chapter 4.4 of this appendix). Therefore, the Master Plan holds the possibility that past and continued land loss could be substantially slowed or even reversed if all measures were fully implemented. Possibly more important than the reversion of land loss trends will be the creation of a more sustainable system whereby freshwater and tidal flows naturally maintain coastal landscapes and their associated ecosystems. The plan will also provide for a continued diversity of habitats in coastal Louisiana that support recreational and commercial activities on the coast. This improved coastal landscape will also increase storm surge protection to many built coastal assets and buffer levee systems from open water conditions. In combination, these hurricane protection and ecosystem restoration improvements provide coastal communities an understood degree of risk reduction that will allow them to make informed decisions for shaping their future.

4.3 Measures Maps

Figures 4.1 through 4.6 contain conceptual representations of all measures. Note that these should not be viewed as definite footprints of proposed measures. Further planning, engineering, and design; as well as scientific, engineering, stakeholder, and public input is required to determine exact specifications for construction. Descriptions of measures may be found in sections 4.4 through 4.10.

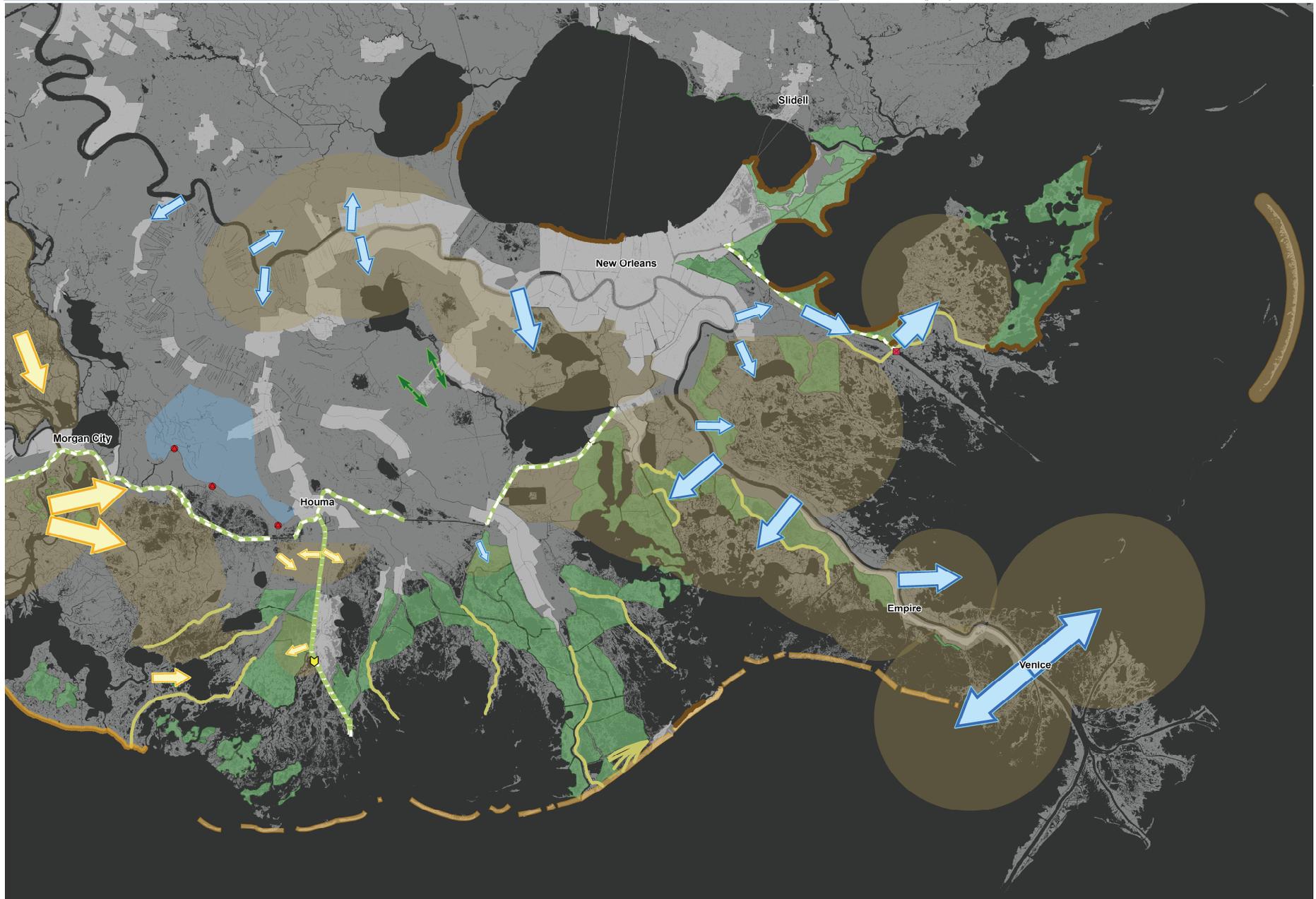
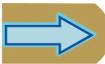


Figure 4.1: Ecosystem Restoration in the Mississippi River Delta Plain (legend follows on page 13).



LEGEND FOR FIGURE 4.1: Ecosystem Restoration in the Mississippi River Delta.

 <p>Mississippi River Diversion</p>	<ul style="list-style-type: none"> - Mississippi River Diversion at Hope Canal - Mississippi River Diversion at Convent/Blind River - Mississippi River Diversion at Violet - Modify Authorization of Caernarvon Diversion - Mississippi River Diversion at White Ditch - Mississippi River Diversion at Bayou Lamoque - Mississippi River Delta Management - Mississippi River Diversion at Bayou Lafourche - Mississippi River Diversions at Strategic Locations in Upper Barataria Basin - Modify Authorization of Davis Pond Diversion - Mississippi River Diversion at Myrtle Grove with Dedicated Dredging - Mississippi River Diversion at West Point a la Hache with Dedicated Dredging - Move Freshwater to Terrebonne Basin from Barataria Basin via GIWW
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 <p>Atchafalaya River Diversion</p>	<ul style="list-style-type: none"> - Convey Atchafalaya River Water eastward via GIWW to benefit Eastern and Lower Terrebonne Marshes - Optimize Flow Distribution at Old River Control Structure - Freshwater Introduction via Blue Hammock Bayou - Freshwater Introduction into Central and Lower Terrebonne Marshes
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 <p>Water Management Area</p>	<ul style="list-style-type: none"> - Chacahoula Basin Plan
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 <p>Pump Station</p>	<ul style="list-style-type: none"> - Chacahoula Basin Plan
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 <p>Closure</p>	<ul style="list-style-type: none"> - Close Mississippi River Gulf Outlet (MRGO) at Bayou La Loutre Ridge
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 <p>Drainage Improvements</p>	<ul style="list-style-type: none"> - Upper Barataria Basin Hydrologic Improvements at Highway 90
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 <p>Barrier Shoreline Restoration</p>	<ul style="list-style-type: none"> - Barrier Shoreline Restoration: Chandeleur Islands - Barrier Shoreline Restoration: Barataria Basin - Barrier Shoreline Restoration: Terrebonne Basin - Barrier Shoreline Restoration: Point Au Fer Island
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 <p>Marsh Restoration using Dredged Material</p>	<ul style="list-style-type: none"> - Maintain and Restore the Breton Sound Marshes - Maintain and Restore Biloxi Landbridge and Barrier Reefs - St. Tammany Marsh Restoration - Central Wetlands Restoration - Marsh Restoration using Dredged Material at Golden Triangle - East Orleans Landbridge Restoration - Marsh Restoration using Dredged Material in Barataria Basin - Mississippi River Diversion at Myrtle Grove with Dedicated Dredging - Mississippi River Diversion at Point a la Hache with Dedicated Dredging - Marsh Restoration in Terrebonne Basin - Marsh Restoration at Point Au Fer Island - Maintain Landbridge between Caillou Lake and Gulf of Mexico - Beneficial use of Dredged Material
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 <p>Shoreline Stabilization in Strategic Areas</p>	<ul style="list-style-type: none"> - East Orleans Landbridge Restoration - Shoreline Protection on South Shore of Lake Pontchartrain - Maintain and Restore Biloxi Landbridge and Barrier Reefs - Maintain MRGO-Lake Borgne Landbridge - Shoreline Stabilization on Maurepas Landbridge - Grand Isle and Vicinity Protection and Shoreline Stabilization
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 <p>Navigable Waterway Stabilization</p>	<ul style="list-style-type: none"> - Mississippi River Gulf Outlet (MRGO) Shoreline Stabilization - Bankline Protection for Gulf Intracoastal Waterway (GIWW) - Bankline Protection for Houma Navigation Canal (HNC)
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 <p>Ridge Habitat Restoration</p>	<ul style="list-style-type: none"> - Restore Bayou LaLoutre Ridge - Ridge Habitat Restoration in Barataria Basin - Ridge Habitat Restoration in the Terrebonne Basin
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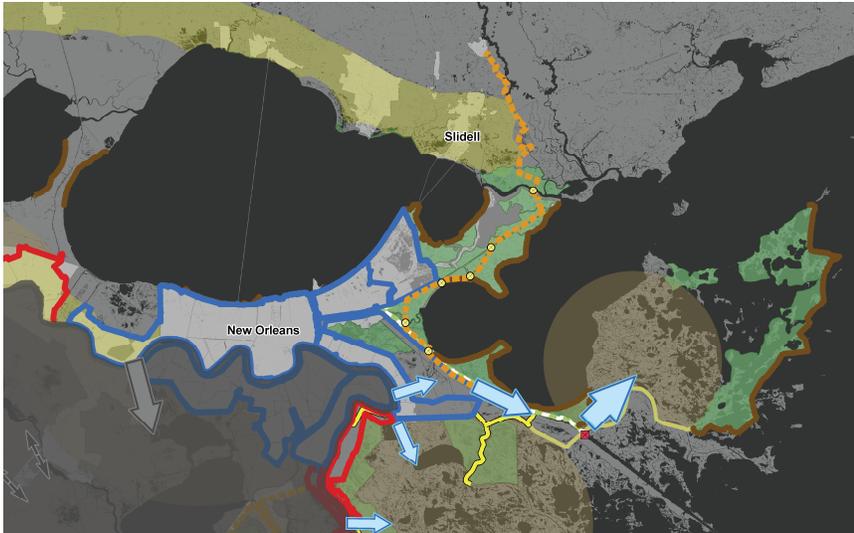


Figure 4.2a: Hurricane Protection for the New Orleans Metropolitan area and surrounding communities, showing Lake Pontchartrain Barrier Alternative 1 – Interior of Golden Triangle (legend follows on page 15).

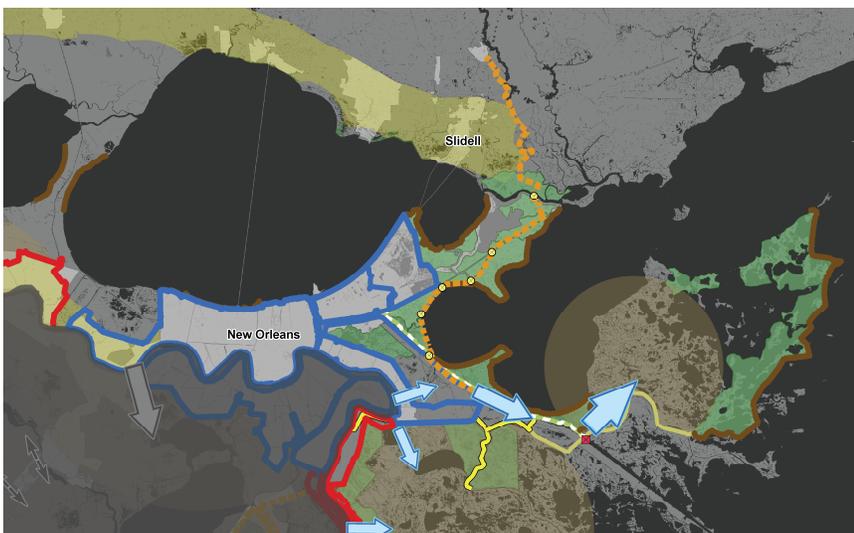


Figure 4.2b: Hurricane Protection for the New Orleans Metropolitan area and surrounding communities, showing Lake Pontchartrain Barrier Alternative 2 – Rim of Lake Borgne (legend follows on page 15).

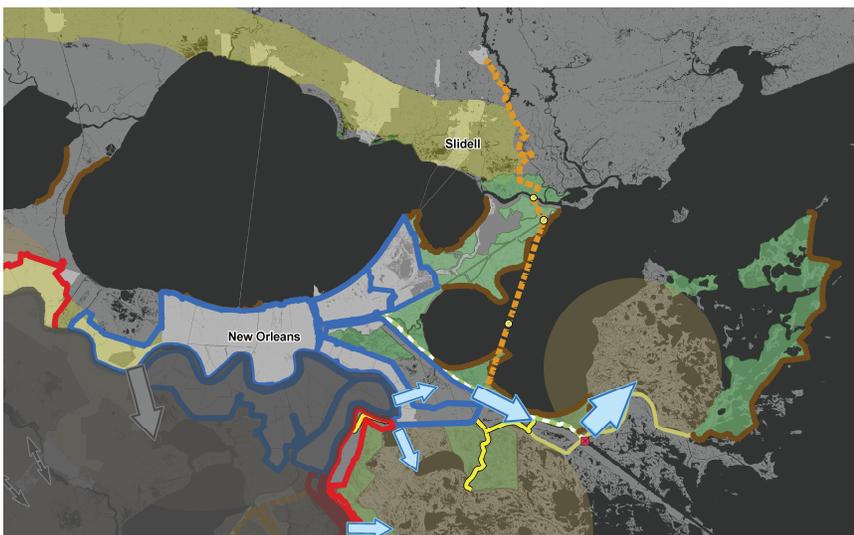
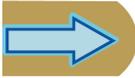


Figure 4.2c: Hurricane Protection for the New Orleans Metropolitan area and surrounding communities, showing Lake Pontchartrain Barrier Alternative 3 – Lake Borgne (legend follows on page 15).



LEGEND FOR FIGURES 4.2a-4.2c: Hurricane Protection for the New Orleans Metropolitan area and surrounding communities, Alternatives 1-3

 <p>Mississippi River Diversion</p>	<ul style="list-style-type: none"> - Mississippi River Diversion at Violet - Modify Authorization of Caernarvon Diversion - Mississippi River Diversion at White Ditch 	 <p>Ridge Habitat Restoration</p>	<ul style="list-style-type: none"> - Restore Bayou LaLoutre Ridge
 <p>Closure</p>	<ul style="list-style-type: none"> - Close Mississippi River Gulf Outlet (MRGO) at Bayou La Loutre Ridge 	 <p>Raise/Maintain Evacuation Routes</p>	<ul style="list-style-type: none"> - Raise/Maintain Evacuation Routes Located Outside Hurricane Protection Systems
 <p>Marsh Restoration using Dredged Material</p>	<ul style="list-style-type: none"> - Central Wetlands Restoration - Marsh Restoration Using Dredged Material at Golden Triangle - East Orleans Landbridge Restoration - St. Tammany Marsh Restoration - Maintain and Restore the Breton Sound Marshes - Maintain and Restore Biloxi Landbridge and Barrier Reefs - Beneficial Use of Dredged Material 	<p>Structural Hurricane Protection</p>  <p>100 Year Protection</p>  <p>Representative Alignment to Increase Protection to Targeted Levels</p>  <p>Greater Than 100 Year Protection</p>  <p>Existing/Authorized Protection</p> <ul style="list-style-type: none"> - Lake Pontchartrain Barrier Plan: Caernarvon to Pearl River Hurricane Protection - Caernarvon to White Ditch Hurricane Protection - St. Bernard 40 Arpent Levee - Lake Pontchartrain and Vicinity Hurricane Protection - West Shore of Lake Pontchartrain Hurricane Protection 	
 <p>Shoreline Stabilization in Strategic Areas</p>	<ul style="list-style-type: none"> - Shoreline Stabilization on Maurepas Landbridge - Shoreline Protection on South Shore of Lake Pontchartrain - East Orleans Landbridge Restoration - Maintain and Restore Biloxi Landbridge and Barrier Reefs - Maintain MRGO-Lake Borgne Landbridge 	 <p>Flood Gate</p>	<ul style="list-style-type: none"> - Navigation Feature Associated with Hurricane Protection Structures
 <p>Navigable Waterway Stabilization</p>	<ul style="list-style-type: none"> - Mississippi River Gulf Outlet (MRGO) Shoreline Stabilization 	 <p>Evaluate Additional Protection Needs</p>	<ul style="list-style-type: none"> - Northshore of Lake Pontchartrain and Lake Maurepas Landbridge Hurricane Protection

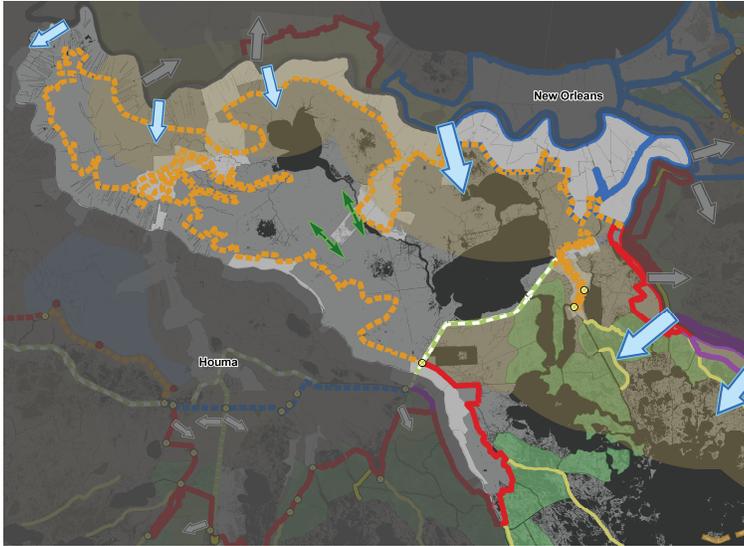


Figure 4.3a: Hurricane Protection for New Orleans West Bank, Lafourche Parish, and Barataria Basin Communities, showing Donaldsonville to the Gulf Alternative 1 – Swamp (legend follows on page 17).

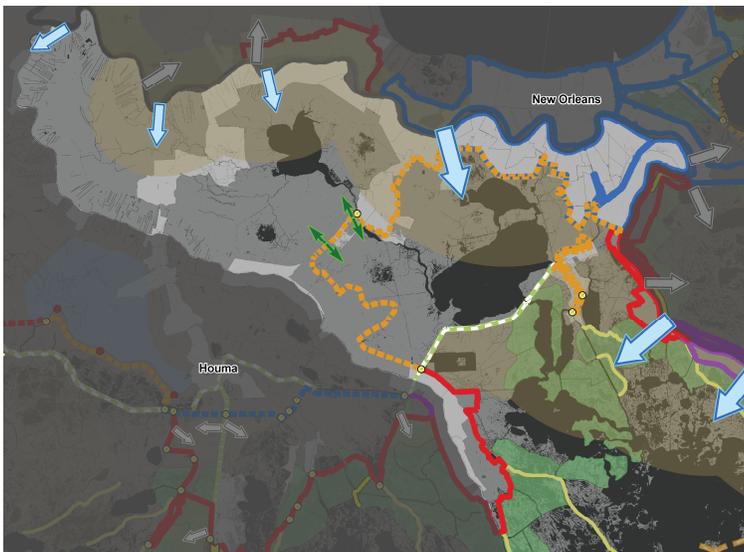


Figure 4.3b: Hurricane Protection for New Orleans West Bank, Lafourche Parish, and Barataria Basin Communities, showing Donaldsonville to the Gulf Alternative 2 – Highway 90 (legend follows on page 17).

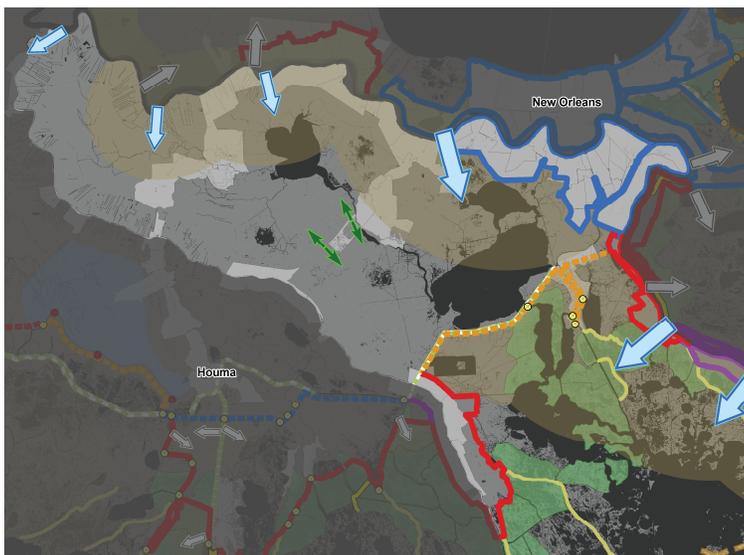
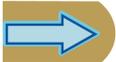


Figure 4.3c: Hurricane Protection for New Orleans West Bank, Lafourche Parish, and Barataria Basin Communities, showing Donaldsonville to the Gulf Alternative 3 – GIWW (legend follows on page 17).



LEGEND FOR FIGURES 4.3a-4.3c: Hurricane Protection for New Orleans West Bank, Lafourche Parish, and Barataria Basin Communities, Alternatives 1-3

 <p>Mississippi River Diversion</p>	<ul style="list-style-type: none"> - Mississippi River Diversion at Bayou Lafourche - Mississippi River Diversions at Strategic Locations in Upper Barataria Basin - Modify Authorization of Davis Pond Diversion - Mississippi River Diversion at Myrtle Grove with Dedicated Dredging - Mississippi River Diversion at West Point a la Hache with Dedicated Dredging
 <p>Drainage Improvements</p>	<ul style="list-style-type: none"> - Upper Barataria Basin Hydrologic Improvements at Hwy 90
 <p>Barrier Shoreline Restoration</p>	<ul style="list-style-type: none"> - Barrier Shoreline Restoration: Barataria Basin
 <p>Marsh Restoration using Dredged Material</p>	<ul style="list-style-type: none"> - Mississippi River Diversion at Myrtle Grove with Dedicated Dredging - Mississippi River Diversion at West Point a la Hache with Dedicated Dredging - Marsh Restoration using Dredged Material in Barataria Basin - Beneficial Use of Dredged Material
 <p>Navigable Waterway Stabilization</p>	<ul style="list-style-type: none"> - Bankline Protection for Gulf Intracoastal Waterway (GIWW)

 <p>Ridge Habitat Restoration</p>	<ul style="list-style-type: none"> - Ridge Habitat Restoration in the Barataria Basin 	
 <p>Raise/Maintain Evacuation Routes</p>	<ul style="list-style-type: none"> - Raise/Maintain Evacuation Routes Located Outside Hurricane Protection Systems 	
<p>Structural Hurricane Protection</p>  <p>100 Year Protection</p>  <p>Representative Alignment to Increase Protection to Targeted Levels</p>  <p>Greater Than 100 Year Protection</p>  <p>Existing/Authorized Protection</p>		<ul style="list-style-type: none"> - Donaldsonville to the Gulf Hurricane Protection - Larose to Golden Meadow Hurricane Protection - Oakville to Myrtle Grove Hurricane Protection - Myrtle Grove to Venice Hurricane Protection - West Bank and Vicinity Hurricane Protection
 <p>Flood Gate</p>	<ul style="list-style-type: none"> - Navigation Feature Associated with Hurricane Protection Structures 	

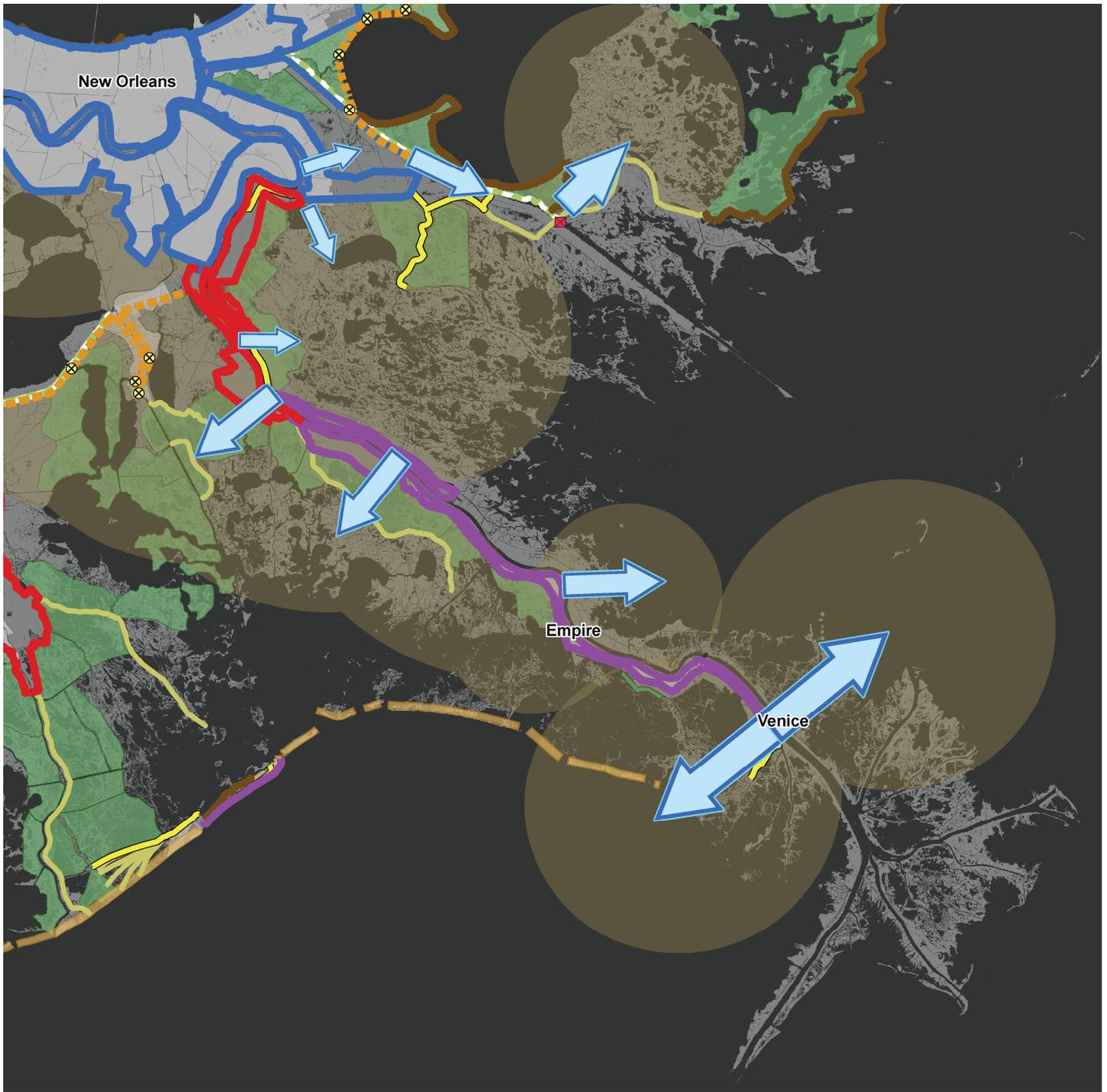


Figure 4.4: Hurricane Protection for Plaquemines Parish and Grand Isle (legend follows on page 19).



LEGEND FOR FIGURE 4.4: Plaquemines Parish and Grand Isle Hurricane Protection

 <p>Mississippi River Diversion</p>	<ul style="list-style-type: none"> - Mississippi River Diversion at Violet - Modify Authorization of Caernarvon Diversion - Mississippi River Diversion at White Ditch - Mississippi River Diversion at Bayou Lamoque - Mississippi River Delta Management - Mississippi River Diversion at Myrtle Grove with Dedicated Dredging - Mississippi River Diversion at West Point a la Hache with Dedicated Dredging 	 <p>Navigable Waterway Stabilization</p>	<ul style="list-style-type: none"> - Mississippi River Gulf Outlet (MRGO) Shoreline Stabilization - Bankline Protection for Gulf Intracoastal Waterway (GIWW) 		
 <p>Closure</p>	<ul style="list-style-type: none"> - Close Mississippi River Gulf Outlet (MRGO) at Bayou La Loutre Ridge 	 <p>Ridge Habitat Restoration</p>	<ul style="list-style-type: none"> - Restore Bayou LaLoutre Ridge - Ridge Habitat Restoration in the Barataria Basin 		
 <p>Barrier Shoreline Restoration</p>	<ul style="list-style-type: none"> - Barrier Shoreline Restoration: Barataria Basin 	 <p>Raise/Maintain Evacuation Routes</p>	<ul style="list-style-type: none"> -Raise/Maintain Evacuation Routes Located Outside Hurricane Protection Systems 		
 <p>Marsh Restoration using Dredged Material</p>	<ul style="list-style-type: none"> - Maintain and Restore the Breton Sound Marshes - Maintain and Restore Biloxi Landbridge and Barrier Reefs - Central Wetlands Restoration - Marsh Restoration Using Dredged Material at Golden Triangle - Marsh Restoration Using Dredged Material in Barataria Basin - Beneficial Use of Dredged Material 	<table border="1"> <tr> <td data-bbox="1014 703 1402 1122"> <p>Structural Hurricane Protection</p>  <p>100 Year Protection</p>  <p>Representative Alignment to Increase Protection to Targeted Levels</p>  <p>Greater Than 100 Year Protection</p>  <p>Existing/Authorized Protection</p> </td> <td data-bbox="1402 703 1944 1122"> <ul style="list-style-type: none"> - Lake Pontchartrain Barrier Plan: Caenarvon to Pearl River Hurricane Protection - Caenarvon to White Ditch Hurricane Protection - Pointe a la Hache to Phoenix Hurricane Protection - St. Bernard 40 Arpent Levee - Lake Pontchartrain and Vicinity Hurricane Protection - Donaldsonville to the Gulf Hurricane Protection - Oakville to Myrtle Grove Hurricane Protection - Myrtle Grove to Venice Hurricane Protection - Larose to Golden Meadow Hurricane Protection - Grand Isle and Vicinity Protection and Shoreline Stabilization </td> </tr> </table>		<p>Structural Hurricane Protection</p>  <p>100 Year Protection</p>  <p>Representative Alignment to Increase Protection to Targeted Levels</p>  <p>Greater Than 100 Year Protection</p>  <p>Existing/Authorized Protection</p>	<ul style="list-style-type: none"> - Lake Pontchartrain Barrier Plan: Caenarvon to Pearl River Hurricane Protection - Caenarvon to White Ditch Hurricane Protection - Pointe a la Hache to Phoenix Hurricane Protection - St. Bernard 40 Arpent Levee - Lake Pontchartrain and Vicinity Hurricane Protection - Donaldsonville to the Gulf Hurricane Protection - Oakville to Myrtle Grove Hurricane Protection - Myrtle Grove to Venice Hurricane Protection - Larose to Golden Meadow Hurricane Protection - Grand Isle and Vicinity Protection and Shoreline Stabilization
<p>Structural Hurricane Protection</p>  <p>100 Year Protection</p>  <p>Representative Alignment to Increase Protection to Targeted Levels</p>  <p>Greater Than 100 Year Protection</p>  <p>Existing/Authorized Protection</p>	<ul style="list-style-type: none"> - Lake Pontchartrain Barrier Plan: Caenarvon to Pearl River Hurricane Protection - Caenarvon to White Ditch Hurricane Protection - Pointe a la Hache to Phoenix Hurricane Protection - St. Bernard 40 Arpent Levee - Lake Pontchartrain and Vicinity Hurricane Protection - Donaldsonville to the Gulf Hurricane Protection - Oakville to Myrtle Grove Hurricane Protection - Myrtle Grove to Venice Hurricane Protection - Larose to Golden Meadow Hurricane Protection - Grand Isle and Vicinity Protection and Shoreline Stabilization 				
 <p>Shoreline Stabilization in Strategic Areas</p>	<ul style="list-style-type: none"> - Shoreline Protection on South Shore of Lake Pontchartrain - Maintain and Restore Biloxi Landbridge and Barrier Reefs - Maintain MRGO-Lake Borgne Landbridge - Grand Isle and Vicinity Protection and Shoreline Stabilization 	 <p>Flood Gate</p>	<ul style="list-style-type: none"> - Navigation Feature Associated with Hurricane Protection Structures 		

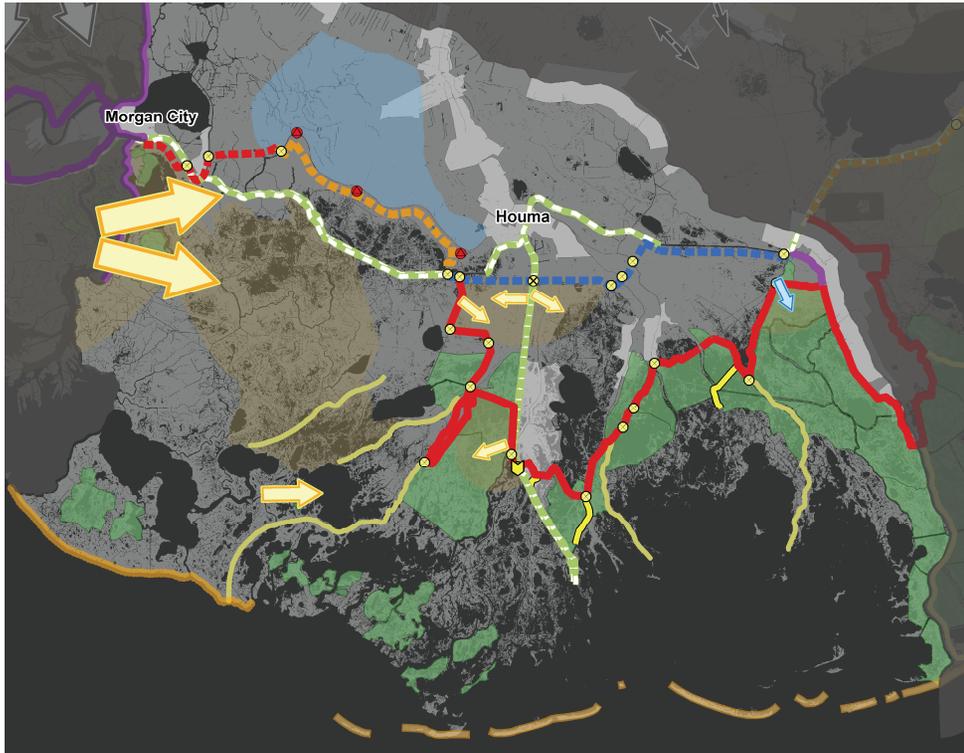


Figure 4.5a: Hurricane Protection for Terrebonne and Lafourche parishes, showing Morganza to the Gulf Alignment – Project Awaiting Authorization (legend follows on page 21).

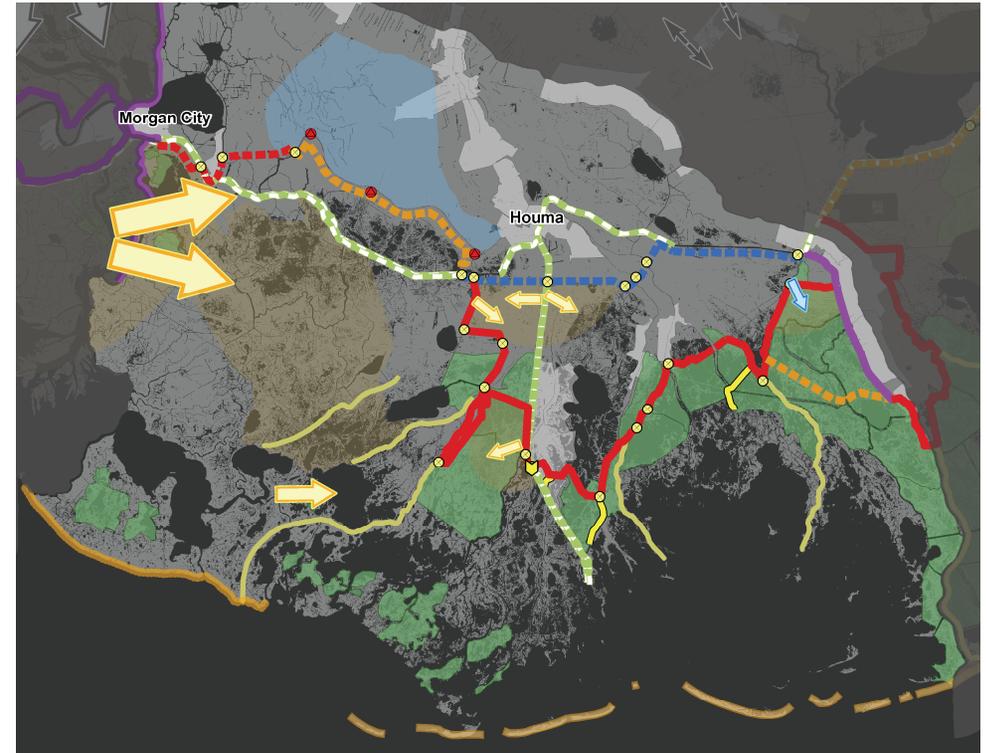


Figure 4.5b: Hurricane Protection for Terrebonne and Lafourche parishes, showing Morganza to the Gulf Alignment addition – Pointe au Chien to Golden Meadow (legend follows on page 21).



LEGEND FOR FIGURES 4.5a and 4.5b: Terrebonne and Lafourche Hurricane Protection Alternatives 1 and 2

 <p>Mississippi River Diversion</p>	<ul style="list-style-type: none"> - Move Freshwater to Terrebonne Basin from Barataria Basin via GIWW 	 <p>Navigable Waterway Stabilization</p>	<ul style="list-style-type: none"> - Bankline Protection for Houma Navigation Canal - Bankline Protection for Gulf Intracoastal Waterway (GIWW)
 <p>Atchafalaya River Diversion</p>	<ul style="list-style-type: none"> - Freshwater Introduction via Blue Hammock Bayou - Convey Atchafalaya River Water Eastward via GIWW to Benefit Eastern and Lower Terrebonne Marshes - Freshwater Introduction to Central and Lower Terrebonne Marshes 	 <p>Ridge Habitat Restoration</p>	<ul style="list-style-type: none"> - Ridge Habitat Restoration in the Terrebonne Basin
 <p>Water Management Area</p>	<ul style="list-style-type: none"> -Chacahoula Basin Plan 	 <p>Raise/Maintain Evacuation Routes</p>	<ul style="list-style-type: none"> -Raise/Maintain Evacuation Routes Located Outside Hurricane Protection Systems
 <p>Pump Station</p>	<ul style="list-style-type: none"> - Chacahoula Basin Plan 	<p>Structural Hurricane Protection</p>  <p>100 Year Protection</p>  <p>Representative Alignment to Increase Protection to Targeted Levels</p>  <p>Greater Than 100 Year Protection</p>  <p>Existing/Authorized Protection</p>	
 <p>Lock</p>	<ul style="list-style-type: none"> -Multipurpose Operation of the Houma Navigation Canal (HNC) Lock 		
 <p>Barrier Shoreline Restoration</p>	<ul style="list-style-type: none"> - Barrier Shoreline Restoration: Terrebonne Basin - Barrier Shoreline Restoration: Point Au Fer Island 		
 <p>Marsh Restoration using Dredged Material</p>	<ul style="list-style-type: none"> - Marsh Restoration Using Dredged Material in Terrebonne Basin - Maintain Landbridge between Caillou Lake and Gulf of Mexico - Marsh Restoration Using Dredged Material at Point Au Fer - Beneficial Use of Dredged Material 		

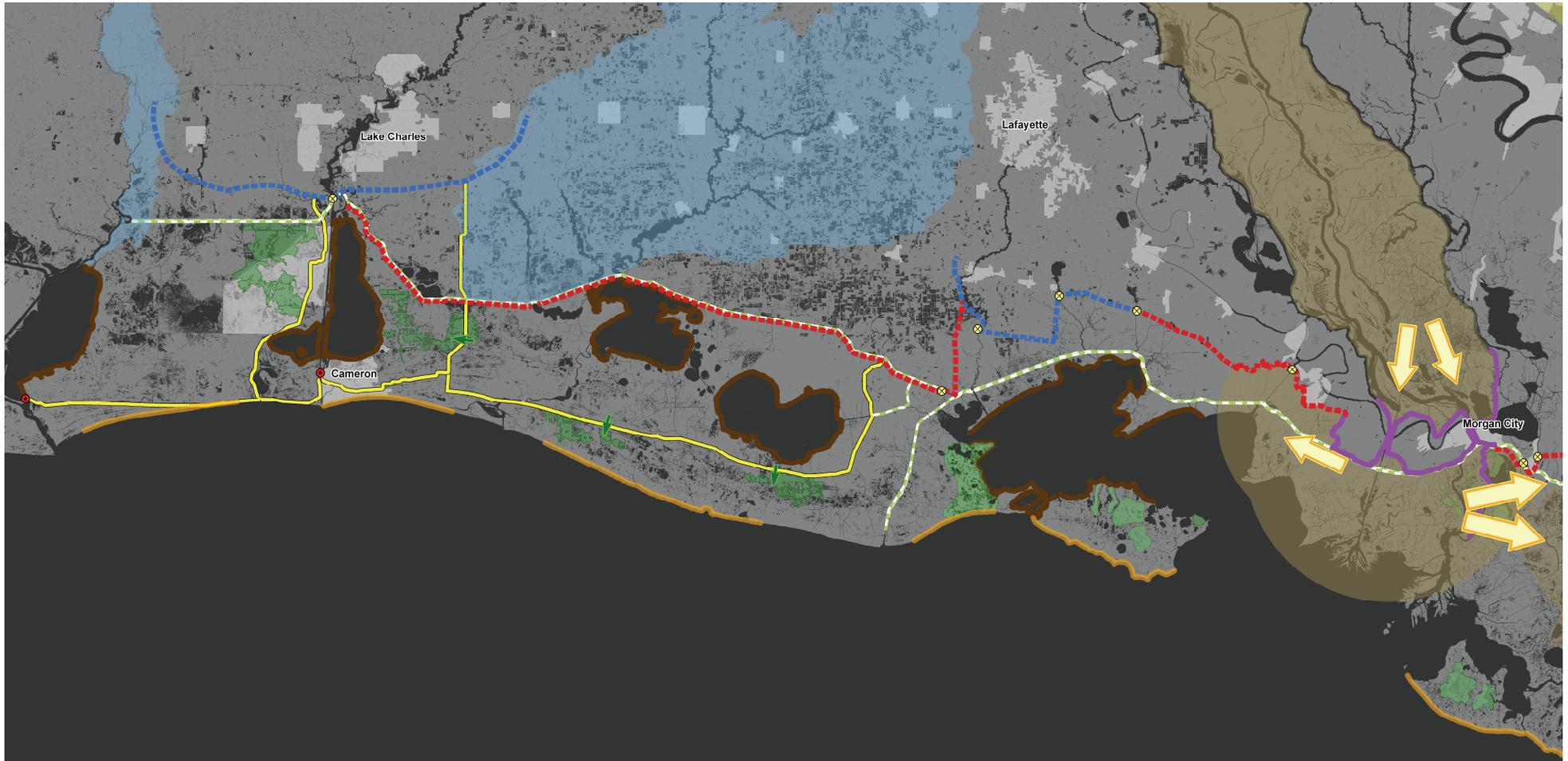
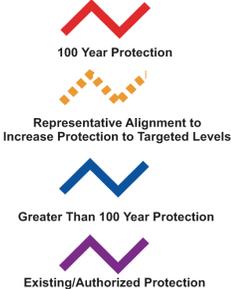


Figure 4.6: Ecosystem Restoration and Hurricane Protection for Atchafalaya River Delta, Acadiana, and the Chenier Plain (legend follows on page 23).



LEGEND FOR FIGURE 4.6: Ecosystem Restoration and Hurricane Protection for Atchafalaya River Delta, Acadiana, and the Chenier Plain

 <p>Atchafalaya River Diversion</p>	<ul style="list-style-type: none"> - Convey Atchafalaya River Water Eastward via GIWW to Benefit Eastern and Lower Terrebonne Marshes - Convey Atchafalaya River Water Westward via GIWW - Freshwater Introduction into Central and Lower Terrebonne Marshes - Increase Sediment Transport Down Wax Lake Outlet - Optimize Flow Distribution at Old River Control Structure 	 <p>Shoreline Stabilization in Strategic Areas</p>	<ul style="list-style-type: none"> - Southwest Pass Shoreline Stabilization - Stabilize Shoreline of Vermilion, East and West Cote Blanche Bays - Stabilize Grand Lake Shoreline - Stabilize White Lake Shoreline - Stabilize Calcasieu Lake Shoreline - Stabilize Sabine Lake Shoreline
 <p>Water Management Area</p>	<ul style="list-style-type: none"> - Chenier Plain Freshwater and Sediment Management and Reallocation - Mermentau Basin Watershed Management Plan to Retain Freshwater Resources - Sabine Basin Watershed Management 	 <p>Navigable Waterway Stabilization</p>	<ul style="list-style-type: none"> - Bankline Stabilization of Freshwater Bayou from Belle Isle Bayou to Freshwater Bayou Canal Lock - Fortify Spoil Banks of GIWW and Freshwater Bayou - Bankline Protection for Gulf Intracoastal Waterway (GIWW) - Bankline Stabilization of Freshwater Bayou - Fortify Spoil Banks of GIWW and Freshwater Bayou
 <p>Salinity Control Structure</p>	<ul style="list-style-type: none"> - Salinity Control Structure at Calcasieu Pass - Salinity Control Structure at Sabine Pass 	 <p>Raise/Maintain Evacuation Routes</p>	<ul style="list-style-type: none"> - Raise/Maintain Evacuation Routes Located Outside Hurricane Protection Systems - Raise and Maintain Highways 82 and 27
 <p>Drainage Improvements</p>	<ul style="list-style-type: none"> - Hydrologic Improvements in Mermentau Basin at Highways 82 and 27 	<p>Structural Hurricane Protection</p>  <ul style="list-style-type: none"> - Maintain Existing Levee Protection for Morgan City and Berwick - Wax Lake Outlet to New Iberia Hurricane Protection - Abbeville to Lake Charles Hurricane Protection - Lafayette and Vicinity Hurricane Protection - Lake Charles and Vicinity Hurricane Protection 	
 <p>Barrier Shoreline Restoration</p>	<ul style="list-style-type: none"> - Barrier Shoreline Restoration: Point au Fer Island - Barrier Shoreline Restoration: Freshwater Bayou to South Point/Marsh Island - Barrier Shoreline Restoration: Sabine River to Calcasieu River - Barrier Shoreline Restoration: Calcasieu River to Freshwater Bayou 		
 <p>Marsh Restoration using Dredged Material</p>	<ul style="list-style-type: none"> - Marsh Restoration using Dredged Material at Point au Fer - Marsh Restoration using Dredged Material at Marsh Island - Marsh Restoration using Dredged Material at Weeks Bay - Raynie Marsh Restoration - Marsh Restoration using Dredged Material South of Highway 82 - Beneficial Uses of Dredged Material from Calcasieu Ship Channel - Beneficial Use of Dredged Material 	 <p>Flood Gate</p>	<ul style="list-style-type: none"> - Navigation Feature Associated with Hurricane Protection Structures



4.4 Large-Scale Planning

LSP-1. Mississippi River Delta Management

This measure will identify and evaluate features that would greatly increase the deposition of Mississippi River sediment in shallow coastal areas and restore deltaic growth in the Mississippi River Delta Plain. Two types of projects, large diversions (greater than 50,000 cfs) from the Mississippi River and alternative navigation channel alignments will be investigated. The large-scale river diversions could potentially maximize the river's sediment and freshwater resources available for ecosystem maintenance. Diversion sites, capacities, and outfall management measures would also be assessed to help optimize diversion plans while accommodating navigation, water supply, and flood control needs.

LSP-2. Optimize Flow Distribution at Old River Control Structure

This measure will conduct a comprehensive study to identify and analyze operational changes from the mandated 70/30 percent flow distribution between the Mississippi and Atchafalaya Rivers at Old River Complex. The focus of the study will be to determine whether distributions may be altered to increase freshwater and sediment availability in the Atchafalaya Basin and the central Louisiana coast without adversely impacting the long term flood carrying capacity of the Mississippi River, stability of the navigation channels, municipal freshwater supplies, and ecosystem restoration in the Pontchartrain and Barataria-Terrebonne Basins, and the coastal zone of the Lower Mississippi River.

LSP-3. Backfill and/or Plug Non-Essential Oil and Gas Canals

This measure will close non-essential oil and gas canals coast wide to restore natural hydrology to wetland areas that have been adversely impacted by canal construction. Abandoned location canals, and other canals that can be eliminated without adversely impacting ongoing production operations, will be identified for restoration to mitigate the adverse effects of unchecked tidal exchanges. Restoration operations could include permanent plugs, spoil bank degradation and marsh creation by backfilling through dedicated dredging projects. Canals identified through this effort would be restored through marsh creation measures included in the individual planning units.

LSP-4. Chenier Plain Freshwater and Sediment Management and Reallocation

This measure will formulate a comprehensive hydrologic and sediment management plan that will maximize environmental restoration benefits and support agriculture, commercial activities, navigation, and recreation in the region. The study will examine structural and nonstructural alternatives that most effectively utilize the freshwater and sediment resources in the study area. A phased but comprehensive planning approach will be used. This approach will use traditional as well as innovative tools, including application of models to assess hydrology, salinity and sediments resulting from current, future without, and future with project conditions.

LSP-5. Sediment Inventory and Allocation

This measure will provide for a full inventory of available sediment from sources to include material dredged from navigation channels, off shore from the Gulf of Mexico, and rivers. Policy, procedure, and priorities will also be developed for using dredged material to create marsh across the state. The sediment inventory and allocation will provide information needed in prioritization and the design and construction of marsh creation, ridge restoration and barrier shoreline restoration measures throughout the coast. For planning and costing purposes, the measure has been divided into two sub-measures:

(a) Beneficial Use of Dredged Material

This sub-measure proposes to formulate and implement a course of action that maximizes beneficial use of material dredged from navigation channels as a tool to attain the Master Plan objectives. The



Louisiana Coastal Area (LCA) Beneficial Use of Dredged Material Program will strive to identify disposal sites and complete site preparation (including environmental clearances and real estate acquisition) in advance of the USACE O&M navigation maintenance program disposal needs. Funds for the beneficial use program would be used for the incremental costs of restoration activities above and beyond the base plan, or Federal Standard, selected by the USACE O&M Program, if beneficial use is not part of that O&M plan. In the current authorizing language, the LCA Beneficial Use Program is recommended for authorization at \$100 million over ten years.

(b) Dedicated Dredging from Rivers and Offshore

This sub-measure proposes to complete a sediment inventory of riverine, navigation channel, and offshore sources of sediment. As stated in one of the plan formulation principles, it is the preference to maximize use of sediment sources from outside of the wetland ecosystem. To this extent, the primary focus of this measure will be to inventory and utilize sediment sources from riverine and offshore locations. However, sediment mining from inland water bodies on an individual-case basis will be evaluated in this measure for its benefits and impacts to the system. Also included in this work would be refining understanding of the availability, particle size, accretion and consolidation rates and other characteristics of sediments that could be used for restoration and protection projects. A regional sediment budget model is also recommended, and will require data compilation and numerical modeling of the Mississippi River. This model can identify sources and sinks of sediment along the coast as well as inland, which will be an invaluable tool to support Master Plan implementation. It is anticipated that this work would be consistent with the USACE National Regional Sediment Management Program. Construction and operations and maintenance costs for this measure are related to specific measures, including but not limited to marsh creation and barrier shoreline restoration, in all planning units.

4.5 Programmatic Measures

PM-1. Applied Coastal Engineering and Science Program

This measure will provide state allocated funds to reduce key uncertainties and to promote advances in the science and technology fields critical to implementation of the Master Plan. Over the life of Master Plan implementation, there will be a need for strategic data collection and management, improved forecasting tools, focused research and development, and assessment of program and project effectiveness. These needs may be related to the science, modeling, socio-economic impacts and changes, implementation, technical methodology, resource constraints, or effectiveness of measures. They may also be related to development and refinement of forecasting tools. These advances in the state of science and technology must be addressed in order to achieve full and balanced integration of protection and restoration objectives. Utilization of existing programs, such as the Louisiana Coastal Area Science and Technology Program will be maximized and extended as a portion of this measure.

PM-2. Coordination with Hazard Mitigation Programs

This measure will provide state allocated funds for the coordination of local, state, and federal entities responsible for planning and implementing of non-structural plan measures such as hazard mitigation grants; hurricane evacuation plans; relocation assistance; local compliance with the FEMA National Flood Insurance Program (NFIP) regulations, including elevating structures; parish, levee district, and state emergency action plan coordination; inhibit development in low lying areas (zoning); and other programs as may be deemed appropriate for this measure.



PM-3. CPRA Management and Capacity Building

There are many issues that will have to be addressed in the first few years to remove existing constraints to implementation of the Master Plan. These include policy, legislative, and institutional issues associated with effective execution of projects and the plan. Examples include the need to develop federal partnerships to establish dedicated funding streams and cost sharing agreements. This will include the need to obtain Congressional authority and appropriations. Another major issue for early resolution includes passing necessary land use planning policies and legislation required for responsible growth in coastal Louisiana. Oversight and coordination of all efforts by both state and federal agencies will require staff and contractor support.

4.6 Planning Unit 1: East of the Mississippi River

1-1. Lake Pontchartrain Barrier Plan: Caernarvon to Pearl River Hurricane Protection

This measure will provide hurricane protection to concentrated, distributed and strategic assets located in the upper and central Pontchartrain Basin. This storm barrier will work in conjunction with the existing levee systems in order to increase the level of hurricane protection. For the purposes of this report, we have analyzed these areas as being protected from storm surges with a 0.2% chance of occurring in any given year. Completion of additional analyses, such as those progressing within the Corps of Engineers' *Louisiana Coastal Protection and Restoration Project*, will inform and ultimately define the technically feasible level of protection. The measure will create a "Barrier Levee" from Caernarvon to I-59 at Pearl River to provide a first line of defense for Metropolitan New Orleans and vicinity. It should be noted that further study will finalize the alignments and any flood gates required to maintain existing levels of tidal exchange. The design of the selected alternative must include guidance in balancing the overall water resources needs of the basin, including integrating river flood protection, Mississippi River diversions, hurricane surge protection, tidal flows and hydrologic exchanges to maintain a stable and healthy landscape.

Alternative Alignment 1—Interior at Golden Triangle: Alignments #1 and #2 are similar, although Alignment #1 would not enclose the Golden Triangle and would thus have the least direct ecosystem impact. However, without proper design, Alignment #1 could change water flow and restrict animal and boat access through major channels. Of the three conceptual alignments, this one does the least to address the existing funnel at the Inner Harbor Area and provides no water storage landward of the protection structure.

Alternative Alignment #2—Rim of Lake Borgne: Unlike alignment #1, this alignment would enclose the Golden Triangle, and would thus have greater ecosystem impact. In addition, without proper design, Alignment #2 could change water flow and restrict animal and boat access through major channels. Impacts to the habitat of the Gulf Sturgeon, a threatened species, would also need to be addressed. Alignment #2 would reduce the funnel at the Inner Harbor Area, although further modeling is needed to assess effects on adjacent levees systems.

Alternative Alignment #3—Lake Borgne: This alignment may provide the most reliable protection against storm surge because it eliminates the funnel at the Inner Harbor Area and provides for waster storage to accommodate overtopping. However, it could be the most challenging of the three alignments to build because it would be situated in the open water of Lake Borgne. This alignment would also pose the greatest challenge for maintaining ecosystem function, including maintaining adequate water exchange and animal movement. Issues related to the Gulf sturgeon, a threatened species, would also need to be addressed. Innovative storm barrier concepts, such as pile-supported concrete structures, could be used to increase the feasibility of this alignment.

**1-2. Caernarvon to White Ditch Hurricane Protection**

This measure will improve existing levees, and new levees will be constructed where no levees exist, to protect concentrated and strategic assets located between Caernarvon and White Ditch in Plaquemines Parish from storm surges with a 1% chance of occurrence in any given year. This levee must be incorporated into the federal hurricane protection system. If required, the measure will include raising the height of the Mississippi River Levee to achieve the targeted level of protection. The back levee alignment is approximately 35 miles long. Communities protected include Braithwaite, St. Clair, Scarsdale, Stella, Dalcour, Betrandville, Wills Point and Belair.

1-3. Pointe a la Hache to Phoenix Hurricane Protection

This measure will maintain existing levees, including the Mississippi River Levee, in Plaquemines Parish on the east bank of the Mississippi River from south of Pointe a la Hache to Phoenix to provide storm protection for concentrated and strategic assets in the communities of Phoenix, Harlem, Bellevue, Nero, Davant, Pointe a la Hache, Beshel, and Bohemia. The existing back levee is a component of the Federal New Orleans to Venice Hurricane Protection Project and is approximately 24 miles in length.

1-4. St. Bernard 40 Arpent Levee

This measure will increase the height of the 40 Arpent Levee in St. Bernard in conjunction with the Lake Pontchartrain Barrier Plan in order to reduce the risk to targeted assets from storm surges originating in Lake Borgne. It will provide a second line of defense from storm surges originating in Lake Borgne for concentrated and strategic assets in Metropolitan New Orleans and upper St. Bernard Parish. The 40 Arpent Levee is approximately 20 miles long and separates the urban areas of St. Bernard Parish from the Central Wetlands and extends from the Intracoastal Canal on the west to Caernarvon-Verret on the east, where it will tie into the Lake Pontchartrain Barrier Plan levee.

1-5. West Shore of Lake Pontchartrain Hurricane Protection

This measure will construct a levee approximately 28 miles long located southwest of Lake Pontchartrain. This new levee will connect to the Lake Pontchartrain and Vicinity Hurricane Protection Project to provide increased hurricane storm surge protection for concentrated and strategic assets in St. Charles, St. John the Baptist and St. James Parishes.

1-6. Lake Pontchartrain and Vicinity Hurricane Protection

This measure will re-evaluate approximately 56 miles of levee along the south shore of Lake Pontchartrain from the Bonnet Carre Spillway to Highway 11, to identify and implement structural improvements required to work in conjunction with the Lake Pontchartrain Barrier plan in order to reduce the risk of targeted assets. For the purposes of this report, we have analyzed these areas as being protected from storm surges with a 0.2% chance of occurring in any given year. Completion of additional analyses, such as those progressing within the Corps of Engineers' *Louisiana Coastal Protection and Restoration Project*, will inform and ultimately define the technically feasible level of protection. The measure will also include an evaluation of compartmentalization opportunities to contain flood water in the event of overtopping.

1-7. North Shore of Lake Pontchartrain and Lake Maurepas Hurricane Protection

This measure will evaluate the storm surge risks expected to remain after implementing the Lake Pontchartrain Barrier Plan and evaluate the vulnerability of communities surrounding Lake Maurepas and Lake Pontchartrain. Results of the evaluation will be used to develop and recommend structural and/or non-structural protection approaches and planning needed to reduce the risk to those communities.

**1-8. Raise/Maintain Evacuation Routes Located Outside the Hurricane Protection Systems**

This measure will raise/maintain evacuation routes outside of hurricane protection structures that are at risk of being damaged by storm surge. Vulnerable routes will be identified and appropriate actions will be recommended to assure the ability to safely and surely evacuate in advance of a storm and rising water and to have a functional road for safe return and recovery after a storm has passed. In many cases this may be accomplished by armoring of the roadway embankment to prevent the roadway embankment from being eroded.

1-9. Mississippi River Diversion at Hope Canal

This measure will divert freshwater, nutrients and sediment from the Mississippi River into the Maurepas Swamp via Hope Canal. Hope Canal is on the east bank of the Mississippi River near Garyville. The diversion will be sized to divert approximately 2,000 cfs.

1-10. Mississippi River Diversion at Convent/Blind River

This measure will divert freshwater, nutrients and sediment from the Mississippi River into the Maurepas Swamp via Blind River. Blind River is located approximately 20 miles south of Lake Maurepas on the east bank of the Mississippi River near Convent. The diversion will be sized to divert up to 5,000 cfs.

1-11. Shoreline Stabilization on Maurepas Landbridge

This measure will stabilize approximate 7.5 miles of shoreline along the Maurepas Landbridge to protect interior marsh on this critical coastal landscape feature located between Lake Maurepas and Lake Pontchartrain.

1-12. St. Tammany Marsh Restoration

This measure will utilize dedicated dredging and vegetation plantings to fortify the lake rim and restore marshes along the north shoreline of Lake Pontchartrain. Approximately 11.7 miles of shoreline will be fortified and approximately 326 acres of marsh will be created.

1-13. Shoreline Protection on South Shore of Lake Pontchartrain

This measure will stabilize approximate 11.4 miles of shoreline along the south shore of Lake Pontchartrain. A 300' wide marsh buffer will be created at strategic locations to protect the interior shoreline, and appropriate breakwaters will be constructed to maintain this critical shoreline.

1-14. East Orleans Landbridge Restoration

This measure will restore and maintain the East Orleans Landbridge, a critical coastal landscape feature located between the western shoreline of Lake Borgne and the eastern shoreline of Lake Pontchartrain. Restoration features will include dedicated dredging for marsh and ridge restoration and shoreline stabilization at critical areas, particularly the in the area near Lake Catherine and the Rigolets. The area targeted for restoration includes the eastern portion of the Bayou Sauvage National Wildlife Refuge. Approximately 38,000 acres of marsh will be restored or enhanced and approximately 145 miles of shoreline and ridges will be protected or restored. The adaptive management program will assess the measure's effectiveness and refine elements of future phases.

1-15. Close Mississippi River Gulf Outlet (MRGO) at Bayou La Loutre Ridge

This measure will close the MRGO at the Bayou La Loutre Ridge with an earthen plug. The MRGO begins at the confluence of the Gulf Intracoastal Waterway (GIWW) and the Inner Harbor Navigation Canal (IHNC) and extends southeastward through the Breton/Chandeleur Sound to the Gulf of Mexico. Appropriate economic mitigation plans must be implemented to address impacts to deep-draft and shallow-draft navigation facilities and industries. In addition, actions must be taken to avoid increased erosion in nearby waterways should shallow draft and recreational traffic circumvent the closure structure. If at any time after the channel is closed with an earthen



plug it is decided to restore limited navigation capacity, any new navigation structure to be constructed would be closed under normal conditions in order to maintain the integrity of the Bayou la Loutre Ridge. The lock structure would be operated only under emergency situations and only for shallow-draft traffic.

1-16. Mississippi River Gulf Outlet (MRGO) Shoreline Stabilization

This measure will provide bank stabilization at strategic locations along approximately 26 miles of the MRGO between the closure structure south of Bayou La Loutre (1-15) and the intersection of the GIWW and Michoud Canal to the north. This measure does not include the most critical portions of the channel, which are included in measure 1-20: Maintain MRGO-Lake Borgne Landbridge.

1-17. Central Wetlands Restoration

This measure will restore and sustain wetlands via pipeline conveyance of sediments dredged from the Mississippi River to sites across the Central Wetlands. Hydraulic management and vegetation planting will also be used to re-establish and sustain cypress swamps in the project area. The Central Wetlands are located between the St. Bernard 40 Arpent Levee and the Mississippi River Gulf Outlet (MRGO), south of the Gulf Intracoastal Waterway (GIWW). Approximately 9,000 acres of marsh will be restored or enhanced. The New Orleans Sewerage and Water Board has expressed interest in using this area for assimilation of nutrients from treated effluent, and this partnering opportunity will be included as a portion of this measure.

1-18. Marsh Restoration Using Dredged Material at Golden Triangle

This measure will restore and sustain approximately 7,000 acres of marsh via pipeline conveyance of sediments dredged from the Mississippi River to the Golden Triangle Area, located between the west lobe of Lake Borgne, the north bank of the Mississippi River Gulf Outlet (MRGO), and the south bank of the Gulf Intracoastal Waterway (GIWW).

1-19. Mississippi River Diversion at Violet

This measure will divert freshwater, nutrients and sediment from the Mississippi River via the Mississippi River Gulf Outlet into the Biloxi Marshes and other areas of St. Bernard Parish. A portion of the diverted water will also benefit the Central Wetlands. The diversion will be constructed on the east bank of the Mississippi River near Violet, and will divert up to a maximum of 50,000 cfs as needed to achieve objectives.

1-20. Maintain MRGO – Lake Borgne Landbridge

This measure will restore and sustain approximately 14,000 acres of wetlands utilizing dedicated dredging, and includes bankline stabilization at strategic locations along the Lake Borgne shoreline. The Lake Borgne Landbridge is a critical coastal landscape feature located between Lake Borgne and the north bank of the MRGO and is a vital feature facilitating the intended operation of the Violet Diversion.

1-21. Modify Authorization of Caernarvon Diversion

This measure will identify and seek approval for operational changes that will increase the ability of the Caernarvon Freshwater Diversion to sustain wetlands in Plaquemines and St. Bernard parishes. The Caernarvon structure is located on the east bank of the Mississippi River about 15 miles downstream from New Orleans, near the St. Bernard-Plaquemines Parish line. The diversion is currently authorized to maintain specific salinity targets. Operational flexibility is needed to maximize sediment diversion and also to modify operations of this single diversion to operate in a coordinated fashion with other projects in the basin as they are constructed.

**1-22. Maintain and Restore the Breton Sound Marshes**

This measure will utilize dedicated dredging to restore and sustain approximately 38,000 acres of marsh at critical areas of the Breton Sound. The Breton Sound Marshes are located between the east bank of the Mississippi River and the south bank of the Mississippi River Gulf Outlet (MRGO).

1-23. Mississippi River Diversion at White Ditch

This measure will divert freshwater, nutrients and sediments from the Mississippi River through a new control structure at White Ditch to restore and sustain wetlands on the east bank of the Mississippi River. White Ditch is located north of Carlisle in Plaquemines Parish. The diversion will be capable of diverting up to 10,000 cfs.

1-24. Maintain and Restore the Biloxi Landbridge and Barrier Reefs

This measure will utilize sediment dredged from offshore sources to restore and maintain the Biloxi Land Bridge. Features include restoration of approximately 25,000 acres of marsh and approximately 75 miles of shoreline stabilization/barrier reefs. The Biloxi Landbridge is a brackish marsh / oyster reef system which separates Lake Borgne and Chandeleur Sound.

1-25. Restore Bayou La Loutre Ridge

This measure includes increasing the ridge elevation and width with dredged material, and includes planting of woody vegetation and native wetland plants, to restore approximately 25 miles of the natural Bayou La Loutre Ridge. The ridge restoration will extend from the east bank of the Mississippi River Gulf Outlet (MRGO) south of Old Shell Beach eastward along the south boundary of the Biloxi Wildlife Management Area.

1-26. Mississippi River Diversion at Bayou Lamoque

This measure will remove the existing operable gates and associated equipment from the Bayou Lamoque freshwater diversion structures to allow for a free-flowing river diversion. The structure is capable of diverting approximately 12,000 cfs from the Mississippi River to Plaquemine Parish marshes. Since the original structure was built for salinity control in Breton Sound (in order to provide for optimal oyster habitat), some modifications of the outfall channel may be necessary to direct the diverted water into the marshes. Any resulting dredged material will be used to create marsh. Bayou Lamoque is located on the east bank of the Mississippi north of Empire in Plaquemines Parish.

1-27. Barrier Shoreline Restoration: Chandeleur Islands

This measure recommends collaboration with the Department of the Interior, and other state and federal resource agencies, as a habitat management plan for continued maintenance of the island chain, the Breton National Wildlife Refuge, is developed. The state will help to define this plan to ensure that it considers the full range of barrier shoreline habitats typically found in coastal Louisiana and will evaluate how best to help implement the plan once it has been completed.

4.7 Planning Unit 2: Mississippi River to Bayou Lafourche

2-1. Donaldsonville to the Gulf Hurricane Protection

This measure will provide increased hurricane protection to concentrated, distributed, and strategic assets located in the upper and central Barataria Basin. This hurricane protection measure will work in conjunction with the existing West Bank and Vicinity Hurricane Protection project to further reduce the risk of targeted assets in West Bank of New Orleans. For the purposes of this report, we have analyzed these areas as being protected from storm surges with a 0.2% chance of occurring in any given year. Completion of additional analyses, such as those progressing within the Corps of Engineers' *Louisiana Coastal Protection and Restoration Project*, will inform and ultimately define the technically feasible level of protection. The alignment will protect the remainder of the



Upper Barataria Basin, including communities along Bayou Lafourche, Lafitte, and Barataria from storm surges with a 1% annual chance of occurrence. The design of the selected alternative must include guidance in balancing the overall water resources needs of the basin, including integrating river flood protection, Mississippi River diversions, hurricane surge protection, tidal flows and hydrologic exchanges to maintain a stable and healthy landscape.

Alternative Alignment #1—Swamp: This alignment follows the upland margin of the Barataria basin wetlands. If a traditional earthen levee were used, this alignment would minimize further disruption to the basin hydrology. However, the length of this alignment would increase construction, operation, and maintenance costs, as well as the number of structures needed for drainage, pipeline, and water channel crossings. As a result, this alignment includes more potential locations for structural failure. In addition, this alignment provides no water storage landward of the levee. If the structure were overtopped, water would flow into populated areas. The West Bank and Vicinity project would also need to be raised beyond the level provided by the Corps' ongoing work, in order to achieve a greater than 1% level of protection for the West bank of Metro New Orleans. There are technical and economic questions as to how feasible it would be to raise this protection system. Ring levees would need to be added around central basin communities, including Chackbay, Kreamer, Crown Point, Jean Lafitte, and Lafitte to provide a 1% level of protection for these communities.

Alternative Alignment #2—Highway 90: Because it would be built near Highway 90, an existing hydrologic barrier in the basin, this alignment would minimize further disruptions to water flow patterns. When coupled with the Upper Barataria Basin Hydrologic Improvements at Highway 90 measure, this alignment could improve water exchange throughout the basin. Its shorter overall length would reduce construction, operation, and maintenance costs, and it would require fewer structures for drainage, pipeline, and water channel crossings. As a result, this alignment would have fewer potential locations for structural failure. However this alignment would still have direct impacts on wetlands. In addition, if this alignment were built the West Bank and Vicinity project would also need to be raised beyond the level provided by the Corps' ongoing work, in order to achieve a greater than 1% level of protection for the West bank of Metro New Orleans. There are technical and economic questions as to how feasible it would be to raise this protection system. Ring levees would need to be added around central basin communities, including Crown Point, Jean Lafitte, and Lafitte to provide a 1% level of protection for these communities.

Alternative Alignment #3—GIWW: This alignment would follow the Gulf Intracoastal Waterway between Oakville in Plaquemines Parish and Larose in Lafourche Parish. It would provide space for temporary water storage should overtopping occur, and it could be designed to help direct water to areas such as eastern Terrebonne Parish, which would otherwise be difficult to reach using river diversions. It would also protect central basin communities, such as Crown Point, Jean Lafitte, and Lafitte. However, if it were not properly designed to increase wetland sustainability in conjunction with necessary restoration projects, this alignment would further stress ecosystems that support commercially and recreationally important fish and wildlife species in Barataria basin. Innovative designs and technologies will need to be used to ensure the sustainability of the basin's wetlands, improve reliability of the protection structure, and reduce maintenance costs.

2-2. West Bank and Vicinity Hurricane Protection

This measure will complete the West Bank hurricane protection protect Metropolitan New Orleans on the West Bank of the Mississippi River from west of Avondale to Oakville from storm surges with a 1% probability of occurring in any given year. The completed hurricane protection system will include 65 miles of levee, floodwalls, and floodgates, and protect over 250,000 citizens. The West Bank hurricane protection project is intended to work in conjunction with measure 2-1, Donaldsonville to the Gulf Hurricane Protection to provide the 0.2% level of protection. The project is located in portions of Orleans, Jefferson and Plaquemines parishes.



2-3. Larose to Golden Meadow Hurricane Protection

This measure will raise the height of the existing Larose to Golden Meadow Hurricane Protection Levee to protect concentrated and strategic assets on both the east and west side of Bayou Lafourche from storm surges with a 1% probability of occurring in any given year. Approximately 24 miles of levees and floodwalls will be raised on the southern reaches, below the Gulf Intracoastal Waterway. The potential for increased surge heights from the adjacent Donaldsonville to the Gulf and Morganza to the Gulf levee systems will be evaluated, and if necessary the Larose to Golden Meadow levees system will be raised accordingly.

2-4. Oakville to Myrtle Grove Hurricane Protection

This measure will improve existing levees, and construct new levees where no levees exist, to protect concentrated and strategic assets located between Oakville and Myrtle Grove along the Mississippi River in Plaquemines Parish from a storm surge with a 1% probability of occurring in any given year. This levee must be incorporated into the federal hurricane protection system. This will include raising the height of the Mississippi River Levee, if required, to achieve the targeted level of protection. The back levee alignment is approximately 21 miles in length. The Conoco Phillips refinery at Alliance is contained within this levee alignment.

2-5. Myrtle Grove to Venice Hurricane Protection

This drainage levee south of Myrtle Grove would be federalized and brought to the same elevation as the current hurricane protection levees in southern Plaquemines Parish. The existing federal hurricane protection levee, a component of the New Orleans to Venice Hurricane Protection Project, would be maintained at its currently authorized height. This measure would provide storm protection to concentrated and strategic assets located between Myrtle Grove and Venice along the Mississippi River in Plaquemines Parish.

2-6. Grand Isle and Vicinity Protection and Shoreline Stabilization

This measure combines coastal restoration and structural improvements to provide hurricane protection to concentrated and strategic assets located on Louisiana's only inhabited barrier island. Project features consist of maintaining the height of the existing levee/dune on the gulf side; constructing segmented breakwaters on the north side of the island; extending the rock dike at the eastern edge of Fifi Island to reduce wave energy on the northeast end of the island; and repairing the breach on Elmer's Island to protect Cheniere Caminada.

2-7. Raise/Maintain Evacuation Routes Located Outside the Hurricane Protection Systems

This measure will raise/maintain evacuation routes outside of hurricane protection structures that are at risk of being damaged by storm surge. Vulnerable routes will be identified and appropriate actions will be recommended to assure the ability to safely and surely evacuate in advance of a storm and rising water and to have a functional road for safe return and recovery after a storm has passed. In many cases this may be accomplished by armoring of the roadway embankment to prevent the roadway embankment from being eroded. In addition to other highways, elevating an approximately 20 mile section of LA 1 from Golden Meadow to Port Fourchon is of particular importance since it is subject to frequent inundation and is vital for re-entry to Port Fourchon to initiate post-storm recovery activities.

2-8. Upper Barataria Basin Hydrologic Improvements at Highway 90

This measure consists of drainage infrastructure, strategically located along that segment of U.S. Highway 90 between Boutte and Raceland, to improve hydrology in the upper Barataria Basin for flood control and wetlands sustainability.

**2-9. Move Freshwater to Terrebonne Basin from Barataria Basin via GIWW**

This measure will utilize dedicated dredging and hard shoreline stabilization materials in order to increase freshwater flow in the GIWW to the west to sustain marsh in the eastern Terrebonne Basin.

2-10. Mississippi River Diversion at Bayou Lafourche

This measure will be located in the upper Barataria Basin near Donaldsonville on the West Bank of the Mississippi River. The diversion will be implemented in accordance with the Louisiana Department of Natural Resources' *Mississippi River Water Reintroduction into Bayou Lafourche, Final Phase 2 Design Report*, dated March 2006. Diversion capacity will be a minimum of 1,000 cfs.

2-11. Mississippi River Diversions at Strategic Locations in Upper Barataria Basin

This restoration measure will divert freshwater, nutrients, and sediment from the Mississippi River into the upper Barataria Basin swamps. For planning purposes, two locations in the area south of Donaldsonville and north of Highway 90, between the Mississippi River and Bayou Lafourche, were analyzed to divert 1,000 cfs each.

2-12. Modify Authorization of Davis Pond Diversion

This measure will identify, and seek approval for, operational changes that will increase wetland restoration outputs from the David Pond Freshwater Diversion located on the west bank of the Mississippi River, in the vicinity of a historic crevasse near Luling. The Davis Pond Diversion is capable of diverting approximately 10,000 cfs, but is currently managed to maintain specific salinity targets. Operational flexibility is needed to maximize sediment diversion and also to modify operations of this single diversion to operate in a coordinated fashion with other projects in the basin as they are constructed.

2-13. Mississippi River Diversion at Myrtle Grove with Dedicated Dredging

This measure includes a Mississippi River diversion of approximately 2,500 to 15,000 cfs to increase sediment and freshwater input to the area. In order to accelerate the wetland building function of this measure and moderate effects on habitat diversity within the Barataria Basin, the measure includes dedicated dredging of river sediments for the restoration of approximately 21,000 acres of wetlands in the outfall area of the diversion. Myrtle Grove is located on the west bank of the Mississippi River between Ironton and Deer Range.

2-14. Mississippi River Diversion at West Pointe a la Hache with Dedicated Dredging

This measure will replace the current 2,000 cfs West Pointe a la Hache siphon with a diversion of approximately 2,500 to 15,000 cfs, thus increasing sediment and freshwater input to the area. In order to accelerate the wetland building function of this project and moderate effects on habitat diversity within the Barataria Basin, the measure also includes dedicated dredging of river sediments for the restoration of approximately 16,500 acres of wetlands in the outfall area of the diversion. West Pointe a la Hache is located on the west bank of the Mississippi River in Plaquemines Parish, Louisiana.

2-15. Marsh Restoration Using Dredged Material in Barataria Basin

This measure will create approximately 148,000 acres of marsh using sediments mined from the Mississippi River and other sources and delivered, via slurry pipelines with pumps and outlet units, to sites across the Barataria Basin as identified in the Louisiana Department of Natural Resources' *Phase 2 Reconnaissance-Level Evaluation of The Third Delta Conveyance Channel Project – Final Report*, prepared by CH2MHill, dated October 2006. The adaptive management program will assess the measures effectiveness and refine elements of future phases. This measure would be implemented in conjunction with measure LSP-5, Sediment Inventory and Allocation.



2-16. Ridge Habitat Restoration in Barataria Basin

This measure includes restoring approximately 23 miles of natural ridge habitat by increasing ridge elevation and width with dredged material, and would also include planting of woody vegetation and native wetland plants. Natural ridges support maritime forests, which are a critically imperiled habitat in coastal Louisiana. Ridges in the Barataria Basin targeted for restoration include: Bayou Lafourche ridge, Bayou L'Ours ridge, Bayou Grande Cheniere ridge, Caminada Chenier ridges, Bayou Dupont ridge, and Bayou Barataria ridge.

2-17. Barrier Shoreline Restoration: Barataria Basin

This measure will utilize sediment dredged from offshore sources or the Mississippi River to reestablish sustainable barrier islands and barrier headlands. The Barataria Barrier Shoreline consists of a barrier island chain which separates Barataria Basin from the Gulf of Mexico. The barrier shoreline is approximately 47 miles in length, extending from Sandy Point in the east to Bayou Lafourche in the west, and includes several barrier islands and the Caminada Headland between Belle Pass and Caminada Pass.

2-18. Bankline Protection for Gulf Intracoastal Waterway (GIWW)

This measure will utilize hard bank line stabilization materials to restore and protect approximately 188 miles of strategic channel banks along both sides of the GIWW between the Mississippi River and Delta Farms. Additional benefits will be protection of critical marsh areas between the GIWW and Lake Salvador and the creation of approximately 20 acres of marsh.

4.8 Planning Unit 3a: Bayou Lafourche to Bayou de West

3a-1. Morganza to the Gulf Hurricane Protection

This measure will construct the Morganza to the Gulf Hurricane Protection Project to protect concentrated, distributed, and strategic assets in Houma, Thibodaux and coastal communities in southern Terrebonne and western Lafourche parishes from storm surges with a 1% probability of occurring in any given year. The Morganza to Gulf Alignment is approximately 72 miles long and is bounded on the west by Miners Canal and on the east by the Bayou Lafourche ridge. An alternative alignment should be considered in the design phase for the eastern most reach to ensure that the junction with the Larose to Golden Meadow Hurricane Protection Project is adequately designed. The alternative alignment follows the Twin Pipeline from Pointe Au Chien to Golden Meadow. The design of the project must include guidance in balancing the overall water resources needs of the basin, including integrating drainage, hurricane surge protection, tidal flows and hydrologic exchanges to maintain a stable and healthy landscape.

Alternative Alignment #1—Project Awaiting Authorization: This alignment follows existing ridges whenever possible and incorporates floodgates and water control structures to mimic natural water flow patterns. The need to maximize protection to coastal communities was balanced with the need to make allowances for sediment and water flow. In many cases, these measures could improve water exchange through wetlands. Throughout the 15 years that this project has been developed, there has been active stakeholder and public input.

Alternative Alignment #2—Pointe au Chien to Golden Meadow: This additional alignment would extend from Pointe au Chien to Golden Meadow and reduce the funnel created where the proposed Morganza to the Gulf alignment meets the Larose to Golden Meadow levee. The additional alignment would also increase protection to Lafourche communities. However, if not properly designed to allow for adequate water movement, this addition could further stress the area's fragile wetlands. As a result, this addition would have to incorporate floodgates and work in tandem with water and sediment diversions to ensure that water exchange contributes to wetland sustainability. Resolution of these issues must not delay the implementation of the current Morganza to the Gulf alignment, which is being considered for federal authorization.



3a-2. Gibson to Houma Hurricane Protection

This measure will provide hurricane protection to concentrated, distributed, and strategic assets from Gibson to Miners Canal, a distance of approximately 17 miles. The levee alignment will connect the Federal Lower Atchafalaya River (LAR) levee alignment at Gibson with the Morganza to the Gulf levee alignment near Houma. The alignment will follow the State Barrier Plan, which is currently designed to alleviate Atchafalaya River backwater flooding, and will incorporate hurricane protection features.

3a-3. Morgan City to Gibson Hurricane Protection

This measure will provide hurricane protection to concentrated, distributed, and strategic assets from Morgan City to Gibson, a distance of approximately 19 miles. The alignment will follow the Federal Lower Atchafalaya River (LAR) Barrier Plan, which is currently designed to alleviate Atchafalaya River backwater flooding, and will incorporate hurricane protection features.

3a-4. Houma and Vicinity Hurricane Protection

This measure will provide hurricane protection to concentrated, distributed, and strategic assets located in the Houma/Thibodaux metropolitan areas. The alignment will work in conjunction with the Morganza to the Gulf Hurricane Protection measure to increase protection in these areas. For the purposes of this report, we have analyzed these areas as being protected from storm surges with a 0.2% chance of occurring in any given year. Completion of additional analyses, such as those progressing within the Corps of Engineers' *Louisiana Coastal Protection and Restoration Project*, will inform and ultimately define the technically feasible level of protection. The alignment begins at Miners Canal, crosses the Houma Navigation Canal (HNC) south of the major industrial facilities on that channel, proceeds along the wetland/upland interface southeast of Bourg to Larose, a distance of approximately 30 miles. The hurricane protection system may include floodgates in the GIWW, HNC, Bayou Petite Caillou, and Bayou Terrebonne.

2-3. Larose to Golden Meadow Hurricane Protection

This measure will raise the height of the existing Larose to Golden Meadow Hurricane Protection Levee to protect concentrated and strategic assets on both the east and west side of Bayou Lafourche from storm surges with a 1% probability of occurring in any given year. Approximately 24 miles of levees and floodwalls will be raised on the southern reaches, below the Gulf Intracoastal Waterway. The potential for increased surge heights from the adjacent Donaldsonville to the Gulf and Morganza to the Gulf levee systems will be evaluated, and if necessary the Larose to Golden Meadow levees system will be raised accordingly.

3a-5. Raise/Maintain Evacuation Routes Located Outside the Hurricane Protection Systems

This measure will raise/maintain evacuation routes outside of hurricane protection structures that are at risk of being damaged by storm surge. Vulnerable routes will be identified and appropriate actions will be recommended to assure the ability to safely and surely evacuate in advance of a storm and rising water and to have a functional road for safe return and recovery after a storm has passed. In many cases this may be accomplished by armoring of the roadway embankment to prevent the roadway embankment from being eroded.

3a-6. Bankline Protection for Houma Navigation Canal (HNC)

This measure will utilize hard bankline stabilization materials to restore and protect approximately 54 miles of strategic channel banks along both sides of the HNC from its confluence with the GIWW to Terrebonne Bay.

**3a-7. Multipurpose Operation of the Houma Navigation Canal (HNC) Lock**

The measure will develop and implement a multi-purpose operational plan for the HNC Lock that will allow the lock to be utilized for coastal restoration purposes. The lock may be used to optimize Atchafalaya River water and sediment flow to sustain wetlands in the Lake Boudreaux, Lake Mechant, and Grand Bayou areas. The lock will be located on the HNC, 1.75 miles south of the Bayou Sale intersection. Planning, Engineering, and construction costs are included in measure 3a-1: Morganza to the Gulf Hurricane Protection.

3a-8. Bankline Protection for Gulf Intracoastal Waterway (GIWW)

This measure will utilize hard bankline stabilization materials to restore and protect approximately 80 miles of strategic channel banks along both sides of the GIWW between Morgan City and Larose.

3a-9. Marsh Restoration Using Dredged Material in Terrebonne Basin

This measure will create approximately 11,400 acres of marsh using sediments, mined from the Mississippi River, Atchafalaya River and/or offshore sources, delivered via slurry pipelines with pumps and outlet units, to Terrebonne wetlands located between the west bank of Bayou Lafourche, the south bank of the GIWW, and east of Bay Junop as identified in the Louisiana Department of Natural Resources' *Phase 2 Reconnaissance-Level Evaluation of The Third Delta Conveyance Channel Project – Final Report*, prepared by CH2MHill, dated October 2006.. The adaptive management program will assess the measures effectiveness and refine elements of future phases. This measure would be implemented in conjunction with measure LSP-5, Sediment Inventory and Allocation.

3a-10. Chacahoula Basin Plan

This measure will implement the Chacahoula Basin Plan, developed by the Terrebonne Levee and Conservation District, to alleviate inundation issues in the Verret sub-basin. The Chacahoula Basin comprises approximately 107,200 acres bounded to the north by Louisiana Highway 1, to the south by Highway 182, to the west by Highway 662 and Highway 398, and to the east by Highway 311.

3a-11. Freshwater Introduction via Blue Hammock Bayou

This measure will increase the Atchafalaya River influence in lower Terrebonne Parish wetlands by increasing the hydraulic cross-section of Blue Hammock Bayou. The project will enhance and sustain marsh in an area between Four League Bay and Bayou du Large, including the areas encompassing Lake Mechant and marshes north to Bayou Decade. Approximately 230 acres of marsh will also be created using dredged material from the channel during project implementation.

3a-12. Ridge Habitat Restoration in Terrebonne Basin

This measure includes restoring and maintaining approximately 65 miles of natural ridge habitat by increasing ridge elevation and width with dredged material. Natural ridges support maritime forests, which are a critically imperiled habitat in coastal Louisiana. This measure also includes planting of woody vegetation and native wetland plants at several degraded natural ridge sites throughout the Terrebonne Basin.

3a-13. Maintain Landbridge Between Caillou Lake and Gulf of Mexico

This measure will use rock revetment and dedicated dredging for marsh creation and nourishment to restore and maintain the landbridge located between Caillou Lake and the Gulf of Mexico. This critical landscape feature, bordered on the west by Bay Junop and on the east by Lake Pelto, is vital to maintain the hydrologic regime. Approximately 1,400 acres of marsh will be restored.

**3a-14. Barrier Shoreline Restoration: Terrebonne Basin**

This measure will utilize sediment dredged from offshore sources to reestablish sustainable barrier islands and barrier headlands. The Terrebonne Barrier Shoreline consists of a barrier island chain which separates Timbalier Bay, Terrebonne Bay and Lake Pelto from the Gulf of Mexico. The barrier shoreline extends from Bayou Lafourche west to Raccoon Island, and includes the Caminada Headland west of Belle Pass.

2-9. Move Freshwater to Terrebonne Basin from Barataria Basin via GIWW

This measure will utilize dedicated dredging and hard shoreline stabilization materials in order to increase freshwater flow in the GIWW to the west to sustain marsh in the eastern Terrebonne Basin.

3b-6. Convey Atchafalaya River Water Eastward via GIWW to Benefit Eastern and Lower Terrebonne Marshes

This measure will increase Atchafalaya River water influence into eastern and southern Terrebonne marshes via the GIWW. This will be accomplished in conjunction with Bankline Protection for Gulf Intracoastal Waterway (3b-11) and Convey Atchafalaya River Water Westward via GIWW (3b-13) to work in tandem to manage and convey freshwater and nutrients using Atchafalaya River waters to reduce saltwater intrusion and enhance/sustain marshes in the southern Terrebonne basin. Bank stabilization of the GIWW will be performed to provide an effective conveyance channel that insures protection of adjacent thin-mat floating marsh. The landowner is concerned that the planned increased flow through the GIWW and into connected channels will degrade fragile floating marshes in northern Terrebonne Basin. The planned increase in water movement eastward via GIWW will require bank and water controls at canal, pipeline, and bayou connections.

4.9 Planning Unit 3b: Bayou de West to Freshwater Bayou Canal

3b-1. Lafayette and Vicinity Hurricane Protection

This measure will provide protection for concentrated and strategic assets for Metropolitan Lafayette and vicinity, including the Abbeville and New Iberia communities. The proposed alignment begins west of Abbeville and ends east of New Iberia. Further study is required, including refinement of economic and surge analysis to determine the level of risk to the area, in order to finalize design of a hurricane protection system that would achieve project objectives in a balanced manner. For the purposes of this report, we have analyzed these areas as being protected from storm surges with a 0.2% chance of occurring in any given year. Completion of additional analyses, such as those progressing within the Corps of Engineers' Louisiana Coastal Protection and Restoration Project, will inform and ultimately define the technically feasible level of protection.

3b-2. Wax Lake Outlet to New Iberia Hurricane Protection

This measure will protect concentrated and strategic assets located between Wax Lake Outlet and New Iberia from storm surges with 1% probability of occurring in any given year. Evaluation is needed, including refinement of economic and surge analysis to determine the level of risk to the area, in order to finalize design of a hurricane protection system that would achieve project objectives in a balanced manner.

3b-3. Maintain Existing Levee Protection for Morgan City and Berwick

This measure will sustain the current level of flood protection from the Morgan City to the Wax Lake Outlet by maintaining existing Mississippi River and Tributaries levees at authorized protection levels.

3b-4. Raise/Maintain Evacuation Routes Located Outside the Hurricane Protection Systems

This measure will raise/maintain evacuation routes outside of hurricane protection structures that are at risk of being damaged by storm surge. Vulnerable routes will be identified and appropriate actions will be recommended



to assure the ability to safely and surely evacuate in advance of a storm and rising water and to have a functional road for safe return and recovery after a storm has passed. In many cases this may be accomplished by armoring of the roadway embankment to prevent the roadway embankment from being eroded.

3b-5. Barrier Shoreline Restoration: Point Au Fer Island

This measure will restore approximately 21 miles of the gulf shoreline along Point Au Fer Island using a combination of sediment dredged from offshore sources and offshore segmented breakwaters. Design should maintain tidal processes and connectivity to interior marshes to maximize wetland sustainability. Point Au Fer Island is located south-southeast of the mouth of the Atchafalaya River.

3b-6. Convey Atchafalaya River Water Eastward via GIWW to Benefit Eastern and Lower Terrebonne Marshes

This measure will increase Atchafalaya River water influence into eastern and southern Terrebonne marshes via the GIWW. This will be accomplished in conjunction with Bankline Protection for Gulf Intracoastal Waterway (3b-11) and Convey Atchafalaya River Water Westward via GIWW (3b-13) to work in tandem to manage and convey freshwater and nutrients using Atchafalaya River waters to reduce saltwater intrusion and enhance/sustain marshes in the southern Terrebonne basin. Bank stabilization of the GIWW will be performed to provide an effective conveyance channel that insures protection of adjacent thin-mat floating marsh. The landowner is concerned that the planned increased flow through the GIWW and into connected channels will degrade fragile floating marshes in northern Terrebonne Basin. The planned increase in water movement eastward via GIWW will require bank and water controls at canal, pipeline, and bayou connections.

3b-7. Bankline Stabilization of Freshwater Bayou from Belle Isle Bayou to Freshwater Bayou Canal Lock

This measure will stabilize approximately 8 miles of bankline located on the eastern side of Freshwater Bayou Canal between the Freshwater Bayou Lock and Belle Isle Bayou in Vermilion Parish. This measure will also provide increased protection to the interior marsh by reducing erosion from wake energy created by vessel traffic.

3b-8. Increase Sediment Transport Down Wax Lake Outlet

This measure will realign the upstream segment of the inflow channel of the Wax Lake Outlet at its intersection with the Atchafalaya River to increase the sediment load per unit of discharge to enhance and restore approximately 260 acres of marsh. The Wax Lake Outlet is located in west St. Mary Parish and discharges into Atchafalaya Bay.

3b-9. Southwest Pass Shoreline Stabilization

This measure will stabilize approximately 5 miles of shoreline along Southwest Pass to prevent further widening of the tidal pass. Rock revetment will be placed at either end of the tidal pass to reduce the volume of salt water entering Vermillion Bay. Southwest pass connects the Gulf of Mexico and Vermillion Bay on the western side of Marsh Island, in Iberia and Vermillion Parishes and is located between two Louisiana wildlife refuges.

3b-10. Barrier Shoreline Restoration: Freshwater Bayou to South Point/Marsh Island

This measure will restore the gulf shoreline between Freshwater Bayou and South Point, Marsh Island using a combination of sediment dredged from offshore sources and offshore segmented breakwaters. Design should maintain tidal processes and connectivity to interior marshes to maximize wetland sustainability. Further analysis is needed to determine the most appropriate mechanism to accomplish this goal.

**3b-11. Bankline Protection for Gulf Intracoastal Waterway (GIWW)**

This measure will utilize hard bankline stabilization materials to protect critical areas along the north and south banks of the GIWW in strategic locations from the Vermillion River to the Atchafalaya River and in addition will stabilize the east bank of Freshwater Bayou from its intersection with the GIWW, southward to the Freshwater Bayou Canal Lock. This bank stabilization will reduce erosion from wake energy from vessel traffic and protect interior marshes.

3b-12. Raynie Marsh Restoration

This measure will utilize dredged sediments from offshore sources for shoreline restoration and to nourish and restore wetlands in the Raynie Marsh area where wetland loss rates are projected to be high. Tidal processes and connectivity to the interior marshes will be maintained to maximize wetland sustainability in the Raynie Marshes.

3b-13. Convey Atchafalaya River Water Westward via GIWW

This measure will stabilize approximately 85 miles of bankline at strategic locations along the GIWW to increase the movement of freshwater and sediment from the Atchafalaya River via the GIWW westward to enhance and sustain marsh in the Tech/Vermilion and Mermentau basins. Bank stabilization of the GIWW will be performed to provide an effective conveyance channel that does not adversely affect the existing landscape.

3b-14. Marsh Restoration Using Dredged Material at Weeks Bay

This measure will utilize sediments dredged from offshore sources to restore and nourish approximately 300 acres of marsh between Weeks Bay and the GIWW in Iberia Parish.

3b-15. Marsh Restoration Using Dredged Material at Marsh Island

This measure will utilize sediments dredged from offshore sources to restore and nourish approximately 430 acres of marsh on Marsh Island.

3b-16. Marsh Restoration using Dredged Material at Point Au Fer

This measure will utilize sediments dredged from offshore sources to restore and nourish approximately 900 acres of marsh on Point Au Fer Island.

3b-17. Stabilize Shoreline of Vermilion, East and West Cote Blanche Bays

This measure will stabilize approximately 42 miles of shoreline at strategic locations in Vermilion Bay, West Cote Blanche Bay, and East Cote Blanche Bay. Restoration of these shorelines will maintain tidal processes and connectivity to interior marshes to maximize wetland sustainability.

3b-18. Freshwater Introduction into Central and Lower Terrebonne Marshes

This measure will manage freshwater from the Atchafalaya River through the operation of numerous existing small water distribution structures such as weirs, culverts etc., and through new distribution structures as needed, to benefit wetlands on the east side of the Atchafalaya Bay. This must be accomplished without adverse impacts in the fresh marshes of northern Terrebonne Basin.

3b-19. Fortify Spoil Banks of GIWW and Freshwater Bayou

This measure will beneficially utilize material dredged from the Acadiana Gulf of Mexico Access Channel project to create and nourish marsh and spoil banks along the GIWW from the Vermilion River Cutoff Channel to Commercial Canal, and along Freshwater Bayou from the GIWW to the Freshwater Bayou Lock, and will include armoring as needed.



4.10 Planning Unit 4: Freshwater Bayou Canal to Sabine River

4-1. Lake Charles and Vicinity Hurricane Protection

This measure will work in conjunction with other measures, such as Raise and Maintain Highways 82 and 27 (4-3) and Salinity Control Structure at Calcasieu Pass (4-9), to provide hurricane protection for concentrated and strategic assets in the Lake Charles metropolitan area, which includes Vinton, Sulphur, Lake Charles and Iowa. Further study is required, including refinement of economic and surge analysis to determine the level of risk to the area, in order to finalize design of a hurricane protection system that would achieve project objectives in a balanced manner. For the purposes of this report, we have analyzed these areas as being protected from storm surges with a 0.2% chance of occurring in any given year. Completion of additional analyses, such as those progressing within the Corps of Engineers' *Louisiana Coastal Protection and Restoration Project*, will inform and ultimately define the technically feasible level of protection.

4-2. Abbeville to Lake Charles Hurricane Protection

This measure will protect distributed and strategic assets located between the Lake Charles metropolitan area and the Lafayette/Abbeville metropolitan areas, which includes the communities of Kaplan, Gueyden, Lake Arthur, and Holmwood from a storm surge with a 1% probability of occurring in any given year. Levees will be constructed where necessary to work in conjunction with other lines of defense such as shoreline measures, navigation channel bank improvements, raising of highways, etc. The proposed protection system is approximately 150 miles in length and begins at the Calcasieu Lock, and extends eastward along the south bank of the GIWW to the Leland Bowman Lock then north across the GIWW then east-northeast to the Lafayette and Vicinity Hurricane Protection System. Further study is required, including refinement of economic and surge analysis to determine the level of risk to the area, in order to finalize design of a hurricane protection system that would achieve project objectives in a balanced manner.

4-3. Raise and Maintain Highways 82 and 27

This measure will elevate and maintain sections of Highways 82 and 27 to provide hydrologic control for maintaining the Mermentau and Calcasieu basins as freshwater ecosystems. If the highway is located on a chenier, the road is already on a landscape feature at or above the targeted elevation, and raising it further is unnecessary. Thus, the plan does not recommend raising the highway on the cheniers. Instead, the plan recommends improving protection to homes and properties located on cheniers by armoring highway embankments in certain vulnerable locations. This will ensure that the road can be used safely after storms. In selected low spots, such as south of White Lake or along the eastern edge of Highway 82 south of Forked Island, the highway will need to be raised in order to protect the Mermentau Freshwater Basin. However, there are few human settlements in such areas, and impacts on landowners are expected to be minimal. In addition to environmental benefits, this measure will provide a level of surge protection benefits for communities in the Chenier Plain, especially the communities north of the eastern portion of Highway 82. This measure will be considered as a line of storm surge defense during the analysis of the level of protection for the Lake Charles and Vicinity Hurricane Protection Measure (4-1) and Abbeville to Lake Charles Hurricane Protection Measure (4-2).

4-4. Bankline Protection for Gulf Intracoastal Waterway (GIWW)

This measure will utilize hard bankline stabilization materials to protect critical areas along the north and south banks of the GIWW in strategic locations from the Sabine River to the Vermilion River to reduce erosion from vessel traffic wake energy and protect interior marshes.



4-5. Restore the Mermentau Lakes Basin Integrity

This measure will utilize earthen embankments, in conjunction with the existing Schooner Bayou salinity control structure and Leland Bowman Lock, to restore the integrity of the Mermentau Lakes Basin. Two earthen embankments, totaling 7 miles in length, will be reconstructed and connected to the existing control structure to close potential avenues for saltwater intrusion. When complete, this measure will provide a salt water barrier from Highway 82 to the Schooner Bayou salinity control structure to the Leland Bowman Lock at the GIWW.

4-6. Stabilize Grand Lake Shoreline

This measure will utilize hard structures, in conjunction with dredged material, to stabilize critical locations of the Grand Lake shoreline in order to reduce shoreline erosion and protect interior marshes. Additionally, connectivity to the interior marshes will be maintained to maximize wetland sustainability in the area. Grand Lake is located east of Calcasieu Lake in Cameron Parish.

4-7. Stabilize White Lake Shoreline

This measure will utilize hard structures, in conjunction with dredged material, to stabilize critical locations of the White Lake shoreline to reduce shoreline erosion and protect interior marshes. Additionally, connectivity to the interior marshes will be maintained to maximize wetland sustainability in the area. White Lake is located southwest of Abbeville, south of the GIWW in Vermilion Parish.

4-8. Bankline Stabilization of Freshwater Bayou

This measure will utilize hard bankline stabilization materials to complete the continuous armoring of the west bank of Freshwater Bayou from the intersection of the GIWW to the Freshwater Bayou Lock. Previous projects constructed under the Coastal Wetlands Planning Protection and Restoration Act (CWPPRA) provided bankline stabilization in all but two reaches. These two reaches extend from the GIWW to Six Mile Canal and from Humble Canal to the Freshwater Bayou Canal Lock.

4-9. Salinity Control Structure at Calcasieu Pass

This measure will reduce the Calcasieu Ship Channel cross section at Calcasieu Pass to 400' width and 40' depth in the vicinity of Cameron and will evaluate other structures to reduce saltwater intrusion and storm surge from the Calcasieu River Channel into Calcasieu Lake. Completion of additional analyses will inform and ultimately define the structural measures required to achieve project goals.

4-10. Barrier Shoreline Restoration: Sabine River to Calcasieu River

This measure will restore portions of the gulf shoreline from the Sabine River to the Calcasieu River using a combination of sediment dredged from offshore sources and offshore segmented breakwaters. Additionally, tidal processes and connectivity to the interior marshes will be maintained to maximize wetland sustainability in the area.

4-11. Barrier Shoreline Restoration: Calcasieu River to Freshwater Bayou

This measure will restore portions of the gulf shoreline from the Calcasieu River to Freshwater Bayou using a combination of sediment dredged from offshore sources and offshore segmented breakwaters. The portion of this shoreline in front of the Rockefeller Wildlife Refuge has the highest rate of shoreline erosion in the Chenier Plain. Additionally, tidal processes and connectivity to the interior marshes will be maintained to maximize wetland sustainability in the area.

4-12. Marsh Restoration Using Dredged Material South of Highway 82

This measure includes using dredged sediment from the Gulf of Mexico to nourish and restore approximately 3,000 acres of marsh areas south of Highway 82, east and west of the Calcasieu Ship Channel.

**4-13. Beneficial Uses of Dredged Material from Calcasieu Ship Channel**

This measure will implement and extend the ongoing LCA beneficial use program for the Calcasieu Ship Channel, including incorporation of measures defined by the Port of Lake Charles. Approximately 37,600 acres of marsh at five sites within the Sabine National Wildlife Refuge may be restored and nourished through beneficial use of dredged material from the Calcasieu River Ship Channel.

4-14. Salinity Control Structure at Sabine Pass

This measure will establish a salinity control structure at the south end of Sabine Lake near the Gulf of Mexico. The ability to control salinity gradients will enhance the ability to maintain large areas of fresh and intermediate marsh in the area.

4-15. Fortify Spoil Banks of GIWW and Freshwater Bayou

This measure will beneficially utilize material dredged from the Acadiana Gulf of Mexico Access Channel project to create and nourish marsh and spoil banks along the GIWW from Freshwater Bayou to the Vermilion River Cutoff Channel, and along Freshwater Bayou from the GIWW to the Freshwater Bayou Lock, and will include armoring as needed.

4-16. Stabilize Calcasieu Lake Shoreline

This measure will utilize hard structures, in conjunction with dredged material, to stabilize critical locations of the Calcasieu Lake shoreline to reduce shoreline erosion and protect interior marshes. Additionally, tidal processes and connectivity to the interior marshes will be maintained to maximize wetland sustainability in the area. Calcasieu Lake is located south of Lake Charles in Cameron Parish.

4-17. Stabilize Sabine Lake Shoreline

This measure will utilize hard structures, in conjunction with dredged material, to stabilize critical locations of the Sabine Lake shoreline to reduce shoreline erosion and protect interior marshes. Additionally, tidal processes and connectivity to the interior marshes will be maintained to maximize wetland sustainability in the area. Sabine Lake is located on the Texas/Louisiana border and a portion of the eastern shoreline encompasses the Sabine National Wildlife Refuge.

4-18. Mermentau Basin Watershed Management Plan to Retain Freshwater Resources

This measure is to develop a comprehensive watershed management plan for freshwater resources in the Mermentau Basin to provide for wetland restoration and to support continued agriculture and navigation in the region. Existing stage and flow data from locks, reservoirs, the GIWW, the Red River and other sources of freshwater will be used to establish water availability and determine allocation needs.

4-19. Sabine Basin Watershed Management

The measure will conduct detailed investigations to develop a comprehensive management plan to increase Sabine River flow via the GIWW so that a reduced salinity regime may be established within the Calcasieu sub-basin for wetlands restoration and sustainability. The strategy includes a hydrologic assessment to identify the impacts of inflow redistribution on coastal areas and the Sabine River/Toledo Bend Reservoir system and to develop measures to mitigate adverse impacts.

4-20. Hydrologic Improvements in Mermentau Basin at Highways 82 and 27

Environmental structures to pass freshwater from north to south across Highway 82 and from east to west across Highway 27 are needed to optimize fresh water distribution. In addition, should these roadways be overtopped by storm surges and the fresh marshes of the Mermentau Lakes Sub-basin are impacted by salt water, these structures would facilitate drainage and may foster a more rapid recovery of these areas.



5.0 Program Implementation Strategy

5.1 Introduction

Both hurricane protection and ecosystem restoration have been on-going for decades in coastal Louisiana; however, integration of these missions and the increasing level of effort raises many new questions regarding how best to balance achievement of all objectives. The Master Plan represents the State's first approximation of the comprehensive solution for coastal protection and restoration. It builds upon previous planning, research, and lessons learned, yet many uncertainties remain regarding program & project impacts and the ability to balance objectives in the face of changing conditions.

This plan represents a point of departure from how planning of activities along coastal Louisiana has been done in the past. As such, it does not represent an end product, but instead a new direction and a new philosophy for how we live in, and manage the resources of, coastal Louisiana. Many adjustments will need to be made in the first few years of implementation, including revisions to existing management practices, policies, and legislation. Although a multitude of local, State and Federal agencies; policies; and legislation already exist which influence the planning, funding, and implementation of the Master Plan, all were created prior to the integration of planning and implementation of coastal protection and restoration. Additionally, although the Master Plan builds upon decades of experience, implementation of this program and some of the measures which comprise the plan will require further analyses including modeling, engineering & design, and environmental study. Therefore, mechanisms for change – not only early in plan implementation, but throughout the life of its implementation – will be required to meet the needs of the Master Plan.

This Chapter sets out the full framework to be utilized in progressing implementation of this first iteration of the Master Plan. The following section presents the process for identifying the first actions to be undertaken. Subsequent sections then present the recommended framework for long-term program management, the policy and legislative issues requiring resolution, and the adaptive management framework that must be established in order that implementation of the plan evolves over time.

5.2 Urgent Early Actions and Implementation Sequencing

5.2.1 Background

The Master Plan sets out a wide range of measures and studies to be implemented in coastal Louisiana, at a cost of tens of billions of dollars over the coming decades. In the evaluations undertaken to define the plan it was necessary to assume that all measures are started in the first year of plan implementation. This is clearly not a realistic assumption as there are many constraints which prevent this from being possible. These constraints include the following.

- Funding, materials, and other resources are limited and will restrict both what can be done and how quickly projects can be completed.
- Certain projects must be constructed before others in order to achieve intended outcomes.
- Some existing laws, policies, and other administrative procedures must be updated if the Master Plan is to be implemented as envisioned.
- Several concepts require further planning before they can be designed or constructed.
- Some of the proposed projects will take many years to plan, design, and construct.



Given these constraints, it is important to define a mechanism to decide which measures are progressed first. The procedure developed is based upon the premise that all measures called for in the Master Plan are critical, but accepts that constraints prevent the full plan from being implemented at once. Thus, the most urgent early actions will be identified and sequenced according to funding availability. Funds from all potential sources will be managed to progress the Master Plan urgent early activities. This includes the Coastal Impact Assistance Program, the Coastal Wetlands Planning, Protection, and Restoration Act Program, Outer Continental Shelf Revenue Sharing, cost-sharing opportunities with Federal Agencies—e.g., Corps of Engineers, Federal Emergency Management Agency, and Water Resources Development Act projects such as Louisiana Coastal Area and Morganza to the Gulf—, the Statewide Flood Control Program, the State Capital Outlay Bond Program, State general funds, local funds, and others. Even with all the above programs, Louisiana cannot complete the Master Plan utilizing only state funds. Given that total costs are estimated to be in the tens of billions of dollars, Louisiana and the nation must work together for the Master Plan to be successful. This will require that many federal and state agencies work together in unprecedented ways for a plan of this scope to be successful.

The process set out below does not attempt to sequence the full set of recommendations presented in the Master Plan, nor does it seek to imply priorities with respect to other actions that may be taken in the coastal zone that are beyond the scope of this plan. It is recognized that there will be changes over time, both near and long term, in priorities and needs in the coastal landscape. Adaptive management is a concept that is embraced in many large-scale ecosystem restoration and flood control programs, and is the approach that will be utilized to manage the implementation of the Master Plan. This approach links all phases of program implementation from concept through project operations and even changes in the plan itself. It is thus dependent upon collaboration, flexibility and continued improvement.

To lay out the actions that will be taken in a timeframe longer than approximately 5 years would require making potentially unfounded assumptions on how existing constraints (including policies, legislation, funding, scientific and technical uncertainties), the physical landscape, and human use of that landscape will change into the future. Thus, just as the components of the entire plan should be managed adaptively, so should the implementation of the plan. As funding opportunities change during implementation, the sequencing will need to be modified as appropriate.

To this end, the reporting and update of the implementation priorities and sequence will be provided via the Annual Plan process, rather than within the Master Plan. This will provide for the review and update of the implementation plan on an annual basis to ensure the program accurately reflects funding availability and the status of individual actions. The process for definition of this Annual Plan will be an elaboration of the existing Annual Planning process, focused directly on implementation of the Master Plan.

The process defined in the following sections only considers sequencing of the measures and studies defined in the Master Plan. It does not provide solutions to the administrative and framework changes that may be necessary to successfully implement the Master Plan. Regardless of the sequence of implementation of measures and studies, it is imperative that immediate action be taken to resolve the legislative, institutional, and policy issues in order that the Master Plan can be effectively and efficiently implemented. A more detailed discussion of early actions needed for administrative and program management is presented in Chapters 5.3 to 5.5.



5.2.2 Process

The following sections set out the criteria and procedures by which urgent early actions and sequencing of those actions will be determined. The process builds on approaches followed for previous planning initiatives, but necessarily is more comprehensive than previous approaches to include the broader objectives of this plan. An overview of the process is presented in Figure 5.1.

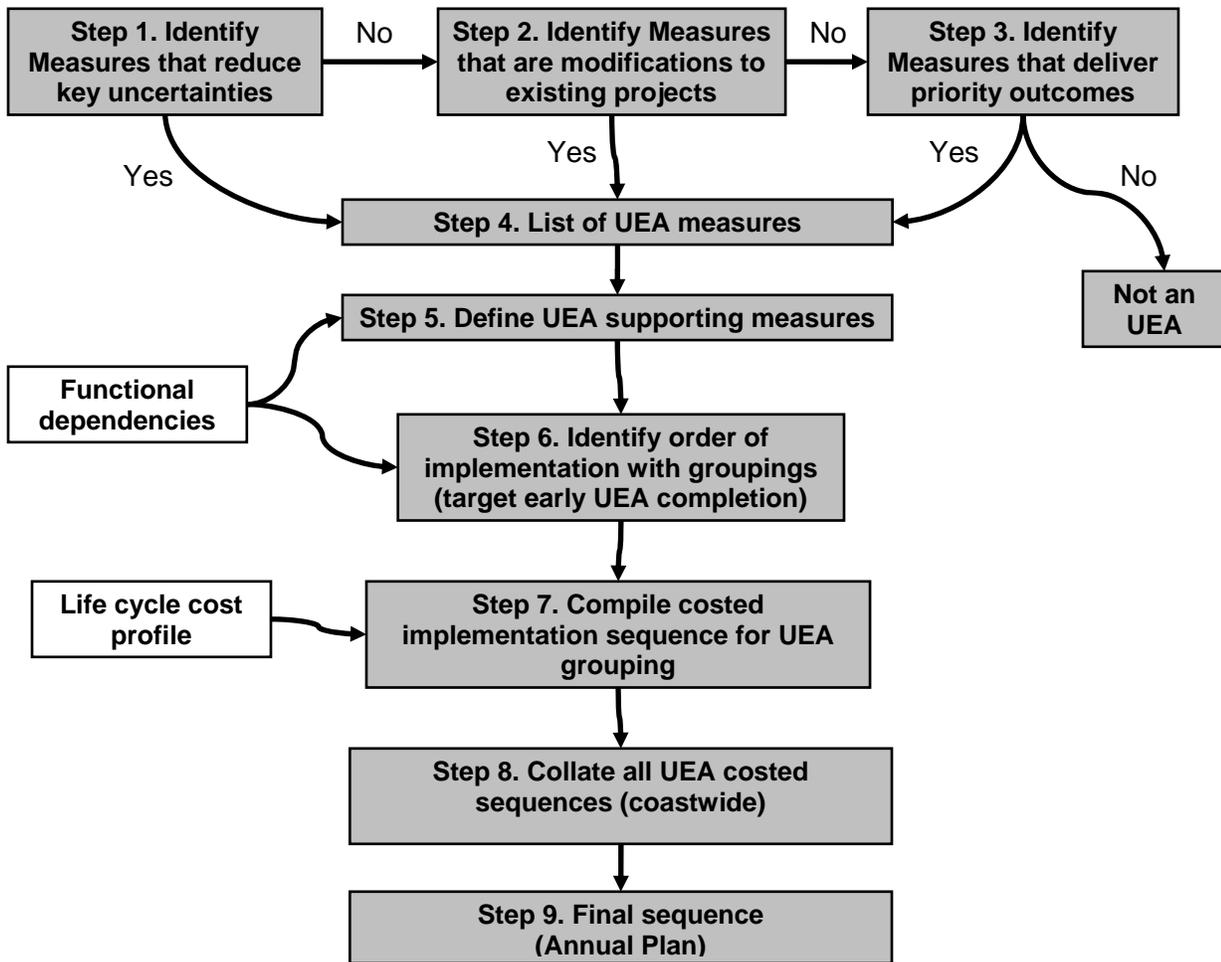


Figure 5.1: Steps in Determining Urgent Early Actions and Sequencing

5.2.3 Identifying the Urgent Early Actions

The plan is expected to achieve positive outcomes that are sequenced based upon the most critical needs both within a region and across the coast. Assumptions were made that all measures in the plan are critical needs, but decisions must be made on what measures are initiated first in order that utilization of our finite resources can be planned. The process set out below seeks to sequence the Urgent Early Actions (UEA's) that will be taken to efficiently implement the Master Plan. Actions will be sequenced in a way that best balances the four coastwide



objectives, and includes those uncertainties, policy, legislative, and funding issues that need to be resolved in order to implement the entire plan. The four coastwide objectives, found in chapter 3, and are summarized as:

- reduce risk to economic assets;
- restore sustainability to the coastal ecosystem;
- maintain a diverse array of habitats for fish and wildlife; and
- sustain Louisiana's unique heritage and culture.

A great deal of information was considered to generate the plan, including the following parameters:

- economic inventories (assets) and population;
- storm surge maps (combined with economics to gauge risk);
- current levels of protection to assets;
- past and future land loss estimates;
- projected changes in habitat suitability for representative species; and
- stakeholder and public input.

This information will also be used as supporting data in the sequencing process.

Urgent Early Action Criteria

In order to determine which of the measures identified in the Master Plan will be elevated for early action, Urgent Early Action criteria will be applied. There are three sets of criteria (Steps 1 to 3 of the sequencing process, Figure 5.1). The first set relates to those measures that must be implemented early as their outcome/design/performance will be used to reduce key uncertainties in future plan implementation. The second set identifies those measures which primarily involve non-construction actions to deliver rapid improvements. The third set relates to those measures that deliver the highest priority outcomes.

Completion of Steps 1 to 3 of the process will result in the identification of a complete list of *urgent early actions* for the Master Plan (Step 4). These steps and the criteria are described further below.

Step 1: Reducing Uncertainties

Measures that will result in the reduction of key uncertainties, and hence improve the future definition and implementation of the remainder of the Master Plan will be identified as *urgent early actions*. The main report sets out the major assumptions and uncertainties associated with this first iteration of the Master Plan. A range of studies and measures are proposed as part of the Plan in order to reduce these uncertainties into the future. It is necessary to ensure early action on these measures such that the information they yield can feed back into the plan process as soon as possible.

The following definitions will be used in the identification of these urgent early actions:

- measures which facilitate the planning or design of other existing or planned projects; and
- large scale planning of promising concepts or projects that reduce key uncertainties related to plan implementation will be started at the earliest opportunity, as they will have implications for future implementation of the Master Plan.



An example of this would be the Mississippi River Delta Management Study to review options for major diversions on the lower Mississippi River.

Step 2: Modifications of Existing Projects

Modifications of existing structures, or their operations, will be defined as an urgent early actions where they can be achieved with minimal capital cost implications. These measures are likely to represent the quickest opportunities to deliver improvements to the Louisiana coastal area and as such their implementation will be prioritized. An example would be modifying the existing authorizations to enable greater flows through the Carneravon and Davis Pond Freshwater Diversion Structures.

Step 3: Priority Outcomes

The following sections identify the attributes of a measure that would define a priority outcome. A measure that meets one of these criteria will be considered an Urgent Early Action.

Hurricane Protection

For Concentrated and Strategic Assets, where there is a high standard of protection targeted in the Master Plan this will be an UEA. The locations with a high target standard of protection are, by definition, those with the greatest levels of risk (flood threat multiplied by vulnerable assets) and hence provide a rational basis for targeting early actions.

These protection urgent early action outcomes will be defined by the following standard:

- Projects that protect concentrated and strategic assets that were identified in the Master Plan as needing a greater than 100 year level of protection, meaning protection over the level needed to withstand a storm that has a 1% chance of occurring in any given year..

Beginning planning and design of the Lake Pontchartrain Barrier Plan to increase the effectiveness of New Orleans's hurricane protection system could be identified as an UEA under this criterion.

Ecosystem Restoration

Measures associated with reestablishing critical ecosystem structure or function, will be defined as an urgent early action. This rationale seeks to ensure early progress on those elements of the coastal landscape that are critical to providing a system that is able to sustain itself.

These restoration UEA outcomes will be defined as those that meet one (or more) of the following criteria:

- Maintains or reestablishes a feature critical to sustaining or restoring the hydrologic regime. This criteria will be used to identify those features of the landscape that facilitate the functioning of the most vulnerable wetland areas by providing the physical setting within which the hydrologic processes operate. Examples of such measures would be restoration of barrier islands and crucial land bridges.
- Restores natural processes in an area of high projected loss. This will be used to ensure that measures which provide for the restoration of land-sustaining or land-building processes in highly vulnerable areas of the coastal ecosystem, are identified for early implementation. Measures that serve to reestablish riverine influence in fragile wetlands would meet this criterion.



- Sustains or improves processes critical to the socio-economic viability of an existing community. This will include those measures that provide for the continuation or improvement of conditions that are essential to the continued viability of human use of natural resources. An example of measures that would meet this criterion includes those that stabilize municipal fresh water supplies.

The priority areas for consideration under the above criteria will be identified using the land change projections, on both 10 and 50 year horizons, provided by the CLEAR analysis (see Appendix G) undertaken to support definition of this plan.

Step 4: List of Urgent Early Action Measures

Resultant from steps 1 to 3 will be a list of all UEA's identified through application of the above process.

5.2.4 Sequencing of Urgent Early Action Measures

Aims

This process will sort the UEA measures into an implementation sequence which will ensure that objectives are achieved as quickly as possible within the overall constraints governing ecosystem restoration and hurricane protection. The actual timescales for implementation will be dependant upon resource availability, the most critical of which is likely to be funding. This process will be used to generate the implementation plan.

Measure Status

The measures identified in the above process as the urgent early actions will be at various stages of development, in terms of their progress towards implementation, and their associated certainty of implementation and performance. Each measure will be identified as being at one of the following stages of implementation:

- **Planning** – concept is currently under evaluation or needs to be evaluated before engineering & design can be undertaken. This phase includes compliance with the National Environmental Policy Act (NEPA).
- **Engineering & Design** – planning is complete, and the measure was found to be feasible. The project is either ready to be designed or engineering and design are already underway.
- **Construction** – planning and design of the measure is complete; the project is awaiting or has received authorization, and construction is ready to begin.
- **Modification** – the measure has already been built and requires modifications either to the structure or to its operations.

It is important to understand the status of each measure when developing a sequence of implementation as this is indicative of timescale to construction, and the current understanding of the level of certainty in the measure's ability to achieve the desired performance.

Sequencing Process Parameters

The decision process of sequencing measures will consider the following data and information (parameters):

- schedules, considering estimated time to begin construction and estimated construction duration, as well as desired schedule to meet the measure's objectives;
- Cost data, including total cost and cost profile (planning – design – construction – operation and maintenance);
- authorization and funding status (including cost sharing opportunities); and
- functional dependencies on other projects.



Sequencing Considerations

There will be four steps involved in the process of sequencing the implementation of urgent early action measures, as follow:

- identify the dependencies on other ‘supporting’ measures (Step 5);
- identify the implementation sequence within groupings (Step 6);
- apply the cost data for the measures, presented as a cost profile (to include planning, design and construction) (Steps 7 & 8); and
- adjust schedule to match funding constraints (Steps 9 & 10).

The following sections set out the process for each of these steps.

Step 5: Dependencies

The process for definition of the UEA measures produces a list of individual measures that are considered to deliver or facilitate important outcomes. However, the successful implementation of these individual measures may be dependant upon their integration with other measures which support them.

For each UEA the supporting measures will be identified using the following criteria:

- measures which facilitate the functioning or sustainability of a UEA (e.g. the Maintain MRGO – Lake Borgne Landbridge is needed for the Mississippi River Diversion at Violet to influence target areas);
- measures where it is necessary to rebuild a particular landscape feature so that a UEA functions as intended (e.g. Shell Island needs to be rebuilt for the integrity of the Barataria Barrier Islands, which is critical to freshwater and sediment retention within the coastal system and for flood protection);
- measures required to achieve balanced implementation of protection and restoration (this will follow the mitigation process which is defined separately).

Based upon these criteria, the measures supporting each UEA will be identified.

Step 6: Implementation Order

Within the individual groupings (a grouping includes the UEA measures plus supporting measures) it is likely that there will be a necessary, or preferable, order to the implementation of individual measures. Factors that will influence the order of implementation within these groupings will include the following:

- based upon the schedules defined for each measure, some will be able to be progressed to construction earlier than others;
- certain measures within a group may deliver the majority of the benefits towards achievement of the UEA outcome; these measures should be built first;
- within a grouping it may be necessary to construct a particular measure(s) first to facilitate the implementation of other measures within the group.

The output from this step will be an order of implementation for the individual measures in each grouping.

Steps 7 & 8: Initial Sequence

The next step is to populate the implementation orders with the individual measure schedules and life cycle costs and compile all the measure groupings to give a comprehensive sequence and cost profile for all measures associated with delivery of the urgent early actions. The consideration of project costs in the implementation order should highlight potential differences in uncertainty of the cost estimate, which reflects the current status of



the measure. The process may delay measures, or may allow implementation of only early phases of a measure. Some situations that may cause this include: budgets are insufficient to promote the measure in full during the initial sequence; the measure's effectiveness may include uncertainties or require technological advancements that warrant refinements to the measure prior to construction. These adjustments will also seek to ensure that plan implementation balances the delivery of protection and restoration outcomes.

Step 9: Final Sequence and Annual Plan

The final results of the above process include a sequence of the implementation plan for the Master Plan UEA's and dependent measures. As identified above, the outputs from the sequencing process are not reported as part of the Master Plan, but will be included as part of the Annual Plan. This provides for the ongoing review of the implementation sequence and incorporation of new understanding arising from implementation and the adaptive management process (see Section 5.5). The implementation sequence presented in the Annual Plan must reflect the dependencies identified through the process set out above. Included in the Annual Plan will be work of ongoing programs that support implementation of the Master Plan, such as CWPPRA, LCA, CIAP, and hurricane protection projects.

5.3 Program Management

The Master Plan articulates a comprehensive vision of actions necessary to sustain Louisiana's coastal ecosystem and safeguard coastal populations and vital socioeconomic resources. Whereas, in the past, individual programs and projects for coastal protection and restoration may have been carried out for single purposes which may not have been a functional portion of a larger vision, the Master Plan provides an opportunity to focus available funding toward a common goal. Programs such as the Coastal Wetlands Planning Protection and Restoration Act (CWPPRA), Louisiana Coastal Area (LCA), and the Coastal Impact Assistance Program (CIAP) may now all be used in a coordinated fashion to implement the Master Plan. In addition to guiding expenditures of protection and restoration funds, the Master Plan provides a context within which to evaluate other types of activities occurring in the coastal zone, including: transportation, navigation, and port projects; oil and gas development; groundwater management; and land use planning.

The CPRA was charged by Act No. 8 of the 2005 1st Extraordinary Special Session of the Louisiana Legislature in November 2005 to develop, coordinate, make reports on, and provide oversight for a comprehensive coastal protection and restoration master plan, and annual coastal protection and restoration plans. The Executive Assistant to the Governor for Coastal Activities, chairperson of the CPRA, has been given broad powers to coordinate activities of state agencies responsible for carrying out coastal protection and restoration activities, and also for coordinating state policies on activities that would significantly affect these activities. Although the primary responsibility for carrying out the coastal restoration elements of the plan lies within the Department of Natural Resources and the primary responsibility for carrying out the hurricane protection elements of the plan lies within the Department of Transportation and Development, the CPRA must coordinate the activities of both departments to ensure available funding is allocated to areas of greatest need. The Integrated Planning Team, responsible for compiling this Master Plan, was an interim response to facilitate coordination of the activities of the two departments, but a critical need exists to provide a long-term mechanism to maintain focus, effectiveness, and integration of Master Plan implementation.

This need was recognized by an independent working group of scientists and engineers who prepared a report titled "A New Framework for Planning the Future of Coastal Louisiana after the Hurricanes of 2005" (Working Group for Post-Hurricane Planning for the Louisiana Coast, 2006). This report recommended establishing a Coastal Assessment Group and vesting them with the responsibility for executing integrated assessments to assure



that proposed projects are integral portions of a larger plan, and evaluate to what extent different economic, social, and environmental objectives are served. A second function of the Coastal Assessment Group would be to direct a Coastal Engineering and Science Program and to coordinate with related on-going initiatives (see chapter 5.5.2) to support adaptive management, participatory decision making, and rigorous independent peer review.

Although the CPRA has been empowered by State law to articulate the State's priorities and provide focus for coastal protection and restoration activities, no comparable body exists within the federal government. Although the LCA Program envisions a task force (including limited participation by the State) to coordinate restoration activities under the direction of the U.S. Army Corps of Engineers, it is unclear how this group would interact with the CPRA to resolve any differences that may arise. In addition, as is the case with the CWPPRA Task Force, it is likely that the State's role on such a federal task force will be limited, specifically with respect to discussions regarding obligations of federal funds. Since it is likely that overall implementation of the Master Plan will require a significant partnership with the federal government for both funding and legislative compliance, these deficiencies must be rectified to avoid significant delays in project implementation.

The following specific actions are recommended to facilitate long-term program management of Master Plan implementation:

1. A Coastal Assessment Group should be formalized and made a permanent group within the State's program management structure. This group should use the talents of scientists and other technical experts who can reach out to the international research community to supplement their understanding of specific issues. This group should specifically be charged with the following duties.
 - a. Report on the progress toward implementation of the Master Plan.
 - b. Make revisions to the Master Plan, as necessary. This process is set out in Chapter 6 of this Appendix.
 - c. Prepare future iterations of the Annual Plan: Ecosystem Restoration and Hurricane Protection in Coastal Louisiana (Annual Plan), ensuring that activities of the implementing agencies and the Coastal Engineering and Science Program are consistent with the priorities set out in the Master Plan.
 - d. Facilitate resolution of policy, legislative, and institutional issues that may hinder the implementation of the Master Plan, as identified by the CPRA.
 - e. Foster communication between CPRA member agencies, federal and local governments, and the public to ensure activities which may affect coastal protection and restoration are consistent with the Master Plan.
2. An Applied Coastal Engineering and Science Program should be established as a vehicle to resolve decision-relevant data and knowledge gaps, and facilitate engineering and technical advancements that support Master Plan implementation. This program should make maximum use of existing programs, such as the LCA Science and Technology Program, supplementing and integrating these programs as needed to ensure that scientific and technical needs relevant to decision making are addressed.
3. The federal government should act quickly to develop mechanisms for focusing federal involvement in an effective, problem-solving, partnership with the State. This should include a process to align the many diverse federal agency missions related to the protection and restoration of coastal Louisiana.



5.4 Policy and Legislative Issues for Early Resolution

Many needs for policy, legislative, and institutional changes have already been identified, and are discussed briefly below. This is by no means an exhaustive list; however, it is imperative that these issues be resolved early in the implementation of the Master Plan to avoid delays in construction of measures or unintended consequences of projects because of ineffective regulations to ensure that measures do not induce inappropriate activities.

5.4.1 Increase Awareness and Use of Non-Structural Protection Measures.

The state must encourage citizens and local governments to take greater advantage of the many non-structural measures available for reducing risk from storm surge. Such measures can help residents and businesses make their homes safer while also reducing flood insurance premiums.

- Mandatory disclosure laws. Require that purchasers be notified if their future property is located in either a 100-year or a 500-year floodplain. This notification should be made before financing for the purchase is approved.
- Floodplain management training. Require mandatory training in floodplain regulations for certified building officials responsible for enforcing the new statewide building codes. The training would help these officials integrate flood elevation requirements with the responsibilities of their jobs as inspectors. Such training should also be extended to real estate agents and lenders.
- Begin a statewide education/outreach campaign. The campaign's goal should be to inform citizens about the Community Rating System and the many ways in which citizens can reduce their flood insurance premiums. This campaign should be conducted by professional media consultants and use public service and/or paid announcements on television, radio, and print media.

5.4.2 Land Use Planning/Zoning/Permitting

During the planning and public comment period, the concern was raised many times that construction of new hurricane protection systems must not have the unintended consequence of inducing unwise development into high risk areas. Indeed, development has expanded into low-lying wetland areas in the past, serving to increase overall levels of risk and increasing the potential consequences if hurricane protection systems overtop or fail. However, this would be counter to our objectives of sustaining wetland ecosystems and reducing risk of coastal communities to storm-related damages. Such an unintended consequence of providing protection to populated areas must be avoided during implementation of the Master Plan.

In very straightforward terms, it is the goal to ensure that wetlands in coastal Louisiana remain sustainable into the future. Louisiana citizens agree that wetlands, both coastal marshes and interior forested wetlands, should be protected from residential and commercial development whether or not a levee is planned for the area. It is an essential component to conserve coastal wetlands and to reduce risk to low lying communities.

Land use planning and zoning are therefore urgent policy/legislative actions that need to be addressed in order to successfully achieve the intended outcomes of the Master Plan. Land use actions by the state must balance individual property rights with the need to maintain our coastal wetlands. While the coastal population of Louisiana requires protection, unwise development should be strongly discouraged in high risk coastal areas. Prudent planning supports examining the need to strengthen the Louisiana Coastal Resources Program and the Louisiana Coastal Zone Management Plan. Zoning actions by local governments, though not popular in



Louisiana, are another means of designating non-development areas in coastal wetlands. State legislation, as well as departmental policies, should endorse this initiative and look for ways to provide incentives to local governing bodies to enact and enforce region-wide land use zoning. Assurances that hurricane protection and coastal restoration measures do not result in wetland losses or increasing the assets at risk in coastal regions are imperative in the successful implementation of the Master Plan.

Louisiana Sea Grant and the Coalition to Restore Coastal Louisiana are currently working on a review of land use planning tools in Louisiana. Their objectives are to assess state land use planning authority and practices, to provide information on legal and policy tools to planners, to identify gaps in planning authority, to provide information on needs of planners' to lawmakers, and to facilitate better planning for public safety in the coastal zone. The CPRA will convene a working group, including parish governments, legislators, landowners, and agency personnel, to examine this report and develop a strategy for implementing required actions to guide smart growth consistent with the objectives of the Master Plan.

5.4.3 Land Owner Concerns/Partnership

Approximately 80% of coastal Louisiana is privately owned and the rights of these landowners, including mineral rights, must be honored as components of the Master Plan are constructed and operated. Through many years of working on projects in coastal Louisiana, DNR and DOTD have built strong working relationships with most of the major landowners to construct projects in a manner that achieves the goals but is also fair and equitable to the landowners. These relationships must be fostered during the implementation of the Master Plan to allow for timely completion of measures.

Land ownership has many faces in coastal Louisiana. In many cases, large tracts of land are owned by a single entity. In other cases, single parcels of property may be owned by hundreds of individuals that are either difficult to contact or, in some cases, unknown. This is particularly the case when land has been passed down through generations. Situations will also arise where multiple parcels of land will be needed to implement very large projects such as those proposed in the Master Plan. In any of these cases, a single landowner's desire not to participate in project implementation can result in a project being delayed indefinitely or even terminated.

Multiple options must be available to reach fair and equitable solutions for building projects on private lands. The first course of action would be to acquire the necessary easements to construct the project. Another option would be to work to allow for separation of surface rights from mineral rights. The state could then purchase the surface rights to the land, while the original landowner would retain all subsurface (including mineral) rights.

In cases where such an agreement cannot be reached expropriation is an option. Both DNR and DOTD have the capability to expropriate under Title 19 of the Revised Statutes. However, expropriating involves filing a law suit, which must be resolved prior to initiating project activities. This is a long and contentious process, and is clearly not a desirable option.

Another choice for acquiring the necessary land rights to construct projects that are in the best interest of the public is an authority known as "quick take". When a negotiated settlement cannot be reached after good faith negotiations between the implementing agency and the landowner, and if delays in land acquisition will delay project construction, quick take authority allows the agency to place the offered compensation in the court registry and file a law suit against the landowner. Progress toward project construction is not hindered by that action, and the suit, and whatever compensation the landowner will ultimately receive, is settled at a later date. The DOTD has this authority for roadway construction, and levee districts have this authority for levee projects. DNR only



has quick-take authority to acquire lands for coastal restoration projects on barrier islands if a settlement cannot be reached, granted to it through an amendment in 2001. No further quick-take authority legislation has been passed for coastal restoration projects because of legislator and landowner opposition and because of technical complications caused by land reclamation issues.

To date, DNR has never entertained the idea of using either form of condemnation and considers both to be options of last resort. However, in order to ensure that these large-scale projects may be built in a timely fashion, these options must be available to both implementing agencies, particularly in cases where property would be damaged or destroyed in order to build project features. Thus, although it is the clear preference to work in partnership with landowners to achieve the objectives of the Master Plan, passage of the needed legislation to provide DNR and DOTD with “quick-take” authority, similar to that already provided to DOTD for highway construction, is a necessary early action in the implementation of the Master Plan.

5.4.4 Coastal Forestry

Louisiana’s coastal wetland forests are of tremendous economic, ecological, cultural, and recreational value to residents of Louisiana, the people of the United States, and the world. Large-scale and localized alterations of processes affecting coastal wetlands have caused the complete loss of some coastal wetland forests and reduced the productivity and vigor of remaining areas. This loss and degradation threatens ecosystem functions and the services they provide.

Best management practices for coastal wetlands were reported in the Louisiana Department of Agriculture and Forestry, Environmental Protection Agency, and Louisiana Department of Environmental Quality report (2000). However, no such recommendations exist for the specific ecosystems of coastal forested wetlands. In response to the public’s concerns for continuing loss of Louisiana’s coastal wetland forests, Governor Foster, before leaving office, commissioned the formation of a task force to address these concerns. Immediately upon taking office, Governor Kathleen Blanco followed through with this response by activating the task force, which later became known as the Coastal Wetland Forest Conservation and Use Science Working Group (hereafter referred to as SWG). The mission of the SWG was to provide information and guidelines for the long-term utilization, conservation, and protection of Louisiana’s coastal wetland forest ecosystem, from both environmental and economic perspectives. Their findings were compiled and submitted in a report entitled “Conservation, Protection and Utilization of Louisiana’s Coastal Wetland Forests” (Coastal Wetland Forest Conservation and Use Science Working Group, 2005).

To accomplish this mission the following objectives were developed:

- Gather and synthesize scientific information available on regeneration, growth, and potential harvesting effects on coastal wetland forests.
- Gather and summarize field information on general characteristics of previously harvested bald cypress and tupelo forest stands to evaluate their potential to regenerate, become established, and remain vigorous.
- Review existing laws, regulations, policy, and guidelines affecting coastal forestry activities (and current forest conditions).
- Develop science-based, interim guidelines for the conservation and utilization of coastal wetland forests.
- Identify critical areas of priority research needed to refine these interim guidelines.



Additionally, the Governor's Office has commissioned the Advisory Panel to define stakeholder issues and make associated policy recommendations for sustainable management of coastal forests in Louisiana based upon the SWG 2005 report. The Advisory Panel, consisting of stakeholders, non-government organizations, and state and federal agencies, have recommended several options for immediate implementation and developing a framework to support long-term planning for sustainability. Major recommendations are summarized below:

1. Develop better data collection, management, and dissemination procedures to identify and assess health of coastal forests and provide necessary information for management decisions.
2. Continue development of forest management guidelines that support sustainable forestry practices in coastal wetland forests as a supplement to the State's forestry best management practices..
3. Create an interagency team to define goals, develop a process and procedure, and create a methodology (through appropriate incentive programs) to manage coastal wetland forests for their ecosystem values, and to protect, conserve, and restore these areas in an economically and environmentally sustainable manner.
4. Develop state programs for restoration of existing coastal wetland forests or creation of new coastal wetland forests on agricultural or other suitable open lands, and ensure these programs work in concert with relevant federal programs.
5. Develop a long-term coordination mechanism for interested stakeholders, including landowners, environmental groups, state and federal resource and regulatory agencies, and scientists and engineers in order to foster information exchange and education, and to coordinate efforts for the protection, conservation, and restoration of coastal wetland forests.

For the full text, please see the Advisory panel's recommendations, available at www.lacpra.org. The CPRA has accepted the recommendations of the Advisory Panel and moved to create a working group under the direction of the Governor's Advisory Commission on Coastal Protection, Restoration, and Conservation. The purpose of this group will be to establish a long term dialogue for this important issue and recommend immediate actionable policies for CPRA approval.

5.4.5 Dedicated Funding Source

Reliable funding streams must be obtained for both the Federal and non-Federal shares of program costs. To date, the State's Coastal Protection and Restoration Fund receives scheduled inputs of \$25 million annually to address coastal protection and restoration issues. Without a significant change in cost sharing requirements for federal projects, this level of funding is not adequate to address the problem. Similarly, the federal government dedicates approximately \$50 million per year to the restoration program through the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) program. Funding for hurricane protection projects and other coastal restoration activities comes through annual Federal and State appropriations process, and as such, it is subject to fluctuations due to changing priorities. This may slow the pace of critical projects. The State has been fortunate to receive two installments of funding from outer continental shelf oil and gas funds through the first two phases of the Coastal Impact Assistance Program. These two installments total approximately \$565 million, but the unpredictable nature of the timing (separated by five years) and magnitude (\$25 million vs. \$540 million) make it difficult to plan for long-term implementation.

Successful national civil works programs, such as the construction of the interstate highway system and the Mississippi River and Tributaries (MR&T) project, are useful examples of programs that were made national priorities and provided with significant and regular funding to implement more certain aspects of the programs



even as uncertainties were being reduced in the overall program. Coordinated Federal and State legislation, and other innovative solutions, will be necessary to define and implement a program that will be capable of responding to the protection and restoration problems of coastal Louisiana in a timely manner and at appropriate scales. Provision of a reliable source of funds, with strict accountability standards, is necessary to ensure sustainability of program implementation.

5.4.6 Implementation Process

The current framework under which the federal government engages in activities related to the Master Plan can be traced back to the Water Resources Council's *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*, the Water Resources Development Act of 1986 and subsequent re-enactments, and attendant administrative policies and Corps of Engineers regulations. This implementation framework can be useful in implementing less-complex water resources projects. However, it is increasingly apparent that large multipurpose programs, such as that laid out in the Master Plan, cannot be effectively implemented on timescales appropriate for the urgency of the need under existing processes. Specific recommendations for improvement of intergovernmental coordination are included in Chapter 5.3 of this appendix, but additional improvements to the Federal water resources implementation framework are required. Several recent National Research Council reports (NRC 2004a; NRC 2004b; NRC 2004c) all make specific recommendations for adapting Federal water resources planning and implementation frameworks to better address the unique challenges of large, multi-purpose programs.

Of specific concern to the CPRA is the relative unpredictability of the Congressional authorization and appropriations processes. Although efforts are made to enact a Water Resources Development Act—the primary vehicle used to obtain project authorization—every two years, this schedule is more often missed than met. The requirement for Executive Branch approval and Congressional action to move from planning to design and then to construction for each project can introduce years of delay in project implementation. Legislative authorizations are typically restrictive and prevent rapid adaptation in project construction or operations. In addition, appropriations decisions are made on an annual basis, resulting in funding instability for long-term, large-scale projects. Increasing reliance on Continuing Resolutions in the early parts of each Federal Fiscal Year exacerbates this problem and contributes to delays in project initiation and completion. The CPRA understands the need for safeguards to ensure that funds are allocated and expended efficiently and appropriately, but authorization and appropriations processes must be put in place to reduce delays and stabilize funding levels so that program implementation is not delayed by political considerations.

5.5 Adaptive Management Framework for Decision Support

It is understood that large programs such as the Master Plan require years to implement. Recognizing the dynamic and interrelated character of natural and socio-economic systems, as well as the rapid pace of advances in science and technology, the coastal protection and restoration program and the associated projects must be managed in a way that allows for adaptation in response to these changes.

As discussed above, long-term sustainability is the underlying goal of Louisiana's Master Plan. To evaluate the progress of Master Plan implementation and whether the coast of Louisiana is on a trajectory towards sustainability, the State must employ a strategy which is responsive to improvements in technology and lessons learned during implementation and management. Adaptive management is a concept that has been embraced in many large-scale ecosystem restoration and flood control programs, and is the approach that will be utilized to manage the long-term implementation of the Master Plan. This approach links all phases of program



implementation from concept through project operations and even changes in the plan itself. It is thus dependent upon collaboration, flexibility and continued improvement.

Adaptive management simply acknowledges that uncertainty exists in the anticipated outcomes of manipulating large complicated systems, that understanding the complexity of systems requires the knowledge or expertise of many disciplines, and that we must continually monitor the results of our actions in order to adapt as necessary. It is also a vehicle to allow the existing body of best practices to be used, while reaching out to all stakeholders to understand the best technically sound and socially acceptable way to proceed.

The adaptive management approach seeks to ensure that all implemented projects contribute to larger-scale benefits. This essentially creates a two-tiered approach: project-level and system-level planning and assessment (figure 5.2).

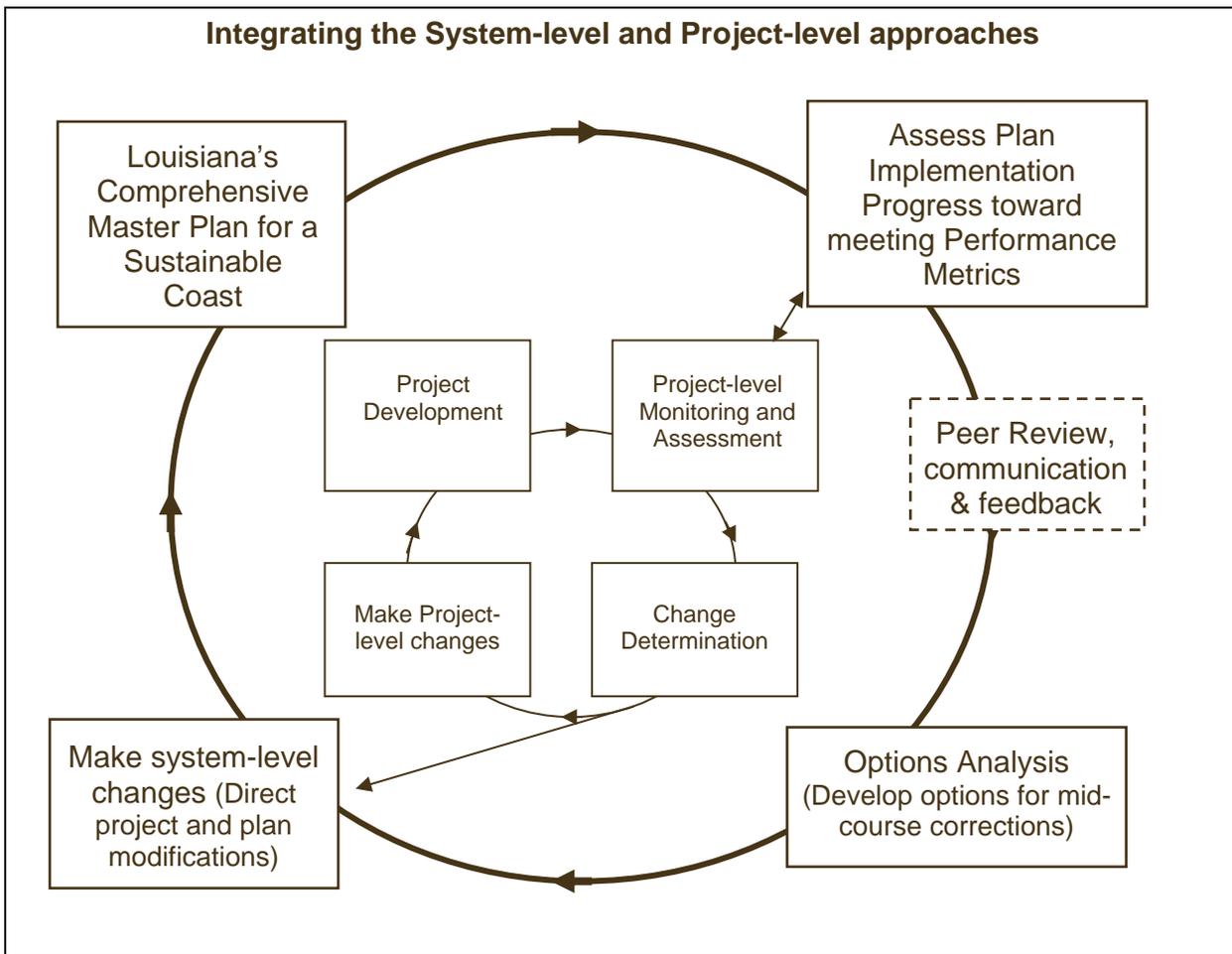


Figure 5.2: A two-tiered approach to adaptive management illustrating the coordination and interdependence of the project- and system-level approaches. The project-level approach (inner loop) is independent of funding authority and falls under the umbrella of the system-wide restoration and protection program (outer loop).

The system-level approach focuses on regional and ecosystem-scale resource management. The project-level approach focuses on more localized impacts and responses. It is essential that these two levels of management are coordinated, are complementary, and contribute to achievement of common principles and objectives which



govern Louisiana’s coastal protection and restoration efforts. In addition to hurricane protection and ecosystem functions and values, human functions need to be considered and evaluated in relation to expected outcomes of ecological services and structure and functions.

Learning and adaptation are elements that close the feedback loop and initialize the next cycle of iterative management actions. Information from monitoring, results of experimental manipulations, model forecasts, and supporting research are combined to yield either confirmations of existing beliefs or new explanations of the factors that control the system. This vital information should be readily available so that all stakeholders, from managers to the general public, may reach the most technically sound and socially acceptable solutions.

The following section describes the necessary actions to manage long term implementation of the protection and restoration program. It does not necessarily seek to charge groups within implementing agencies with tasks, but rather to identify all of the major components that must work together to track the intended effects of actions, projects, and programs to determine whether the benefits materialize as predicted, and use that information to adjust projects, or even the overall plan, as appropriate. A specific organizational structure will need to be created, and funds dedicated, to ensure that all of the necessary components of adaptive management are implemented as part of the long term management of the Master Plan.

5.5.1 Master Plan Management – Adaptive Implementation

There are three basic components of plan management: program definition, implementation actions, and adaptation. Implementation actions include not only construction of projects but also policy and legislation changes, tool development and advancing knowledge, which inform and facilitate plan adaptation (Figure 5.3).

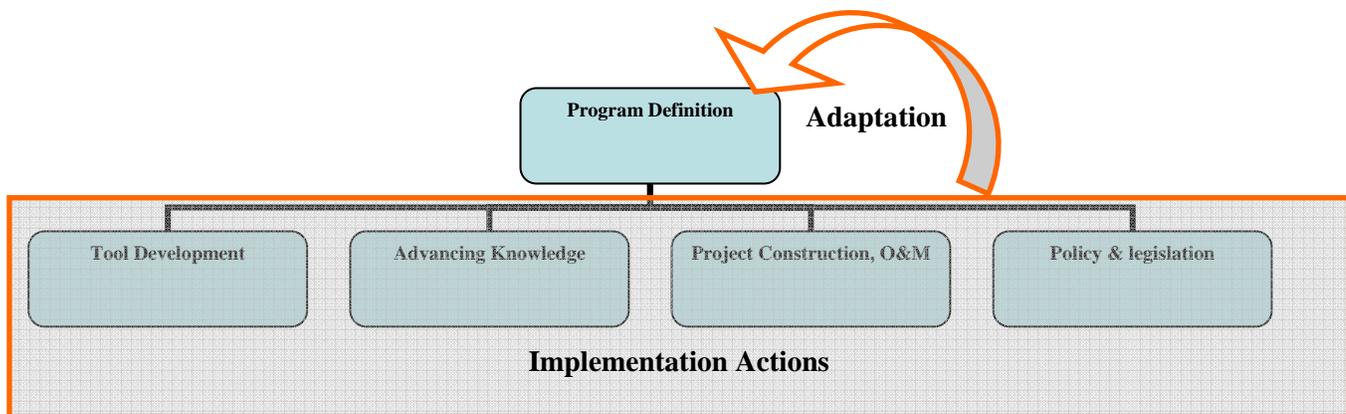


Figure 5.3: Basic components of plan management and their relationships



5.5.1.1 Program Definition

Program definition is the intent of this report. The Master Plan defines the coastwide objectives and provides a list of measures (projects and promising concepts) that are expected to deliver results that will meet the objectives. However, this list of measures was generated based upon existing understanding of ecosystem function, existing protection systems, and human land use patterns. It is fully anticipated that this list of measures, and possibly even the program objectives, will change in the future based on changed conditions and advances in knowledge and continued public input.

5.5.1.2 Implementation Actions

All activities should support implementation and advancement of Master Plan objectives. Actions are related not only to project construction and operations and maintenance (as described in Chapter 4), but also to recommendations for policy and legislative changes (see Section 5.4) and monitoring, modeling, assessment, and adaptation (discussed below). In order to maintain a common vision and to ensure institutional memory, design and operations & maintenance manuals that serve as ‘living documents’ to aid planners and engineers, and regular reporting on implementation performance are also necessary actions. All actions are unified toward common goals with an effective and on-going stakeholder & public communication strategy.

Tool Development

Tools must be developed that will improve forecasting and assessment capabilities. This applies not only to those tools needed to design and evaluate projects but also to those needed to evaluate overall program success.

At the system scale, performance metrics must be established against which program implementation success is measured. These performance metrics should stem from coastwide objectives and be based upon the current understanding of system function as described in conceptual models. Some examples of performance metrics may include land:water ratio; habitat change; salinity (isohalines); marsh surface elevation/accretion; subsidence/sea level rise; social and economic metrics; and protection metrics. Program-scale analytical forecasting and assessment models must also be developed and maintained that build upon conceptual models to provide planners with the most current understanding of system function, needs, and response to actions as plans are developed, implemented, and modified.

Project goals and modeling tools must also be established and updated regularly as new information becomes available. These tools are necessarily more detailed, accounting for biological and physical processes at a higher resolution than those used for program-level modeling.

Advancing Knowledge

Modeling, monitoring, and assessment of program implementation must be linked in order to effectively and efficiently advance the program. Existing data collection efforts and modeling capabilities must be reviewed and additional needs identified and addressed in order to resolve program implementation or assessment uncertainties. These needs may be related to the science, engineering, modeling, socio-economic impacts and changes, implementation, technical methodology, resource constraints, or effectiveness of measures. They may also be related to development and refinement of forecasting tools. These advances in the state of science and technology must be addressed in order to achieve full and balanced integration of protection and restoration objectives.



Each need will require a different resolution strategy, including focused demonstration or research projects, and monitoring of existing projects or natural conditions. At the system scale, coastwide monitoring and baseline data collection are essential to support the advancement of conceptual and analytical models that will inform planners as they review program performance in order to make recommendations for change. Planners will also require more detailed understanding of individual projects' contribution to program objectives. Demonstrations of new technologies, such as those to advance engineering of protection measures, would also be very useful for increasing understanding of project level impacts.

Project Construction, Operations & Maintenance

Recommendations for changes in construction or operation and maintenance of individual projects could stem from either underperformance in contributing to coastwide objectives, as described above, or from underperformance from an engineering perspective. Thus, individual projects also need to be assessed for their engineering performance and their long-term sustainability (operation & maintenance cost and feasibility).

Policy & Legislation

Policy and legislation are more difficult to manage adaptively. Once promulgated, changes or modifications are slow to enact. However, recommendations for changes in current policy and legislation may be necessary to protect Louisiana's citizens from future vulnerability and harm. Some key areas may include land use and development restrictions or guidelines, insurability, social services and infrastructure support. Different areas of the coast will have different levels and measures of protection, depending on technical feasibility of construction and long-term sustainability. Revising policy and legislation will protect citizens from unanticipated future risk.

5.5.1.3 Adaptation

Learning from the actions taken and making project or even plan modifications based on the increased knowledge is perhaps the most challenging of all the steps of plan management. In fact, the most commonly identified barrier to adaptive implementation of a program is the lack of a structured framework for "closing the loop" on learning, communicating, and applying lessons at all phases of implementation. As outlined above (Figure 5.2), a management framework must incorporate program and project evaluation (modeling) of anticipated performance, and utilize performance assessment against overall program goals and objectives (monitoring) to guide decisions for changes to projects or even to the Master Plan (Parsons and PBS&J 2003).

Plan implementation requires modeling, data collection, and analyses at appropriate scales to ensure that actions are achieving their intended outcomes at both project and program scales. This requires a systematic review and analysis of project monitoring data against anticipated performance, to assess whether the project is delivering anticipated benefits to coastwide objectives. From these activities come recommendations on the actions that are needed to improve performance against program objectives.

Future decisions on projects and their operations must be informed by an integrated assessment of contributions of these actions to the multiple program principles and objectives. Any engineering, scientific, or technical advancements that are deemed necessary for successful implementation of measures or integration of program objectives must be identified and resolved expeditiously. Thus, work must focus on pursuing answers to questions that are critical to the decisions being made.

Under the existing management framework, the Department of Transportation and Development (DOTD) and the Department of Natural Resources (DNR) are responsible for all aspects of project implementation, including planning; design; construction; and operation, maintenance and monitoring of protection and restoration projects.



Each agency already operates under a management structure that allows for effective implementation of projects, including mechanisms for performance assessment of the engineered effectiveness of projects.

At the program level, continued planning, performance assessment, and plan management must be maintained. Performance metrics against which plan implementation is reviewed must be established, and projects or even the plan must be updated as needed to improve program effectiveness. Program effectiveness must be appraised in an integrated manner to ensure that each project, as well as the overall program, takes advantage of synergies and avoids or mitigates conflicts among coastwide objectives.

Because this is in effect a new program which integrates and focuses activities of two distinct departments of state government, a mechanism for managing the overarching responsibilities for program planning, implementation, monitoring, assessment, and revisions must be identified and implemented. Specific recommendations for this may be found in section 5.3 of this chapter.

5.5.2 Scientific & Technical Needs – Early Actions

5.5.2.1 Background

The State of Louisiana, in cooperation with local and federal government entities, the academic community, and the affected public, has been working for decades on advancing the science and technology related to ecosystem restoration and hurricane protection. Hurricane Betsy in 1965 served as the impetus for change in how Louisiana's vulnerability to flooding was perceived. After this storm, the USACE was given the authority to begin work on levee systems that would protect the extremely vulnerable low-lying regions of coastal Louisiana not only from river flooding but also hurricane surge flooding events. Since that time, the State and USACE have worked to improve hurricane protection and the technologies for providing such protection in this vulnerable landscape. Alterations to the natural landscape were first documented in the 1920's (Viosca 1927), and by 1978 the crisis had become so severe that the State passed the Louisiana State and Local Coastal Resources Management Act. Since that time, the state and federal governments have evolved their management and technical approaches to addressing the land loss crisis in response to increased scientific understanding of the problems and ecosystem response to restoration technology.

Today, the DNR Office of Coastal Restoration and Management (OCRM) works to ensure that the best available scientific and engineering knowledge is applied to the planning, construction, operation, and maintenance of restoration projects through a variety of efforts. Recently the decision was made to transition from small-scale, project level monitoring to an ambitious coastwide monitoring program. Currently, two components are being implemented and are known as the Coastwide Reference Monitoring System (CRMS) - Wetlands and the Barrier Island Comprehensive Monitoring (BICM) program. Other components that have been proposed should also be implemented to ensure that ecosystem monitoring parameters needed to inform models and managers are collected (Steyer et al. 2003). Through the Louisiana Coastal Area Science and Technology Program (see Appendix A, USACE 2004), DNR is working with USACE to reduce key uncertainties related to ecosystem restoration. This program includes a management organization designed to ensure that the modeling, monitoring, research, and technology development that are supported by this program are directly tied to the needs of the restoration program. It also includes a structure for stakeholder and peer participation and review. Through the Coastal Louisiana Ecosystem Assessment and Restoration (CLEAR) Program, administered by faculty at Louisiana State University (sponsored by the Department of Natural Resources), the state has also been building its own capacity to readily address such uncertainties. These initiatives, in addition to other on-going monitoring, modeling, research, database management, and assessment work throughout the state, will allow the restoration program to continue to meet the challenges of implementing such a large-scale restoration effort.



Levee construction, inspection, and maintenance have also evolved through the decades since many of the levee boards and districts were established. The federal government first began work on levee and flood control as a national response to the Mississippi River flood of 1927. The Mississippi River and Tributaries Act of 1928, required local non-federal sponsorship of levee construction projects as well as local operation and maintenance of the completed structures. After the disastrous hurricanes of 2005, the state took steps to enhance the levee inspection program (La.RS:38:241 and 38:247). The Coastal Protection and Restoration Authority is now responsible for ensuring that hurricane protection levees are well planned, constructed, and maintained. In support of this goal, The Department of Transportation and Development (DOTD) has implemented a mandatory levee inspection program for hurricane levees and is in the process of obtaining an elevation survey of the existing hurricane levee protection system. Inspections are the responsibility of the individual levee districts. To ensure consistency in quality and documentation of the inspections, DOTD developed a levee inspector training and certification program in addition to its training program for directors and staff of levee boards that has been in effect for many years. The Department of Transportation and Development is also designing a program to provide oversight and quality assurance inspection of all USACE levee construction projects. As required by state legislation, each levee district also has maintained operational and emergency plans for many years.

In addition, the Governor's Office of Homeland Security and Emergency Preparedness, Louisiana State Police, and DOTD work together to maintain and improve an emergency operation plan for hurricane evacuation. In 2004, DOTD and Louisiana State Police, in cooperation with the New Orleans and Baton Rouge American Red Cross chapters as well as Mississippi transportation officials, began developing a new evacuation plan because of performance deficiencies that were discovered during the Hurricane Ivan evacuation. The new plan was released on June 1, 2005, and was put to the test August 27, 2005 as Hurricane Katrina approached. The contra-flow implemented provided greatly increased evacuation efficiency in southeast Louisiana. In a May 28, 2006 article, The Times-Picayune stated that the "...evacuation in the two days before the hurricane struck was no less than a triumph." In 2006, the National Partnership for Highway Quality (NPHQ), a group of government and private industry transportation leaders, presented DOTD with the Gold Award for its collaborative evacuation operations that helped more than 1 million people leave the New Orleans area before Hurricane Katrina struck. In announcing the award the NPHQ noted:

- Evacuation by contra-flow during Hurricane Katrina was faster and more efficient than the Hurricane Ivan evacuation. A two-thirds increase in traffic volume on the road was achieved – 20,000 vehicles per hour versus 12,000 during Hurricane Ivan.
- Real-time traffic information was provided through the Traffic Control Center every 30 minutes to the media and to other gulf states.
- During the 25 hours that contra-flow operated, more than 1 million people were evacuated.

DOTD continues to work on evacuation operations improvement, using the most recent experiences from Hurricane Rita to improve the plan and adapt for unforeseen consequences. DOTD also considers hurricane evacuation in the planning of all transportation improvements throughout the State's roadway network.

Also recognized is the direct impact that storms can have on the infrastructure itself. Many at-grade coastal roads are subject to storm surge and need protection from the scouring action of surge waters, both when rising and retreating. In furthering ongoing efforts, a strong emphasis has been placed on new technology, such as Intelligent Transportation Systems, including such elements as dynamic message signs with real time information displays. In addition, to assure that needed research is conducted on important transportation issues, including improved hurricane evacuation, as well as the timely investigation and implementation of cutting edge



technology, DOTD works closely with the Louisiana Transportation Research Center (LTRC). Created in 1986, and sponsored jointly by DOTD and LSU, LTRC has grown to national prominence. The center conducts short-term and long-term research and provides technology assistance, engineering training and continuing education, technology transfer, and problem-solving services to DOTD and others in the transportation community. The center is largely supported by funding authorized by the Federal Highway Administration. LTRC's goal is to merge the resources of state government and universities to identify, develop, and implement new technology to improve the state's transportation system. LTRC combines the efforts of DOTD and the state's universities to find innovative solutions to Louisiana's wide ranging transportation problems. Examples of titles of recent reports include "Development of Geotechnical Information Database-Computer Program to Expedite Soil Subgrade Survey Data to Designers" and "Louisiana Offshore Terminal Authority (LOTA) Environmental Monitoring: Marine/Estuarine".

In 2005, hurricanes Katrina and Rita prompted another paradigm shift in how the State approaches these issues that are so crucial to the long term sustainability of our coastal zone. The passage of Act 8 also challenges the science and engineering community to work to further advance the scientific understanding and technological tools in ways that will allow us to meet seemingly conflicting objectives within the coastal zone: provide for increased levels of hurricane protection while improving the sustainability of the natural landscape. These advances will come by building upon past and ongoing work in these disciplines.

5.5.2.2 Recommendations

An Applied Coastal Engineering and Science Program (measure PM-1) is recommended to provide a dedicated funding stream using state resources to reduce key uncertainties and to promote advances in the science and technology fields critical to implementation of the Master Plan. Some early specific needs have been identified as discussed below. Many have been initiated by programs such as those discussed above, while others will need to be expanded in scope or level of effort utilizing this measure (PM-1) in order to meet the broader needs of the Master Plan.

Improve and integrate forecasting and design tools required to assess plan and project effectiveness in meeting objectives

Models are mathematical or conceptual approximations of systems. They simulate essential processes, functions, and structure of systems. They are useful in identifying attributes that provide a measure of the behavior of a broad suite of properties and predict the outcome of alternative courses of action. Used as a template on which knowledge about system processes and functions are systematically organized, integrated, and updated, models become the dynamic archive for knowledge about system response to variability in driving forces including management actions.

There are myriad models available to assist with plan forecasting and project design including conceptual, hydrodynamic, storm surge, and ecosystem impacts at various geographic scales. Many models have been utilized in coastal Louisiana to guide distinct hurricane protection and ecosystem restoration decisions. However, further development and integration is required to aid in the planning and analysis of the newly integrated objectives of the Master Plan in order to provide more robust analyses and more defensible results. Two types of improvements are envisioned. One type of improvement is to link ecological model components (e.g. habitat switching and suitability models) with physics-based models (e.g. hydrodynamic and storm surge models). The other type of improvement resides in improving the ecological modeling components, including land change, water quality, habitat switching, and habitat suitability – including fisheries dynamics. In addition, socioeconomic models which link human and economic value to biological



and physical processes have not been given equal attention and must also be advanced if we are to have all the tools needed to fully evaluate management decisions against all four Master Plan objectives.

Support a robust data collection and information management program

Models are only as reliable as the input data quality and the assumptions by which the models are calibrated and validated. Monitoring provides the data, and focused research and demonstration projects inform the assumptions used in model development. Monitoring parameters and data collection frequency must also supply information appropriate to assess program implementation performance. Program performance metrics against which program implementation progress is measured must also be generated early, and used to guide expansion of the monitoring program.

Basic data collection is a necessary component of calibrating and advancing predictive models. Some examples of the types of basic data that should be collected, archived, and updated as conditions warrant include: bathymetry; topography; geotechnical information; surveys; regional subsidence/ relative sea level change rates, including investigations of fault zones; settlement rates of stacked material (levees, marsh creation, etc); flow at critical hydraulic exchange points; community population statistics; and economic inventories. Additionally the coastwide ecosystem monitoring efforts described above should be expanded to include a broader array of biological, physical, and societal parameters in order to fully assess success of plan implementation in meeting the Master Plan objectives.

Data sets are most useful when they are organized and integrated into forms that are universally accessible and useable. The data collection effort described above will require that the database management and repository capacities be increased in order to ensure that all pertinent data and research findings are readily available for plan forecasting and evaluation. Thus, it is recommended that existing spatial and temporal data management systems be reviewed and expanded to ensure that all scientific and engineering information needed to aid in design and review of performance of projects and the program is maintained appropriately and may be readily accessible to various agencies, academia, and the public.

Regional Sediment Management

There is a substantial amount of marsh creation outlined in this document. One of the most significant uncertainties surrounding this effort involves whether sufficient sediment resources exist within the Mississippi River and the Louisiana coastal zone to facilitate the amount of marsh construction outlined in this document. Specifically, at present we do not have a reliable inventory of how much sediment will be available in both the near-term and long-term future from the river, offshore, and via beneficial use and dedicated dredging efforts, to support coast-wide marsh creation efforts. The LCA Science and Technology Program has recently initiated efforts with the State of Louisiana and the US Army Corps of Engineers to develop a coast-wide Regional Sediment Management Program, which will provide the information that we need to determine how much marsh creation we can realistically expect to do under present circumstances.

Support focused research and demonstration projects to reduce uncertainties or test new technologies associated with plan implementation

Many questions may be answered through modeling supported by focused data collection. Others require that theories or new technologies be tested under field conditions or through utilization of other experimental techniques. Such research that focuses on advancing the state of knowledge or technology available to support management decisions must be supported. Some examples of such topics include: investigate and describe potential impacts of climate change on program recommendations; increase understanding of the influence of wetlands and other coastal features on storm surge and wave patterns may facilitate balanced



achievement of Master Plan objectives. These are but a few of the potential topics that would benefit from focused research initiatives.

Ensure adequate program performance assessment and feedback mechanisms

One of the early actions of Master Plan implementation will include the generation of performance metrics against which program implementation progress will be measured. This will not only provide a benchmark against which planners gauge implementation progress, but will also inform decisions regarding which specific data parameters, models, and research should be pursued to support decisions.

In order to assist managers with this task, every project constructed should also include ‘as built’ designs as part of the contractor deliverable. Other “living” documents, such as design, operations & maintenance, and assessment protocol manuals should also be developed to maintain institutional knowledge of projects and the program in general. Peer review, to include both technical and public stakeholders, is another crucial tool that managers must employ to improve the technical quality and scope of the on-going management decisions that will be made. Using these tools, a regular implementation performance reporting mechanism must be established to allow managers, stakeholders, and the public to understand program progress and to make timely adjustments to projects or the plan. A framework to integrate hydrodynamic, hydraulic and ecological models into the decision-making process would aid in this effort. The framework should include a decision-making protocol. One example of this is Multiple Criteria Decision Analysis (MCDA), which is well-suited for addressing problems where multiple stakeholders are balancing multiple alternatives to achieve numerous objectives.

Increase stakeholder and public participation

Establishing an effective and on-going stakeholder & public communication policy must also be an early action in order to ensure successful implementation of the Master Plan. In formulating this first approximation of the comprehensive solution for coastal hurricane protection and ecosystem restoration, the Integrated Planning Team hosted upwards of 4 dozen stakeholder, science and engineering, and public meetings. All of this information was invaluable in the development of the Master Plan. As implementation and refinement of the plan continues, it is imperative that this sort of interaction continue, and even increase, to ensure the long-term success of the program.



6.0 Future Plan Review & Modification

6.1 The need for review

The process described below will be used to consider future iterations of the plan. The first iteration of Louisiana's Comprehensive Master Plan for a Sustainable Coast has been prepared utilizing the best information and analytical tools available to the CPRA Integrated Planning Team. This has provided a sound basis upon which to define the long term management strategy; however the uncertainties in this plan, indeed in any plan based upon predictions of future conditions, require that the Master Plan be regularly revisited to ensure it remains appropriate for the prevailing conditions.

The Master Plan is designed to be a 'living document' that will evolve over time to reflect our improving understanding of the coast and its management, and as external factors change. This evolution will occur in two primary ways:

- Firstly, the operation and implementation of individual measures within the program will be regularly assessed to determine the need for adaptation either because of engineering performance relative to objectives or to reflect changing societal or environmental circumstances or improved scientific understanding of how to deliver specific outcomes.
- Secondly, the full Master Plan will be periodically reviewed to assess the need for modifications; new information will be incorporated at this time to ensure that the plan remains appropriate to deliver the defined objectives.

Central to these processes will be the monitoring and science and technology programs described above. The operation and maintenance of individual measures, and the process for modifying operation based upon programmatic learning, are set out in the proceeding sections of this chapter.

The process for future review of the full Master Plan will be established to ensure the plan is consistent with:

- improved technical understanding arising from plan implementation (e.g. design and performance of measures, coastwide physical processes, habitat development);
- scientific developments (e.g. understanding of climate change);
- changes in regulatory or administrative arrangements;
- significant changes to the form of the coast (built or natural) which alter the context of the plan.

The following sections set out the process by which the Master Plan will be reviewed into the future.

6.1.1 Scheduled review

The early stages of implementation of this first iteration of Louisiana's Comprehensive Master Plan for a Sustainable Coast, in particular the large-scale planning measures and Applied coastal Engineering and Science Program will provide for significant improvements in our understanding of key aspects of this coast. This, together with the resolution of the program management framework, make it possible that there will be a need to revisit the plan within a relatively short timescale to use this improved understanding to make revisions.

It is not possible, or necessary, at this time to define an exact timetable for this review, however it is anticipated that the review will take place within five years of starting the implementation of the plan.



Beyond the first review of the Master Plan, it will be necessary to regularly review the plan into the future. It is considered likely that a 5 to 10 year period will be appropriate for these future reviews, however, changes in understanding of the coast or the management framework will be monitored to determine (within that 5 to 10 year period) when the Master Plan measures become sufficiently out of date as to warrant a full review of the Plan. This will be a judgment made by the CPRA. Regardless of other developments, it is considered that a review should be undertaken every 10 years (if not before) in order to ensure the recommendations remain appropriate.

6.1.2 **Unscheduled Review**

In addition to these regular reviews it is possible that circumstances could unexpectedly change sufficiently to warrant an early review of the Master Plan. By definition it is not possible to predict what such events may be; however, possible scenarios would include:

- a major storm event which changes the feasibility of the plan measures;
- a significant change in the funding streams available for the Master Plan; and
- findings that may make major assumptions regarding constraints to plan implementation invalid.

These reviews would be triggered by the CPRA, based upon their judgment of the implications of the change for plan implementation.

6.2 **Master Plan Review Process**

The process for future review of the Master Plan will follow a risk-based process, similar to that taken in development of this first version of the Plan (set out in Appendices B and H). This process is defined to address the requirements of long-term planning for the Louisiana coast, and builds on the experiences from existing sustainable coastal planning approaches, in particular the Shoreline Management planning process being followed in the United Kingdom (Defra, 2006).

A review of the Master Plan will involve consideration of all aspects of the existing plan, from the principles and objectives through to the individual measures. It will be important to involve stakeholders in all stages of this process. This will be facilitated through the definition and execution of a clear and inclusive stakeholder engagement strategy. The flow chart below provides a description of the steps involved in this process (Figure 6.1), and the following sections elaborate on this process.

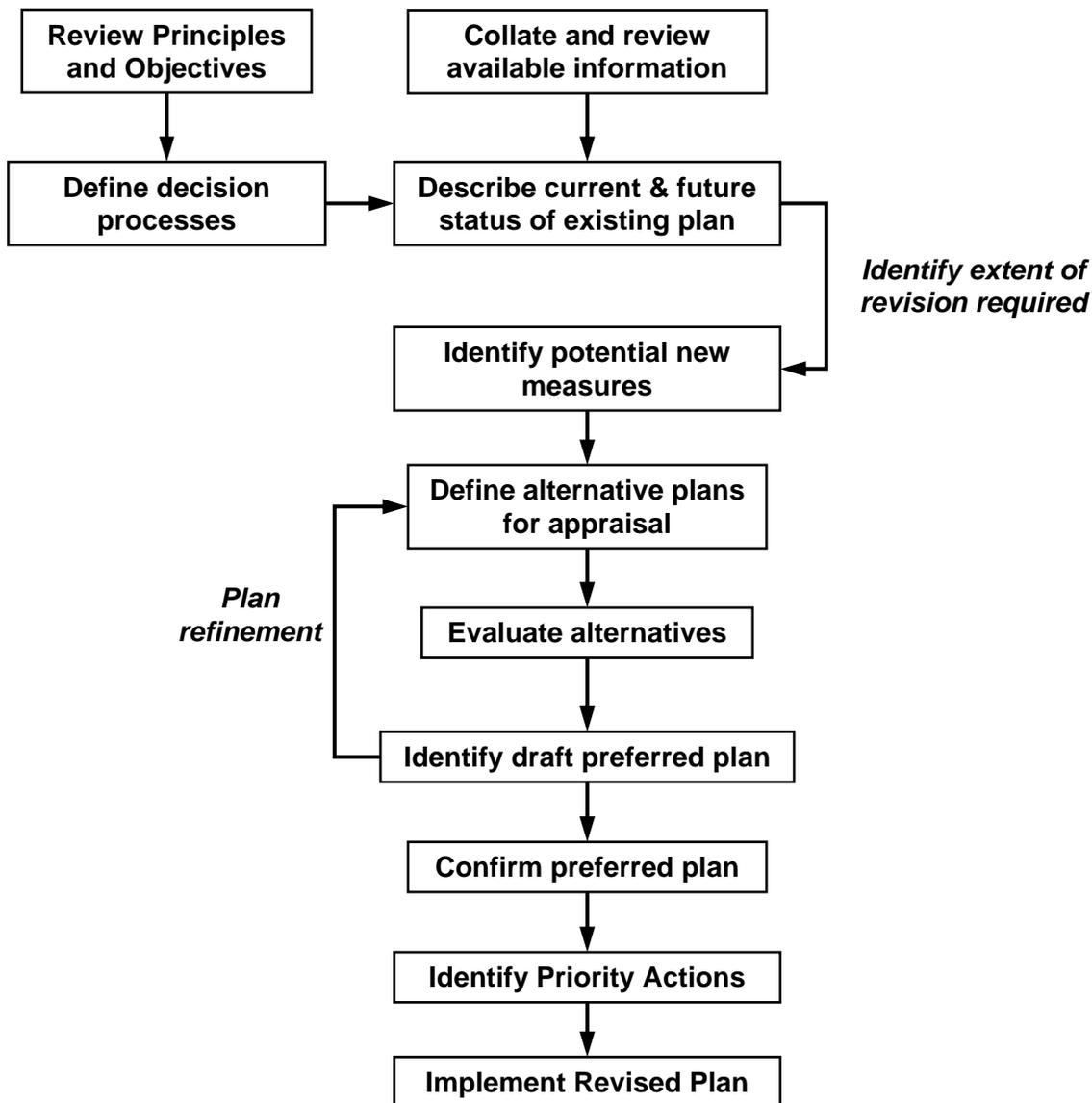


Figure 6.1: Process for future review and modification of the Master Plan.

The extent of review required will be assessed during the initial stages of the review process. This will not reduce the number of steps to be followed, but may change the effort required for each step.

It is recommended that at each scheduled review a complete reevaluation of the existing plan is undertaken, rather than a simple (non-appraisal based) consideration of whether the plan is satisfactory. It will be important to reappraise the existing plan in light of the lessons learned from the adaptive management process and incorporate any changes within the coastal environment that have occurred since the plan was originally defined. It is possible that there might come a time where evaluation tools are sufficiently accurate, and the plan has limited uncertainty, such that after initial reevaluation of the existing plan the CPRA is able to confirm that the plan remains as good as can be achieved. However, developments in our understanding and ability to predict outcomes of proposed actions will be required for this situation to be reached. Thus, it is unlikely to be viable for the next iteration of the Master Plan.



However, a scaling of the review effort should be undertaken. Following the existing plan appraisal against objectives it will be possible to identify the extent of possible improvements or alternative approaches that should be considered. The extent of these potential changes will dictate the extent to which new alternative plans will need to be defined for appraisal. The process of alternative plan definition and appraisal could reconfirm that the existing plan is still the most appropriate, or lead to modifications.

6.2.1 Review of Principles and Objectives

The first task to be undertaken in a review of the Master Plan will be to revisit the principles and objectives. The principles and objectives defined for this first iteration of the plan are considered likely to remain applicable over the long-term as they represent good practices and valid aims for coastal Louisiana. However, it is recommended that once it has been identified that the Master Plan is to be reviewed then its aims should also be reviewed. This must be undertaken in association with key stakeholders as considered to be necessary to ensure the principles and objectives appropriately reflect societal values and needs from the coast, and the have widespread support amongst those who will be affected by the plan recommendations.

When undertaking this review it is important to remember that the principles and objectives provide the basis upon which potential plans are appraised, so must clearly articulate the characteristics that the Master Plan should seek to deliver, and provide for the definition of a quantifiable assessment of objective achievement. To assist in the process of applying these objectives to the decision making process, the relative importance of each should be identified.

6.2.2 Define the Decision Process

The appendices to this plan set out the process followed in the development of the plan. This has followed an analytical process, linked with inputs from stakeholders; however, the process has been constrained by the datasets available at this time. As such, while this process is likely to remain largely applicable for future revisions of the plan, there will need to be a review of the detail in light of the objectives and data available at the time of plan review.

A key aspect of the process that will need to be revised will be the approach to appraising achievement of objectives. This will require the definition of datasets to be used, metrics and appraisal processes. It is important that a clear and consistent process is used, in order to limit the subjectivity in the process of plan appraisal. Review of the existing objective appraisal process (Appendix B) will provide the starting point for this process.

It will also be important to set out the process through which the objective achievement outputs for each alternative plan will be compared in order that the preferred plan can be identified. This process should involve the generation of comparable outputs for each alternative appraised and may take account of the relative importance of the objectives.

6.2.3 Collate and Review Available Information

The comprehensive monitoring program, and targeted research and large-scale planning that will be promoted through this first Master Plan will provide an improved information base upon which to undertake future reviews. The Adaptive Management program (see Section 5.5) should provide for the ongoing analyses of new data to consider the potential implications for implementation of the Master Plan, and these data should be combined with the existing data in this first version of the plan to provide the complete set of baseline data to be appraised for the review.



Key datasets include the following:

- Storm surge flooding risks;
- Distributions of people, property and infrastructure;
- Human use of the coast, including the economics of commercial and recreational activity;
- Coastal landscape change, rates of loss/gain;
- Habitat types and distribution;
- Species types and distribution; and
- Coastal heritage features.

This compiled dataset will be appraised to present a review of the uncertainties in understanding. This will consider both uncertainties related to the current form and function of the coast, and uncertainties in our ability to predict future evolution. These uncertainties will be addressed through the use of scenarios when appraising future plan performance.

In addition to data compilation, it will also be important to identify the analytical tools to be used during plan evaluation. This first Master Plan is looking to establish a program whereby the existing tool can be continually improved and updated to represent the best understanding of the form and function of the Louisiana coast. Tools to appraise storm flood risk and wetland ecological functioning will be central to the appraisal process.

6.2.4 Current and Future Status

The comprehensive dataset should be analyzed to define the current status of the Louisiana coast, in particular identifying the levels of risk to human assets and the status of the wetlands, considering land area, habitats and species. This will focus on identifying the progress toward achievement of the Master Plan objectives, considering the newly defined objectives (where they have been revised). The reporting will explicitly identify notable changes in the coastal landscape, to include:

- alterations to the physical environment; this will include the construction/results of hurricane protection projects, restoration projects such as diversions and marsh restoration with dredged material, and natural changes to the landscape;
- changes to habitat or species composition or distribution; and
- changes to development patterns or the human use of the wetlands, such as navigation or fishing;

Further analyses will then consider the likely future physical evolution of the coast over the next 100 years, both without any further action and with continued implementation of the existing program of measures. These analyses will apply appropriate analytical tools (e.g. numerical models) to define the likely future landscape changes and their implications for risk to people and built assets, and for changes to coastal habitats and species.

It is important that these analyses reflect the identified uncertainties in order that the range of potential outcomes can be considered. This is likely to be best achieved through the consideration of a number of scenarios which explicitly capture the uncertainties. For example, analyses of plan performance may be run with different values for factors such as relative sea level rise rates or river sediment loads. The outcomes from these analyses will then provide an indication of the likely range of possible outcomes under a single course of action, and provide for better informed decision making.



The ‘no action’ scenario will be used to identify the potential implications for the plan objectives of no further investment in coastal protection or restoration, and as such provide the justification for future actions. The analysis of the existing plan measures will identify the extent to which this represents a satisfactory plan to achieve the defined objectives. Using the process defined through the previous steps (section 6.2.2), achievement of objectives will be identified and reported, and aspects where there is scope to improve upon plan performance will be identified.

6.2.5 Assess Extent of Revision Necessary

Having identified the areas where the existing plan could be improved to better deliver the (new) plan objectives, it will be possible to identify the likely extent of plan revision necessary.

If the existing plan appears generally satisfactory, then it may only be necessary to consider adjustments, or the inclusion/modification of a few measures, to test whether future plan performance could be improved. In this scenario the extent of effort in subsequent tasks (6.2.6 to 6.2.12) may be relatively small.

However, it is likely that the improved understanding that will be available for plan development (based upon the outputs from the adaptive management program) will provide many potential opportunities to improve upon plan performance and hence full appraisal of a number of alternative approaches may be valid, in order to consider differing trade-offs. In this case a more significant effort will be required and appropriate time and resources should be allocated to the process.

6.2.6 Public and Stakeholder Engagement

Stakeholder Engagement will be an important element of the decision process for the plan, so it will be important to define how and when stakeholders will be involved. The approach to, and extent of, stakeholder involvement should be defined in light of the extent of revision required (section 6.2.5).

A more extensive involvement program will offer greater benefits, and potentially, wider acceptance of the outcomes. The engagement strategy will include the process for integration and liaison with other governing bodies such as Federal, State, Parish and Local Authorities. This involvement will be an extension of stakeholder and public involvement throughout implementation of the Master Plan program since definition of the previous iteration of the plan.

6.2.7 Identify Potential New Measures

Having identified the likely long term performance of the existing plan under a range of scenarios, in particular the areas of potential weakness in achievement of objectives, it will be possible to identify new measures, or modifications to existing ones, that might improve plan performance.

This identification of measures will be informed by the following:

- outcomes from project and program monitoring;
- studies of promising concepts;
- research initiatives; and
- measures identified by stakeholders.



The process of selecting or amending measures to improve the existing plan will be informed by the understanding of potential measure performance, mapped against the areas of plan weakness.

Using the same information sources, this process should also seek to identify any measures within the existing plan that may not be contributing to achievement of the objectives, or possibly having a negative impact on plan performance. Consideration should be given to removing these measures from the revised plan.

It may be appropriate to involve the public and other stakeholders in this process of reviewing the existing plan appraisal outputs and identifying potential changes to the plan to improve performance.

6.2.8 Define Alternative Plans for Appraisal

Having identified the measures, or modifications to measures, that might be considered for the revised plan, together with those existing measures that might be removed, it will be necessary to define complete alternative plans for appraisal. In the process of development of this first version of the Master Plan two alternative plan rationales were used to define the alternatives for appraisal (see Appendix H). It may be appropriate to repeat this exercise if a wide range of possible new measures are being considered, otherwise a more intuitive process of defining plans may be sufficient. There is no set number of alternatives that should be defined, but clearly the more alternatives the more effort that will be required to appraise them, but also the more performance data they will generate.

Unless the existing plan is shown to be wholly inadequate, based upon the appraisal of future status, it is likely that each of the alternatives will represent a modified version of the existing plan. The alternatives for appraisal should be defined to represent differing approaches to improving plan performance in order that outputs from their appraisal will clearly identify the better performing approaches.

6.2.9 Alternative Plan Evaluation

The alternative plans identified will each be evaluated using the same tools as were used to appraise the no action scenario and existing plan. Again, a number of scenarios will be considered to capture the key uncertainties in understanding, in order that the range of potential outcomes can be identified. In addition, the use of scenarios will enable the identification of any plans which are highly vulnerable to certain scenarios.

The outputs from these appraisals will be used to identify the performance of each alternative plan against the Master Plan objectives, under each of the scenarios considered. These outputs may be presented graphically (such as the Radar Diagrams used in Appendix B) to aid their review. A summary table explaining the objective scores should also be produced for each plan.

6.2.10 Define Draft Preferred Plan

This step will involve the interpretation of the objective testing outputs to identify the plan that performs best by providing the most gains (and the fewest losses) against the objectives across the range of scenarios tested. This process will also include review of the performance of the existing plan, as it is possible that it may still offer a strong performance.

If a single plan is clearly offering the strongest performance and improvements across the range of objectives, then this should be taken forward as the basis for the preferred plan. Where no single plan delivers improvements against all areas of weakness in the existing plan, then it will be necessary to identify the strong elements of each



and attempt to compile a composite plan that is likely to deliver a strong performance across objectives, under a range of future scenarios

This process may be assisted by considering the objectives in their order of priority, such that a strong performance against the higher priority objectives is considered more important than against the lower priority ones. Tabulation and reporting of these appraisals is necessary to ensure transparency in this process.

When a preferred plan has been identified the potential for adding, removing or amending individual measures to potentially improve plan performance should be considered. In undertaking any such modification of the plans it is very important that any changes do not detrimentally impact other measures or reduce effectiveness against other criteria.

This process should be undertaken with some level of stakeholder involvement. This may involve the definition of a preferred plan which stakeholders then critically review, or including stakeholders in the review of appraisal outputs and definition of the preferred plan. These inputs must be defined through the Stakeholder Engagement Strategy.

Based upon these appraisals a single complete preferred plan for the whole coast should be defined. Once the complete plan is set out it is important that it is reviewed for consistency, for example to ensure that protection measures provide for consistent levels of protection to discrete areas of population.

6.2.11 Confirm Preferred Plan

Having defined the draft preferred plan analyses, such as those developed through the S&T Program, should be undertaken to confirm it delivers an improved performance against the existing plan and the alternatives appraised. A public review of the proposals, and the results of analyses of the plan, will also serve to confirm the plan. Full and open discussion of the proposed plan and its performance is required to ensure that it represents the best possible solution and that it is widely understood.

The analyses will be a repeat of the process used for the alternative plans and will output analyses of performance against the objectives. If these analyses suggest that there are still areas of poor performance, then it may be possible to incorporate additional measures or modifications. Alternatively it may be considered impossible to address that weakness without unacceptably compromising performance against another objective. In such a situation, that weakness would be accepted as part of the plan and reported as a know limitation in our ability to deliver against the range of plan objectives. Once the preferred plan has been analyzed and consulted upon it should be finalized and its costs and anticipated benefits reported.

6.2.12 Identify Implementation Plan

Having defined the revised Master Plan it will be necessary to set out a plan for its implementation. The process adopted for this first iteration of the Master Plan is set out in Chapter 5 of this appendix. A similar process could be followed for future iterations of the plan. Alternatively, it may be considered necessary or desirable to set out a plan for implementation beyond the ‘near term’, if it is deemed advantageous to include a schedule and cost estimate for implementation of all planned measures.

Regardless, the process of defining an implementation sequence is likely to start with the identification of areas of greatest need and promoting those measures that address those needs. The existing status of measures—such as their funding status, likely timescales to implementation, and level of certainty in the proposed measure—will also be important factors in this process.



The actual process to be applied will need to be developed at the time of undertaking the review as it will depend upon the objectives appraised and the aims of the implementation plan.

6.2.13 Plan Dissemination and Implementation

Having finalized the plan and its implementation process it is important that the recommendations are publicized and taken forward for formal adoption as necessary. This will follow the appropriate process for ratification of the plan and approval of budgets for implementation. It is likely that this implementation will be a continuation of the ongoing implementation effort, modified as appropriate to take account of changes to the plan.



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